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Electrical and Raman Studies of Bilayer Mg/Co and Mg/Mn Thin Film Metal Hydrides

By M. K. Jangid & M. Singh
Vivekananda Institute of Technology, India

Abstract- Bilayer Mg/Co and Mg/Mn (700nm) thin films were prepared using thermal evaporation method at pressure10-5 torr at room temperature. The films were rapid thermal annealed (RTA) using halogen lamp to get a homogeneous structure of thin films. The hydrogen gas was introduced in hydrogen chamber, where samples were kept at different pressure from 10 to 40 psi of H2 for thirty minutes. The conductivity has been found to be decreased with increasing pressure of hydrogenation and also intensity of Raman peaks is decreased. I-V characteristics and Raman spectroscopy of annealed hydrogenated thin films have been studied to find out the effect of hydrogenation.

Keywords: bilayers, annealing, hydrogenation, electric and raman studies.

GJRE-J Classification : FOR Code: 090699, 091207

ELECTRICALANDRAMANSTUDIESOFBILAYERMGCOANDMGMNTHINFILMMETALHYDRIDES

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Electrical and Raman Studies of Bilayer Mg/Co and Mg/Mn Thin Film Metal Hydrides

M. K. Jangid [α] & M. Singh [σ]

Abstract- Bilayer Mg/Co and Mg/Mn (700nm) thin films were prepared using thermal evaporation method at pressure10^{-5} torr at room temperature. The films were rapid thermal annealed (RTA) using halogen lamp to get a homogeneous structure of thin films. The hydrogen gas was introduced in hydrogen chamber, where samples were kept at different pressure from 10 to 40 psi of H_2 for thirty minutes. The conductivity has been found to be decreased with increasing pressure of hydrogenation and also intensity of Raman peaks is decreased. I-V characteristics and Raman spectroscopy of annealed hydrogenated thin films have been studied to find out the effect of hydrogenation.

Keywords: bilayers, annealing, hydrogenation, electric and raman studies.

I. Introduction

Metal hydride technologies have reached more practical and applied stages in recent years. The hydriding/dehydriding kinetics of metal hydrides are relevant to areas of design and applications of various metal hydride devices, especially in energy conversion devices such as heat pumps, refrigerators, automobiles, power generators, batteries and thermal energy storage units [1]. Several methods have been employed to overcome the kinetic limitation and/or thermodynamic stability of Mg-based hydrogen storage materials, including surface modifications addition of catalysts, and formation of metastable structures or multi-phase materials. Transition metals have shown good catalytic effects on hydrogen desorption of MgH_2 after being mechanically milled with the hydride [2]. Electrical measurements such as current/voltage provide detailed information about the electronic effects of hydrogen. A "universal alignment" model successfully describes the electronic behavior of hydrogen in a wide range of materials and allows for prediction for materials in which the role of hydrogen is yet to be explored [3, 4]. The interaction of hydrogen in a metal hydride can be understood by using different models, i.e. the anionic model of Wallace [5, 6], the protonic model of Westlake [7] and the band covalent model as described by Switendick [8]. In the present work the current-voltage measurements and Raman spectroscopy with hydrogen pressure have been presented. Current-voltage and Raman characteristics have been studied to study role of hydrogenation in thin films.

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II. Experimental

The samples were prepared by thermal evaporation method using vacuum coating unit. The HIND HIGH VACUUM unit was used for this purpose and vacuum chamber contains pressure of the order of 10^{-5}. Mg granules (99.999%), Mn powder (99.98%) & Co powder (99.998%) pure were purchased from Alfa Aesar, Jonson Matthay Company, U.S.A. used for the present study, is placed into different boats in the vacuum chamber. The source to substrate distance was kept 15 cm. The bilayer thin films of Mg/Co and Mg/Mn (700nm) have been performed by stacked layer method in situ evaporation. The thickness of film measured by Quartz crystal thickness monitor. The thin films of Mg/Co and Mg/Mn were rapid thermal annealed (RTA) by Halogen light lamp (1000 W) to get homogeneous mixture. For this process thin films were kept in quartz tube and then annealed by halogen light lamp at 400°C for 30 minutes in atmospheric conditions for mixing to get homogeneous structure and interdiffusion of thin films of Mg/Co and Mg/Mn. Hydrogenation of Mg/Co and Mg/Mn thin films have been performed by keeping these in hydrogenation cell, where hydrogen gas was introduced at different pressures (10-40 psi). Transverse I-V characteristics of as grown hydrogenated and annealed hydrogenated samples have been recorded using Keithley-238 high current source measuring unit. The applied voltage was with in the range of -2.0 to +2.0 volts with increasing step of 0.1 volt. For I-V characteristics, electrode contacts have been made using silver (Ag) paste on the thin films. I-V characteristics of thin films have been monitored with the help of SMU Sweep computer software. Raman spectra of annealed and hydrogenated Mg/Co and Mg/Mn samples are taken by a continuous wave-Green laser with a constant wavelength 532 nm by help of R-3000 Raman system. All the measurements have been performed at room temperature.

III. Results and Discussion

Fig.1. shows that the I-V characteristics of pristine Mg/Co and Mg/Mn bilayer thin films have found to be ohmic. But the conductivity has been found to slightly smaller in case of Mg/Mn thin films. Fig.2&3 shows I-V characteristics curves for annealed Mg/Co

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and Mg/Mn thin films, which shows the effect of annealing on the thin film structure indicating the possibility of mixing of structure at the interface showing the partially semiconducting behavior in I-V characteristics and The conductivity has been found to be decreased from 9.4308×10^{-5} to 4.014×10^{-5} Ω^{-1}-m^{-1} for Mg/Co and from 8.310×10^{-5} to 1.986×10^{-5} Ω^{-1}-m^{-1} for Mg/Mn thin films with increasing pressure (10-40 psi) of hydrogenation. It means hydrogen passivated defects at interface or it takes electrons from the conduction bands of each of the samples during the hydrogen absorption process and blocks the flow of charge carriers across the interface and current decreases in forward as well as reverse direction. The electronic passivation of host impurities induced by atomic hydrogen in semiconductor well agrees as reported by Pankove et al [9]. Hydrogen interacts with metals and semiconductors and takes electron from conduction band of metal as anionic model. This similar to our earlier work [10] in witch we found that the electrical conductivity of CdTe/Mn bilayer thin film decreased from 1.88×10^{-5} to 4.80×10^{-6} $\Omega^{-1}m^{-1}$ in the case of annealed samples. And also Rusu et al [11] show that the electrical conductivity of CdTe semiconducting thin film are of ranged from 10^{-6} to 10^{-4} Ω^{-1}-m^{-1}. The conductivity decreases with hydrogen pressure in both cases of Mg/Co and Mg/Mn thin films. But the current are slightly smaller in case of Mg/Mn thin film. This indicates that the Mn accelerates the hydrogen absorption rate and absorption capability of Mg/Mn thin films and Mn promotes the hydrogen absorption activation. This is similar to an earlier work by Singh et al. [12]. This found that the activation of FeTi by the mixing of Mn was found to promote the absorption rate and remove the slow rate period of hydrogen absorption in FeTi thin films.

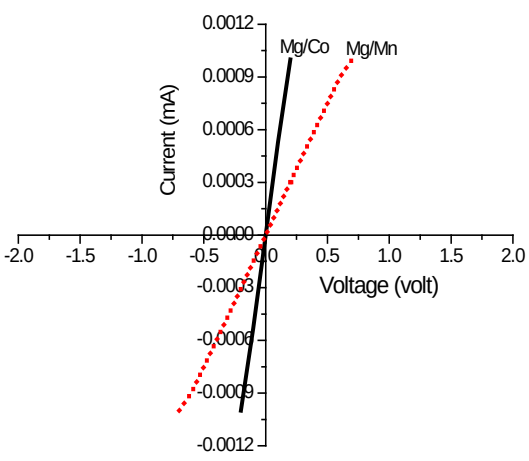

Figure 1 : I-V characteristics of as grown bilayer Mg/Co and Mg/Mn thin films

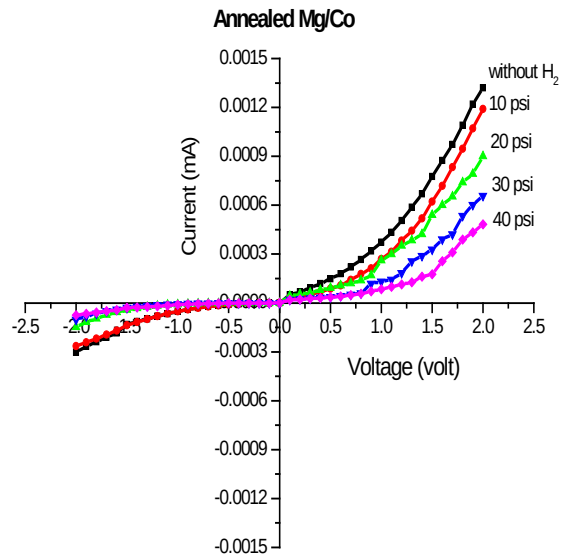

Figure 2 : I-V characteristics of annealed bilayer Mg/Co thin films

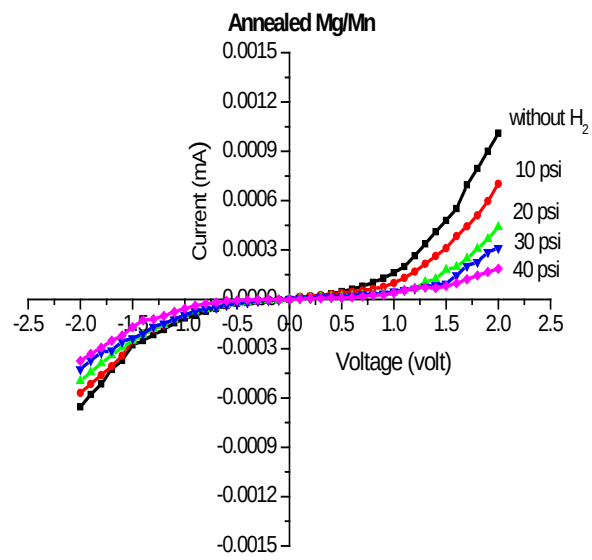

Figure 3 : I-V characteristics of annealed bilayer Mg/Mn thin films

Fig. 4 & 5 shows the variation in intensity versus wave number of Raman spectroscopy. In these spectra intensity of Raman peaks is decreased for both Mg/Co and Mg/Mn thin films with hydrogen pressure and one predominant peak is observed at 47.70 cm^{-1} for Mg/Co & at 43.15 cm^{-1} for Mg/Mn that shows the clear evidence of presence of hydrogen in sampled at room temperature and also noted decrease in broadening of peaks. It suggests that hydrogenation may change the phase or make the bonding with metal interstitial as well as surface locations. In case of Si crystalline structure, hydrogen absorption peak were observed at 590 cm^{-1} by fukata et al [13]. Raman studies of rare earth hydrides under high pressure carried out by Kume et al

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[14] according them optical band gap disappear at higher pressure in case of YH_3 and ScH_3 and suggested that there was a common mechanism for the structural transformation from hexagonal to the intermediate phase. In our case we also relate the decrease in intensity of Raman peak with phase transformation and confirmation of presence of hydrogen in thin films.

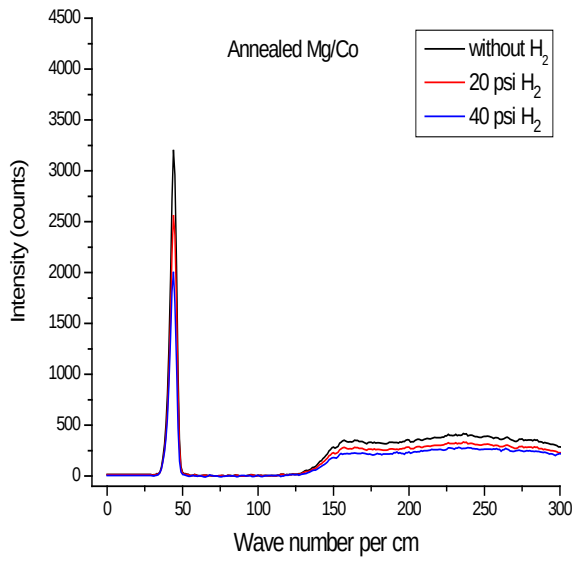

Figure 4 : Raman spectra of bilayer Mg/Co thin films

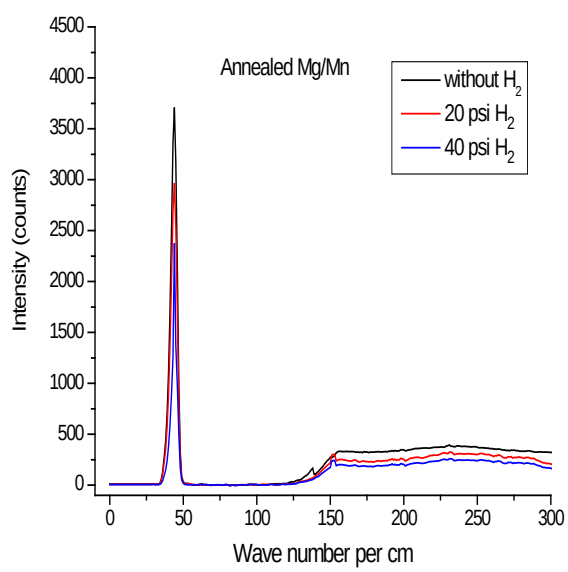

Figure 5 : Raman spectra of bilayer Mg/Mn thin films

IV. Conclusions

It is concluded from the above study that I-V characteristics of as grown Mg/Co and Mg/Mn thin films have been found to be ohmic and the I-V characteristics of annealed samples shows semiconductor behavior and conductivity has been found to be decreased with increasing pressure of hydrogenation. Decrease in intensity of Raman peak may be due to phase transformation.

V. Acknowledgements

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Indigenous Contractors Involvement and Performance in Construction Procurement Systems in Nigeria

By Inuwa Ibrahim Ibrahim, Wanyona Githae & Diang'a Stephen
Jomo Kenyatta University of Agriculture and Technology, Kenya

Abstract- The demand for contemporary procurement systems posea challenge to contractors. Yet, no study has been conducted on Nigerian indigenous contractors (NICs') involvement and performances in construction procurement systems. This research therefore sought to investigate NICs' involvement and performances in construction procurement systems. Questionnaires were administered to indigenous contractors and the data obtained were analysed forreliability and significance tests, as well as descriptive statistics. Subsequently, collective case study was used to probe the questionnaire responses. Result reveals that: public and private clients involves NICs' in traditional and non-traditional procurement system; public clients procure 75% of it projects through the traditional systems, while private clients procure 78-100% of it projects through non-traditional systems; NICs' performances record high rates of time overruns (traditional: 34-146%; non-traditional: 45-60%) and cost overruns (traditional: 35-47%; non-traditional:31-36%). The research recommends NICs': apply project management techniques; employ competent personnel and embark on continuous training; invest in knowledge management and; clients and consultants adheres to project management procedures.

Keywords: indigenous contractors, involvement and performance, nigeria, procurement systems.

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Keywords: indigenous contractors, involvement and performance, Nigeria, procurement systems.

I. Introduction

Construction procurement systems according to Oyegoke (2006), establishes the contractual framework that determines the nature of the relationship between the construction project team within the duration of their interaction. One of the key player in the construction project team is the Contractor (Usman, *et al.* 2012a; Idoro, 2011; Bennett, 2003). Construction contractorsare entrepreneurs involved in the management of construction projects (Inuwa *et al.* 2013; Harris & McCaffer, 2005). In Nigeria, construction contractors are categorised by several criteria: scope of operation (local, regional, national and multinational); specialization (building and engineering); size and category of contracts (small, medium and large); and the company's owners' nationality (foreign and indigenous) (Idoro, 2011; Idoro & Akande-Subar, 2008; Muazu & Bustani, 2004). The debate on project performance in the Nigerian construction industry (NCI) centres mainly on the performances of foreign and indigenous contractors (Idoro & Akande-Subar, 2008). Indigenous contractors are contracting firms that are fully-owned and managed by Nigerians; the nationality of the firms' ownership and management is exclusively Nigerian.

According to Uduak, (2006) and Ibrahim Y. (2012) the performance of projects managed by Nigerian Indigenous Contractors' (NICs') are better and claimed they can be entrusted with large and highly technical projects, whereas most studies reports that their projects performance is replete with: project abandonment, cost and time overruns, poor workmanship, poor management capability, financial difficulties, poor planning, poor mechanization and high frequency of litigation (Odediran *et al.* 2012; Oladimeji & Ojo, 2012; Muazu & Bustani, 2004; Achuenu, *et al.* 2000; Bala *et al.* 2009; Adams, 1997). Many researchers have attributed NICs' poor performance to incompetence, inexperience, poor innovation and dynamism, and the adoption of traditional management approaches amongst other things (Ekundayo, Jewell, & Awodele, 2013; Odediran, *et al.* 2012; Aniekwu & Audu, 2010; Muazu & Bustani, 2004; Achuenu, *et al.* 2000; Bala *et al.* 2009; Adams, 1997). These resulted in the few foreign firms, which constitute just 5% of the total number of contractors in the formal sector, control 95% of the major public projects in the construction market, giving the indigenous firms just 5% share of the market (Aniekwu & Audu, 2010; Oladapo, 2007; Muazu & Bustani, 2004). The outcome to the industry is: low income generation and redistribution due to expatriates repatriating their profits abroad, an insignificant value addition to construction and local industries supplying construction materials, and consistent contribution of 1% employment over the last decade as against the World Bank's average observation of about 3.2% in other developing countries (Aniekwu & Audu, 2010; Idrus & Sodangi, 2010; Jinadu, 2007).

More to the numerous challenges confronting the NICs' is the demand for contemporary construction procurement systems on contractors; their roles goes beyond their traditional role as integrators in a design-bid-build procurement system (Mbamali & Okotie, 2012; Gollenbeck, 2008), to more complex roles in either management oriented systems, integrated systems or, discretionary contracts (Mathonsi & Thwala, 2012;

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Babatunde. *et al.* 2010; Harris & McCaffer, 2005). These have obviously add to the problems militating against effort towards developing the NICs' to meet international best practice. Yet, none of the studies conducted on NICs' investigated their involvement and performances in construction procurement systems in Nigeria (Idoro, 2012; Odediran, *et al.* 2012; Oladimeji & Ojo, 2012; Aniekwu & Audu, 2010; Idoro & Akande-Subar, 2008; Uduak, 2006; Muazu & Bustani, 2004; Saleh, 2004; Achuenu, *et al.* 2000; Bala *et al.* 1999; Adams, 1997). Understanding the indigenous contractors' involvements and performances in the various procurement systems will provide an insight on their weaknesses, and will assist in proffering solution to that effects. This research therefore, sought to investigate NICs' involvement and performances (cost and time) in construction projects procurement systems in Nigeria.

II. Procurement Systems Application and Performances in Nigeria

Construction procurement systems are broadly classified into traditional and non-traditional (for detail see: Mathonsi & Thwala, 2012; Babatunde *et al.* 2010; Harris & McCaffer, 2005). Several studies have shown that both traditional and non-traditional procurement systems are currently embraced in Nigeria (Idoro, 2012b; Mbamali & Okotie, 2012; Babatunde *et al.* 2010; Ikediashi *et al.* 2012; Ibrahim 2008; Ojo, Adeyemi, & Fagbenle, 2006). According to Ojo *et al.* (2006) direct labour, which is a traditional system, was mainly used during the colonial era all through the 1960s in the execution of construction projects in Nigeria and to date (Ibrahim, 2008), direct labour is still minimally used across the three tiers of government (Federal, States and Local government), primarily for maintenance and new works of minor nature. However, direct labour projects are said to be ineffectively managed resulting in cost and time overruns (Mbamali & Okotie, 2012)

The oil boom in Nigeria and the need for reconstruction and rehabilitation works to mend the havoc resulting from a fratricidal war that ended in 1970, usher in the use of the design-bid-build (DBB) procurement system (traditional) into the NCI (Mbamali & Okotie, 2012; Ojo *et al.* 2006). This system was also used by the National Housing Policy (NHP); a policy enacted into law in 1991 by the Nigerian government to provide decent housing accommodation at affordable cost for the country, in adherence to the campaign launched by the United Nation (UN) tagged 'Housing for All by the year 2000'. Though, the DBB method was later discovered to bring long delays in project conception and delivery thus leading to high project cost (Mbamali & Okotie, 2012; Ojo *et al.* 2006 citing Osemenam, 1992). Despite the criticism of the performance of DBB system in Nigeria, the system is still use by government establishments and some uninformed private clients (Ojo *et al.* 2006). The short comings of the traditional systems (Direct labour and DBB) in Nigeria brought about the emergence of the non-traditional procurement systems amongst which is the design and build (DB) method (Mbamali & Okotie, 2012; Ikediashi, *et al.* 2009 cited in Ikediashi, *et al.* 2010). The DB option according to Babatunde *et al.* (2010), is one of the procurement systems that have gained prominence in the NCI, however, its application in Nigeria records high time and cost overrun (Idoro, 2012b).

The use of management contracting (MC) in Nigeria, spanned back to the era of the defunct Petroleum (Special) Trust Fund (PTF) mass rehabilitation of key public infrastructure across the country in 1994-1999 (Hassan, 2004 in Ibrahim, 2008). Babatunde, *et al.* (2010) also reported that management oriented contracts and PPP/PFI are among the methods use in the execution of construction projects in metropolitan Lagos, but not as much as the DBB method. According to Ibrahim and Musa-Haddary (2010) the immediate past (1999-2008) and present governments (2008 to date) at various levels/tiers in Nigeria encourage the introduction of public-private partnerships (PPPs) as a way of promoting active private sector involvement in the provision of public infrastructure and services, in an attempt to contain the infrastructure deficits in the country. According to Mbamali and Okotie (2012) partnering which is a discretionary procurement system has also evolved in Nigeria. All the studies reviewed elicited vital information on the application of procurement systems and their performances in the NCI, yet, none of the studies focused entirely on NICs' involvement and performances in construction procurement systems in the NCI.

III. Research Methodology

This study used descriptive (questionnaire) and explanatory survey method (collective case study). The study targeted medium and large indigenous contractors in the northern geo-political zones of Nigeria. The zones constitute 3 of the 6 geo-political zones of Nigeria (North-central, north-east and north-west), and slightly more than half of Nigeria's 36 states and its Capital (19 states and Abuja), representing almost 80% (744,249.08 sq. km) of Nigeria's total land size (NPC, 2010). It has a population of over 75 million people, representing 54% of Nigeria's total population (NPC, 2010). A structured questionnaire was employ to elicit information from indigenous contractors on: demographic profiles, involvement and performances (cost and time) in the various construction procurement systems. Afterwards, an explanatory method through collective case study approach was used to follow up the questionnaire responses to ascertain whether the involvement and performance of indigenous contractors in construction procurement systems followed the same

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pattern in Northern Nigeria (McNabb, 2009). This method allows for more extensive probe on specific issues identified in the main questionnaire responses (Guthrie, 2010; McNabb, 2009).

A total of 150 questionnaires were evenly administered through purposive sampling technique to indigenous contractors. The contractors' construction/ project managers' were used to respond on behalf of their respective company in the cities of Abuja, Bauchi/Gombe (two cities merged) and Kano respectively. These cities are located in the north-central, north-eastern and north-western geopolitical zones of Nigeria respectively and have the highest concentration of construction activities and contractors in their respective zones (Usman *et al.* 2012; Ameh & Odusami, 2010). The choice of purposive sampling was informed by: non availability of an authoritative sampling frame of active indigenous contractors in Nigeria (Muazu and Bustani, 2004; Achuenu, *et al.* 2000; Adams, 1997), and the ability to target specific contractors who are best able to respond to the research issues (Ibrahim A. D. 2011). The study record an overall response rate of 46% (69). This rate is higher than other studies in the construction industry: 25.4% (Emuze, 2011); 33.5% (Olatunji, 2010); and 35% (Adams, 1997). Subsequently, SPSS version 17 was used to run reliability test using Cronbach's Alpha, significance test, and frequencies and percentages (descriptive statistics) to analyse the data obtained from the questionnaire responses. Stratified random sampling technique was then applied on the returned questionnaires to select 15 contractors for the case study; five from each city. The documents used for the case study are project files in the custody of the contractors' clients representing all correspondence during the contracts execution.

a) Research Hypotheses

The research tested the following null (H_o) and alternative (H_1) hypotheses:

i. H_0 *:* There is disproportionate distribution in the frequencies of responses among indigenous contractors to a question on their level of involvement in various building procurement systems in Nigeria.

   H_1*:* There is no disproportionate distribution in the frequencies of responses among indigenous contractors to a question on their level of involvement in various building procurement systems in Nigeria.

ii. H_0 *:* Indigenous contractors do not underperformed in terms of cost and time in building procurement systems in Nigeria.

   H_1 *:* Indigenous contractors' underperformed in terms of cost and time in building procurement systems in Nigeria.

IV. Data Analysis

a) Reliability and Hypotheses Tests

Table 1 : Result of X^2 Hypotheses Test

Attribute	Confidence level	Computed p-value	DF	Significance	Decision
Procurement systems	0.05	0.72	2	Not Significant	Accepted
Time and cost overrun	0.05	0.00	1	Significant	Rejected

Cronbach's alpha test used to test the reliability and consistency of the questionnaire construct, shows items in the contractors involvement and performances in building project systems to be 0.83 and 0.92 respectively , signifying high reliability and consistency in a scale of 0-1; with a cut off value of 0.7 (A.D. Ibrahim, 2011; Ogwueleka, 2011).

The research used non-parametric one-sample chi-square (X^2) test to test the two research hypotheses. Table 1 above shows the details of the research X^2 hypotheses test. The one-sample X^2 test is used when a study has questions about the distribution of responses in data taken from a sample (McNabb, 2009). The first null hypothesis was accepted because the computed p-value of 0.720 at 2 degree of freedom (DF) is greater than 0.05 confidence level for the test (McNabb, 2009). The second null hypothesis was rejected because the computed p-value of 0.00 at 1 degree of freedom is less than 0.05 confidence level (McNabb, 2009).

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Table 2 : Contractors Demographic Profiles

Contract Registration Category				
Category		Frequency		%
B (₦5-₦15M)		15		21.7
C (₦15-₦50M)		21		30.4
D (Over ₦50M)		33		47.8
Total		69		100
Business Registration Category				
Category		Frequency		%
Sole proprietorship		8		11.6
Partnership		30		43.5
Private company		28		40.6
Public company		3		4.3
Total		69		100
Construction/Project Managers' EducationalQualification				
Qualification		Frequency		%
Higher National Diploma		10		14.5
Bachelor of Science		37		53.6
Masters		22		31.9
Total		69		100
Project Managers'Educational Specialization				
Specialization		Frequency		%
Architecture		13		18.8
Building		19		27.5
Engineering		12		17.4
Estate management		1		1.4
Quantity surveying		15		21.7
Project management		6		8.7
Land surveying		1		1.4
Business Administration		2		3
Total		69		100
Project Managers' Experience				
Experience (yrs.)	Mid value (X)	Frequency(F)	FX	% F
≤ 5	2.5	8	20	11.6
5-10	7.5	29	217.5	42.0
10-15	12.5	17	212.5	24.6
≥ 15	15	15	225	21.7
Total		69	675	
Mean years of experience = FX/F= 675/69 = 9.78 years				

Note : Naira (₦)-Nigerian currency; $1= ₦160

Source : Field survey (2013)

Table 2 above portray contractors' demographic profiles. Fifty two percent of the contractors are medium sized contractors according the Federal government of Nigerian registration category (category B & C), while the remaining 48% are large contractors (category D). This result reveals that the respondents are almost evenly represented. Substantial number of the contractors are into partnerships (43.5%) and private company (40.6%), followed by sole proprietorship (11.6%), while few are public companies (4.3%). Almost eighty six percent of the contractors' construction/ project managers' hold Bachelor's Degree and Masters, while 14.5% (10) hold Higher National Diploma. Almost all (94.2%) of the respondents specializes in core construction disciplines (Ameh & Odusami, 2010): architecture, building, engineering and quantity surveying. Virtually half (46.3%) of the respondents have over 10 years' experience, with all respondents having a mean experience of 9.8 years. Findings from the contractors demographic profilereveals thatthe respondents' are well experienced and educated enough to respond to this research enquiry.

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Table 3 : Contractors Construction Procurement Systems Involvement

Details of Procurement Systems Involvement according to Client's Types								
	Public Clients'							
Contract Category	DBB	MC	CMC	DMC	DCC	DB	Total	%
> ₦50M	59	2	4	7	2	1	75	54.35
₦15-₦50M	22	1	3	0	1	0	27	19.57
₦5-₦15M	26	0	7	2	0	1	36	26.08
Total	107	3	14	9	3	2	138	100
% Total	77.54	2.17	10.14	6.52	2.17	1.45	100	100
	Private Clients'							
Contract Category	DBB	MC	CMC	DMC	DCC	DB	Total	%
> ₦50M	4	4	2	2	2	7	21	45.65
₦15-₦50M	5	4	4	2	1	3	19	41.30
₦5-₦15M	1	1	2	1	1	0	6	13.04
Total	10	9	8	5	4	10	46	100
% Total	21.74	19.57	17.39	10.87	8.69	21.74	100	100

Summary of Contractors Procurement Systems Involvements				
Contract Category	Frequency of Procurement Systems			% of contract category
	Traditional	Non-Traditional	Total	
> ₦50M	63	33	96	52.17
₦15-₦50M	27	19	46	25.00
₦5-₦15M	27	15	42	22.83
Total	117	67	184	100
%	63.59	36.41	100	100

Note: DBB-design-bid-build; MC-management contract; CMC-construct & management contract; DMC-design & management contract; DCC-design-construct contract; DB-design-build; ₦-Nigerian currency-Naira: $1=₦160

Source: Field survey (2013)

Table 3 above depict NICs' building procurement systems involvement. Datawere collected from a total of 184 building projects executed within 2008-2013. Seventy five percent of the projects were procured by public clients, while 15% were procured by private client. The frequency of the involvement of contractors in the various procurement systems by public clients were: 77.54% (DBB); 2.17% (MC); 10.14% (CMC); 6.52% (DMC); 2.17% (DCC); and 1.45% (DB). For private clients, their frequency of involvement were: 21.74% (DBB); 19.57% (MC); 17.39% (CMC); 10.87% (DMC); 8.69% (DCC); and 21.74% (DB). Almost 74% of the contractors contracted by public clients were medium sized contractors, while 26% were large contractors. Private clients contracted most of their projects (87%) to medium sized contractors, while only few (13%) were contracted to large contractors. Summarily, 63.59% of the projects were procured through the traditional procurement systems, while 36.41% were procured through the non-traditional procurement systems: MC, CMC, DMC, DCC, and DB.

Table 4 : Percentage Time Overrun (TO)

DBB (% TO)	Mid value (X)	Frequency (F)	FX	% mean time overrun (∑FX/∑F)
≤ 25	12.5	15	187.5	
25-50	37.5	15	562.5	
50-75	62.5	11	687.5	
75-100	87.5	5	437.5	
≥ 100	100	9	900	
Total		55	1875	34.09
MC (% TO)	X	F	FX	
≤ 25	12.5	7	87.5	
25-50	37.5	11	110	
50-75	62.5	5	312.5	
75-100	87.5	3	262.5	
≥ 100	100	9	900	45.12

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Total		35	1672.5	
CMC (% TO)	X	F	FX	
≤ 25	12.5	7	87.5	
25-50	37.5	9	337.5	
50-75	62.5	2	125	
75-100	87.5	1	87.5	
≥ 100	100	4	400	47.79
Total		23	1037.5	
DMC (% TO)	X	F	FX	
≤ 25	12.5	1	12.5	
25-50	37.5	5	187.5	
50-75	62.5	2	125	
75-100	87.5	2	175	
≥ 100	100	3	300	61.54
Total		13	800	
DCC (% TO)	X	F	FX	
≤ 25	12.5	4	50	
25-50	37.5	-	-	
50-75	62.5	1	62.5	
75-100	87.5	-	-	
≥ 100	100	3	300	51.56
Total		8	412.5	
DB (% TO)	X	F	FX	
≤ 25	12.5	1	12.5	
25-50	37.5	2	75	
50-75	62.5	-	-	
75-100	87.5	-	-	
≥ 100	100	1	100	
Total		4	187.5	46.88

Source : Field survey (2013)

Table 4 shows the percentage time overruns of the contractors' performances in the various procurement systems. The contractors recorded TOs' in all the procurement systems. The DMC system records the highest % mean TO of 61.54%, then DCC (51.56%), the CMC (47.79%), DB (46.88%), MC (45.12%), and the least 34.09% (DBB).

Table 5 : Percentage Cost Overrun (CO)

DBB (% CO)	Mid value (X)	Frequency (F)	FX	% mean cost overrun (∑FX/∑F)
≤ 25	12.5	20	250	
25-50	37.5	10	375	
50-75	62.5	8	500	
75-100	87.5	10	875	
≥ 100	100	5	500	
Total		53	2500	47.17
MC (% CO)	X	F	FX	
≤ 25	12.5	15	187.5	
25-50	37.5	14	525	
50-75	62.5	3	187.5	
75-100	87.5	-	-	
≥ 100	100	2	200	
Total		34	1100	32.35
CMC (% CO)	X	F	FX	
≤ 25	12.5	9	112.5	
25-50	37.5	9	337.5	
50-75	62.5	2	125	
75-100	87.5	1	87.5	
≥ 100	100	2	200	
Total		23	862.5	37.50

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DMC (% CO)	X	F	FX	
≤ 25	12.5	8	100	
25-50	37.5	2	75	
50-75	62.5	1	62.5	
75-100	87.5	2	175	
≥ 100	100	2	200	
Total		15	612.5	40.83
DCC (% CO)	X	F	FX	
≤ 25	12.5	3	37.5	
25-50	37.5	4	150	
50-75	62.5	1	62.5	
75-100	87.5	2	175	
≥ 100	100	-	-	
Total		10	425	42.50
DB (% CO)	X	F	FX	
≤ 25	12.5	2	25	
25-50	37.5	1	37.5	
50-75	62.5	1	62.5	
75-100	87.5	-	-	
≥ 100	100	-	-	
Total		4	125	31.25

Source : Field survey (2013)

Table 5 above shows the percentage cost overruns of the contractors' performances in the various procurement systems. The contractors recorded COs' in all the procurement systems. The DBB system records the highest % mean CO of 47.17%, then DCC (42.50%), the DMC (40.83%), DMC (37.50%), CMC (32.35%), and the least 31.25% (DB).

Table 6 below shows detail of the collective case studies conducted on building projects executed by indigenous contractors. The cases studied are building projects executed between the periods 2003-2013 (10 years), representing 15 number case studies (CS01-CS15). This research used the external and internal criticism test to test the validity and reliability of the document used for the case study (Guthrie, 2010). The external criticism technique which is a validity test, is concern with ascertaining the genuineness of a data from a source (Guthrie, 2010). To ensure the genuineness of the data obtained from the clients' custody, all the materials used as a source of data for the research case study bears (Guthrie, 2010): letter heads; titles; file numbers; official stamps; dates; and official signatures. While the internal criticism technique is a reliability test concern with the meaning of a documentary data; whether it present the full picture and whether there is a balance view (Guthrie, 2010). This test was satisfied by the research. All the project files used for the study were in the custody of the clients representing all correspondence of the parties involved during the execution of the building contracts.

Fifty three percent (8) of the projects were contracted to large contractors (category D), while 47% (7) were contracted to medium sized contractors (category B & C). Both traditional (80%) and non-traditional procurement systems (20%) were used to procure the projects.

The cases studied reveals that 73.33% (11) of the clients' were public clients', while the remaining 26.67% (4) were private clients'. The contractors were involved in both traditional and non-traditional procurement systems. Eleven (73.33%) of the twelve (100%) projects procured through the DBB systems were procured by public clients, with just one (26.67%) out of the twelve procured by private clients. Only three of the cases studied were procured through the DB non-traditional procurement systems, and all were procured by private clients. All the cases studied record time overruns, while all but one records cost overruns. The contractors' record a mean % time overrun of 146% in the DBB systems (traditional), and a mean % time overrun of 60.42% in the DB system (non-traditional). The contractors' record a mean % cost overrun of 35.5% in the DBB systems (traditional), and a mean % cost overrun of 36.42% in the DB system (non-traditional). The total cost of the cases studied was ₦2.04 billion, with an initial estimated total contract periods of 176 months. In all, the cases studied overran their time and cost by 100.57% (352 months) and 43.02% (₦876, 040, 000) respectively. The result from the case study shows that indigenous contractors' involvement and performances in building procurement systems follow the same pattern and reveals that the responses from the questionnaires truly reflect to some extent the responses obtained from the questionnaires on NICs' involvement and performances in building project procurement systems.

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V. Result Discussion

This research finding shows that both public and private clients involved NICs' in traditional and non-traditional procurement systems. Public clients procure 75% of their projects through the DBB traditional procurement systems as against private client who procure 78-100% of their projects through the non-tradtional procurement systems. This result conforms to Ojo *et al.* (2006) findings that DBB systems are mostly used by public and uninformed private clients in Nigeria. Result shows that public clients has the largest share of the projects procured in the industry. This is in line with Mbamali and Okotie (2012), and Iro *et al.* (2012) reports that the Government in Nigeria (public client) has almost 75% of the total construction share in the country.

The performancesof NICs' in both the traditional and non-traditional procurement systems reveal high rates of time overruns (traditional: 34-146%; non-traditional:45-60%) and costoverruns (traditional: 35-47%; non-traditional:31-36%).These findings agrees with the findings of: Idoro (2012); Mbamali and Okotie (2012); Babatunde *et al.* (2010); Ikediashi *et al.* (2012); Ibrahim (2008); Ojo *et al.* (2006).

VI. Conclusion and Recommendation

This research sought to investigate NICs' involvement and performances in building projects procurement systems using descriptive and explanatory methods in northern Nigeria. This was informed by the numerous challenges confronting the NICs' and above all, absence of a study that investigated the NICs' involvement and performances in various procurement systems in the NCI. This research finding shows that NICs' are involved by both public and private clients in both traditional and non-traditional procurement systems and their performances in both of the systems reveal high rates of timeoverruns (traditional: 34-146%; non-traditional:45-60%) and costoverruns (traditional: 35-47%; non-traditional:31-36%). The research reveals that public clients procure 75% of their projects through the DBB traditional procurement systems as against private client who procure 78-100% of their projects through the non-tradtional procurement systems. In addition, the research result reveals that the government (public clients) has the largest share of the projects procured in the industry.

This research recommended that NICs' should: adopt and apply project management techniques in their operations; employ competent personnel and embark on continuous training; keep abreast with global construction trend through investment in knowledge management and; clients and consultants adheres to project management procedures. Though, this research is delimited to NICs' involvement and performances in building projects procurement systems in northern Nigeria. More studies can be conducted to investigate the causes of NICs' underperformances in time and cost in the various building procurement systems in Nigeria.

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Table 6: Co llective Case Study

Case study	Type of building	Year	Location	Client's	Procurement Type	Cost (₦000,000) E	Cost (₦000,000) F	Cost overrun %	Time overrun (months) E	Time overrun (months) F	Time overrun %
CS01	Hospital	2009-2012	Abuja	Public	DBB	248.62	421.04	69.35	6.5	30	361.54
CS02	Administrative block	2003-2012	Abuja	Public	DBB	282.56	712.87	152.29	54	117	117
CS03	Mega shopping plaza	2008-2010	Abuja	Private	DB	572.35	680.02	18.81	14	21	50
CS04	Administrative block	2005-2009	Abuja	Public	DBB	249.12	297.79	19.30	15	28	86.67
CS05	Shops & offices	2009-2010	Abuja	Private	DB	23.42	33.76	44.15	5	7.5	50
CS06	Lecture hall	2011-2013	Bauchi/Gombe	Public	DBB	47.20	57.20	21.19	7.5	16	113.33
CS07	Office blocks	2007-2009	Bauchi/Gombe	Public	DBB	13.05	15.31	17.32	3	21	600
CS08	Classroom blocks	2005-2006	Bauchi/Gombe	Public	DBB	23.68	31.97	35	4.5	8.5	88.89
CSO9	Classrooms & Residential	2010-2011	Bauchi/Gombe	Public	DBB	190.05	226.05	18.94	15	22.5	50
CS10	Residential	2010	Bauchi/Gombe	Public	DBB	18.22	21.85	19.92	2	5	150
CS11	Library extension	2006-2007	Kano	Public	DBB	87.12	87.12	0.00	9	14	55.56
CS12	Lecture theatre	2003-2004	Kano	Public	DBB	87.77	114.80	30.80	14	20	42.86
CS13	Offices/classrooms	2005-2006	Kano	Public	DBB	163.01	170.44	4.60	8.5	10.5	23.53
CS14	Residential	2004-2005	Kano	Private	DB	10.00	14.63	46.30	8	14.5	81.25
CS15	Shops & offices	2010-2011	Kano	Private	DBB	20.00	27.36	36.80	9.5	16.5	73.68
					TOTAL	2036.17	2912.21	43.02	175.5	352	100.57

Note: E- estimation; F-final; DBB-*design-bid-build*; DB-*design-build;* ₦-Nigerian currency-Naira: $1 = ₦160

Source: Field survey (2013)

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X-Ray Switching Study on Thin Film Silicon Photovoltaic Solar Panel

By Aditya Chaudhary & Kulvinder Singh
Guru Gobind Singh Indraprastha University, India

Abstract- Thin film silicon solar panels are subjected to switching study under high energy X-Rays exposures. Photo current of unbiased cell is recorded with time at short regular intervals (10 sec) at room temperature. These exposures develop reproducing photocurrents. Long exposures (Kilo second) are found to degrade the photocurrent almost linearly at a rate 2.4X10-14A/s. Solar panels are found to recover from the radiation damage in time spanning from 10-15 Hr. Trends of photo-currents at on-set and off-set are analysed in the light of trap-centers and reverse electric field at the electrodes. Variations of photocurrent with intensity of X-rays were also obtained. Results show that silicon based thin film solar cells are sufficiently stable and hard under the short exposures (10s) from high energy X-rays and can be used as X-ray sensors for space applications.

Keywords: solar cell, thin film photovoltaic cells, x-ray sensor, photoconduction.

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XRAYSWITCHINGSTUDYONTHINFILMSILICONPHOTOVOLTAICSOLARPANEL

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X-Ray Switching Study on Thin Film Silicon Photovoltaic Solar Panel

Aditya Chaudhary [α] & Kulvinder Singh [σ]

Abstract- Thin film silicon solar panels are subjected to switching study under high energy X-Rays exposures. Photo current of unbiased cell is recorded with time at short regular intervals (10 sec) at room temperature. These exposures develop reproducing photocurrents. Long exposures (Kilo second) are found to degrade the photocurrent almost linearly at a rate $2.4X10^{-14}$A/s. Solar panels are found to recover from the radiation damage in time spanning from 10-15 Hr. Trends of photo-currents at on-set and off-set are analysed in the light of trap-centers and reverse electric field at the electrodes. Variations of photocurrent with intensity of X-rays were also obtained. Results show that silicon based thin film solar cells are sufficiently stable and hard under the short exposures (10s) from high energy X-rays and can be used as X-ray sensors for space applications.

Keywords: solar cell, thin film photovoltaic cells, x-ray sensor, photoconduction.

I. Introduction

In recent years many new systems were found suitable for making solar cells. This includes $CuInSe_2$, Dye-sensitized nano-structured materials, Bipolar AlGaAs/Si, Organic Solar materials etc. [1-5]. However technology of Silicon based solar cells is sufficiently developed and its commercialization has reached to heights much above than other materials. Solar panel arrays are commercially available for various applications ranging from house hold to the space applications. For long term usage of these panels, it is necessary to make them immune towards high energy radiations, especially for space applications. Degradation of structures is expected from high energy radiations including X-rays and high energy charged particles etc. In this regard it is planned to study the commercially available solar panels under the high energy X-Rays.

II. Experimental Details

Solar panel SC 1418I from TRONY was taken for the present work. It is a small panel of 18mmX14mm in size. There are 8 silicon thin film solar cells on ITO glass. Panel is encapsulated in a metallic chamber with black paper cover from the front side. This is ensured that no visible light can enter in to the chamber except X-Rays. Panel is mounted normal to X-Ray beam having circular cross section of 8mm diameter falling in the middle of the panel. Room temperature is kept between 18-20^{0}C for entire experimentation. X-Rays are obtained from Cu-Target tube (Philips Holland), operated at 30 kilo volt and plate current is kept between 2mA-10mA. Panels were subjected to basic switching studies. Firstly panel is given three shots of 10 second each with regular interval of 10 second. Process is repeated at changing intensity of X-rays. This is done by changing the plate current between 2mA to 10mA. Secondly the panel is given long exposure of 7 minute with a gap of one minute. Panel is taken as a photovoltaic source and is loaded by a series resistance of 99.3 kilo ohm. Set-up connections are shown in Fig.1. This high value insures the low current through the panel so as to avail almost the open circuit voltage. Photo-current obtained is recorded by a digital pico-meter (DPM 111 Scientific Equipment, Roorkee, India). Whole set up is electromagnetically shielded. All connecting wires are Teflon coated to minimize lead leakages.

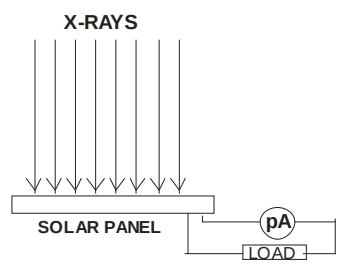

Figure 1 : Probe set up used for photocurrent measurements

III. Results & Discussions

Long exposure of solar panel to X-rays, clearly indicates the reduction of photocurrent with time. [Fig.2]. During these measurements it was insured that accelerating tube voltage, plate current and temperature remains constant. In order to check any variation due to instrumental setting, X-ray exposure is stopped for one minute. On the restart of exposure, photocurrent started from the last exposure value. Average current shows a trend of linear decrease at a rate around $2.4X10^{-14}$ A/s for a typical panel. When panel is left ideal for 10-15 Hr, it was found that photocurrent recovers to its initial value. This clearly indicates that the degradation is temporary. There are two possibilities of such a degradation viz. open circuit voltage decreases with radiation dose due

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decrease in the carrier life time and secondly due to radiation induced charge trapping near the anode/cathode interface giving rise to a compensating electric field opposing the effect of the built in potential. [6].

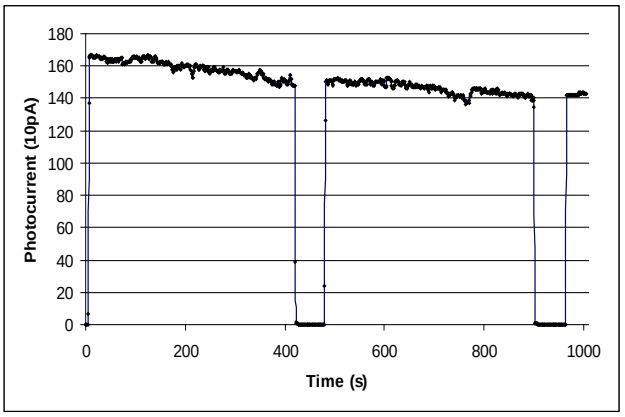

Figure 2 : Time degradation of solar panel

Decrease in carrier life time is due to enhanced scattering of charge carriers under high energy radiations. To under stand this effect we provided periodic shots of exposure at regular intervals of 10 second each. Process is repeated with increasing intensity of X-rays. It was found that with increasing intensity average photocurrent is increasing linearly with intensity of X-rays [Fig 3, 4]. It is expected as the photo-conversion also increases linearly.

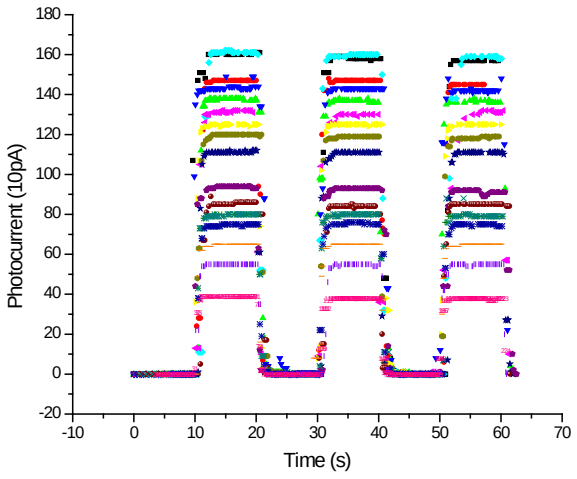

Figure 3 : Variation of photocurrent with switching time

This result indicates that decrease of carrier life time is not a prominent factor for degradation of solar panel. Possible factor which mainly seem to be responsible is therefore the charge trapping at the electrodes. This is also confirmed by the recovery of photo-current when sufficient time is given to the solar panel (10-15hr.) since the panel is left in close circuit for this duration. Our results of 10 second switching with 10 second recovery time clearly indicates that there is almost constancy in the photo-current with time.

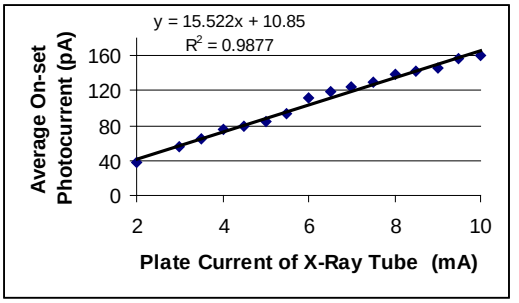

Figure 4 : Variation of average On-set Current with Plate current of X-Ray tube

In the recent study [7] degradation of a sample polymer solar cell was studied and it is found that with time active layer of the solar cell changed in the course of seven hours. The researchers at Helmholtz center Berlin [8] have studied the degradation of polycrystalline solar thin film panel and found that micro-voids existing within them are responsible for reduction of their efficiency by 10-15 percent.

IV. Conclusions

Time degradation of solar panel under the X-Ray exposure is mainly due to charge trapping at the electrode rather than reduction in the carrier life time. It however needs further direct experimentation for the measurement of trap charges at the electrodes. If sufficient relaxation time is given to the solar panel, degradation can be minimized. In such cases these panels can be used as X-ray sensing devices.

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The Shewhart-Ewma Automatic Control Chart

By John J. Flaig
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Abstract- As the amount of critical process data increases due to automatic data acquisition systems, two problems present themselves. First, it becomes uneconomic to add sufficient staff to monitor all these processes using control charts, and second, the skill level required to observe and interpret the control charts becomes an ongoing issue of assuring accuracy and consistency via expensive training programs. An automated control procedure could conceivably provide a solution to both of these issues.

Keywords: statistical process control (SPC), automatic process control (APC), exponentially weighted moving average (EWMA).

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I. Introduction

Statistical process control (SPC) is a powerful tool whose primary purpose is process stabilization based on the identification of the assignable causes of a significant process change and appropriate corrective action. A side benefit of SPC is that the process is "improved". That is the process becomes more predictable.

Automated process control (APC) is an advanced tool whose primary purpose is to analyze the data coming from the process, apply the appropriate heuristics rules, and signal if the process behavior changes significantly, and/or automatically adjust the process input variables to maintain control. The value of APC is that it replaces the human being in analyzing the data and it assures that the heuristic analysis rules are consistently applied. In addition, it allows exception reporting (i.e., receiving a notification only when there is a significant change in the process occurs).

The utilization of these tools adds substantially to the ability to effectively monitor and control processes at minimum cost. If the two tools are combined, then even greater benefits can be achieved. However, the effectiveness of the SPC-APC system is a function the strength of the SPC control procedure and the soundness of the APC heuristic algorithms applied to the data. The goal is thus to marry a powerful control procedure with a robust heuristic program for data analysis and inference generation.

II. Methodology

The exponential weighted moving average is an extremely effective SPC control procedure that has been used in industry for years. It is a procedure that has a number of design features that make it a highly desirable choice in selecting a control methodology.

- It is very sensitive to small process changes and thus allows the practitioner to detect changes early and respond to them.
- It is robust against non-normal data. This means it can be applied to distributions where the data is skewed or not bell shaped and it will still provide reasonably accurate results (see the appendix).

a) The Exponentially Weighted Moving Average Control Chart for the Process Mean

Roberts introduced the EWMA control chart in 1959. See also Crowder (1989), and Lucas and Saccucci (1990) for a good discussion on the EWMA control chart. The exponentially weighted moving average is defined as follows:

$$z_i = \lambda x_i + (1 - \lambda) z_{i-1}$$

where $0 < \lambda \leq 1$ is a constant and the starting value (required with the first sample at $i = 1$) is the process target, so that:

$$z_0 = \mu_0$$

Sometimes the average of preliminary data is used as the starting value of the EWMA so in that case $z_0 = \bar{x}$.

- *Formula for the EWMA Control Limits*

$$CLz = \mu_0$$

$$UCLz = \mu_0 + K\sigma\sqrt{\frac{\lambda}{(2-\lambda)}[1-(1-\lambda)^{2i}]}$$

$$LCLz = \mu_0 - K\sigma\sqrt{\frac{\lambda}{(2-\lambda)}[1-(1-\lambda)^{2i}]}$$

where K is the distance to the control limit.

- *Example of and EWMA Control Chart*

Given that $\mu_0 = 10$ and $\sigma = 1$ the EWMA using $\lambda = .1$ and $K = 2.7$ for the following set of observations is given in Table 1:

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Table 1 : EWMA Example

Obs No.	Obs X	Predicted EWMA
1	9.45	9.9450
2	7.99	9.7495
3	9.29	9.7036
4	11.66	9.8992
5	12.16	10.1253
6	10.18	10.1307
7	8.04	9.9217
8	11.46	10.0755
9	9.20	9.9880
10	10.34	10.0232
11	9.03	9.9238
12	11.47	10.0785
13	10.51	10.1216
14	9.40	10.0495
15	10.08	10.0525
16	9.37	9.9843
17	10.62	10.0478
18	10.31	10.0740
19	8.52	9.9186
20	10.84	10.0108
21	10.90	10.0997
22	9.33	10.0227
23	12.29	10.2495
24	11.50	10.3745
25	10.60	10.3971
26	11.08	10.4654
27	10.38	10.4568
28	11.62	10.5731
29	11.31	10.6468
30	10.52	10.6341

The Graph of the EWMA Control Chart

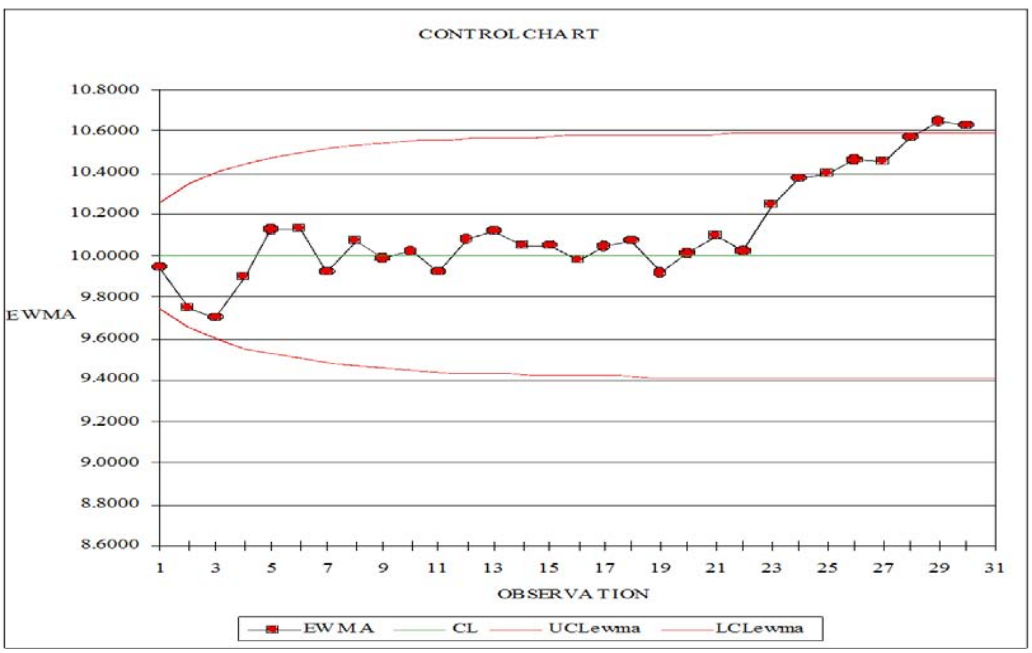

Figure 1 : EWMA Control Chart

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b) Control Chart Design

One of the critical performance measures for any control procedure is its Average Run Length (ARL). That is, how long it takes to signal when a significant change occurs. More precisely, if the process experiences a change in its mean or variance, then the Average Run Length is the average number of samples that will be evaluated before a warning signal is generated indicating a change has occurred. The ARL can also be thought of as the time that it takes to signal once a change of a given magnitude has occurred, assuming a constant time interval between samples. Using this metric, good chart performance means that the ARL is a large number when the process is stable (i.e., no change has occurred (denoted ARL_0). A signal in this case would be a false alarm), and a small number one when the process is unstable (i.e., when there has been a change, and thus providing quick detection). Control system design goals seek to find procedures that maximize ARL_0 and simultaneously minimize ARL_x for $x > 0$.

The ARL_0 for a Shewhart individuals control chart using the single test, one point outside the control limits is 370, whereas for an EWMA with $\lambda = .1$ and $K = 2.8$ it is 500 (see Figure 2). This is a much better false alarm rate than the Shewhart individuals control chart. Further, if the K value were set to 3, the typical value, then the EWMA false alarm rate would be even better.

Examining Figure 2 it can be seen that the EWMA control chart is very effective in detecting small process shifts but not large changes. The Shewhart chart, on the other hand, is insensitive to small changes but sensitive to large ones. If we could combine the procedures, we would have an even better control procedure.

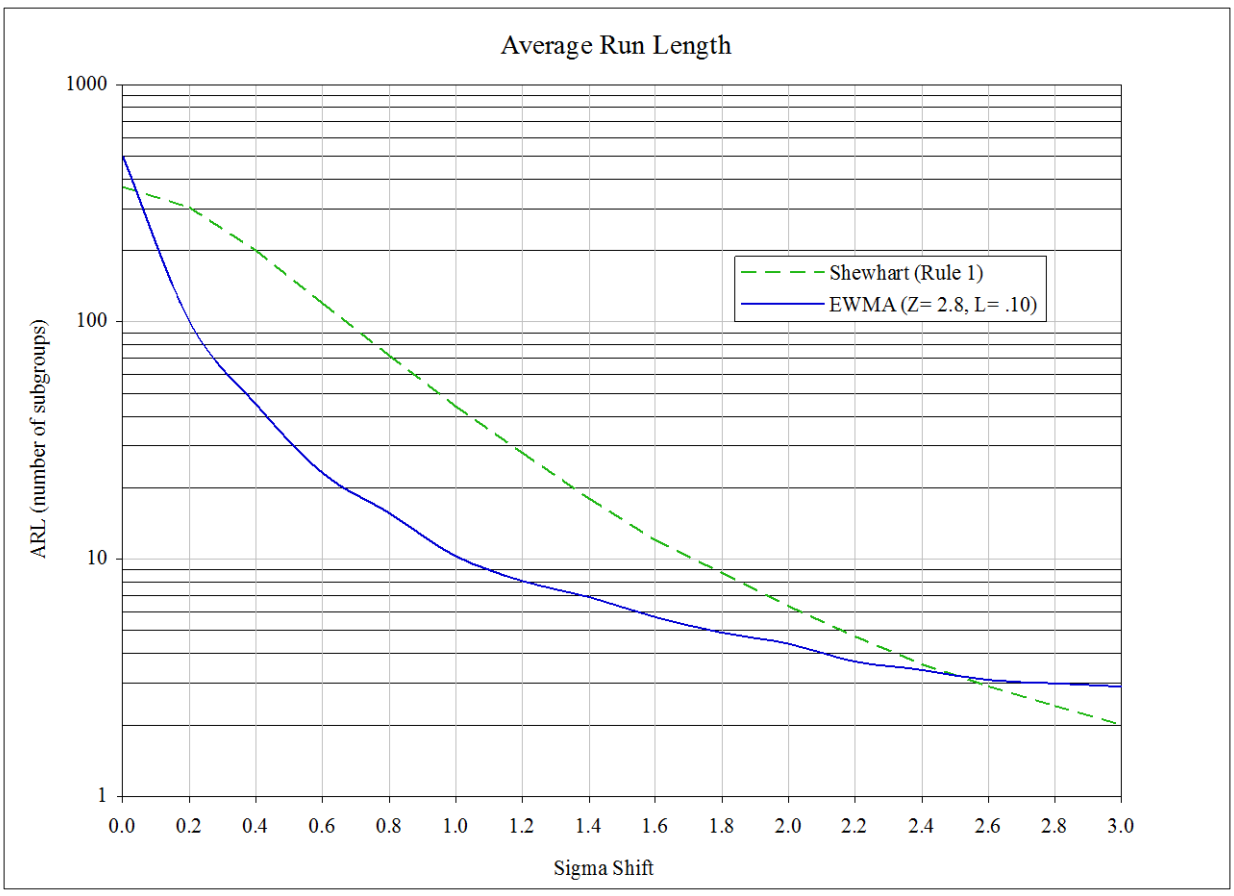

Figure 2 : ARL for a Shewhart and EWMA Control Procedure

c) The Shewhart-EWMA Control Chart

Since the EWMA chart performs well in detecting small shifts but does not react to large shifts as quickly as the Shewhart chart. A good way to further improve sensitivity of the control procedure to large shifts without sacrificing the ability to detect small shifts quickly is to combine a Shewhart chart with the EWMA. These combined Shewhart-EWMA control procedures are effective against both large and small process changes. When using such schemes, it may be helpful to use slightly wider than usual limits on the Shewhart chart (e.g., 3.2 sigma is recommended by Montgomery, 2001). The reason for this is to prevent the false alarm rate from increasing too much when we add the Shewhart chart.

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It is also possible to plot the observed value x and the EWMA on the same control chart along with both Shewhart and EWMA limits. This produces one chart for the combined control procedure that operators quickly become adept at interpreting because there is only one test–a single point outside the control limits on either chart is an out-of-control signal. When the plots are computer generated, different colors or plotting symbols can be used for the two sets of control limits and statistics. In the automated case when a signal is generate it can be plotted as a large red dot or an X on the control chart.

Graph of a Shewhart-EWMA Control Chart

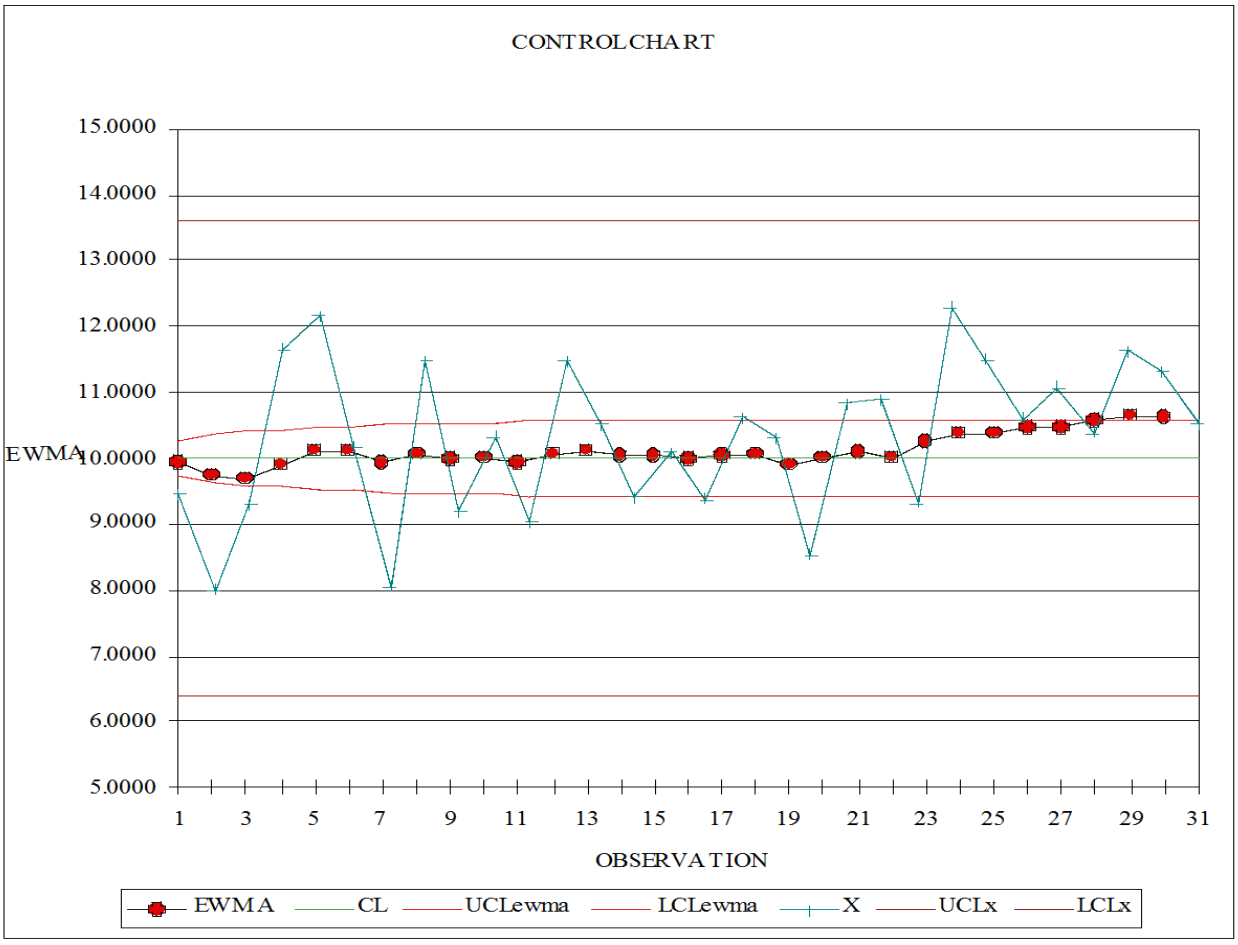

Figure 3 : Shewhart-EWMA Control Chart

d) Automating the Shewhart-EWMA

The control chart establishment process consists of two phases.

- *Phase I :* The center line, and control limits are determined from the mean and variance of a process that is in a state of statistical control, or from the data that has been edited to remove signals and corrective action has been taken prevent reoccurrence.
- *Phase II :* The centerline, and control limits are used as standards for incoming data after Phase I. They are used until such time as the process parameters (mean and/or variance) have statistically been determined to have changed. If the process parameters have changed, then the practitioner must take the appropriate actions, which may include going back to Phase I and re-computing a new center line and control limits.

The automation program proposed here attempts to mimic this procedure algorithmically.

- First it establishes the baseline performance (the number of samples used is adjustable and if a signal occurs within the window, then the baseline program restarts). The program would not go on to Phase II if the initial baseline were unstable.
- Once the initial baseline parameters are established, the automation algorithm takes over. Any point that is outside the Shewhart limits or the EWMA limits generates a signal. If four points in a row signal on the EWMA chart, then the program assumes the process has shifted. If this happens, the old parameters are reset and the program goes

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back to step 1 and attempts to establish a new baseline. The number of points in a row required to declare a shift is selectable.

The assumptions and algorithm rules for the procedure are listed below:

i. *EWMA design rules (λ, K_1)*

Initially set: λ = .10 and K_1 = 2.58 (this gives an alpha of .01 or 99% control limits)

ii. *Shewhart design rules (K_2)*

Initially set: K_2 = 3.0 (Montgomery suggests using 3.2 to reduce the combined alpha risk of having two charts.)

iii. *Initial process baseline computation rules*

Readings are taken until there are eight (8) in a row that are all within the EWMA control limits. The control parameters (mean and variance) are computed from these eight readings and are used to compute the center line (CL), the Upper Control Limit (UCL) and Lower Control Limit (LCL) for both the EWMA and Shewhart control procedures.

iv. *Signal rules*

If a single point falls outside the control limits on either the EWMA or Shewhart control chart, then a warning signal is generated and an email notification is sent to the responsible authority.

v. *Process change rules*

If there are four (4) points in a row outside the EWMA control limits, then the process is assumed to have changed (i.e., the mean has changed) and the program resets. The probability of this happening assuming that the process was stable is about 1 in 2000 for λ = .10 based on simulation studies. The EWMA false reset rate depends on the autocorrelation induced in the EWMA data by the λ value selected.

vi. *Revised baseline computation rules*

If a process change is detected, then all historical data prior to the four signal points is no longer used and the new control chart parameters are generated following the procedure listed in step 3 above.

vii. *Communication and response rules*

If a signal is generated, then an email is sent to the responsible authority. Receipt of the email must be acknowledged. If it is not acknowledged within one (1) day, then an email is sent to the designated alternate. This email also requires acknowledgement.

The Automated Shewhart-EWMA Control Chart

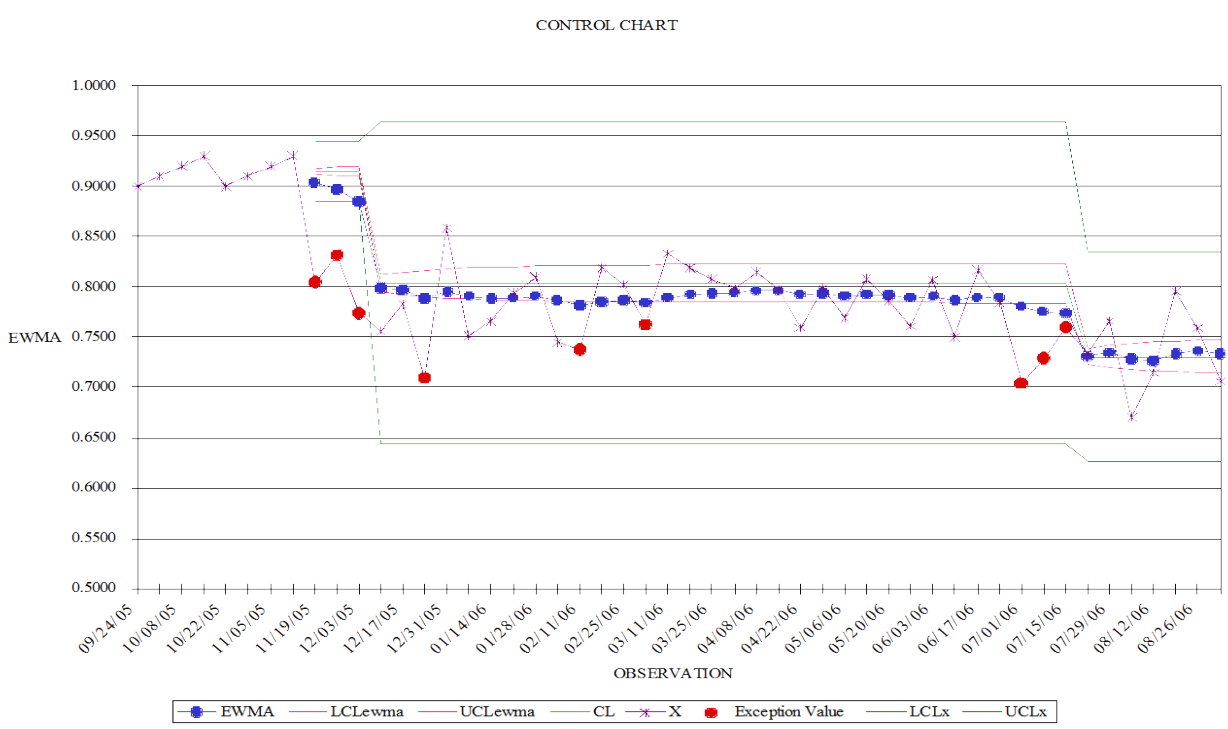

Figure 4 : Automated Shewhart-EWMA Control Chart with Shift Rule of Three in a Row

III. Summary

There are infinitely many ways a process may exhibit unstable behavior. Therefore, it is impossible to define a finite set of detections rules that would be able to detect all the possible types of instability. Hence, there is no perfect control chart as each one has its define a finite set of detections rules that would be able

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to detect all the possible types of instability. Hence, there is no perfect control chart as each one has its strengths and weaknesses. The Shewhart individuals control chart offers a good graphical representation of the process performance, capability, and is sensitive to large process shifts, but it not robust against nonnormality. The EWMA control chart does not give the practitioner a good view of individual observations, process performance, or capability, but it is fairly robust against nonnormality and it is sensitive to small process changes. The Shewhart-EWMA control procedure resolves most of these issues but is designed to detect changes in the mean and not the variance unless we apply more runs rules to the Shewhart x-chart (e.g., 5 points in a row outside ± 1 sigma).

Also, when the Shewhart-EWMA is automated a host of additional issues present themselves. These include the reasonableness of the following design decisions:

EWMA design rules (λ, K_1)

Shewhart design rules (K_2)

Initial baseline computation rules

Signal rules

Process change declaration rules

Revised baseline computation rules

Communication and response rules

The value of an automated process control procedure rests on its ability to accurately and precisely perform its detection and communication function in a timely manner. Since the goal is to reduce the labor content of the process monitoring activity via automation and exception reporting. The authors have attempted to make rational design choices, but in the final analysis the procedure must work in practice, or as Dr. Shewhart noted:

> *The fact that the criterion, which we happen to use, has a fine ancestry of powerful statistical theorems does not justify its use. Such justification must come from empirical evidence that it works.*
>
> *Walter A. Shewhart*

IV. Acknowledgement

I wish to thank Mr. Kip Rapp for programming the algorithms and providing the process behavior chart used in Figure 4.

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Optimal Energy Management System for PV/Wind/Diesel-Battery Power Systems for Rural Health Clinic

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Abstract- Good operation of a hybrid system can be achieved only by a suitable control of the interaction in the operation of the different devices. This paper presented a supervisory control system that monitors the operations of PV/Wind-Diesel hybrid power generation system with energy storage. The controller was developed in such a way that it coordinates when power should be generated by renewable energy (PV panels and Wind turbine) and when it should be generated by diesel generator and is intended to maximize the use of renewable system while limiting the use of diesel generator. Diesel generator is allocated only when the demand cannot be met by the renewable energy sources including battery bank. The structural analysis of the supervisory control is described in details through data flow diagrams. The developed control system was used to study the operations of the hybrid PV/Wind-Diesel power system for the three hypothetical off-grid remote health clinics at various geographical locations in Nigeria. It was observed that the hybrid controller allocates the sources optimally according to the demand and availability. From the control simulation, we were able to see the performance of the system over the course of the year to see which mode(s) the system spends most time in, the power supplied by each of the energy sources over the year, and the power required by the load over the year. This is a very useful manner to check how the system is being supplied and which source of energy is the most proficient in supplying the load.

Keywords: hybrid system, supervisory control, power consumption, power supply, health clinic.

GJRE-J Classification : FOR Code: 090607, 850499

OPTIMALENERGYMANAGEMENTSYSTEMFORPVWINDDIESELBATTERYPOWERSYSTEMSFORRURALHEALTHCLINIC

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I. Introduction

Application of renewable energy for power generation has several benefits (such as clean energy, reduction of electricity cost) but its intermittency has leads to special attention on the mix of renewable energy systems (an electricity production system which consists of a combination of two or more renewable types of electricity generating source) and hybrid systems (an electricity production system which consists of a combination of two or more types of electricity generating source which one of the sources must be diesel generator).

In a mix of renewable energy systems with batteries, the control strategy is simple: the battery charges if the renewable energy exceeds the demand, and the battery discharges if the load exceeds the renewable energy. However, the control strategies of a hybrid system can become very complex if the system includes batteries. Therefore, in a hybrid system it is necessary to determine how the batteries are charged and what element (batteries or diesel generator) have priority to supply energy when the load exceeds the energy generated from renewable sources. A hybrid system uses advanced system control logic (also known as a supervisory control) to coordinate when power should be generated by renewable energy and when it should be generated by sources like diesel generators [1]. Another useful aspect of control system is that it increases renewable energy participation in the load sharing. Without a supervisory controller, it is expected to limit the renewable energy in around 20% [2].

This paper presented a supervisory control system that monitors the operation of the hybrid system with the objective of maximizing renewable energy and limit the use of diesel generator.

a) Hybrid Energy System Configuration

A hybrid power generation system is defined as the interconnection of several power generators (PV panels, wind turbine, and diesel generator) and a set of batteries. The hybrid energy system is based on a generalized three-bus configuration. The three buses are a DC bus, an AC bus, and a load bus. The technologies that generate DC current– PV, wind, and battery–are connected to the DC bus (V_{DC}). Technologies that generate AC current, i.e. diesel generators, are connected to the AC bus (V_{AC}). Only AC appliances are used and are connected to the load bus (I_{AC}). A battery charger is used to convert AC (I_{ch_AC}) current from diesel generator to DC (I_{ch_DC}) current to charge the battery and serve the load. An inverter, or a DC-to-AC converter, is used to convert DC current (I_{inv_DC}) to AC current (I_{inv_AC}) (from the DC bus to serve the AC load) as shown in figure 1.

A Hybrid Controller shown in figure 2 is used to coordinate when power should be generated by renewable energy (PV panels and wind turbine) and when it should be generated by diesel generator and to control the charge and discharge current from the battery.

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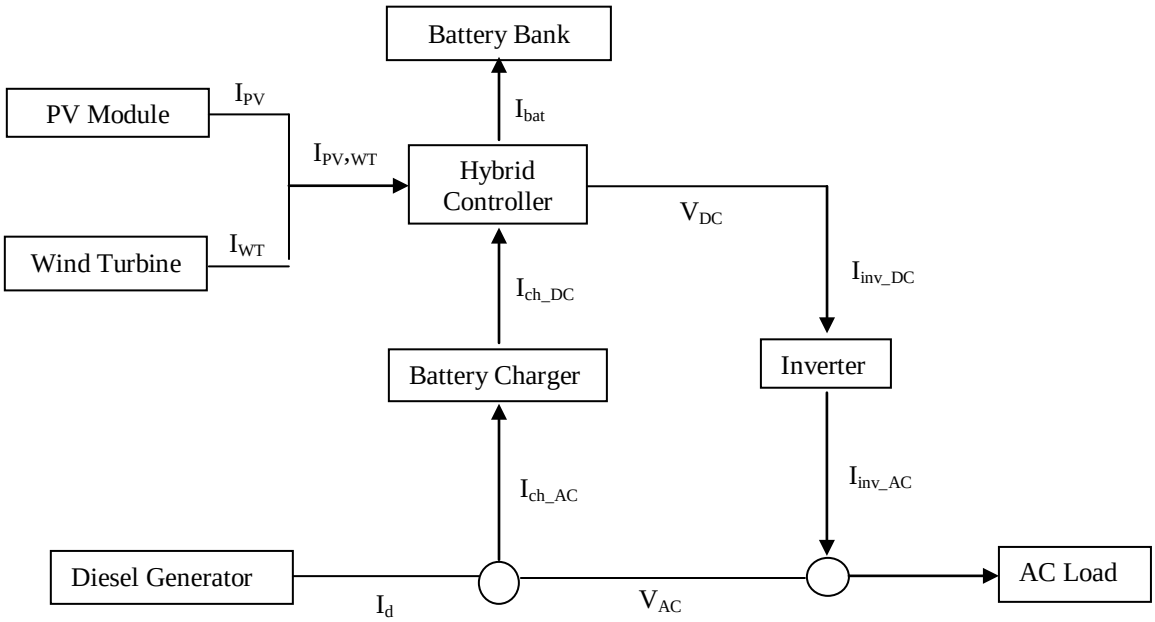

Figure 1 : Configuration of the proposed PV/Wind/Diesel Hybrid System

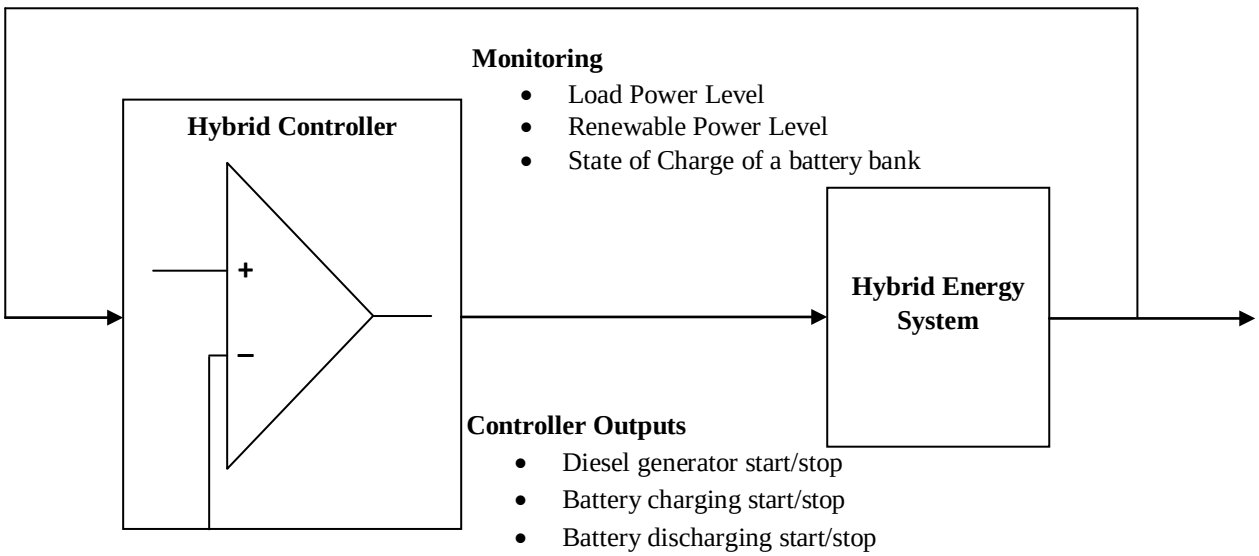

Figure 2 : Hybrid System Controller Block Diagram [3]

b) Supervisory Control for PV/Wind-Diesel Hybrid System

As is well-known, a good operation of energy systems can be achieved only by a suitable control of the interaction in the operation of the different devices. A thorough knowledge of the management strategies to be chosen in the preliminary stage is therefore fundamental to optimize the use of the renewable source, thereby, minimize the wear of batteries and use of diesel [3, 4, 5]. In this study, a sliding control was used; using the PV power (P_{PV}) generation as the primary source of energy, wind power (P_{WT}) generation as the secondary source and battery ($P_{char_max,disch_max}$) as the supplement and the diesel as the backup. The system moves between different mode depending on the power needed by the load and the power able to be supplied by each of the sources. Fig. 3 outlines the flow between the different modes.

The controller operates in 4 modes, modes 1-4 according to which of the Hybrid System Components [PV, H, W, DG] is generating the dispatch power to the load. The detailed mode of operational control (sliding) is given below:

i. *Mode 1*

Mode 1 uses solely the energy generated by the PV panel to supply the load. When the system is in

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mode 1, at times, the energy available from the PV panel might be in excess of what is needed by the load and therefore the amount of energy supplied to the load must be matched to the load demand. This is called sliding control. As the wind turbines are connected to the system, but not used to supply the load in this mode, the energy generated by the wind turbine as well as any excess energy from the PV panels can be used to charge the battery. During the charging of the battery, if the SOC of the battery is at its maximum possible SOC value, the excess power is sent to a dump load [Dump load is a device to which power flows when the system batteries are too full to accept more power], which can be defined according to the health clinic's needs, charging of phones, etc. The flowchart inside the dotted line shown in Fig. 3 is the charging control circuit. If the SOC of the battery is less than the maximum SOC, the amount of excess power is checked. Battery-Experts [6] advised not to use a charging current of more than 60A. The power is then checked to make sure that the current used to charge the battery will be less than 60A. If the excess power is less than this maximum charging power, the battery is charged with the full excess power. If the power is above that of maximum charging of the battery, the maximum battery charge power is used to charge the battery and the excess is used for the dump load.

ii. *Mode 2*

Mode 2 uses the power of the PV panels plus the power of the wind turbine to supply the load. In Mode 2, if the energy available from the PV panel and the wind turbine combined is in excess of what is needed by the load, then the full power available from the PV panels is used to supply the load and the power from the wind turbine is supplied using the sliding control to match the power required by the load. The excess energy from the PV panels and the wind turbine can be used to charge the battery, as in Mode 1.

iii. *Mode 3*

The system enters Mode 3 when the power generated by the PV panels and wind turbine is not sufficient to supply the load. The full power generated by the PV panels, the wind turbine, and the battery (with the condition that if the SOC of the battery is greater than the SOC minimum amount and the power needed to be discharged by the batteries is below the discharge maximum), then the load is supplied. Battery-Experts [6] also adviced that the batteries should not supply more than 80A current, and therefore the amount of power needed to be supplied by the batteries must be checked before it can supply that amount.

There is, however a possibility that the amount of power required by the load is not able to be supplied by the PV panels, wind turbine and the batteries, and when this occurs, it enters mode 4.

iv. *Mode 4*

When the system is in mode 4, it means that the combined power of the wind turbine and the PV panels is not sufficient to supply the load and the battery is at its minimum SOC and therefore cannot be used to supply the deficit of power required, and the hybrid controller connects (starts the generator) to the diesel generator to enable the necessary load to be met.

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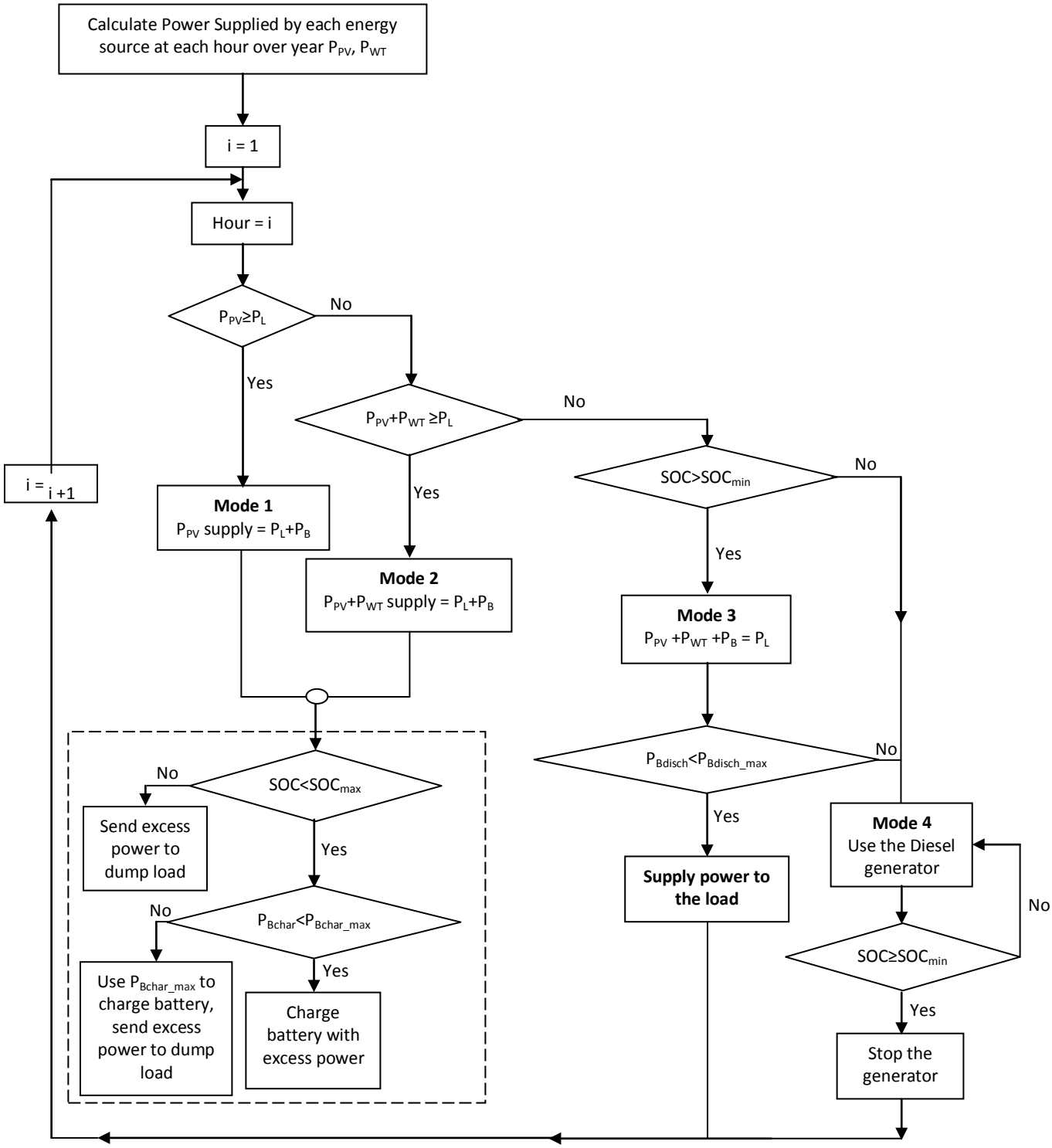

Figure 3 : Flowchart of modes of control for PV/Wind/Diesel - Battery Energy System

The operations which activate or deactivate the charging or discharging of the battery, start (ON) and stop (OFF) the diesel generator are managed and done by a hybrid controller unit. The controller unit monitors and manages the load demand and energy supplied as shown in figure 2.

II. Material and Method

The inputs to the control simulator are the technical data of all the components of the hybrid system. These data were: solar insulation (kWh/m^2), wind speed (m/s), the load required, and a hypothetical

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health clinic power configuration, which was gotten from [7]. The tables that contain the parameters are shown in the appendix. The hypothetical health clinic power configuration is composed of hybrid PV (5kW), BWC Excel-R wind turbine (7.5kW), diesel generator (2kW), 24 units Surrete 6CS25P battery and converter (19kW) system.

Initially, the power supplied by the PV panels and the wind turbines is calculated for each hour over the year and stored in matrices, so that power availability in each hour can be accessed easily. The control process then begins at hour 1.

III. Results and Discussion

Tables (1, 2, and 3) show the contributions of the different renewable sources (PV and wind) and the diesel generator. These tables (1, 2, and 3) also show how the demand is met by the hybrid energy system (PV, wind, and diesel generator) for the three health clinic locations in the month of July. This month (July) was chosen due to its poor radiation and poor wind speed in Nigeria. The entire operations of the hybrid controller can be seen in figure 3.

a) Nembe

The PV power supply is between 8:00h to 19:00h while the radiation peak is at 13:00h as can be seen in table 1. Between 6:00h and 9:00h, and at 17:00h there is no deficit in the system and the renewable energy supplies the load and charges the battery. During these times, there is little or no supply of PV power, but there is good wind power. There is a deficit in other remaining hours due to either higher load that occurs between 10:00h and 15:00h, or due to poor radiation (between 20:00h to 5:00h) and the deficit is being completed by either the battery or the diesel generator. It was mentioned in this paper that the hybrid controller allocates the diesel generator only when the renewable energy with the battery will not meet the load demand. For example in table one, at 21:00h when the renewable energy (no PV supply, the wind power is inadequate, and the battery state of charge is 40.21%) cannot match the load demand then the hybrid controller turns on the diesel generator.

b) Abaji

The PV power supply is between 8:00h to 18:00h while the radiation peak is between 12:00h and 14:00h as can be seen in table 2. Between 9:00h and 12:00h there is no deficit in the system and the renewable energy supplies the load and as well charges the battery. During these times, there is an increase in the load demand, but sufficient supply from the PV power and wind power satisfies the load. The demand of the other remaining hours cannot be met by the renewable energy due to either higher load that occurs between 13:00h and 15:00h, or due to poor renewable resources (little or no PV power between 19:00h and 7:00h; poor wind power between 16:00h and 18:00h) and the deficit is being completed by the battery at these very times. Thus, the hybrid controller allots PV, wind, and battery bank to provide the power to the load without allocating the diesel generator.

c) Guzamala

The PV power supply is between 7:00h to 18:00h while the radiation peak is between 12:00h and 14:00h as can be seen in table 3. As from 4:00h to 9:00h, 11:00h to 12:00h, and 14:00h to 0:00h there is no deficit in the system and the renewable energy supplies the load and charges the battery. There are deficit between 1:00h and 3:00h, 10:00h, and 13:00h. These were due to no PV power, low wind power, and increased load, respectively, and this deficit is being completed by the battery.

In summary, the renewable energy were found to be variable as well as the demand in all the three hypothetical health clinic locations studied, but the supervisory control allots the sources optimally and the hybrid energy system supplies the demand of the particular health clinic location effectively.

Table 1 : Contributions and Power demand met by the hybrid energy system (PV, wind, and diesel generator) in Nembe

Time (h)	Global solar (kW/m^2)	Incident solar (kW/m^2)	Wind speed (m/s)	AC load (kW)	PV power (kW)	BWC-Excel-R (kW)	Diesel generator (kW)	Inverter input (kW)	Inverter output (kW)	Rectifier input (kW)	Rectifier output (kW)	Battery power (kWh)	Battery state of charge (%)
0:00	0.000	0.000	3.570	0.503	0.000	0.267	0.000	0.592	0.503	0.000	0.000	-0.325	46.728
1:00	0.000	0.000	3.035	0.503	0.000	0.134	0.000	0.592	0.503	0.000	0.000	-0.458	46.420
2:00	0.000	0.000	3.054	0.503	0.000	0.138	0.000	0.592	0.503	0.000	0.000	-0.453	46.115
3:00	0.000	0.000	2.432	0.503	0.000	0.035	0.000	0.592	0.503	0.000	0.000	-0.557	45.740
4:00	0.000	0.000	2.994	0.503	0.000	0.125	0.000	0.592	0.503	0.000	0.000	-0.467	45.426
5:00	0.000	0.000	3.653	0.503	0.000	0.309	0.000	0.592	0.503	0.000	0.000	-0.282	45.237
6:00	0.000	0.000	4.563	0.503	0.000	0.811	0.000	0.592	0.503	0.000	0.000	0.220	45.355
7:00	0.003	0.003	4.734	0.463	0.013	0.943	0.000	0.544	0.463	0.000	0.000	0.412	45.576
8:00	0.035	0.031	4.685	0.463	0.140	0.906	0.000	0.544	0.463	0.000	0.000	0.502	45.846
9:00	0.029	0.026	4.472	0.463	0.117	0.741	0.000	0.544	0.463	0.000	0.000	0.314	46.015
10:00	0.047	0.042	4.725	0.994	0.191	0.937	0.000	1.169	0.994	0.000	0.000	-0.042	45.987
11:00	0.041	0.037	4.518	1.257	0.167	0.777	0.000	1.479	1.257	0.000	0.000	-0.535	45.627
12:00	0.034	0.031	3.757	1.257	0.138	0.362	0.000	1.479	1.257	0.000	0.000	-0.979	44.969
13:00	0.135	0.123	3.578	3.372	0.552	0.270	0.000	3.967	3.372	0.000	0.000	-3.144	42.855

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14:00	0.121	0.110	3.709	1.840	0.494	0.337	0.000	2.165	1.840	0.000	0.000	-1.333	41.958
15:00	0.076	0.069	3.762	1.850	0.310	0.364	0.000	2.177	1.850	0.000	0.000	-1.502	40.948
16:00	0.055	0.049	3.613	0.483	0.223	0.289	0.000	0.568	0.483	0.000	0.000	-0.057	40.910
17:00	0.002	0.002	4.180	0.463	0.008	0.578	0.000	0.544	0.463	0.000	0.000	0.041	40.932
18:00	0.018	0.016	2.177	0.463	0.073	0.021	0.000	0.544	0.463	0.000	0.000	-0.450	40.629
19:00	0.027	0.023	2.713	0.503	0.102	0.061	0.000	0.592	0.503	0.000	0.000	-0.429	40.340
20:00	0.000	0.000	3.819	0.503	0.000	0.393	0.000	0.592	0.503	0.000	0.000	-0.198	40.207
21:00	0.000	0.000	3.444	0.503	0.000	0.227	2.000	0.000	0.000	1.497	1.273	1.500	41.014
22:00	0.000	0.000	3.398	0.503	0.000	0.217	2.000	0.000	0.000	1.497	1.273	1.489	41.815
23:00	0.000	0.000	3.455	0.503	0.000	0.230	2.000	0.000	0.000	1.497	1.273	1.502	42.623

Table 2 : Contributions and Power demand met by the hybrid energy system (PV, wind, and diesel generator) in Abaji

Time (h)	Global solar (kW/m²)	Incident solar (kW/m²)	Wind speed (m/s)	AC load (kW)	PV power (kW)	BWC-Excel-R (kW)	Diesel generator (kW)	Inverter input (kW)	Inverter output (kW)	Rectifier input (kW)	Rectifier output (kW)	Battery power (kWh)	Battery state of charge (%)
0:00	0.000	0.000	4.687	0.503	0.000	0.908	0.000	0.592	0.503	0.000	0.000	0.316	65.720
1:00	0.000	0.000	4.050	0.503	0.000	0.511	0.000	0.592	0.503	0.000	0.000	-0.080	65.666
2:00	0.000	0.000	4.346	0.503	0.000	0.662	0.000	0.592	0.503	0.000	0.000	0.071	65.704
3:00	0.000	0.000	3.690	0.503	0.000	0.328	0.000	0.592	0.503	0.000	0.000	-0.264	65.527
4:00	0.000	0.000	4.142	0.503	0.000	0.558	0.000	0.592	0.503	0.000	0.000	-0.033	65.505
5:00	0.000	0.000	4.478	0.503	0.000	0.746	0.000	0.592	0.503	0.000	0.000	0.155	65.588
6:00	0.000	0.000	3.274	0.503	0.000	0.188	0.000	0.592	0.503	0.000	0.000	-0.403	65.317
7:00	0.011	0.009	3.646	0.463	0.042	0.305	0.000	0.544	0.463	0.000	0.000	-0.197	65.185
8:00	0.072	0.065	3.229	0.463	0.291	0.178	0.000	0.544	0.463	0.000	0.000	-0.075	65.134
9:00	0.060	0.054	4.813	0.463	0.244	1.005	0.000	0.544	0.463	0.000	0.000	0.704	65.513
10:00	0.102	0.092	4.575	0.994	0.415	0.821	0.000	1.169	0.994	0.000	0.000	0.067	65.549
11:00	0.098	0.089	5.128	1.257	0.399	1.248	0.000	1.479	1.257	0.000	0.000	0.168	65.639
12:00	0.100	0.090	5.778	1.257	0.407	1.815	0.000	1.479	1.257	0.000	0.000	0.743	66.039
13:00	0.281	0.255	4.926	3.372	1.145	1.092	0.000	3.967	3.372	0.000	0.000	-1.729	64.876
14:00	0.248	0.225	4.027	1.840	1.012	0.499	0.000	2.165	1.840	0.000	0.000	-0.654	64.437
15:00	0.157	0.142	2.491	1.850	0.640	0.038	0.000	2.177	1.850	0.000	0.000	-1.499	63.429
16:00	0.109	0.099	2.132	0.483	0.446	0.019	0.000	0.568	0.483	0.000	0.000	-0.103	63.360
17:00	0.007	0.006	2.292	0.463	0.028	0.027	0.000	0.544	0.463	0.000	0.000	-0.489	63.031
18:00	0.036	0.033	2.484	0.463	0.147	0.037	0.000	0.544	0.463	0.000	0.000	-0.360	62.789
19:00	0.018	0.016	1.678	0.503	0.073	0.000	0.000	0.592	0.503	0.000	0.000	-0.519	62.440
20:00	0.000	0.000	2.079	0.503	0.000	0.016	0.000	0.592	0.503	0.000	0.000	-0.575	62.053
21:00	0.000	0.000	1.912	0.503	0.000	0.008	0.000	0.592	0.503	0.000	0.000	-0.584	61.661
22:00	0.000	0.000	2.478	0.503	0.000	0.037	0.000	0.592	0.503	0.000	0.000	-0.554	61.288
23:00	0.000	0.000	2.805	0.503	0.000	0.082	0.000	0.592	0.503	0.000	0.000	-0.510	60.945

Table 3 : Contributions and Power demand met by the hybrid energy system (PV, wind, and diesel generator) in Guzamala

Time (h)	Global solar (kW/m²)	Incident solar (kW/m²)	Wind speed (m/s)	AC load (kW)	PV power (kW)	BWC-Excel-R (kW)	Diesel generator (kW)	Inverter input (kW)	Inverter output (kW)	Rectifier input (kW)	Rectifier output (kW)	Battery power (kWh)	Battery state of charge (%)
0:00	0.000	0.000	4.243	0.503	0.000	0.610	0.000	0.592	0.503	0.000	0.000	0.018	98.009
1:00	0.000	0.000	3.476	0.503	0.000	0.234	0.000	0.592	0.503	0.000	0.000	-0.357	97.769
2:00	0.000	0.000	3.872	0.503	0.000	0.420	0.000	0.592	0.503	0.000	0.000	-0.171	97.654
3:00	0.000	0.000	3.996	0.503	0.000	0.484	0.000	0.592	0.503	0.000	0.000	-0.108	97.581
4:00	0.000	0.000	4.349	0.503	0.000	0.664	0.000	0.592	0.503	0.000	0.000	0.072	97.620
5:00	0.000	0.000	4.289	0.503	0.000	0.633	0.000	0.592	0.503	0.000	0.000	0.041	97.643
6:00	0.002	0.000	5.245	0.503	0.000	1.338	0.000	0.592	0.503	0.000	0.000	0.747	98.044
7:00	0.042	0.038	4.342	0.463	0.169	0.660	0.000	0.544	0.463	0.000	0.000	0.285	98.197
8:00	0.144	0.127	4.177	0.463	0.570	0.576	0.000	0.544	0.463	0.000	0.000	0.601	98.521
9:00	0.128	0.116	3.342	0.463	0.520	0.204	0.000	0.544	0.463	0.000	0.000	0.180	98.617
10:00	0.210	0.190	3.099	0.994	0.854	0.148	0.000	1.169	0.994	0.000	0.000	-0.166	98.505
11:00	0.213	0.193	4.612	1.257	0.868	0.850	0.000	1.479	1.257	0.000	0.000	0.238	98.634
12:00	0.216	0.196	5.224	1.257	0.882	1.322	0.000	1.479	1.257	0.000	0.000	0.525	98.916
13:00	0.472	0.414	4.452	3.372	1.863	0.726	0.000	3.967	3.372	0.000	0.000	-1.378	97.989
14:00	0.410	0.363	4.869	1.840	1.636	1.048	0.000	2.165	1.840	0.000	0.000	0.519	98.269
15:00	0.265	0.239	6.383	1.850	1.076	2.394	0.000	2.177	1.850	0.000	0.000	1.019	98.817
16:00	0.172	0.156	4.724	0.483	0.700	0.936	0.000	0.568	0.483	0.000	0.000	0.235	98.943
17:00	0.023	0.021	5.500	0.463	0.093	1.563	0.000	0.544	0.463	0.000	0.000	0.210	99.056
18:00	0.042	0.038	5.008	0.463	0.171	1.155	0.000	0.544	0.463	0.000	0.000	0.188	99.157
19:00	0.004	0.000	4.563	0.503	0.000	0.811	0.000	0.592	0.503	0.000	0.000	0.168	99.247
20:00	0.000	0.000	5.659	0.503	0.000	1.707	0.000	0.592	0.503	0.000	0.000	0.150	99.328
21:00	0.000	0.000	4.603	0.503	0.000	0.843	0.000	0.592	0.503	0.000	0.000	0.134	99.400
22:00	0.000	0.000	6.542	0.503	0.000	2.561	0.000	0.592	0.503	0.000	0.000	0.119	99.464
23:00	0.000	0.000	6.252	0.503	0.000	2.256	0.000	0.592	0.503	0.000	0.000	0.107	99.521

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IV. Conclusion

In this study, a supervisory control was developed to satisfy the load demand by optimally allocate the renewable energy sources to the maximum extent while limiting the use of diesel generator. From the control simulation results, it was found that the supervisory control allots the sources optimally and the hybrid energy system supplies the demand of the particular health clinic location effectively. The controller also utilizes the battery bank effectively by switching the batteries into charging mode (power positive) whenever excess power is available from the sources, and switches to discharging mode (power negative) whenever there is a shortage of power from sources. The hybrid controller allocates the diesel generator only when the demand cannot be met by the renewable energy sources (PV+Wind) including the battery bank. This is intended to maximize the use of the renewable energy system while limiting the use of diesel generator which is the aim of the study. This reduces the operational hours of the diesel generator thereby reducing the running cost of the hybrid energy system as well as the pollutant emissions.

From this control simulation, the performance of the system is seen over the course of the year as well as which modes the system spends most time in, the power supplied by each of the energy sources and the power required by the load. This is useful to check how the system is being supplied and which source of energy is the most proficient in supplying the load.

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Appendix

Table A1 : Solar and wind Resources for Nembe (Bayelsa State) [7]

Month	Clearness Index	Average Radiation (kWh/m^2/d)	Wind speed (m/s)
Jan	0.547	5.240	2.900
Feb	0.509	5.130	3.000
Mar	0.454	4.730	2.800
Apr	0.434	4.500	2.300
May	0.408	4.090	2.300
Jun	0.354	3.450	3.000
Jul	0.316	3.110	3.900
Aug	0.336	3.420	4.000
Sep	0.311	3.220	3.600
Oct	0.356	3.600	2.800
Nov	0.433	4.180	2.300
Dec	0.520	4.880	2.600
Scaled annual average		4.124	2.960

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Table A2 : Solar and wind Resources for Abaji (Abuja, FCT) [7]

Month	Clearness Index	Average Radiation (kWh/m²/d)	Wind speed (m/s)
Jan	0.652	5.880	2.400
Feb	0.630	6.090	2.300
Mar	0.610	6.270	2.500
Apr	0.577	6.060	2.500
May	0.539	5.580	2.500
Jun	0.497	5.060	2.300
Jul	0.434	4.440	2.500
Aug	0.404	4.190	2.500
Sep	0.460	4.730	2.400
Oct	0.542	5.310	2.000
Nov	0.655	5.980	2.400
Dec	0.668	5.860	2.200
Scaled annual average		5.449	2.375

Table A3 : Solar and wind Resources for Guzamala (Borno State) [7]

Month	Clearness Index	Average Radiation (kWh/m²/d)	Wind speed (m/s)
Jan	0.642	5.610	4.100
Feb	0.666	6.300	4.100
Mar	0.658	6.700	4.500
Apr	0.628	6.620	4.600
May	0.606	6.360	4.200
Jun	0.576	5.970	3.500
Jul	0.523	5.430	3.300
Aug	0.492	5.140	3.100
Sep	0.544	5.570	2.900
Oct	0.612	5.890	3.200
Nov	0.658	5.840	3.800
Dec	0.631	5.350	4.300
Scaled annual average		5.894	3.799

Table A4 : Health Facility's Energy Needs [1]

S/no	Power Consumption	Power (Watts)	Qty	Load (watt x qty)	Hours/day	On-Time (Time in Use)
1	Vaccine Refrigerator/Freezer	60	1	60	24	(0.00hr – 23.00hr)
2	Small Refrigerator (non-medical use)	300	1	300	5	(10.00hr – 15.00hr)
3	Centrifuge	575	1	575	2	(12.00hr – 14.00hr)
4	Hematology Mixer	28	1	28	2	(10.00hr – 12.00hr)
5	Microscope	15	1	15	5	(09.00hr – 14.00hr)
6	Security light	10	4	40	12	(18.00hr – 6.00hr)
7	Lighting	10	2	20	7	(09.00hr – 16.00hr)
8	Sterilizer Oven (Laboratory Autoclave)	1,564	1	1,564	1	(12.00hr – 13.00hr)
9	Incubator	400	1	400	24	(0.00hr – 23.00hr)
10	Water Bath	1,000	1	1,000	1	(14.00hr – 15.00hr)
	Communication via VHF Radio		1			
11	Stand-by	2		2	24	(0.00hr – 23.00hr)
12	Transmitting	30		30	4	(09.00hr – 13.00hr)
13	Desktop Computer	200	2	400	5	(09.00hr – 14.00hr)
14	Printer	65	1	65	3	(09.00hr – 10.00hr; 13.00 – 15.00hr)

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E-Journals Download Patterns using Web Log Analysis of Selected Publishers among the Aerospace Organizations of Bangalore: A Research Study

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Abstract- With the widespread use of computer and network technologies for facilitating access to scholarly journals, a new methodology has emerged for studying journal usage and scholarly information seeking behavior. Computers record or log all user transactions in a plain text file known as a 'transaction log'. Log files contain data about many of the details of the user's interaction with the system. Hence, some researchers have adopted log analysis to find out about the use of electronic journals in terms of both the volume and patterns of use. Web log analysis or the Transaction log analysis has immense potential for studying online journal's use and their user's information seeking behavior. Log studies have been particularly helpful in understanding the searching and browsing behavior of e-journals' users. Most importantly, the data generated from 'log analysis' is 'pure', and most importantly 'without human intervention'. Hence the authenticity of the data is guaranteed. The major findings that the authors would like to report in this paper are: Analysis of Variance (ANOVA) was applied for testing the significant difference among the mean scores attained from the aerospace scientists and engineers of the 5 aerospace organizations selected for the study for 'e-Journal downloads per year / per publisher'. It is observed that all the 5 aerospace organizations show a significant difference ($P < 0.05$) in their mean scores viz., 'Elsevier', John Wiley (Inter-Science)', 'Cambridge University Press (CUP', 'Oxford University Press (OUP)', 'American Mathematical Society (AMS)', 'American Chemical Society (ACS)', 'American Institute of Physics (AIP)', 'Indian National Science Academy (INSA)', 'Indian Academy of Sciences (IAS)', 'Royal Society of London (RSL)', 'Journal of Atmospheric Sciences (JAS)', 'Air Force – Airman' and 'Aircraft Engineering and Aerospace Technologies (AEAT)' *except for* 'Springer Link', 'Taylor and Francis (T&F)', 'Emerald (P=0.067)', 'Blackwell', 'American Institute of Aeronautics and Astronautics (AIAA) (P=0.057)', 'American Society of Mechanical Engineers (ASME)', 'American Society of Civil Engineers (ASCE)', 'Elsevier – Science Direct (P=0.054)', 'Royal Society of Chemistry (RSC)', 'Web of Science' and 'Institution of Electronics and Electrical Engineers (IEEE) (P=0.085).

Keywords: web log analysis, transaction log analysis, e-journal download patterns, e-journal publishers, aerospace organizations, city of bangalore.

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I. Introduction

In the context of exploding aviation activity in the Asian region in general and India in particular, aerospace is seen as a key technology. Indian aerospace scientists and engineers currently working on strategically important projects depend heavily on rapid collection of information from various e-information resources. Seeking information through e-resources is an upcoming and endearing activity. The use of Electronic Information Resources is highly expected from the aerospace scientists and engineers particularly as an Integrated Information System to their Learning and Working environment.

Let us first try to understand as to why the Web Server Transaction Log Analysis Methodology plays an important role in understanding the e-journal full-text download patterns. Web server transaction log file analysis is a network-based assessment technique that is particularly useful when performed in conjunction with other ongoing activities *(Nicholas, et al., (2006).* Generally, the intent of the Web server log analysis is multi-purpose: First, one can determine the overall Web site traffic including the location of users, the portions of the site accessed, and the number of document downloads; Second, one can determine the Web site directory traffic including the location of users, portions of the site accessed, and the number of document downloads (both hits and accesses); third, one can experiment with developing new log analysis techniques that go beyond domain, hit, and browser counts; and finally, one can assist government agencies to develop, implement, and maintain ongoing log file analysis.

Even though there is a debate about the reliability of the results of the log analysis, this methodology has immense potential for studying online journals' use and their users' information seeking behaviour. With the widespread use of computer and network technologies for facilitating access to scholarly journals, a new methodology has emerged for studying

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journal usage and scholarly information seeking behaviour. Computers record or log all user transactions in a plain text file known as a "transaction log". Log files contain data about many of the details of the users' interaction with the system. Hence, some researchers have adopted log analysis to find out about the use of electronic journals in terms of both the volume and patterns of use.

Web server log analysis technique generally involves a three-fold process that includes determining the types of information server administrator and decision makers need; developing a program that can parse through, manipulate, and present value-added information from the log files; and analyzing the information generated from the program. Web servers automatically generate four different log files: access logs (e.g. hits), agent log (e.g., browser, operating system), error log (e.g. download aborts), and referrer logs (e.g. referring links). These files are text files that can range in size from 1 KB to 100 MB, depending upon the traffic at a particular site. Distinction between a hit and an access is critical to understanding the type of data contained in these files. A hit is any file from a web site that a user downloads. Download of a Web page with 6 images on it accounts for 7 hits (6 images + 1 text page). An access (or a page hit) is an entire page download regardless of the number of images, sounds, or movies on the page. Download of a web page with 6 images accounts for only one access.

Log studies have been particularly helpful in understanding the searching and browsing behaviour of e-journals' users. To sum up, log analysis is clearly useful for certain kinds of analyses, like shedding light on the format of the articles scientists read (PDF or HTML), the age of the articles (obsolescence), and the way scientists navigate to the required material (searching and browsing behaviour). The results of log analysis should be enhanced by a triangulation of the findings of studies with other methodologies (e.g. employing a combination of log analysis, questionnaire surveys and observation studies).

The value of this study is further enhanced in using tools like the Web Log Analysis, which ensures that the data remains 'unfiltered', 'pure', and most importantly without 'human intervention'. Applying such tools further ensures authenticity of the data analyzed.

In this research study among the 16 reputed aerospace organizations of Bangalore, a different type of questionnaire (as part of a related major survey of 'Use Patterns of Electronic Information Resources among the Aerospace Scientists and Engineers of Bangalore') was distributed among the Chief Librarians, Web Administrators and Network Administrator to ascertain the full-text e-journal downloads from their respective Server Log Data.

Amongst the 16 aerospace organizations selected for the study only 7 aerospace organizations responded to this questionnaire, namely: (a) National Aerospace Laboratories (NAL), Bangalore, (b) Aeronautical Development Agency (ADA), (c) Indian Space Research Organization (ISRO), (d) Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), (e) Indian Institute of Science (IISc), (f) Electronics Research Development Establishment (LRDE) and finally, (g) Hindustan Aeronautics Limited (HAL).

It was presumed that only the above organizations had access to server log data. Out of these 7 organizations, information from two organizations was not usable (incomplete). Hence, the remaining 5 organizations, namely: NAL, ADA, ISRO, JNCASR, IISc responded to the questionnaire and these were selected for the Study.

II. Review of Literature

Several interesting studies came to light on using web log analysis in analyzing the use patterns of electronic journals. Some of these studies are: *Zhang (1999)* discusses the method of www server log file analysis and its application to evaluating electronic periodicals services and in monitoring their usage. *Nicholas and Huttington (1999)* reports results of an investigation into ways of using web logs to study user behaviour on the WWW, based on a detailed examination of the Web logs of the Times/Sunday Times. *Yu and Apps (2000)* report the experience of using the log file data to understand user behaviour in the SuperJournal project, addressing methodological and analytical issues that may have wider relevance. *Thelwall (2001)* describes that web log files are a useful source of information about the visitor's site use and navigation behaviour. *Hochheiser and Shneiderman (2001)* report that HTTP server log files provide web site operators with substantial detail regarding the visitors to their sites. *Dias (2002)* presents an approach to the evaluation of access to electronic journals available on the World Wide Web through the analysis of the access log file. *Marek and Valauskas (2002)* opine that the development of World Wide Web based scholarly periodicals offers new tools, such as server logs, for tracking an article's use and distribution. A study was undertaken in which logs recording the use of First Monday were examined in order to understand the use of the periodical's content over time. *Griffiths (2002)* reports a novel approach to studying user-system interaction that captures a complete record of the searcher's actions, the system responses and synchronized talk-aloud comments from the searcher. *Jantz (2003)* observes that transaction log analysis can provide a rich source of information on user behaviour and insights as to how user interfaces can be improved. *Kassim and Kochtanek (2003)* describe the five-stage evaluation of an educational digital library resource

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(www.coe.missouri.edu/rafee/idigital/libraryR/indes.php). The five evaluation methods used were focus group reviews, web log analysis, database transaction logs, a web survey, most recently a report usability evaluation. *Marchionini (2003)* describes a series of user studies that were used to advance understanding of how people use electronic tables (E-tables) and inform the development of a web-based statistical table browser for use by non-specialists. *Cohen (2003)* proposes a two-tiered model for analyzing website usage statistics for academic libraries. *Baeza-Yates and Saint-Jean (2003)* state that the information left by users as they use a browser can be used to complement the result of traditional hierarchy algorithms in such a way as to allow human knowledge to be added to the result. *Chien (2003)* proposes an effective term suggestion approach to interactive web search and present a new, effective log-based approach to relevant term extraction and term suggestion. *Homewood (2003)* states that transaction log files generated by digital information services do record the pages (topics or content) viewed by users and this is perhaps the most interesting aspect of the logs. *Huntington and Nicholas (2003)* propose improved ways of analyzing web server files using transaction log and deep log analysis techniques. *Abe (2003)* describes the Tokyo Shika Daigaku (Tokyo Dental College) Library's analysis of its website access logs to inform future developments.

Davis (2004) analysed referral URL data of the Cornell University IP address from the American Chemical Society servers, to better understand the tools used and pathways taken when scientists connect to electronic journals. *Bracke (2004)* explores the potential of multinomial logistic regression analysis to perform web usage mining for an academic health sciences library web site. *Kato (2005)* reviews the current state of electronic journals: He discusses particularly the number of electronic journals, merger and acquisition of publishers, flip pricing, use of large national universities, transaction log analysis and impact of ILL. *(Jansen (2005)* reports research that used transaction log analysis to examine the characteristics and changes in Altavista web searching that occurred from 1998 to 2002. *Combs (2005)* examined why State University of New York at Cortland, New York, chose web server logs as the technique for tracking who was using the Library's web sites. *Simunic (2005)* says that a log file is a carrier of numerous data and indicators that should be used in the best possible way to improve the entire business operations of a company. However, this is not always simple and easy. *Park (2005)* analysed transaction logs of NAVER, a major Korean web search engine to track the information seeking behaviour of Koren web users. Results showed that users also behave in a passive way: they seldom change search environments set by the system. Also, generally users tend to change their queries totally rather than adding or deleting terms to modify the previous queries. *Jamali (2005)* reviewed the log analysis studies of use and users of scholarly electronic journals. The advantages and limitations of log analysis are described. There is a debate about reliability of the results of log analysis, this methodology has great potential for studying online journals' use and their users' information seeking behaviour. *Sherry (2006)* reports on results from a transaction log analysis of vivisimd.com, which is a web meta-search engine that dynamically clusters users' search results. The results provide insights into search characteristics with a cluster-based web search engine and extend research into web searching trends. *Lau and Goh (2006)* conducted a transaction log analysis of the Nanyang Technological University (NTU) OPAC to identify query and search failure patterns with the goal of identifying areas of improvement for the system. *Shih (2006)* studied Web Crawler activities based upon web access logs from the web site of an academic library. He compared crawler behaviour with that of regular human visitors. *Yun (2006)* in his paper examined the validity of the client-side and server-side web log data. As a result of the triangulation of two datasets, research designs and propose analysis schemes could be recommended. *Koch (2006)* undertook a study to explore the navigation behaviour of all users of a large web service, Renardus, using web log analysis. *Proffitt (2006)* provides specific case studies of usability studies, focus groups, interviews, web log analysis etc. His paper provides practical advice and tools for those interested in exploring user-centred design concepts for web-based tools and services in archives, libraries and museums. *Nicholas and Huntington (2006)* made a detailed analysis of the use of OHIOLink as well as the Blackwell Synergy, Science Direct, emerald insight, and OUP databases by CIBER at University College, London, to quantify the usage of electronic journals as an aid to making judgements on the use of document supply. "Deep log" analysis sheds valuable light on the actual as distinct from perceived use of electronic full text databases.

Meats (2007) studied the Web log analysis undertaken of the TRIP database-a-meta-search engine covering 150 health resources including MEDLINE, the Cochraine Library, and a variety of guidelines. Web log analysis showed most searches used a single term and no Boolean operators. *Goddard (2007)* by looking at logs, reports and data sources from proxy servers, makes a survey of data sources which are likely to be immediately available to the typical practitioner who wishes to engage in statistical analysis of collections and services within his or her own library. *Nicholas (2007)* describes an emerging, but significant, form of digital information seeking behaviour among information consumers, called 'bouncing'. The evidence for this behaviour emerged from five years of deep log analysis studies – an advanced form of transaction log analysis –

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of a wide range of user of digital information resources. Evidence shows that (1) a high proportion of people view just a few times or pages during a visit to a site and, (2) a high proportion of visitors either do not come back to the site or they did so infrequently. Typically those who penetrated a site least tended to return the least frequently. These 'bouncers' bounce into the site and then bounce out again, presumably, to another site, as a high proportion of them do not appear to come back again. *Villen-Rueda (2007)* looks at how different types of users effect queries in the catalog of a university library. Log files were analysed to determine which was the frequent type of search conducted among different user types. *Harley and Henke (2007)* state that there is little empirical data about how intellectual and cultural resources are actually used or who is using them. Transaction log analysis (TLA) and online site surveys were conducted by the authors. *McCain (2007)* reports the results of one academic librarian's reference desk transaction log analysis which focuses on the categories of assistance provided to patrons who called the library's reference desk. *Ravid (2007)* report that LogFile analysis of SHIL, the website of Israeli Citizens' Advice Bureau, revealed that about 60.7 percent of the requests reaching SHIL from external sites (excluding requests from robots) are from general search engines (e.g. Google and MSN), and users reach a specific page on the site linked from the search results page. *Huntington (2007)* analysed search logs from the BBC website and extracted metrics. Two search metrics – the time lag between searches and the number of searches in a session – were developed to see whether they could measure search success or satisfaction. He made a unique analysis that related questionnaire data to site usage as recorded in the transaction log reports of ScienceDirect, for the same people. They studied the online behaviour of three types of navigational users: those accessing the site via a gateway (either via a reference hyperlink or subject search facility), those using the on site search facility and those employing menus. *Nicholas (2007)* evaluated the logs of four universities using the OhioLink journal system for a period of fifteen months using deep log analysis methods in order to compare and contrast the information seeking behaviour of their users. Large differences were found, especially between the research and teaching universities. *Whittle (2007)* describes a novel method for the analysis of web logs, using techniques that look for similarities between queries and identify sequences of 'query transformation'.

Nicholas (2008) demonstrated a novel form of deep log analysis by linking questionnaire data with transactional server log data generated by the same users; and to provide a richer understanding of the information seeking behaviour of a strategic community of virtual scholars. He studied usage data on a large scale in respect to full-text down loads of journal articles, which is considered an important usage metric by librarians and publishers. Results showed that there is a great deal of variety amongst scholars in their full text viewing habits and a large proportion of views are very cursory in nature, although there is a survey evidence to suggest that reading goes on offline. *Galyan and Moballeghi (2008)* review the methodologies employed by researchers working on scientific journals usage. *Huntington (2008)* reports that metrics derived from user visits or sessions provide a means of evaluating websites and an important insight into online information seeking behaviour, the most important of them being the duration of sessions and the number of pages viewed in a session, a possible busyness indicator. *(Wolfram 2008)* analyzed transaction logs from four different web-based information retrieval environments (bibliographic databank, OPAC, Search engine, specialized search system) for empirical regularities in search characteristics to determine whether users engage in different behaviours in different web-based search environments. *Nicholas (2008)* describes a novel form of deep log analysis by linking questionnaire data with transactional server log data generated by the same users; and provide a richer understanding of the information-seeking behaviour of a strategic community of virtual scholars. *Hider and Pymm (2008)* describe a content analysis aimed at identifying the distribution of empirical research strategies and techniques reported in high-profile LIS journal literature published in 2005. *Guruprasad, Nikam, et al. (2009)* present a case study of full-text e-journal patterns amongst the scientists and engineers at the National Aerospace Laboratories (NAL). The analysis of data on the full-text e-journal patterns is presented for the period 2005 to 2007 with regard to 4 international journal publishers. *Guruprasad, Nikam, et al. (2009)* in their paper present a detailed web log analysis of e-journal usage and scholarly communication , a case study of e-journal download patterns taking NAL Scientists and Engineers. Their study was conducted with regard to 8 international journal publishers whose downloaded data has been analyzed for 3 consecutive years, i.e. 2005.2007. *Nicholas, D., et al. (2009),* In this research, data were gathered as part of CIBER's ongoing Virtual Scholar programme. In particular log data from two digital journals libraries, Blackwell Synergy and OhioLINK, and one e-book collection (Oxford Scholarship Online) are utilized. The study showed a distinctive form of information-seeking behaviour associated with students and differences between them and other members of the academic community. For example, students constituted the biggest users in terms of sessions and pages viewed, and they were more likely to undertake longer online sessions. Undergraduates and postgraduates were the most likely users of library links to access scholarly databases, suggesting an important "hot link" role for libraries, *Nicholas, et. Al (2010),* in their

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paper present some of the results of the project "Evaluating the usage and impact of e-journals in the UK". The particular research evaluated the use of the Science Direct journals database with regard to Life Sciences, Economics, Chemistry, Earth & Environmental Sciences and Physics by ten major UK research institutions. The aim of the study is to investigate researchers' digital behaviour, and to ascertain whether their use and behaviours varied by subjects and disciplines, or in relation to the institutions in which they worked. The methodology they adopted was in studying the raw logs which were obtained for Science Direct for the period January to April 2007. They were subjected to deep log techniques and analzed using the Software Package for Social Sciences (SPSS).

III. National Aerospace Laboratories, Bangalore and Allied Aerospace Organizations in Bangalore: The Scope of the Present Study

The city of Bangalore, Karnataka is considered the 'Aerospace Hub' of the country with many key aerospace organizations which have already been established several years ago like (a) The Hindustan Aeronautics Limited (HAL), (b) The National Aerospace Laboratories (NAL), (c)The Aeronautical Development Establishment (ADE), (d) The Indian Space Research Organization (ISRO), (e) The Aeronautical Development Agency (ADA). It also comprises many key Indian Air Force establishments like (a) Air Force Systems and Testing Establishment (ASTE), (b) Air Force Technical College (AFTC) and the (c) Institute of Aviation Medicine (IAM). In a nutshell, many of these organizations come under the broad umbrella of (i) Council of Scientific and Industrial Research (CSIR), (ii) Defense Research and Development Organizations (DRDO), (iii) The Indian Air Force (IAF), (iv) Educational Institutions like IISc, and (v) Major public sector undertakings and (vi) The Department of Space. All of them in their own way have significantly contributed to a large number of Indian aerospace programmes.

The National Aerospace Laboratories is India's premier civil aviation R & D aerospace research organization in the country. Its main mandate is the 'Development of aerospace technologies with strong science content and with a view on their practical application to the design and construction of flight vehicles'. NAL is also required 'to use its aerospace technology base for general industrial applications'. 'Technology' would be its core engine-driver for the future. NAL is also best known for its main sophisticated aerospace R&D testing facilities which are not only unique for this country but also comparable to similar facilities elsewhere in the world.

IV. Objectives of the Study

- To determine the 'e-Journal downloads per year / per publisher', amongst the aerospace scientists and engineers of the selected 5 aerospace organizations of Bangalore.
- To ascertain whether the percentage of preference of 'e-Journal downloads per year / per publisher', amongst the aerospace scientists and engineers of the selected 5 aerospace organizations of Bangalore are approximately the same.
- To study whether there exist similar patterns (homogeneous) of 'e-Journal downloads per year / per publisher' among the selected aerospace organizations of Bangalore.

V. Null Hypothesis

There is no significant difference in the mean scores of 'e-Journal downloads per year / per publisher' from the selected aerospace organizations of Bangalore.

VI. Material, Methods, Scope and Limitations of the Study

The present study is part of a larger survey of the 'Use Patterns of Electronic Information Resources among the Aerospace Scientists and Engineers of Bangalore'. A total number of 650 survey questionnaires were distributed amongst the aerospace scientists and engineers belonging to these 16 aerospace organizations. A total number of 612 questionnaires were received back finally 583 (89.7%) were selected for the study which were found suitable for the study.

A survey questionnaire has been used to conduct this research study. The total population size of this research study is restricted to the 1220 aerospace scientists and engineers in Bangalore. The distribution of Source Data is indicated in *Table 1*. Random sampling technique has been used for selection of the sample size. *Table 2* describes the Full-Text e-Journal Downloads Amongst Selected the 5 Aerospace Organizations (Yearly Average of e-Journal Downloads Per Publisher).

However, the work presented in this paper ('e-Journal downloads per year / per publisher') is restricted to 7 reputed aerospace organizations in Bangalore. A different type of Questionnaire was circulated to the (a) Chief Librarians, (b) Net Work Administrators, (c) Web-In-Charge and (c) Web Log Server Data Administrators.

The present study of 'e-Journal downloads per year / per publisher' is for the years 2005-2008 and restricted to 24 reputed e-journal publishers only.

The study also has looked into the Cumulative e-Journal Downloads for the Period (2005-2008) among the selected 24 publishers related to the 7 aerospace organizations selected for the study.

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VII. Results and Discussion

- Summary of Total Mean Scores on e-Journal Downloads Per Year / Per Organization

The summary of total scores obtained with regard to 'e-Journal Downloads Per Year / Per Organization' amongst the selected 7 Aerospace Organizations are as follows: The highest mean score of 44421.75(CV=308.15) is reflected by 'Elsevier – Science Direct'. This is followed by a mean score of 43972.42(CV=233.79) by the respondents of 'Web of Science'. This is followed by the respondents of 'Elsevier' with a mean score of 5676.15(CV=233.22). The respondents of 'Springer Link' reflect themselves with a mean score of 4241.70(CV=338.28). This is followed by a mean score of 1021.85(CV=283.22) by the respondents of 'American Society of Mechanical Engineers (ASME)'. The respondents of 'Emerald' come up with a mean score of 560.00(CV=315.22). A mean score of 510.05(CV=230.87) is accrued by the respondents of 'John Wiley – Inter Science'. This is followed by the respondents of 'American Institute of Physics (AIP)' with a mean score of 286.85(CV=271.23). A mean score of 265.05(CV=351.80) is accrued by the respondents of 'American Society of Civil Engineers (ASCE)'. The respondents of 'Cambridge University Press (CUP)' present themselves next with a mean score of 62.30(CV=186.38). A mean score of 47.26(CV=289.06) is reflected by the respondents of 'American Chemical Society (ACS)'. This is followed by a mean score of 38.25(CV=350.58) by the respondents of 'Taylor and Francis (T&F)'. The respondents of 'Oxford University Press (OUP)' express themselves with a mean score of 34.90(CV=219.91). A mean score of 33.90(CV=342.83) is accrued by the respondents of 'Royal Society of Chemistry (RSC)'. This is closely followed by a mean score of 30.65(CV=179.11) by the respondents of 'Royal Society of London (RSL)'. The respondents of 'Institution of Electronics and Electrical Engineers (IEEE)' reflect themselves with a mean score of 20.95(CV=323.57). The respondents of 'Blackwell' project themselves with a mean score of 9.25(CV=343.54). This is followed by the respondents of 'American Institute of Aeronautics and Astronautics (AIAA)' with a mean score of 1.35(CV=309.93). The lowest mean score of 0.55(CV=247.27) is portrayed by the respondents of 'Aircraft Engineering and Aerospace Technologies (AEAT)'. The respondents of 'American Mathematical Society (AMS)', 'Indian National Science Academy (INSA)', 'Indian Academy of Sciences (IAS)', 'Journal of Atmospheric Sciences' and 'Air Force – Airman' express themselves with similar mean scores 0.00 each and aggregate corresponding CV values of 0.00 each.

- *Analysis of Variance (ANOVA)* was applied fortesting the significant difference among the meanscores attained from the scientists and engineers of the 5 aerospace organizations (described above in table 2) for the 'e-Journal downloads per year / per publisher'. It is observed that all the 5 aerospace organizations show a significant difference ($P < 0.05$) in their mean scores viz., 'Elsevier', John Wiley (Inter-Science)', 'Cambridge University Press (CUP', 'Oxford University Press (OUP)', 'American Mathematical Society (AMS)', 'American Chemical Society (ACS)', 'American Institute of Physics (AIP)', 'Indian National Science Academy (INSA)', 'Indian Academy of Sciences (IAS)', 'Royal Society of London (RSL)', 'Journal of Atmospheric Sciences (JAS)', 'Air Force – Airman' and 'Aircraft Engineering and Aerospace Technologies (AEAT)' *except for* 'Springer Link', 'Taylor and Francis (T&F)', 'Emerald (P=0.067)', 'Blackwell', 'American Institute of Aeronautics and Astronautics (AIAA) (P=0.057)', 'American Society of Mechanical Engineers (ASME)', 'American Society of Civil Engineers (ASCE)', 'Elsevier–Science Direct (P=0.054)', 'Royal Society of Chemistry (RSC)', 'Web of Science' and 'Institution of Electronics and Electrical Engineers (IEEE) (P=0.085)
- The study also reveals that the most preferred file formats for e-journal downloads happens to be PDF (NAL, ISRO) while the others (ADA, JNCASR and IISc) have chosen both PDF HTML and MS-Word.

VIII. Conclusions

The main conclusions that we would like to draw from this study are:

- *Analysis of Variance (ANOVA)* was applied for testing the significant difference among the mean scores attained from the scientists and engineers of the 5 aerospace organizations for the 'e-Journal downloads per year / per publisher'. It is observed that all the 5 aerospace organizations show a significant difference ($P < 0.05$) in their mean scores viz., 'Elsevier', John Wiley (Inter-Science)', 'Cambridge University Press (CUP', 'Oxford University Press (OUP)', 'American Mathematical Society (AMS)', 'American Chemical Society (ACS)', 'American Institute of Physics (AIP)', 'Indian National Science Academy (INSA)', 'Indian Academy of Sciences (IAS)', 'Royal Society of London (RSL)', 'Journal of Atmospheric Sciences (JAS)', 'Air Force – Airman' and 'Aircraft Engineering and Aerospace Technologies (AEAT)' *except for* 'Springer Link', 'Taylor and Francis (T&F)', 'Emerald (P=0.067)', 'Blackwell', 'American Institute of Aeronautics and Astronautics (AIAA) (P=0.057)', 'American Society of Mechanical Engineers (ASME)', 'American Society of Civil Engineers (ASCE)', 'Elsevier–Science Direct (P=0.054)', 'Royal Society of Chemistry (RSC)', 'Web of Science' and 'Institution of Electronics and Electrical Engineers (IEEE) (P=0.085).

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- This also implies that, the percentage of preference of the 'e-Journal downloads per year/ per publisher'. by the aerospace engineers and scientists are not approximately the same, *except for* 'Springer Link', 'Taylor and Francis (T&F)', 'Emerald (P=0.067)', 'Blackwell', 'American Institute of Aeronautics and Astronautics (AIAA) (P=0.057)', 'American Society of Mechanical Engineers (ASME)', 'American Society of Civil Engineers (ASCE)', 'Elsevier–Science Direct (P=0.054)', 'Royal Society of Chemistry (RSC)', 'Web of Science' and 'Institution of Electronics and Electrical Engineers (IEEE) (P=0.085).
- The study also reveals that there is heterogeneity in the 'e-Journal downloads per year / per publisher', amongst the aerospace scientists and engineers of the selected 7 aerospace organizations of Bangalore, *except for* "Springer Link', 'Taylor and Francis (T&F)', 'Emerald (P=0.067)', 'Blackwell', 'American Institute of Aeronautics and Astronautics (AIAA) (P=0.057)', 'American Society of Mechanical Engineers (ASME)', 'American Society of Civil Engineers (ASCE)', 'Elsevier – Science Direct (P=0.054)', 'Royal Society of Chemistry (RSC)', 'Web of Science' and 'Institution of Electronics and Electrical Engineers (IEEE) (P=0.085).
- PDF format happens to be the most preferred 'File Download Format' amongst the selected aerospace organizations.

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Tables and Figures

Table 1 : Distribution of Source Data

Sl.No.	Organizations	No. of Questionnaires distributed	No. of Questionnaires received	No. of usable questionnaires usable
1.	ADA	67	63	58
2.	AFTC	19	16	15
3.	ADE	14	12	12
4.	ASTE	33	30	29
5.	CABS	16	15	14
6.	CEMILAC	33	30	29
7.	C-MMACS	8	6	6
8.	DARE	11	9	9
9.	LRDE	5	3	2
10.	GTRE	24	22	21
11.	HAL	144	140	134
12.	IAM	40	36	33
13.	ISRO-ISTRAC	25	24	22
14.	IISc	38	37	34
15.	JNCASR	5	3	1
16.	NAL	168	166	164
Total		650	612	583 (89.7%)

Geographical Boundary of the Sample: 16 Prominent Aerospace Organizations of Bangalore, INDIA

Key: ADA=Aeronautical Development Agency, *AFTC*=Air Force Technical College, *ADE*=Aeronautical Development Establishment, *ASTE*=Aircraft Systems Testing Establishment, *CABS*=Centre for Airborne Systems, *CEMILAC*=Centre for Military Airworthiness and Certification, *C-MMACS*=Centre for Mathematical Modeling and Computer Simulation, *DARE*=Defense Avionics Research Establishment, *LRDE*=Electronics and Radar Development Establishment, *GTRE*=Gas Turbine Research Establishment, *HAL*=Hindustan Aeronautics Limited, *IAM*=Institute of Aerospace Medicine, *ISRO-ISTRAC*=Indian Space Research Organization, *IISc*=Indian Institute of Science, *JNCASR*=Jawaharlal Nehru Centre for Advanced Scientific Research, *NAL*=National Aerospace Laboratories.

Table 2 : Full-Text e-Journal Downloads Amongst Selected the 5 Aerospace Organizations (Yearly Average of e-Journal Downloads Per Publisher)

SN	Organizations	Mean and CV	Elsevier	Springer Link	Taylor and Francis (T & F)	Emerald	John Wiley (Inter-Science)	Black well	Cambridge University Press (CUP)	American Institute of Aeronautics and Astronautics (AIAA)	Oxford University Press (OUP)
1	ADA	Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		CV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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2	ISRO-ISTRAC	Mean	570.00	2.50	0.00	0.00	0.00	0.00	0.00	6.75	0.00
		CV	74.56	200.00	0.00	0.00	0.00	0.00	0.00	116.89	0.00
3	IISc	Mean	0.00	19355.25	0.00	2800.00	0.00	0.00	0.00	0.00	0.00
		CV	0.00	156.36	0.00	120.44	0.00	0.00	0.00	0.00	0.00
4	JNCASR	Mean	2901.50	0.00	43.50	0.00	432.75	46.25	100.00	0.00	137.25
		CV	81.60	0.00	157.42	0.00	55.56	138.67	66.96	0.00	82.79
5	NAL	Mean	24909.25	1850.75	147.75	0.00	2117.50	0.00	211.50	0.00	37.25
		CV	87.94	107.57	200.00	0.00	97.13	0.00	86.94	0.00	200.00
Total Mean Scores of e-Journal Downloads Per Year / Per Publisher		Mean	5676.15	4241.70	38.25	560.00	510.05	9.25	62.30	1.35	34.90
		CV	233.22	338.28	350.58	315.22	230.87	343.54	186.38	309.93	219.91
P Values			0.011	0.234	0.493	0.067	0.022	0.134	0.013	0.057	0.024
Cumulative e-Journal Downloads for the Period (2005-2008)			113523.00	84834.00	765.00	11200.00	10201.00	185.00	1246.00	27.00	698.00

Table 2 : Contd..

SN	Organizations	Mean and CV	American Society of Mechanical Engineers (ASME)	American Society of Civil Engineers (ASCE)	American Mathematical Society (AMS)	American Chemical Society (ACS)	Elsevier – Science Direct	American Institute of Physics (AIP)	Indian National Science Academy (INSA)	Indian Academy of Sciences (IAS)
1	ADA	Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		CV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	ISRO-ISTRAC	Mean	55.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		CV	125.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	IISc	Mean	4069.25	1279.75	0.00	0.00	222069.50	0.00	0.00	0.00
		CV	147.68	151.92	0.00	0.00	115.75	0.00	0.00	0.00
4	JNCASR	Mean	0.00	0.00	0.00	0.00	39.25	29.25	0.00	0.00
		CV	0.00	0.00	0.00	0.00	200.00	200.00	0.00	0.00
5	NAL	Mean	985.00	45.50	0.00	299.33	0.00	1405.00	0.00	0.00
		CV	72.68	200.00	0.00	78.19	0.00	94.04	0.00	0.00
Total Mean Scores of e-Journal Downloads Per Year / Per Publisher		Mean	1021.85	265.05	0.00	47.26	44421.75	286.85	0.00	0.00
		CV	283.22	351.80	0.00	289.06	308.15	271.23	0.00	0.00
P Values			0.207	0.202	0.000	0.002	0.054	0.014	0.000	0.000
Cumulative e-Journal Downloads for the Period (2005-2008)			20437.00	5301.00	0.00	898.00	888435.00	5737.00	0.00	0.00

Table 2 : Contd..

SN	Organizations	Mean and CV	Royal Society of Chemistry (RSC)	Royal Society of London (RSL)	Web of Science	IEEE	Journals (Individual Titles)		
							Journal of Atmospheric Sciences	Air Force – Airman	Aircraft Engineering and Aerospace Technologies
1	ADA	Mean	0.00	0.00	0.00	104.75	0.00	0.00	0.00
		CV	0.00	0.00	0.00	125.94	0.00	0.00	0.00
2	ISRO-ISTRAC	Mean	0.00	0.00	0.00	0.00	0.00	0.00	2.75
		CV	0.00	0.00	0.00	0.00	0.00	0.00	68.72
3	IISc	Mean	0.00	0.00	131917.25	0.00	0.00	0.00	0.00
		CV	0.00	0.00	115.66	0.00	0.00	0.00	0.00
4	JNCASR	Mean	0.00	112.75	0.00	0.00	0.00	0.00	0.00
		CV	0.00	55.71	0.00	0.00	0.00	0.00	0.00
5	NAL	Mean	169.50	40.50	0.00	0.00	0.00	0.00	0.00
		CV	138.23	117.58	0.00	0.00	0.00	0.00	0.00
Total Mean Scores of e-Journal Downloads Per Year / Per Publisher		Mean	33.90	30.65	43972.42	20.95	0.00	0.00	0.55
		CV	342.83	179.11	233.79	323.57	0.00	0.00	247.27
P Values			0.132	0.001	0.403	0.085	0.000	0.000	0.001
5	NAL	Mean	169.50	40.50	0.00	0.00	0.00	0.00	0.00
		CV	138.23	117.58	0.00	0.00	0.00	0.00	0.00
Total Mean Scores of e-Journal Downloads Per Year / Per Publisher		Mean	33.90	30.65	43972.42	20.95	0.00	0.00	0.55
		CV	342.83	179.11	233.79	323.57	0.00	0.00	247.27

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P Values		0.132	0.001	0.403	0.085	0.000	0.000	0.001
Cumulative e-Journal Downloads for the Period (2005-2008)		678.00	613.00	527669.00	419.00	0.00	0.00	11.00

To Be Answered By Chief Librarian / Web Administrator / Network Administrator / Sc.In.Charge E-Journals Full-Text Download

Questionnaire

E-Journal: Web Log Analysis Or Transaction Log Analysis Of Full Text Journal Downloads

1. Amongst the following reputed publishers of international journals, what is the total number of full-text journal article download over the last 4 years with specific reference to Aerospace Research?

Number of Full-Text Downloads from these Publishers of Electronic Journals:	2005	2006	2007	2008
(1) Elsevier				
(2) Springer Link				
(3) Taylor and Francis (T&F)				
(4) Emerald				
(5) John Wiley (Inter-Science)				
(6) Blackwell				
(7) Cambridge University Press (CUP)				
(8) American Institute of Aeronautics and Astronautics (AIAA)				
(9) Oxford University Press (OUP)				
(10) American Society of Mechanical Engineers (ASME)				
(11) American Society of Civil Engineers (ASCE)				
(12) American Mathematical Society (AMS)				
(13) Elsevier – Science Direct				
(14) American Institute of Physics (AIP)				
(15) Indian National Science Academy (INSA)				
(16) Indian Academy of Sciences (IAS)				
(17) Royal Society of London (RSL)				
(18) IEEE				
JOURNALS (Individual Titles):				
(1) Journal of Atmospheric Sciences				
(2) Airforce – Airman				
(3) Aircraft Engineering and Aerospace Technologies				
Grand Total:				

2. What is the total number of downloaded full-text e-journals from January to December 2005?

Sl. No.	Publishers of Full Text E-Journals	YEAR 2005											
	MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
(1)	Elsevier												
(2)	Springer Link												
(3)	Taylor and Francis (T&F)												
(4)	Emerald												
(5)	John Wiley (Inter-Science)												
(6)	Blackwell												
(7)	Cambridge University Press (CUP)												

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(8)	American Institute of Aeronautics and Astronautics (AIAA)												
(9)	Oxford University Press (OUP)												
(10)	American Society of Mechanical Engineers (ASME)												
(11)	American Society of Civil Engineers (ASCE)												
(12)	American Mathematical Society (AMS)												
(13)	Elsevier – Science Direct												
(14)	American Institute of Physics (AIP)												
(15)	Indian National Science Academy (INSA)												
(16)	Indian Academy of Sciences (IAS)												
(17)	Royal Society of London (RSL)												
(18)	IEEE												
(19)	**JOURNALS (Individual Titles):**												
	(1) Journal of Atmospheric Sciences												
	(2) Airforce – Airman												
	(3) Aircraft Engineering and Aerospace Technologies												

3. What is the total number of downloaded full-text e-journals from January to December 2006?

Sl. No.	Publishers of Full Text E-Journals	YEAR 2006											
	MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
(1)	Elsevier												
(2)	Springer Link												
(3)	Taylor and Francis (T&F)												
(4)	Emerald												
(5)	John Wiley (Inter-Science)												
(6)	Blackwell												
(7)	Cambridge University Press (CUP)												
(8)	American Institute of Aeronautics and Astronautics (AIAA)												
(9)	Oxford University Press (OUP)												
(10)	American Society of Mechanical Engineers (ASME)												
(11)	American Society of Civil Engineers (ASCE)												
(12)	American Mathematical Society (AMS)												

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(13)	Elsevier – Science Direct												
(14)	American Institute of Physics (AIP)												
(15)	Indian National Science Academy (INSA)												
(16)	Indian Academy of Sciences (IAS)												
(17)	Royal Society of London (RSL)												
(18)	IEEE												
(19)	JOURNALS (Individual Titles):												
	(1) Journal of Atmospheric Sciences												
	(2) Airforce – Airman												
	(3) Aircraft Engineering and Aerospace Technologies												

4. What is the total number of downloaded full-text e-journals from January to December 2007?

Sl. No.	Publishers of Full Text E-Journals	YEAR 2007											
	MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
(1)	Elsevier												
(2)	Springer Link												
(3)	Taylor and Francis (T&F)												
(4)	Emerald												
(5)	John Wiley (Inter-Science)												
(6)	Blackwell												
(7)	Cambridge University Press (CUP)												
(8)	American Institute of Aeronautics and Astronautics (AIAA)												
(9)	Oxford University Press (OUP)												
(10)	American Society of Mechanical Engineers (ASME)												
(11)	American Society of Civil Engineers (ASCE)												
(12)	American Mathematical Society (AMS)												
(13)	Elsevier – Science Direct												
(14)	American Institute of Physics (AIP)												
(15)	Indian National Science Academy (INSA)												
(16)	Indian Academy of Sciences (IAS)												
(17)	Royal Society of London (RSL)												
(18)	IEEE												

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(19)	JOURNALS (Individual Titles): (1) Journal of Atmospheric Sciences (2) Airforce – Airman (3) Aircraft Engineering and Aerospace Technologies												

5. What is the total number of downloaded full-text e-journals from January to December 2008?

Sl. No.	Publishers of Full Text E-Journals	YEAR 2008											
	MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
(1)	Elsevier												
(2)	Springer Link												
(3)	Taylor and Francis (T&F)												
(4)	Emerald												
(5)	John Wiley (Inter-Science)												
(6)	Blackwell												
(7)	Cambridge University Press (CUP)												
(8)	American Institute of Aeronautics and Astronautics (AIAA)												
(9)	Oxford University Press (OUP)												
(10)	American Society of Mechanical Engineers (ASME)												
(11)	American Society of Civil Engineers (ASCE)												
(12)	American Mathematical Society (AMS)												
(13)	Elsevier – Science Direct												
(14)	American Institute of Physics (AIP)												
(15)	Indian National Science Academy (INSA)												
(16)	Indian Academy of Sciences (IAS)												
(17)	Royal Society of London (RSL)												
(18)	IEEE												
(19)	JOURNALS (Individual Titles): (1) Journal of Atmospheric Sciences (2) Airforce – Airman (3) Aircraft Engineering and Aerospace Technologies												

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6. What is the most preferred file format of full-text download amongst the different aerospace journal publishers for the years 2005-2008?

P = Acrobat (.PDF format), W = MS-Word (.DOC format), H = HTML (.html format), O = Others.

Number of Full-Text Downloads from these Publishers of Electronic Journals:		2005				2006				2007				2008			
		P	W	H	O	P	W	H	O	P	W	H	O	P	W	H	O
(1)	Elsevier																
(2)	Springer Link																
(3)	Taylor and Francis (T&F)																
(4)	Emerald																
(5)	John Wiley (Inter-Science)																
(6)	Blackwell																
(7)	Cambridge University Press (CUP)																
(8)	American Institute of Aeronautics and Astronautics (AIAA)																
(9)	Oxford University Press (OUP)																
(10)	American Society of Mechanical Engineers (ASME)																
(11)	American Society of Civil Engineers (ASCE)																
(12)	American Mathematical Society (AMS)																
(13)	Elsevier – Science Direct																
(14)	American Institute of Physics (AIP)																
(15)	Indian National Science Academy (INSA)																
(16)	Indian Academy of Sciences (IAS)																
(17)	Royal Society of London (RSL)																
(18)	IEEE																
(19)	JOURNALS (Individual Titles): (1) Journal of Atmospheric Sciences																
	(2) Airforce – Airman																
	(3) Aircraft Engineering and Aerospace Technologies																

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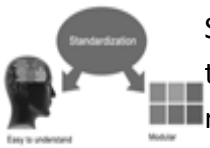

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3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

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- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

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- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

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- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

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- Submit to work done by specific persons (including you) in past tense.
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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
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Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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