

Requirement Analysis Document in Google Drive for Green and Sustainable Software Engineering Approach

M. Mohankumar, M Anand Kumar, S.Aruna Devi, R.Suresh Kumar

Abstract: *This study shows how a requirement analysis can help to organizations become more environmentally sustainable in a structured and efficient manner, for this we have analyzed the Google Drive document as a requirement analysis document with the help of that document we try to cover the software requirement specification from the customer, then we try to observe the if that document located in desktop pc what is the cumulative processor energy, IA energy and GT energy, if that document shared with cloud environment minimum and maximum communication of resource sharing details are analyzed for user base and data center of various regions, finally the load event details are observed for the requirement document shared in the Google drive , This result show that the technologies delivers specific suggestions for improvement both on reducing the environmental foot print of ICT and on using ICT as a green solution for software requirement analysis process.*

Keywords: *Green ICT, IA Energy, GT Energy, Google Drive, Software Requirement Specification*

I. INTRODUCTION

Requirement elicitation (RE) has much attention in research and practice due to its importance to software project success. Requirements directly contribute to appropriateness and cost effectiveness in the development of a system. Where by RE is determinant of productivity and product quality. Improper RE makes the implementation of the entire requirement not feasible. Thus a proper decision has to be made on the Requirement engineering process for the project to be successful. Requirement elicitation is the beginning stages in the software development life cycle. If the project failure is due to poor communication with analyst and user, so the objective of RE process is required to solve problems. Now days much technology has introduced for Requirement Elicitation technique and provided with various possible technologies. So requirement Engineering can use these options for adopting green methodologies for developing software RE should focus on green environment how to achieve this green environment

Manuscript published on 30 November 2018.

*Correspondence Author(s)

Dr.M.Mohankumar, Assistant Professor Department of CS, IT and CA, Karpagam Academy of Higher Education, Coimbatore, Tamil Nadu, India.

Dr. M Anand Kumar, Professor, Adigrat University Ethiopia

Mrs.S.Aruna Devi, Assistant Professor, Department of Science and Humanities, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India.

R. Suresh Kumar, Assistant Professor, Department of Electrical and Electronics Engineering, Kumaraguru College of Technology, Coimbatore Tamil Nadu, India.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

on earth. In the literature, found that the different elicitation technique depends on time and resources and green software engineering. In the modern requirements elicitation technique how it is helpful for green software system for reducing the environmental impacts during the requirement analysis or gathering the extent of requirement elicitation process. Therefore we have two research questions

1. How the modern technologies used for requirement engineering process?
2. If any one of the modern technologies reduces the processor power consumption while collecting the requirement for software development process?

II. RELATED WORK

A continuous research methodology are being proposed from recent years to find the best suitable technique for observe the requirement analysis in green based software development life cycle approach ruzanna chitchya et al[1](sustainability design in RE)were among the first to find out and suggested the sustainability education and rethink about professional norms and practices about software development life cycle phases, they also observer the individual findings about sustainability in requirement engineering process in professional environment and norms in professional practice, mendez Fernandez et.al[2] tried to demonstrate practical difficulty related to Requirement engineering problems which constitutes a qualitative analysis of data that being obtained from 228 companies working out in ten different countries in various domain and reveal the problems faced by the practitioners they finding more than ten problems that is related to requirement engineering that is incomplete and /or hidden requirements, flaws in communication between requirement engineer and customer, certain changes in business processes and goals, un specified requirement, time boxing, misunderstanding about the requirement project team, not giving proper support by customer while gathering the requirement, and weak access about customer requirement. Swati et al[3] recommended a software requirement prioritization technique using fuzzy logic, they studied and finding out the influence factors in requirement prioritization almost 14 technique and factors they stated like consistency, traceability, priority basis etc. they created a framework methodology in three phases that in training phase, fuzzy

inference process, and testing phase and finally try to prove the predictable appropriate requirement prioritization method. ummakhatauna[4] trying to declaring the green software engineering adaption in requirement elicitation process, tried to adopt the new green software systems using existing technique and also demonstrate. Albert hankel [5] highlight that ICT as a green solution for business processes , they further stated that participation of individuals like customer or requirement engineer awareness on what Green ICT can do improve the sustainability of a software engineering process in software development life cycle phases and also they identified the potential bottlenecks for further adoption about Green ICT. Erik jagroep [6] argue that rising energy consumption of ICT industry triggered for more sustainability so they recommended the energy consumption based on software architecture. Paul [7] suggest that the going green in ICT it will help to promote an eco-friendly and cleaner ecology it will also help to get benefit like cost cutting, energy consumption and green house gases. They further says green computing is a great development for future. Christoph becker et e [8] find out software engineering practices for sustainability standard current practice and focus of future practice in that they stated the requirement elicitation for current practice focus on the features and immediate effects the stakeholders want in future the stakeholders understand the systems enabling effects use creativity technique and long term scenarios to forecast the potential structural impact then they says requirement validation key stakeholders verify that their interest are captured it ensure the understanding effects, in the requirement documentation task they find out the current format of documentation not considering the sustainability in future practice of requirement documentation template need to support analysts with check list. colin c. and Norbert seyff[9] also highlights the study that explored the concept of sustainability requirement in order to understand how the term is being used in software and requirement engineering, in the design of study in which they combines corpus linguistics and qualitative content analysis. Finally the analysis shows the sustainability requirement may be considered as a red herring in the sense that it is constructed. Vivek shukla et el [10] tried to conduct a survey about requirement engineering in that they find out different types of requirements they are BRD that is business requirement documents, URD that is User requirement document, SRD Software requirement document it is further divided into two that is functional requirement and non functional requirements, they specifically stated the software failure occur because of bad requirement engineering.

Marimuthu and Chandrasekaran[12] tried to identify the systematic mapping study for green and sustainable software engineering in that study they did software engineering research topic classification in that software requirement and energy and sustainability related aspect topics was considered in 18 studies were published from 2010 to may 2016. his research stated that more green and sustainability related requirement analysis methodology need to be done in future. komeil raisian[13] introduced a current challenges related to green and sustainable software engineering he was created a conceptual model of the study

in that he was taken a SPLC (software product life cycle) phases of development ,distribution ,usage ,disposal and deactivation, in this conceptual model also not consider the requirement analysis in green and sustainable aspect. Damiano Torre[14] suggested the green and sustainable software engineering in higher education curriculum it was good idea to teach the student about green and sustainability in early stages itself. Nasir Rashid[15] stated the risk factors for vendors in green and sustainable software development method in agile technique in that they indentified the eight risk factors the very first risk factor was insufficient system documentation frequency range from 26 to 62 percentage. Amit Mishra [16] stated the problems facing in requirement gathering , the problem due to communication gap between software developer and customer, some important requirement missing because of the various software development process these factors affect the quality aspect of the software. Maqbool Ahmed Muhammad Azeem[17] stated that importance, the project requirement documents are the backbone of the project success and failures in that maqbool analysed the project success rate from 1994 to 2000 in that mainley identified factor was incomplete requirement details are 13.10%. reason for project failure. Hassan Reza[18] in that contribution of work describe the design of requirement engineering tool it can be used to speed up the requirement elicitation and system specification to improve the qualities in the areas of avilibility, performance, and security based on quality attributes try to document the non functional requirements and quality aspect template. Huma Hayat Khan[19] describe the global software development time how the requirement engineering process influencing and creating a challenging task like cultural and language differences, working time, communication and coordination creating different challenges influencing the requirement engineering process and finally it concluded GSD based requirement engineering process. Supavas Sithithanasakul [20] tried to contribute the new approach of software requiremnt engineering ontology construction for the structured software requirement engineering process . These related work shows what happen in requirement engineering process, it is because of there is no user friendliness in maintain the document in both the customer and end user side so we tried the new approach with the help of Google drive document.

III. RESEARCH METHODOLOGY

The overarching research question guiding our analysis is the following how does current requirement technologies playing a role in green sustainability in the software requirement analysis. To answer it we conduct a analysis technique about green and sustainability with different software development teams. A selective set of questions that is related to green and sustainability aspect we raise this questions to the various software development team and also with the help of the modern technology we try to observe the energy consumption ,CO2 emission , memory and CPU utilization with the help of this factors we try to describe

how the modern technology play a important role during software requirement analysis approach.(4 Umma khantuna jannat) find out three different classic requirement elicitation process there are interviewing, document anlaysis, interface analysis.

Interviewing: It's a most common technique for requirement analysis used by the software companies. This process mostly based on question and answers with the help of that question and answer try to discover the problem it may be some time open discussion or direct meet with the customer this classical methodology document mostly maintain by paper base with different types of environment some of the basic interview questions are mentioned in the sustainability back ground check, sustainability related to guideline in company [12].

Sustainability background check

1. Which of the following apply when it comes to your Knowledge of sustainability?
 - a. You read about it in the news
 - b. You regularly have discussions with friends/family/colleagues about it
 - c. You have read (at least one) book about it
 - d. You learn through active engagement in community activities or political action
 - e. You have a degree in a related discipline
 - f. What else describes your knowledge and sources of knowledge in sustainability? List anything that comes to your mind.
2. What do you do for sustainability in your daily private life? Please list some concrete examples.
3. What do you do for sustainability in daily work life? Please list some concrete examples
4. What is your understanding of the term "sustainability"? Sustainability guidelines in place
5. Are you aware of any standards/guidelines in your company that relate to sustainability? (yes/no/I don't know). If yes, which one(s)

Requirement elicitation process for implementation:

Here we maintain the Google drive document for maintain the requirement and enhancement process of software industries instead of paper base Figure 1 shows the template format for requirement analysis process for one leading software company for educational software development team and customer.



Figure 1 shows the template format for requirement analysis process for one leading software company for educational software development team and customer.

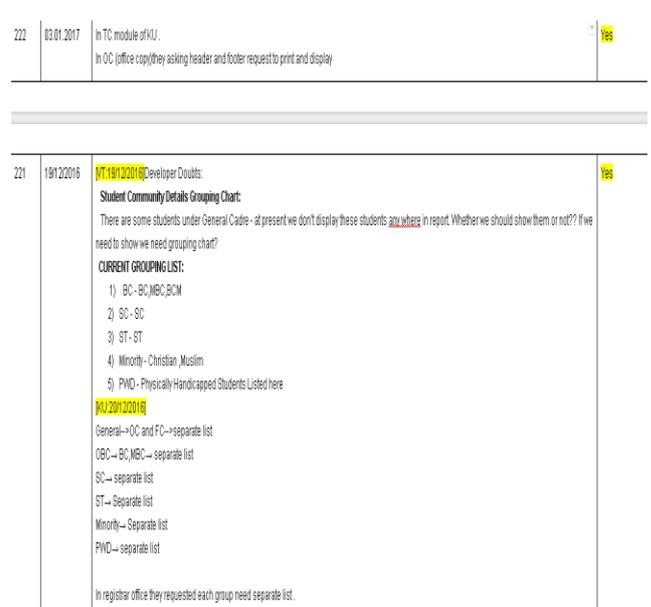


Figure 2 describe the requirement representation details

Based on this document the requirement engineer or observer first have to type the requirement date, month and year details, then they have to give the detail requirement details for example if the requirement engineer type the following requirement information in the requirement details column the following figure 2 describe the requirement representation details

The serial no 221 the details given by the requirement engineer about student community details grouping chart for that the development team asking some clarification and also they display the current grouping list in existing software package again the requirement engineer how the customer was expected in software like that he /she typed in requirement analysis sheet that was maintained in Google drive doc. If they developer completed that process then they give the process completion date after the buddy testing process that required changes released to the customer that also mentioned in the released date column. This document will helpful to software requirement observation this document was shared with the both the development team and requirement engineer and customer this type of document will helpful to maintain the sustainability in requirement elicitation process.

Method of analysis:

Desktop

We try to analysis the requirement document in desktop PC process with the help of tool Intel power gadget this tool help to find out the RDTSC(Read Time- Stamp Counter)in GhZ, Elapsed time in (seconds) CPU frequency, processor power, cumulative processor energy in joules and mWh(megawatt hour), IA power in Watt, Cumulative IA energy in (joules) and energy in(mWh), package temperature(cool and hot) GT(Generator Transformer) Power in Watt, cumulative GT energy(joules)and(mWh) these are all evaluated in CPU load and idle time and also try to observe the memory utilization process the memory usage related to running the document. Table 1 Shows the statistical information about document in the idle time and processing time average power process details are mentioned in Watt, total elapsed time(sec) and measured RDTSC frequency in (Ghz). It's mostly in same in requirement document process and idle and time.

Cloud analyst:

This is the one of the approach if suppose if that Requirement analysis document will maintained in the cloud what is response time by various region, user base hourly average response time in millisecond in the minimum and maximum details we will get, same way data center request servicing time also examine the data center loading, total virtual machine cost and total data transfer cost are observed with the help of clod analyst.

Evaluation:

For example the requirement analysis document will be shared to six regions that is Region zero north America,Region one south America, region two---- region three Asian countries region four African countries and region five Australia as shown in the figure , if we fix the document sharing simulation duration sixty minute for the

user bases from one to six user base for six region it shown in figure 3

Parameters	Idle time			process time		
	joules	mWh	Ave. process power. Watt	joules	mWh	Ave. process power. Watt
Cumulative processor Energy	1465.73	407.15	4.71	2064.96	573.60	6.61
Cumulative IA Energy	380.39	105.66	1.22	946.14	262.82	3.03
Cumulative GT Energy	53.68	14.91	0.17	65.49	18.19	0.21

Table 1 Shows the statistical information about document in the idle time and processing time average power process details are mentioned in Watt, total elapsed time(sec) and measured RDTSC frequency.

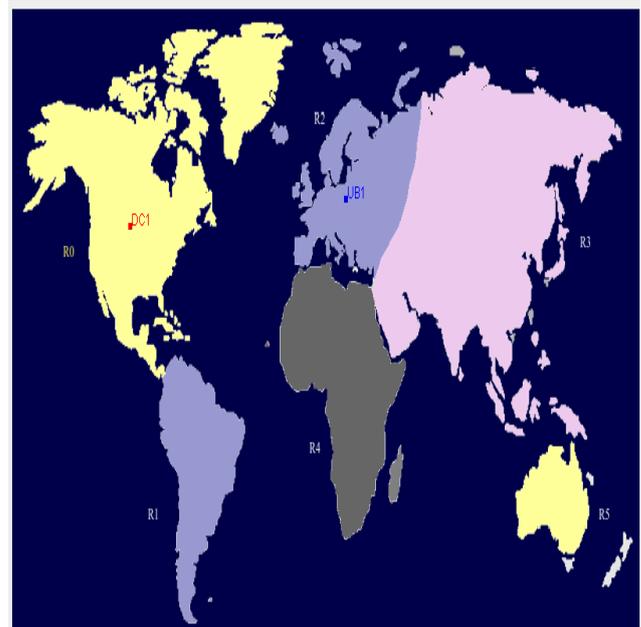


Figure 3: Document sharing simulation duration sixty minute for the user bases from one to six user base for six region

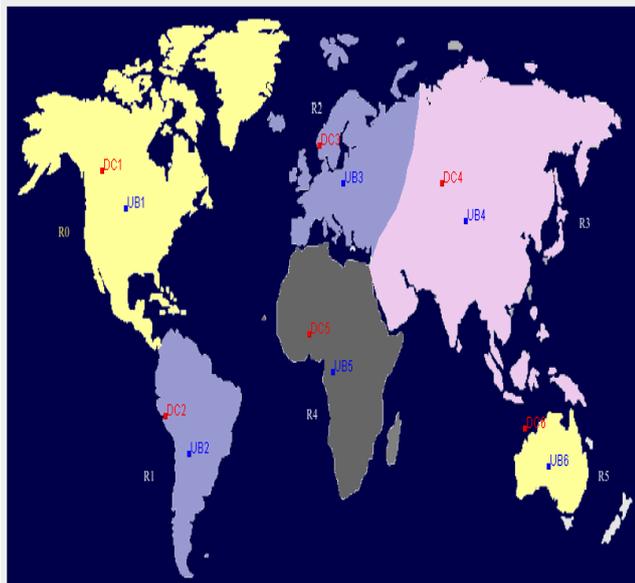


Figure 4 shows the user base for each and every regions was displayed that is(Data center) DC1 (User Base)UB1 in region 0, DC2 UB2 for Region1, DC3 UB3 for Region2, DC4 UB4 for Region 3, and DC6 UB6 for region 5. If we run the simulation then it will show the following details overall response time summary for the requirement document sharing Table 2, Response time by region table 3, Data center request servicing time in table 4.

Details	Avg (ms)	Min (ms)	Max (ms)
Overall response time:	50.11	37.61	61.06
Data Center processing time	0.49	0.02	0.90

Table 2 show the overall response time summary for the requirement document sharing.

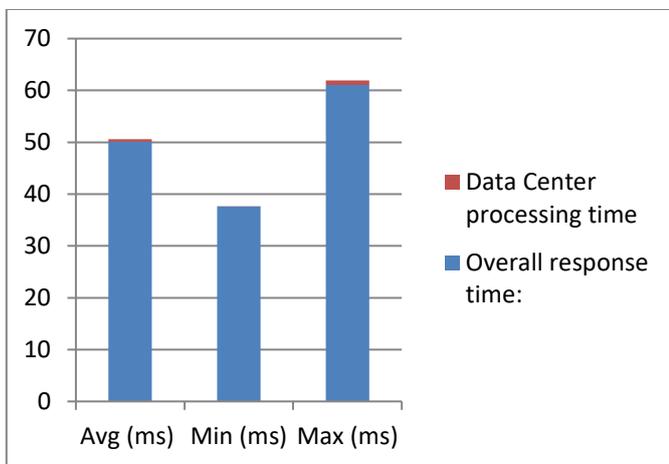


Figure 5 : Data center processing time and overall response time in (ms)

Userbase	Avg (ms)	Min (ms)	Max (ms)
UB1	50.19	37.61	60.86
UB2	49.99	38.64	60.40
UB3	49.95	38.88	61.06
UB4	50.24	39.14	60.88
UB5	50.16	37.66	60.66
UB6	50.11	38.86	60.61

Table 3 shows the Response time by region

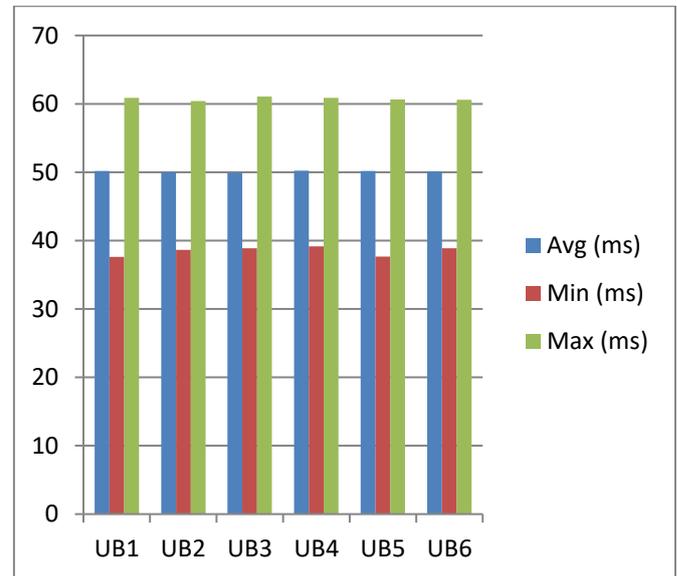


Figure: 6 shows the user base Response time details

Data center	Avg (ms)	Min (ms)	Max (ms)
DC1	0.46	0.02	0.86
DC2	0.50	0.03	0.89
DC3	0.49	0.02	0.88
DC4	0.50	0.02	0.88
DC5	0.50	0.03	0.90
DC6	0.46	0.02	0.86

Table 4 shows the Data center request servicing time

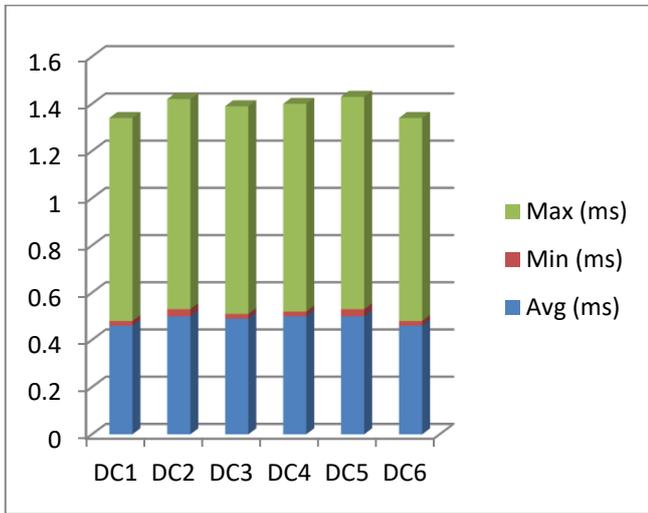


Figure7: Data center request details

So with the help of the cloud analysis tools the requirement document sharing with various datacenter to user base minimum, maximum and average request and response times we will get it will concluded that instead of maintaining the requirement document in desktop pc if we maintain the document in cloud it will save the energy and resource of the company. The figure 8 shows the simulation result as follow as

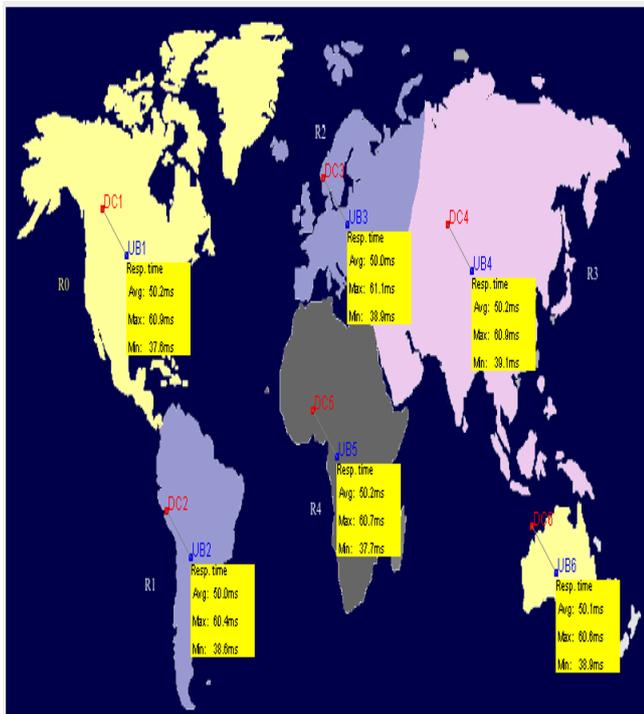


Figure 8: simulation result

Google Drive document act as requirement document. Suppose if the requirement analysis document sharing in Google drive doc, the user could consider the three main activities first one Google mail account opening time that is page loading time of the Google mail account of the user, second main activity google drive document page loading time interval finally process was page loading time of the requirement analysis document sharing the page load time.

Event	When	How long	Sum
Redirect	0	0	0
DNS	0	0	0
Connect	0	0	0
Request	0	546	546
Response	546	510	1056
Dom	569	8124	9180
Interactive	1632	0	-
Content Load	1632	0	-
Load Event	8694	0	9180

Table 5 shows the Google mail opening record details in 8.6ms.

Event	When	How long	Sum
Redirect	0	446	446
DNS	446	0	446
Connect	446	0	446
Request	626	323	769
Response	949	1668	2437
Dom	952	6096	8533
Interactive	2713	0	-
Content Load	2713	0	-
Load Event	7079	2	8535

Table 6 Google Drive page loading

Event	When	How long	Sum
Redirect	0	0	0
DNS	0	0	0
Connect	0	0	0
Request	28	6238	6238
Response	6266	691	6929
Dom	6271	5858	12787
Interactive	9010	0	-
Content Load	9010	0	-
Load Event	12129	0	12787

Table 7 Requirement analysis document sharing the page load

So it the above table record details shows the maximum of 12.1 ms is enough to share the requirement analysis document to team members of the development team and also it will give the transparency in maintaining the document in both the customer and development team energy consumption also is very much reduced instead of maintaining the document in desktop computer.

IV. CONCLUSION

In this paper we proposed a requirement analysis technique with the modern technology how it is differ from traditional approaches for example here we are using the of Google drive document how to act as a requirement engineering for observing the requirement of the end user for the software company, here we also concluded that the requirement document if we used in individual personal computer. The energy utilization in individual desktop pc observed suppose if that document if we saved in cloud environment minimum and maximum response time of the various regions are analyzed , finally we concluded the Google drive document in shared environment with the end user and development team, request and response load event details are observed finally we concluded instead of maintaining the requirement document in manual or desktop Pc cloud based requirement analysis document approach was the best one compare to other approach it will save the time and energy of individual and group of development teams it also give the sustainable approach for software development life cycle phases.

REFERENCES

1. R. Chitchyan *et al.*, "Sustainability Design in Requirements Engineering: State of Practice," 2016 *IEEE/ACM 38th International Conference on Software Engineering Companion (ICSE-C)*, Austin, TX, 2016, pp. 533-542.
2. D. Mendez Fernandez, S. Wagner Naming the Pain in Requirements Engineering: Design of a Global Family of Surveys and First Results from GermanyIn: Proc. of the 17th International Conference on Evaluation and Assessment in Software Engineering (EASE '13), ACM, 2013.
3. S. Dhingra, Savithri G, M. Madan and Manjula R, "Selection of prioritization technique for software requirement using Fuzzy Logic and Decision Tree," 2016 Online International Conference on Green Engineering and Technologies (IC-GET), Coimbatore, 2016, pp. 1-11. doi: 10.1109/GET.2016.7916822
4. Umma Khatuna Jannat ,” Green Software Engineering Adaption In Requirement Elicitation Process”2016 international journal of scientific & technology research volume 5, issue 08, august 2016 issn 2277-8616
5. A. Hankel and P. Lago, "How organisations can assess and improve their green ICT activities in a standard and efficient way," 2016 ITU Kaleidoscope: ICTs for a Sustainable World (ITU WT), Bangkok, 2016, pp. 1-6
6. Erik Jagroep” Extending software architecture views with an energy consumption perspective Computing, 2017, Volume 99, Number 6, Page 553
7. Paul p.k,”Is green computing a social software engineering domain?”,2016 international journal of applied science and engineering 4(2).PP.67-73
8. Becker, Colin (2016) Requirements: The Key to Sustainability. IEEE S oftware, 33 (1). pp. 56-65. ISSN 07407459
9. C. C. Venters et al., "Characterising Sustainability Requirements: A New Species Red Herring or Just an Odd Fish?," 2017 *IEEE/ACM 39th International Conference on Software Engineering: Software Engineering in Society Track (ICSE-SEIS)*, Buenos Aires, 2017, pp. 3-12.
10. Vivek Shukla, Dharendra Pandey and Raj Shree. Article: Requirements Engineering: A Survey. Communications on Applied

- Electronics3(5):28-31, November 2015. Published by Foundation of Computer Science (FCS), NY, USA
11. C. Becker, D. Walker and C. McCord, "Intertemporal Choice: Decision Making and Time in Software Engineering," 2017 *IEEE/ACM 10th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE)*, Buenos Aires, 2017, pp. 23-29
12. C. Marimuthu K. Chandrasekaran," Software Engineering Aspects of Green and Sustainable Software: A Systematic Mapping Study". Proceedings of the 10th Innovations in Software Engineering Conference Jaipur, India 2017 PP[34-44]
13. Komeil raisian," Current Challenges And Conceptual Model of Green And Sustainable Software Engineering," *Journal of Theoretical and Applied Information Technology* 31st December 2016 -- Vol. 94. No. 2 – 2016
14. D. Torre, G. Procaccianti, D. Fucci, S. Lutovac and G. Scanniello, "On the Presence of Green and Sustainable Software Engineering in Higher Education Curricula," 2017 *IEEE/ACM 1st International Workshop on Software Engineering Curricula for Millennials (SECM)*, Buenos Aires, 2017, pp. 54-60.
15. Rashid," Developing Green and Sustainable Software Using Agile Methods in Global Software Development: Risk Factors for Vendors",2017 Proceedings of the 11th International Conference on Evaluation of Novel Software Approaches to Software Engineering ENASE 2016 PP 247—253
16. Maqbool Ahmed Muhammad Azeem," Requirement Engineering the backbone of a project ", 2017, [www.researchgate.net/ publication/318787262](http://www.researchgate.net/publication/318787262),
17. H. Reza, R. Sehgal, J. Straub and N. Alexander, "Toward model-based requirement engineering tool support," 2017 *IEEE Aerospace Conference, Big Sky, MT*, 2017, pp. 1-10.
18. H. H. Khan, M. N. bin Mahrin and S. bt Chuprat, "Situational requirement engineering framework for Global Software Development," 2014 *International Conference on Computer, Communications, and Control Technology (I4CT)*, Langkawi, 2014, pp. 224-229.
19. S. Sithithanasakul and N. Choosri, "Application of software requirement engineering for ontology construction," 2017 *International Conference on Digital Arts, Media and Technology (ICDAMT)*, Chiang Mai, 2017, pp. 447-453.
20. S.Aruna devi, Dr.Vijeta Iyer, "A Study on M/M/C Queueing Model under Monte Carlo Simulation in Traffic Model", 2017, *International Journal of pure and Applied Mathematics(IJPAM)*, No:12, vol 116, pg:199-207.
21. <http://sustainabilitydesign.org>