

The Impact of Digital Library Resources' Usage on Research Productivity: A Study Among Engineering Students in Pakistan

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The role of digital library resources (DLRs) in accelerating academic and research productivity has been acknowledged worldwide. To examine its impact on engineering research in Pakistan, this study empirically explored the DLRs usage as predictor of respondents' satisfaction and research productivity. Quantitative research method was adopted to solicit viewpoints from a sample (n=196 out N=707) of Master and PhD students selected randomly from the public sector engineering universities in KPK, Pakistan. After the initial data screening, 177 questionnaires were processed as usable for statistical data analysis while five questionnaires with some missing values, erroneous or insufficient data were rejected. The response rate was computed as 90%. The findings of this empirical study show that the frequency of DLRs usage and purpose of DLRs significantly contributed to users' satisfaction and research productivity. In addition, a significant relationship was found between the independent variables IVs (DLRs Purpose, DLRs Frequency) and dependent variables DVs (users' satisfaction and research productivity). Outcomes of the study also supported all the four hypotheses between the variables. Major findings of this study could lead to further change in the provision of information sources by university libraries in order to support research efforts and make a scientific knowledge based society in the country. These outcomes are also helpful for HEC authority, university library administrators, LIS professionals /

Information providers to develop e-resources, formulate effective DLRs usage policies through which they could make best use of these resources. This study empirically examines the impact of DLRs usage on engineering research in the context of engineering universities in Pakistan.

Keywords Digital Library Resources Usage, Scholars' Satisfaction, Research productivity, Engineering students, Universities, Pakistan.

Introduction and Background

Digital library resources (DLRs) play a key role in education, research and learning environment (Chanson, 2007), and also serve as an important gateway to huge collections of scientific knowledge (Feng, Jeusfeld, & Jeroen, 2005). Historically, the medium of recording and accessing information has evolved from stone, papyrus, parchment, clay tablets, and paper to digital libraries. Since last 30 years, the existing printed library materials are almost changed into electronic format. DLRs have become an important source for researchers, academicians and students to retrieve material in electronic format for their various information tasks, as they rate these resources to be conveniently accessible from remote areas (PITAC, 2001; Samadi, Masrek, & Yatin, 2014). The role of researchers in the promotion of research culture has been recognized worldwide. They required fast access to authentic and intellectual information resources (Khan & Ahmed, 2013a). In this connection, the DLRs can assist them to create and expand the horizon of knowledge (Neuman, 1997), because the authenticity and

intellectual information in original formats are available there (Downs & Friedman, 1999; Gorton, 2007).

DLRs offers “not only convenient access to and retrieval of information resources but also easier acquisition of full-text information than do conventional library services (Samadi et al., 2014). Other features of DLRs include the rapid and fair access to DL materials, and the provision of various search techniques (Wiederhold, 1995). Due to these intensive advantages, in 2004, the Pakistani Higher Education Commission (HEC) started access to international DLRs to all universities, higher learning institutions, R & D bodies. Now these DLRs include near about 30 renowned electronic databases (e.g. Sciencedirect, Emerald, Sagepublication, Taylor & Francis, JSTOR, EBSCOhost, etc.) on major disciplines of human knowledge, more than 20,000 scientific journals and 45 thousand e-book collections (Khan & Ahmed, 2013a; Warraich & Kanwal, 2010). The HEC DLRs not only fulfills the information needs of faculty members and researchers, but also assists them in sustaining and recognizing local research efforts. Tahir, Mahmood, and Shafique (2008) observed the effect of HEC DLRs on users’ academic performance in Pakistan as they provide needed information resources to end users (Bhatti & Hanif, 2013; Jan & Sheikh, 2011). Vaidyanathan, Sabbaghi, and Bargellini (2005) observed that as DLRs were gradually becoming popular, there existed a need to examine the factors that could increase the impact of DLRs on research and innovation. The need exits to identify the factors that can intensify the impact of DLRs usage because users’ involvement in the evaluation of DLRs, and information system is a vital factor for developing a standard system and verifying system operation (Baroudi, Olson, & Ives, 1986).

In the past, numerous studies were carried out on the importance, usage, and satisfaction with HEC DLRs and services in the context of Pakistan (e.g. Ameen & Rafiq, 2009; Arif & Kanwal, 2009; Hussain & Mahmood, 2012; Khan, 2011-13; Khan & Ahmed, 2013a; Said, 2006; Tahir, Mahmood, &

Shafique, 2008; Warraich & Kanwal, 2010; Warraich & Tahira, 2009). Though, the researches were restricted to social science, management, humanities and medical science disciplines.

Engineering scientists work to provide safe, quick and less expensively solution to practical problems, by using mathematics, scientific knowledge and skills while considering technical restrictions (Nwagwu, 2012) and in this way they have a major contribution in making human life modern. Engineering students extensively use DLRs for various academic and research needs in developed as well as developing countries (Dhanavandan & Tamizhchelvan, 2012; Majid & Tan, 2002). In the context of Pakistan, research is needed to report the usage of DLRs and its impact on engineering research. Since the foundation of HEC DLRs, no study has been conducted to assess the impact of DLRs on engineering research output. In addition, it is unknown whether the frequency & purpose of DLRs usage positively predict researchers’ satisfaction & research productivity in engineering discipline. As a result, the rationale of the present study is to fill this gap by empirically investigating the association of users’ satisfaction and research productivity with two dimensions of DLRs, namely DLRs usage frequency and purpose of DLRs usage.

Research Framework

Research studies on evaluating DLRs from users’ perspectives have used various models and approaches (Samadi & Masrek, 2013). However, the most commonly used and popular approach is the user evaluation containing interaction between the users and the DLRs. Some evaluative studies were mainly concentrating on respondents’ characteristics, information seeking strategies, and their experiences with the usage of DLRs e.g. (Atilgan & Bayram, 2006; Khan, Ahmed, & Masrek, 2014; Monopoli, Nicholas, Georgiou, & Korfiati, 2002). Thong, Hong, and Tam (2002) examined (a) the interface attributes of DLRs (b) contents structure, (c) individual characteristics (i.e. Computer self-

efficacy, domain knowledge and computer usage experience), and (d) observed the usefulness of DLRs. In this study, the adopted framework was based on the previous research model (Delone & McLean, 1992; Delone & McLean, 2003) and it was tested empirically in various contexts and culture (Bernroider, 2008; Delone & Mclean, 2004; Masrek, Jamaludin, & Mukhtar, 2010; Masrek, Jusoh, Karim, & Hussein, 2009; Petter & McLean, 2009; Sabherwal, Jeyaraj, & Chowa, 2006; Samadi & Masrek, 2013; Samadi, Masrek, & Yatin, 2014; Tsakonas & Papatheodorou, 2008). Delone and McLean (1992) created a model known as '*Information Systems Success Model*' which is applied to assess the usefulness of information systems. The model was tested to examine the efficiency of university library web portal (Masrek et al., 2010). Masrek et al. (2009) modified the same model by incorporating other determinants such organizational culture and respondents' characteristics to explore the impact of company website. Another study adapted this model to evaluate the effectiveness of DL in the university of Tehran (Samadi &

Masrek, 2013). Samadi et al. (2014) used the Delone and McLean Model to study the influence of user characteristics and DL qualities on DL effectiveness. Based on the aforementioned framework, the present research adapted the same model (Figure 1) with the four enlisted hypotheses.

Hypotheses

H1: Frequency of DLRs usage positively predicts satisfaction.

H2: Purpose of DLRs usage positively predicts satisfaction.

H3: Frequency of DLRs usage positively predicts research productivity.

H4: Purpose of DLRs usage positively predicts research productivity.

In this model, the two factors of DLRs (DLRs frequency and DLRs purpose) are independent variables while satisfaction and research productivity are considered as dependent variables.

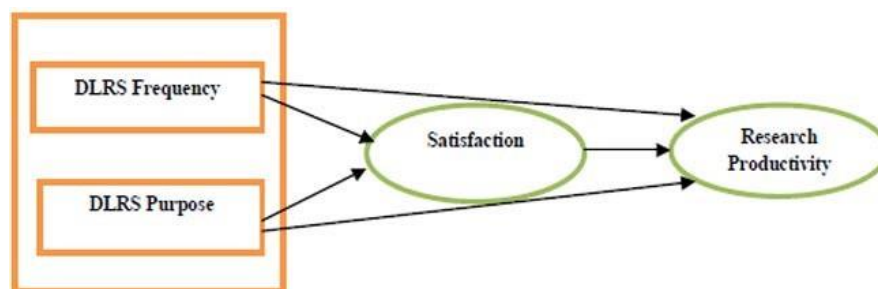


Figure 1. Research Framework

Review of the Literature

The review of the previous studies proposed two main types of DLRs usage success factors in the electronic environment, which are behavioral and attitudinal factors. Jung (1997) stated that measuring users' success in the DL environment, behavioral factors comprised of DLRs use and function, while attitudinal factor involved the respondents' satisfaction. The respondents' satisfaction is the mainly tested and accepted assessment of respondents' success in DL environment (Delone & McLean, 1992; Delone &

McLean, 2003), and recognized it as a determinant of system efficiency. Earlier researches recognized just the respondent role and the assessment of the respondent satisfaction was mainly related to respondents' familiarity and need attainments. In addition, respondent role also tested at the individual level rather than institutional level. Delone & McLean (2003) reported that prominent models in information system effectiveness, information authenticity and system attribute an impact on respondents' satisfaction.

Hence, empirically the study of the respondents' satisfaction and research productivity, as dependent variables, were required to be conducted within the perspective of the DL and electronic setting. The frequency of DLRs usage and the purpose of its use are significant constructs that positively predict satisfaction and research productivity. It is important to have a holistic assessment of these variables. This study strived to investigate the usage of DLRs by the engineering students in the context of academic institutes in Pakistan. An extensive review of relevant as well accessible studies was carried out on the frequency of the use of DLRs, the purpose of its usage, users' satisfaction and the impact of DLRs on research productivity. Hence, a modified conceptual framework was designed to conduct this study. The research model predicts a relationship between the frequency and the purpose of DLRs usage with satisfaction and research productivity of engineering students.

Samadi et al. (2014) surveyed 425 academic DL users aimed at verifying the IS success model and found that the DLRs usage was strongly related to user satisfaction and their individual sense of achievements. Furthermore, the study also revealed that the respondent tendency about DLRs, information authenticity and system efficiency were the predictors of DLRs usage. In a study, Majid and Tan (2002) observed that the students of engineering disciplines in Nan Yang Technological University Singapore used DLRs for different academic tasks and had a great influence on their academic and research performance. The usage patterns of Chinese students are also changing drastically from traditional library to DLRs and have a positive relationship between the usage patterns of DLRs and academic productivity (Zha, Li, & Yan, 2012). In addition, Dadzie (2005) surveyed 141 DL users of Ashesi University Ghana and reported a strong relationship between individual characteristics, IT infrastructure and DLRs. According to Dhanavandan and Tamizhchelvan (2012), the respondents in engineering institutions of Tamil

Nadu were more mostly consulted DLRs for various research tasks.

Bar-Ilan, Peritz, and Wolman (2003) evaluated the use of databases and e-journals among the engineering students at Israeli academic institutes and reported a positive relationship between the usage frequency of DLRs and various learning and research purposes. The same results were also explored by Ghosh (2009), who established a significant relationship between the DLRs, individual characteristics of engineering students and their purpose of usage in Maharashtra India. Furthermore, individual's experience was also correlated with research and innovative tasks (Carol Tenopir et al., 2003). Borrego, Anglada, Barrios, and Comellas (2007) believed that the researchers of natural and engineering disciplines mainly used DLRs for various academic and research activities. According to Mirza and Mahmood (2012), most of the students in the universities of Pakistan accepted DLRs and services for education and research needs.

The assessment of the impact on an individual covers a wide range of objective and subjective dimensions. Individual's satisfaction has been examined as a determinant of DL system success (Bowen & Guo, 2011; Delone & McLean, 1992). According to Samadi et al. (2014) "user satisfaction refers to the feeling of pleasure or displeasure that results from aggregating all the benefits that a person hopes to receive from the interaction with the library portal" (p.216). Numerous researches established positive relationships between individual usage of DLRs and users' satisfaction (Bhatt & Rana, 2011; Dhanavandan & Tamizhchelvan, 2012; Khan & Ahmed, 2013a; Mirza & Mahmood, 2012; Monopoli et al., 2002; Samadi & Masrek, 2013). Furthermore, multifarious studies have acknowledged the contribution of individual DLRs use in improving users' performance, especially in terms of research productivity, self-efficiency and scholarly communication (Arif & Kanwal, 2009; Atilgan & Bayram, 2006; Bollen & Luce, 2002; Chowdhury, Landoni, & Gibb, 2006; Grover, Jeong, & Segars, 1996; Jiang & Klein,

1999; Khan & Ahmed, 2013a; Khan et al., 2014; Rafiq & Ameen, 2012). The study by Khan and Ahmed (2013b) and Masrek et al. (2010) reported the role of DLRs usage in supporting research and academic achievements.

The aforementioned studies has recommend that the effectiveness of DLRs can be evaluated from the perspectives of users' task achievement and research productivity which also indicates their satisfaction with using DLRs. Similarly, several researchers have also adopted overall usage of DLRs for measuring users' satisfaction and also the impact of DLRs use on various education and research tasks. Therefore, keeping in views the findings of the above mentioned studies, this empirical research argues that DLRs usage and purpose of usage will be positively related with engineering scholars' satisfaction and impact on research. In addition, the available studies highlighted that no research has been done to report the impact of DLRs in promoting engineering research culture in Pakistani universities.

Research Methodology

Population and Sample

Survey research method was employed to gather data from the target population regarding the; frequency of usage, purpose, satisfaction level and impact of DLRs usage on research productivity. The survey method has been widely used in earlier LIS researches. The Master and PhD research scholars enrolled in the University of Engineering Peshawar and University of Science & Technology Bannu, [Pakistan] were investigated as sample for this survey. The target population was large (N=707) and in this sense the process of survey was difficult. Therefore, a random sample of 196 researchers, based on Bartlett, Kotrlik, and Higgins (Spring 2001) formula, was chosen with a margin error of ± 0.05 . The random sampling technique provides equivalent opportunity for each individual of the population to be selected

and eliminates bias during sample selection (Fraenkel & Wallen, 1996). The data collection process was completed by distributing the closed-ended questionnaire supported by a cover letter among the participants through their postal addresses, email contacts and by the personal visit of principal researcher in concerned universities and their research labs. In addition, the LIS professionals serving in the targeted universities also helped the researchers in collecting data from the research sample.

The collected data were checked for errors, missing values or insufficient responses. After that process, 177 instruments were processed as suitable for data analysis while five instruments were excluded. The response rate was computed as 90%. The screened data were analyzed through the use of IBM SPSS V.17 for testing the formulated hypotheses.

Validity and Reliability of the Questionnaire

The constructs were adapted and adopted from scales tested in past studies (Arbib & Shor, July 2002; Bar-Ilan & Fink, 2005; Bar-Ilan, Peritz, & Wolman, 2003; Bishop, Van, & Bittenfield, 2003; Khan & Ahmed, 2013; Warraich & Kanwal, 2010). The respondents' views were collected through a 5 point Likert measure to determine the purpose of use as; 5 = Most Frequently Use, 4= Frequent Use, 3= Occasional Use, 2 = Rarely Use, and 1= Never Use. In addition, the scale for satisfaction was determined as; 5 = Extremely Satisfied, 4 = Satisfied, 3 = Neutral, 2 = Unsatisfied and 1= Extremely Unsatisfied. The items for research productivity was categorized as; 5= Strongly Agree, 4= Agree, 3= Neutral, 2 = Disagree, and 1= Strongly Disagree. Cronbach's Alpha (CA) coefficient of the instrument were computed and reported as CA value for; purpose of usage (n= 12, $\alpha=0.877$), satisfaction (n=13, $\alpha=0.797$) and for research productivity was (n=9, $\alpha=0.930$) (Table1). A minimum CA of .70 is a standard value for conducting social science study (Spector, 1992).

Table 1:

Reliability of the Instrument

Variable	No. of items	Cronbach Alpha
Purpose	12	0.877
Satisfactions	13	0.797
Research Productivity	9	0.930

Findings and Discussion

Regression Testing

Regression test was executed to test the study hypotheses. The use of regression test was established with a linear combination of IV (DL purpose and DL frequency) that was statistically associated with DV (satisfaction and research productivity) of engineering respondents. It allowed us to predict well dependent variables (Y) from independent ones (X) with HEC DLRs in Pakistan. The findings of the enter method test were significant ($F = 346.908$), with a $p = .000$. The data discovered that a linear combination of two IVs (DL purpose and DL frequency) positively predicted engineering respondents' satisfaction with DLRs. The correlation coefficient ($R = .894$) shows strong association of two IV with DV and thus, the model has a positive effect on DV (satisfaction). Moreover, the $R^2 = .799$ indicates that about 80% difference rate is found in the model for respondents' satisfaction through the use of two predictors with adjusted $R^2 = .797$ variance values (Table 2 and Table 3). A regression equation employed to predict for users' satisfaction variable i-e $Y = a + b_1x + b_2x$, explained as $Y = 2.640 + .887$ (DL frequency) + $.568$ (DL purpose). Y showed users' satisfaction as DV. In addition, to explore those variables that supported the prediction of DV, the association of each IV was assessed by using a regression coefficient (standardized coefficient). The results indicated that the largest beta value is 1.096 for DL frequency. It shows that this variable constructs the greatest association by supporting the DV in comparison with beta coefficient value (-.936) for DL purpose.

The sample t-test was used and found that all variables were statistically significant. The results have described that probability of beta values $= .000$ is estimated among the study population. Thus the calculated beta scores have verified that all IVs supported in the model predicting scores for engineering students' satisfaction with DLRs (Table 4). The findings of hypotheses testing are presented in Table 8. Furthermore, the regression analysis was utilized to indicate if a linear combination of dependent variables (DL_Purpose, DL_Frequency) that significantly correlated with the second dependent variable (research productivity). The enter method analysis found a significant combination of two predictor variables with the predicted variable i-e. Engineering respondents' research productivity ($F = 1259.201$, $p = .000$). Apart from that, the correlation coefficient ($R = .967$) discovered the correlation of two independent variables (DL_Purpose, DL_Frequency) with dependent variable and thus, the model had a strong effect on the dependent variable (research productivity) prediction. In addition, the $R^2 = .935$ found that a 93% of variance was found in the model for research productivity utilizing two predictors with adjusted $R^2 = .935$ variance values (Table 5 and Table 6). Moreover, a regression equation used to predict for research productivity variable i-e. $Y = a + b_1x + b_2x$, was interpreted as $Y = 4.404 + 1.085$ (DLRs frequency) + 1.087 (DLRs purpose). Y represented research productivity as the dependent variable. To know which of the variables included in the model that contributed to the prediction of the dependent variable, the influence of each independent variable was

compared with employing a regression coefficient (standardized coefficient). The analysis shows that beta coefficient is .913 for DLRs frequency. This found that this variable produced the strongest contribution to explaining the dependent variable in comparison with the beta value (-1.221) for DLRs purpose. Consequently, the analysis of each predictor variable incorporated a sample t-Test, which

discovered that all variables were statistically significant. The results described that likelihood of beta values which was equivalent to .000 was expected in the population. The weighted beta values verified that all independent variables supported in the model predicting values for research productivity using DLRs (Table 7). The findings of hypotheses testing are presented in Table 8.

Table 2. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.894	.799	.797	.16820

a. Predictors: (Constant), DLRS_Purpose, DLRS_Frequency

Table 3. ANOVA of Regression Between IVs and Respondents' Satisfaction

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	19.630	2	9.815	346.908	.000
Residual	4.923	174	.028		
Total	24.553	176			

a. Predictors: (Constant), DLRS_Purpose, DLRS_Frequency
b. Dependent Variable: Users' Satisfaction

Table 4. Relationship of IVs with Respondents' Satisfaction

Model	Coefficients		Beta	T	Sig.
	Unstandardized Coefficients				
	B	Std. Error			
(Constant)	2.640	.094		27.981	.000
DL_Frequency	.887	.035	1.096	25.259	.000
DL_Purpose	-.568	.026	-.936	-21.576	.000

a. Dependent Variable: Users' Satisfaction

Table 5. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.967	.935	.935	.14017
a. Predictors: (Constant), DLRS_Purpose, DLRS_Frequency				

Table 6. ANOVA of Regression Between IVs and Research Productivity

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	49.478	2	24.739	1259.201	.000
Residual	3.419	174	.020		
Total	52.897	176			
a. Predictors: (Constant), DLRS_Purpose, DLRS_Frequency					
b. Dependent Variable: Research Productivity					

Table. Relationship of IVs with Research Productivity

Model	Coefficients		T	Sig.
	Unstandardized Coefficients	Standardized Coefficients		
	B	Beta		
(Constant)	4.404	.079	56.019	.000
DL_Frequency	1.085	.029	37.081	.000
DL_Purpose	-1.087	.022	-49.550	.000
a. Dependent Variable: Users' Satisfaction				

Table 8. Summary of Hypotheses Testing

Statements	Hypotheses	Status
Frequency of use positively predicts satisfaction	Hypothesis 1	Supported
Purpose of use positively predicts satisfaction	Hypothesis 2	Supported
Frequency of use positively predicts research productivity	Hypothesis 3	Supported
Purpose of use positively predicts research productivity	Hypothesis 4	Supported

Discussion

The findings of this study indicate some key factors, namely the frequency of DLRs usage behavior and purpose of DLRs. These factors are found to be important in establishing users'

satisfaction with DLRs. The contents of the DLRs are considered to be the most important ones than other the sources of information for research activities. Its reason is when the DLRs are frequently updated, relevant and wide-

ranging in terms of scope and coverage, the users will definitely be satisfied with the DLRs (Samadi et al., 2014). The results of this study confirm the findings of Khan et al. (2014) as they observed that a majority of the research scholars were frequently using DLRs for research tasks and were mostly satisfied with authenticity and scope of DLRs and services. Tenopir, Wang, Zhang, Simmons, and Pollard (2008) also reported that most of the students of engineering disciplines used DLR for various academic and research purposes. In addition, the results of this study also verify Zha, Li, and Yan (2012) statements, as they found a strong relationship between usage patterns of DLRs and users' satisfaction. In a research environment, users' satisfaction is also related to the accuracy of DLRs and other electronic information, because researchers always want to get the updated development on their research domain (Samadi & Masrek, 2013). In contrast, the outdated contents may transform into users failing trust and interest in consulting DLRs. Furthermore, the findings of this empirical research also reveal that the usage frequency and purpose of DLRs has a positive impact on engineering knowledge and research productivity. These findings also support previous research studies (e.g. Dorner, 2004; Khan & Ahmed, 2013; Nasser Al-Saleh, 2004; Rapp, Taylor, & Crane, 2003; Voorbij & Ongerling, 2006). Hence, in an academic environment, the DLRs are expected to be able to provide rich collections of all information sources that is able to meet the diversified information needs (academic courses, research endeavor & self-interest) and promised services to end users effectively. When users information needs of various types are being fulfilled via the use of DLRs, the users would definitely give high rating in terms of their satisfaction and research efficiency (Samadi et al., 2014).

Conclusion & Recommendations

The results of this study have clearly revealed that DLRs usage is important in shaping users' satisfaction and effectiveness on their research endeavor. Furthermore, the findings have shown a positive attitude towards DLRs usage among engineering researchers. The outcomes of this empirical research should aware the competent authorities that are concerned with the provision of DLRs and services, so that they can continuously keep themselves affiliated with users' information needs. The study results are also helpful for LIS professionals and other information providers in formulating effective policies for the provision of DLRs. Once the users discover that the DLRs features are fulfilling their requirements, they will always consult DLRs to its maximum level. As indicated earlier, the usage of DLRs would also increase the researchers' satisfaction and research productivity. The findings of this study further establish the importance of the DLRs from the perspectives of engineering students. The results of this study can lead to further change in the provision of information resources of the university libraries by supporting research efforts as well as making a scientific knowledge based society in the country. In addition, the findings can also help different stakeholders who are working in higher education sectors and library administrations in developing valuable collections and in improving their resources and services to meet the researchers' demand more efficiently and effectively.

The results of this research will also attain the attention of scholars to explore this topic more rigorously. The research framework created in this research can be checked in other DLRs context with different culture. Furthermore, the impact of DLRs can also be extended to measure students' academic performance and personal achievements. The research framework can also be utilized as a conceptual framework for a study that employs the mixed method or qualitative research approach such as a focus group, interview, observation, document analysis as a procedure of data collection. Such methods will

endow an insight and comprehensive outcome that can explore extensively the phenomenon of DLRs usage and its impact on research endeavor.

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