Analysis on the Performance of Weir Based on Criteria Assessment of Building Functions and Structures Using AHP (Analytic Hierarchy Process) Method (Case Study of Samiran Weir in Pamekasan District)

by Lies Kurniawati Wulandari

Submission date: 01-Apr-2021 11:48AM (UTC+0700)
Submission ID: 1547949977
File name: es_Using_AHP_Analytic_Hierarchy_Process_Method_Case_Study_2.pdf (383.95K)
Word count: 3685
Character count: 19463

International Journal of Scientific Engineering and Science
Volume 3, Issue 9, pp. 51-55, 2019. ISSN (Online): 2456-7361

Analysis on the Performance of Weir Based on Criteria Assessment of Building Functions and Structures Using AHP (Analytic Hierarchy Process) Method (Case Study of Samiran Weir in Pamekasan District)

Fairus Zabadi[1], Kustamar[2], Lies K. Wulandari[2]
[1, 2]Civil Engineering Study Program of Construction Management, National Institute of Technology
Email address: [1]fairuszabadi93@gmail.com, [2]kustamar@lecturer.itn.ac.id, [3]lieskwulandari@gmail.com

Abstract— *This study aims to: (1) determine the criteria for evaluating the function and condition of the weir against aspects of the structure of the building, (2) obtaining weights of weir components that can be used as indicators of weir performance based on the condition and functioning of the building, (3) analyzing the weir performance at Samiran Weir in Pamekasan District is based on the condition and functioning of the building. This study took place in Samiran Dam located in Samiran Village, Proppo Subdistrict, Pamekasan District, East Java Province. Data collection technique was done by direct observation in the field which then the data was processed. From the results of data processing, the condition and functioning of Samiran Weir was analyzed. Data analysis used AHP (Analytic Hierarchy Process) method). The results of data analysis conducted from weir survey data resulted in weir performance based on component damage conditions in the form of a discharge weight of 18.89%, sediment weight of 1.25%, light weight of 0.19%, weight of retrieval building of 2.56%, weight of drainage building of 4.26%, weight of rinsing building is 1.88%, and the weight of the mud bag is 4.15%. As for the results of the analysis on the performance of the weir based on the component function, namely in the form of a discharge weight of 32.92%, sediment weight of 3%, light weight of 2.39%, weight of retrieval building by 14.29%, weight of drainage building by 21.14%, weight of rinsing building by 21.14%, and mud bag weights of 9.86%. The condition on the performance component of Samiran Weir experienced damage to components in the weir by 33.18% and the weir condition experienced MILD DAMAGE. The component performance function at Samiran Weir is 93.31% and the weir's function is in GOOD condition.*

Keywords— *Weir Performance, Analityc Hierarchy Process, Samiran Weir.*

I. INTRODUCTION

Weir is a main building that has a function to raise the elevation of river water level and divide and provide water so that it can flow into the carrier channel with certain alternatives (Wigati, 2016). Weir is a building made of stone pairs, concrete or gabion, with a transverse position in a river that functions as an irrigation channel (Richard et al, 2013). Samiran Weir is one of several weirs in Madura, located in Samiran Village, Proppo Subdistrict, Pamekasan District, East Java Province. This weir is a weir building which was built in 1901 with a service area of 2462 Ha and a planting area of 2600 Ha. To improve the function and extend the life of the weir and the network that has been built, we need an analysis and evaluation of the weir's performance.

As an irrigation infrastructure building, weir buildings are influenced by the volume of river water and flowrate. Unstable discharge conditions and external factors that are not expected to damage the structure of the building on the weir. In such conditions an assessment of the weir conditions is needed based on the structure of the building, so that proper handling can be done to repair and manage the weir before damage occurs on the weir (Wahyudi, 2017).

Starting from this, this research will discuss the weir component damage based on the structural function aspects of the building. Damage condition assessment in Samiran weir building includes 7 components, namely discharge, sediment, lighthouse, retrieval building, rinse building, mud bag and drainage building. From the 7 components of the weir building, theoretically and visually the damage assessment of leakage types and peeling layers is theoretically to produce a weir criterion.

Criteria for assessing the condition of the weir are made for each component of the weir. Weir criteria will be analyzed using the AHP (Analytic Hierarchy Process) method which is then applied to the Samiran Weir. The results obtained later can show how the performance conditions of the Samiran Weir from the criteria made earlier.

II. LITERATURE REVIEW

A. Weir

Weir is a building that serves to raise the level of the water level in the river to the height needed so that water can flow into irrigation channels and tertiary plots. The elevation can determine the area of irrigated area (Wigati et al, 2016). Weir is a construction of a water structure located transversely as a regulator of the flow of river water through the weir. There are several types of weirs according to their function and type of construction (Sosrodarsono in Wahyudi, 2017).

International Journal of Scientific Engineering and Science
Volume 3, Issue 9, pp. 51-55, 2019. ISSN (Online): 2456-7361

The component of the weir that is the main constituent of the weir building that it can perform the function of the weir is ideal:

1. *Weir lighthouse*

Weir lighthouse is one of the main components that play a role in the weir. Construction of a weir lighthouse in a transverse position on a river that has a function to raise the water level. Weir lighthouse is usually built with masonry and concrete construction (Sosrodarsono in Wahyudi, 2017).

2. *Stilling basin*

Stilling basin is a building that has a function as a reduction of runoff water energy from a weir lighthouse so as to avoid damage to the river bed. The slope of the weir causes the falling water to have a change in the speed of the water flow. The change has a scouring effect on the riverbed (Sosrodarsono dalam Wahyudi, 2017).

3. *Wing dam*

Wing dam is a building that was instrumental in directing the flow of river water weir lighthouse thus it is very difficult to experience events that erode the cliff side stream dam body foundation. These wing dams are on both sides of the lighthouse (flanking the lighthouse). In maintaining the stability of the weir lighthouse, wing dam has an important role to hold the soil in securing the weir from the cliff avalanche (Sosrodarsono in Wahyudi, 2017).

4. *Intake building*

Intake building is a building that has a function in taking water from the river channel to meet crop water needs. The main part of the intake building is the entrance gate. The take-up door function controls the amount of water flowing into the channel. In addition to regulating the amount of water flowing into the channel, the take-up gate also plays a role in preventing sediment and flood water from entering the channel (Sosrodarsono in Wahyudi, 2017).

5. *Dike*

Weir building on the river causes disruption to normal flow, thus it can result in new flow patterns in the river upstream and downstream of the building. This pattern can trigger scouring at the bottom and river banks. Therefore it is necessary to protect the river from scouring. The existence of dykes on the river is also able to increase the stability of the river channel (Sosrodarsono in Wahyudi, 2017).

6. *Measuring building*

In order for the management of irrigation water to be effective, what needs to be done is to measure the flow of water that enters the primary channel. Discharge measurements are carried out using a measuring building (Sosrodarsono dalam Wahyudi, 2017).

7. *Drainage building*

Drainage building is part of a weir that has the role of preventing sediment from entering the irrigation channel. The completeness of the drainage structure is a drainage gate which is built as a channel from the body of the weir and is located downstream of the threshold. Drainage door height is conditioned the same as the height of the lighthouse thus flood water can be run off. When the sediment contained in the upstream of the lighthouse interferes with the amount of water entering the intake gate, the sedimentation and flushing of the sediment is carried out by opening the drainage door (Sosrodarsono in Wahyudi, 2017).

8. *Rinse building and mud bags*

Rinse building is one of the main equipment of the weir which is located near the intake and becomes a single unit. The function of the rinse building is to avoid the transport of sediment loads and reduce the load of elevated sediment entering the intake. A mud bag is an enlargement of a cross section of a channel to a certain length to reduce flow velocity and the opportunity for sediment to settle. The bottom of the channel is deepened and widened to accommodate the sediment deposition. This basin is cleansed every time by rinsing the sediment back into the river with super critical flow. The mud bag is placed at the beginning of the primary channel right at the back of the intake (Kartino et al, 2015).

B. Weir Performance Assessment

Abdurrahman, et al (2015), explained that the performance evaluation carried out is to identify the condition of the weir building and the pattern of its operation and maintenance. The performance evaluation carried out consisted of two main components namely:

1. Physical performance evaluation, has an overall weighting value in the performance evaluation of 70%.
2. Performance audit, has an overall weighting value in the performance evaluation of 30%.

C. Sedimentation

Sedimentation is a continuation of the process of erosion of the surface due to rain water or erosion. Then the land flows through hollows, canals and then into rivers. The function of the river, in addition to being a means of flowing water, also functions as material transporting material in the form of sediment (Qohar in Sulistiyono et al, 2015).

D. Flow Debit

Sosrodarsono in Wahyudi (2017), stated that the discharge is a coefficient which states the amount of water flowing from a source of time unity, usually in a SI system of units the discharge is expressed in units of cubic meters per second (m3 / s). To meet the needs of irrigation water, water discharge must be more sufficient to be channeled into prepared channels.

E. AHP (Analytic Hierarchy Process)

Paryogi in Wahyudi (2017), explained that AHP is a decision making method developed by Prof. Thomas L. Saaty. AHP method is a method used to obtain a decision (decision maker) from several parameters that are qualitative or quantitative. In this method, a problem is broken down into several parameter groups and organized into a hierarchy. In this study, the multi-criteria problem which is the problem of placing weir component weights. The determination of alternative solutions can be proven quantitatively thus weir components can be determined which have the highest level of importance based on the condition and function of the weir component.

International Journal of Scientific Engineering and Science
Volume 3, Issue 9, pp. 51-55, 2019. ISSN (Online): 2456-7361

III. Research Method

A. Research Method

The focus of this research is the Samiran Weir Performance Analysis. This research uses descriptive research method. Descriptive research is research conducted to know the value of an independent variable, either one or more variables (independent) without making comparisons, or connecting with other variables. This study also uses a quantitative approach, which is an approach used to examine a particular population or sample, data collection was one using research instruments, quantitative or statistical data analysis, with the aim of testing a predetermined hypothesis.

B. Rsearch Location

The research site was conducted in Samung Bendung, Proppo Subdistrict, Pamekasan District, East Java Province.

Figure 3.1. Location Map of Samiran Weir

Figure 3.2. Detail on the Location of Samiran Weir

C. Research Data

The data needed in this study were grouped into two categories, namely primary data and secondary data. The data collected needs to be further processed according to its designation, in order to produce the expected conclusions.

1. *Primary Data*

Primary data is data obtained directly from the field, through a direct observation process for 6 Weeks from February (2nd Week) to March (3rd Week). Primary data needed in this study include:

a. Weir physical data includes weir size and weir type of Samiran weir.

b. Physical data on the weir infrastructure building includes the visual condition of Samiran Weir infrastructure building.

2. *Secondary data*

Secondary data is data that is not obtained directly from the field, but through data collected by previous researchers. Secondary data needed in this study include:

a. Samiran Weir technical data

b. Map of Samung Bendung locations

c. Information about the quality of weir building structures obtained from literature studies.

After primary and secondary data were obtained, data was processed to obtain the components of the weir building in Samiran Weir. Each component was processed to know the function and condition of the Samiran Weir, especially those related to the weir's performance.

D. Data Analysis

Data analysis was performed by testing the condition and function assessment techniques of the weir building at Samiran Weir. The assessment was done by giving a value to each criterion that has been prepared based on the AHP method with the preparation of a hierarchy, and then processed according to the AHP method. After obtaining weir component weights, research data were entered into the results of the weir performance component analysis. The final result will be in the form of the performance condition of Samiran Weir based on the condition and function of the building.

Stages in analyzing data namely:

1. *Weir Survey*

Weir surveys were carried out to identify components of weir performance, condition and functioning. Component identification was done by filling in the weir evaluation forms that prepared by the researcher.

2. *Determination of weir component weights*

Determination of weir component weights based on the AHP method was done by determining the score on the pairwise matrix (Pairwise comparison), Determination of the score was taken together with the Irrigation Service that handles Samiran Weir. Using the AHP (Analytic Hierarchy Process) method).

3. *Performance evaluation, condition and function of weir components*

Assessment was done by analyzing the observed data gathered in the field and component weight calculation weir with AHP method that has been carried out to obtain the true value of Samiran Weir.

Table 3.1 Calculation of Weir Survey

Weir Component	Dimension Long	Wide	Total Area	Type of Damage		Damage	Damage Percentage	Damage Total	Percentage Assessment of Building Conditions
(l)	(p)	(l)	(L)				(%)	KS	(%)
(1)	(2)	(3)	(4) = (2)*(3)	(5)		(6)	(7) = (6)/(4)*100	(8) = K1+K2+K3	(9) = 100-(8)
Lighthouse	25	2.5	62.5	Collapse	K1	-	-	6.95	93.05
				Leaked Out	K2	2.293	3.67		
				Peeling Layer	K3	2.048	3.28		
Building Taking	2.5	1.7	4.25	Collapse	K1	-	-	13.98	86.2
				Leaked Out	K2	0.054	1.27		
				Peeling Layer	K3	0.54	12.71		
Drainage Building	2	1.8	3.6	Collapse	K1	-	-	20.16	79.84
				Leaked Out	K2	0.026	0.72		
				Peeling Layer	K3	0.7	19.44		
Rearing Building	2.5	1.5	3.75	Collapse	K1	-	-	18.33	81.67
				Leaked Out	K2	0.009	0.13		
				Peeling Layer	K3	0.72	18.2		
Mud Bag	5.5	2.5	3.75	Collapse	K1	-	-	42.13	57.87
				Leaked Out	K2	1.58	42.13		
				Peeling Layer	K3	-	-		

International Journal of Scientific Engineering and Science
Volume 3, Issue 9, pp. 51-55, 2019. ISSN (Online): 2456-7361

Table 3.2 Calculation of Weir Function Surveys

Weir component	Function Indicator	Function (F)				Score F	Weight AHP	FxWeight
		<20%	<40%	<75%	>90%			
(i)						(Fi)	(Di)	(FixDi)
(1)	(2)	(3)				(4)	(5)	(6): (3)*(5)
Debit	Ability to irrigate irrigation areas				93.31	4	35.28	32.92
Sediment	Sediment management ability				100	4	3	3
Lighthouse	The ability to raise the water level of the river			88.24		4	2.71	2.39
Building taking	Arrangement of water entering the canal			78.12		3	18.29	14.29
Drainage building	Drainage of mud on the upper reaches of the lighthouse				100	4	21.14	21.14
Rinsing building	Disposal of deposits in mud bags				100	4	9.71	9.71
Mud bag	Sedimentation of river deposits				100	4	9.86	9.86
Total							100 %	93.31 %
Component condition : Σ (5) / Σ (4)						F AHP	Description	
						4	GOOD	

Table 3.3 Calculation of Weir Condition Surveys

Weir component performance	Component damage	Score KS	Weight AHP	KS x Weight AHP
(i)	(Ki)		(Ci)	(Ki x Ci)
	(%)			
(1)	(2)	(3)	(4)	(5): (2)*(4)
Lighthouse	53.55		35.28	18.89
Debit	41.67		3	1.25
Sediment	6.95		2.71	0.19
Building taking	13.98		18.29	2.56
Drainage building	20.16		21.14	4.26
Rinsing building	19.33		9.71	1.88
Mud bag	42.13		9.86	4.15
		Total	100 %	33.18 %
Component condition : Σ (5) / Σ (4)			K AHP	Description
			2	MEDIUM DAMAGE

IV. ANALYSIS AND DISCUSSION

A. *Data and Research Results*

Research data wer obtained from literature review. Literature reviews is needed to determine criteria needed to perform weir construction structures. Weir data were obtained in Samiran Weir located in Samiran Village, Proppo Subdistrict, Pamekasan District, East Java Province. Stages in this research refer to the weir condition assessment criteria arranged by Wahyudi (2017).

B. *Weir Performance Components*

Weir performance component is a supporting factor of performance from a certain weir, which functions to regulate, repair, utilize as well as maintain the weir. Performance component of weir as an indicator of weir condition is divided into seven components, namely discharge, sediment, lighthouse, intake building, rinse building, mud bag, and drainage building.

The selection of this component is based on the factors that are dominant to the performance and condition of weir, the ease of visual observation in the field and the location of weir components easily found in weirs in Indonesia.

C. *Criteria for Assessing Functions and Weir Conditions*

Criteria for assessing the condition of the weir are made for each component of the weir. The criteria for each component of the weir were then grouped based on a structural damage review of the components, called Indicators.

D. *Weighting on the Condition and Function Assessment Criteria of Weir*

After the weir assessment criteria have been prepared, it is necessary to assign weights to each component. The weighting was based on the effect of the structure of the component on the overall condition of the weir. The component structure was given weighting in each sub-component that makes up the overall condition of the component. Weighting was done by using the AHP (Analytic Hierarchy Process) method, which is a decision method based on parameters (criteria) that are both qualitative and quantitative. AHP calculation was performed from indicators on a predetermined structure.

1. *Calculation of AHP*

In this assessment criterion, AHP calculation was used on the components that make up the weir's performance. The weight obtained from the AHP calculation for each component was then multiplied by the weight of the building condition assessment. All weights were written as a percentage (%).

2. *Distribution of component weight*

After the AHP calculation was performed on each component, a component weight distribution can be arranged. The distribution of component weights to the weir performance evaluation criteria based on the function and condition of the building can be seen in Figure 4.1.

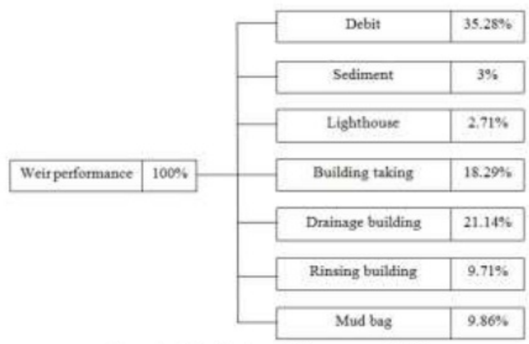

Figure 4.1 Distribution of Component Weight

E. *Performance Assessment of Concrete Weir*

Table 4.1. Calculation of Weir Condition Survey

No	Component	Damage (%)	Weight AHP	Damage Weight
1	Debit	53.55	35.28 %	18.89 %
2	Sediment	41.67	3 %	1.25 %
3	Lighthouse	6.95	2.71 %	0.19 %
4	Building taking	13.98	18.29 %	2.56 %
5	Drainage building	20.16	21.14 %	4.26 %
6	Rinsing building	19.33	9.71 %	1.88 %
7	Mud bag	42.13	9.86 %	4.15 %
	Total weight		100 %	33.18 %

Table 4.2 Functioning of Samiran Weir Performance Components

No	Component	Function (%)	Weight AHP	Weight of function
1	Debit	93.31	35.28 %	32.92 %
2	Sediment	100	3 %	3 %
3	Lighthouse	88.24	2.71 %	2.39 %
4	Building taking	78.12	18.29 %	14.29 %
5	Drainage building	100	21.14 %	21.14 %
6	Rinsing building	100	9.71 %	9.71 %
7	Mud bag	100	9.86 %	9.86 %
Function of weir component performance			100%	93.31 %

V. Conclusions and Suggestions

A. Conclusions

The conclusions from the results of the analysis of the weir's performance based on the functional aspects of the building structure are as follows:

1. Criteria for evaluating the function and condition of weirs against aspects of the structure of the building include weir components in the form of debit, sediment, lighthouse, intake building, drainage building, rinse building and mud bags. To determine the relationship between components of weir performance, weighting was done by the AHP (Analytic Hierarchy Process) method. Weighting results obtained weight of discharge was 35.28%, weight of sediment was 3%, weight of lighthouse was 2.71%, weight of intake building was 18.29%, weight of drainage building was 21.14%, weight of rinse building was 9.71%, and weight of mud bag was 9.86%.
2. Weighting criteria for the evaluation of the function and structure of the building using the AHP method in Samiran Weir in Pamekasan District, results in the weir's performance based on the component damage conditions in the form of a discharge weight was 18.89%, sediment weight was 1.25%, light weight was 0.19%, intake building weight was 2.56%, weight of drainage building was 4.26%, weight of rinse building aws 1.88%, and weight of mud bag was 4.15%. As for the results of the analysis on the performance of the weir based on the function of the components in the form of a discharge weight was 32.92%, sediment weight was 3%, light weight was 2.39%, building intake weight was 14.29%, weight of drainage building was 21.14%, weight of rinsing building was 9.71%, and mud bag weights was 9.86%.
3. The Performance of Samiran Weir in Pamekasan District based on the criteria for evaluating the function and structure of the building using the AHP method, it was found that the performance component of the Samiran Weir experienced damage to components in the Weir by 33.18% and the weir experienced MILD DAMAGE. The component performance function at Samiran Weir was 93.31% and the weir's function was in GOOD condition.

B. Suggestions

Based on the conclusion of this research, the following suggestions and input from related parties can be made:

1. Need repair and replacement of some building components in Samiran Weir so that the weir's performance can be seen from the condition of MILD DAMAGE component to become GOOD, while the function of the components is GOOD.
2. Further research is needed by increasing the number of weir performance components in order to produce priority weir rehabilitation based on the function and condition of the better weir.
3. To the next researchers, it is expected that this thesis can add insight knowledge about the performance of the weir based on the function and condition of the building.

References

[1] Abdurrahman, dkk. 2015. *Evaluasi Kinerja Bendung Irigasi Cipta Graha Kabupaten Kutai Timur*. Universitas 17 Agustus 1945 Samarinda.
[2] Adhytia, LP. 2015. *Analisis Efektivitas Waduk Ciawi Menggunakan Model Swat Sebagai Upaya Pengendalian Banjir DAS Ciliwung*. Institut Pertanian Bogor.
[3] Ahmed, YM. 2013. *Numerical Analysis Of Flow Over Side Weir*. Iraq: University Of Mosul.
[4] Irzooki RH, dkk. 2014. *Experimental Study Of Charcteristics Of Flow Over Weirs*. King Fahd University Of Petroleum and Minerals.
[5] Kartino DF, dkk. 2015. *Evaluasi Fungsi Bendung dan Perencanaan Kembali Bendung Katulampa*. Universitas Diponegoro.
[6] Kementrian PUPR Nomor 12/PRT/M/2015 Tentang Indeks Kinerja Sistem Irigasi.
[7] Kementrian PUPR Nomor 13/PRT/M/2012 Tentang Pedoman Pengelolaan Aset Irigasi.
[8] Kementrian PUPR Nomor 32/PRT/M/2007 Tentang Pedoman Operasi dan Pemeliharaan Jaringan Irigasi.
[9] Khalili, M dan Honar, T. 2017. *Discharge Coefficient Of Semi-Circular Labyrinth Side Weir In Subcritical Flow*. Iran: Shiraz University.
[10] Mahardika, BAP. 2016. *Desain Kriteria Penilaian Kondisi Sungai Berdasarkan Aspek Struktur Bangunan (StudiKasus : Sungai Pepe Baru Surakarta)*. Universitas Sebelas Maret Surakarta.
[11] Prayogi, KA. 2015. *Model Penetapan Prioritas* Rehabilitasi *Bendung Berbasis Metode Analytical Hierarchy Process (AHP) Studi Kasus Di Wilayah Kerja UPT Pengairan Kalisat Kabupaten Jember)*. Universitas Jember.
[12] Pierre, J. 2014. *Hydraulic Engineering*. Erik Sutherland.
[13] Richard VM, dkk. 2013. Perencanaan *Bendung untuk Daerah Irigasi Sulu*. Universitas Sam Ratulangi Manado.
[14] Sulistiyono H, dkk. 2015. *Pengaruh Perubahan Iklim dan Tataguna Lahan Terhadap Sisa Umur Bendungan Batujai*. Universitas Mataram.
[15] UPT PSDA WS Pamekasan. 2019. Data Teknis Bendung Samiran.
[16] UPT PSDA WS Pamekasan. 2019. Data Debit Bendung Samiran.
[17] Wahyudi, M. 2017. *Analisa Kinerja Bendung Berdasarkan Aspek Fungsi Struktur Bangunan (Studi Kasus Bendung Perkatingan)*. Universitas Muhammadiyah Purworejo.
[18] Wigati R, dkk. 2016. *Kaji Ulang Bendung Tetap Cipaas (Studi Kasus Desa Bunihara Kecamatan Anyer) Serang-Banten*. Universitas Sultan Ageng Tirtayasa.
[19] Zachoval, Z dan Rousar, L. 2015. *Flow Structure In Front Of The Broad-Crested Weir*. EPJ Web Of Conferences.

Analysis on the Performance of Weir Based on Criteria Assessment of Building Functions and Structures Using AHP (Analytic Hierarchy Process) Method (Case Study of Samiran Weir in Pamekasan District)

ORIGINALITY REPORT

5%	4%	0%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to LL Dikti IX Turnitin Consortium Student Paper	3%
2	www.scribd.com Internet Source	2%

Exclude quotes	On	Exclude matches	< 2%
Exclude bibliography	On		