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A FACTORIAL STUDY OF CONTRACTOR SELECTION CRITERIA IN OIL INDUSTRY

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ABSTRACT
This paper was designed to investigate the various contractors' selection criteria and information sources on contractors so as to determine the common significant ones used for the selection of contractors within the oil industry in the Niger- Delta. The study employed a survey approach, using the Rensis Likert's attitudinal scale, to generate respondents data matrix that was analysed with principal component analysis (PCA), and which was facilitated by statistiXL software which clustered the fifty variables into fourteen fewer dimensions and the ten information variables into three dimensions. Our findings showed that the key selection criteria are acculturation, outsourcing management, duration of work, worker welfare and adherence to clients health. Others include safety and environment (HSE) programme, delivery capability, contractors responsiveness, quality assurance, innovation and drive to complete work and installation skill. Overall, this study has been successful in providing broad guide for contractors/vendors selection decisions for improved service delivery in the oil and gas industry.

Keywords: *contractors, factor loading, varimax rotation, likert scale, earliest-start-time passion*

1. INTRODUCTION
The oil and gas industry is a dominant contributor to the Nigerian economy and the on-going activities in this sector have been a major source of concern to stakeholders and the general public at large. It has been alleged at various fora that management of indigenous public and private companies in this industry do not follow due process in the allocation of some contracts regarding certain long-term and short-term projects. The present situation in the country has shown that certain public procurements did not follow stipulated standard. A typical example is the issues surrounding the Minister of Petroleum Resources Jet Scandal which is reported in [1].

The process of selecting contractors for the execution of projects in the oil industry is an integrated one and it involves many certification and pre-evaluation activities. The Federal Government of Nigeria enacted a Public Procurement Act of 2007 in order to ensure that due process is followed in the selection of contractors generally. The nature of activities in the oil industry prompted the establishment of National Petroleum Investment Management Services (NAPIMS) which has the mandate to ensure that international standards and set criterion are strictly adhered to in the contracting process. Recent efforts to resolve the issues relating to contractors' selection criteria are reported in [2-5]. These papers did not identify underlying variables, or factors, that explain the pattern of correlations within the contractor selection criteria highlighted thereof.

This study focused on discussions regarding the establishment of the relative importance of contractors' selection criteria in the oil industry and the industry information sources on contractors. The influence that different tasks (routine services and capital projects) and different organisations (Exploration and Production Companies) have on the importance of contractor selection criteria is discussed. Hatush and Skitmore [5] identified five main processes as common factors in the contractor selection process for all types of procurement arrangements. These are project packaging, invitation, prequalification, short listing and bid evaluation. Also, Russel and Skibiniewski [6] defined bid evaluation as a decision-making process that involves the development and consideration of a wide range of necessary and sufficient decision criteria used to

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assess the contractors capabilities. Selecting the most suitable contractor for a construction project is a crucial decision for owners and project managers alike. In Egypt, the process of contractor selection for the public projects is regulated by Act 89/1998. The act was later reviewed. Relatedly in the United Kingdom, contractor selection are based on the lowest price philosophy. However, recent researchers show that there is a growing urge for a shift of emphasis from lowest-price wins to multi-criteria selection practices in the contractor selection process. In Nigeria, past performance, contractors experience, workmanship quality, tender sum, as well as plant and equipment are the most important criteria for contractors' prequalification/ bid evaluation. Tender evaluation is a very important and critical means through which the best evaluated tenderer is selected to undertake a project for a client so as to achieve best value for money. See for examples [8-17] As pointed out by Palaneeaswaran [18], contractor prequalification is generally preferred by clients to minimize risks and failures and to enhance the performance levels of selected contractors by means of established minimal capacities below which contractors will not be considered. Lam et al [19] proposed a fuzzy neural network (FNN) model, based on the fuzzy set and neural network theories for contractor pre-qualification and selection. The studies [21 – 23] examined the factor analysis to discern the inter-correlation among apparently many disparate variables that influence contractor selection process. This is made possible on account of the fact that factor analysis discern similarity in dissimilarity.

2. RESEARCH METHOD

The survey approach used incorporates the administration of questionnaires with five-point Rensis Likerts attitudinal scale. The response options were transformed into metric variables to aid statistical computation. This was used to develop a data matrix of fifty by sixty-three (50x63) based on the collation of the respondents scores. The metric quantities, collated as data matrix, served as input into the PCA. StatistiXL software was used to generate correlation matrix, factor matrix, parameter estimates, descriptive statistics, unrotated and Varimax rotated factors, scree plot and factor plot of the 50 variables studied. Factor loadings with acceptable values were highlighted in the factor matrix which yielded fourteen (14) factors. The factors were creatively labelled, interpreted and used as decision support for policy development. The unrotated factor space obtained could not lend itself to easy interpretation and so Varimax rotation became necessary. Factor loadings in the factor matrix below the threshold of 1 were discarded, (not considered for interpretation). It is important to observe that factorability of the correlation matrix was examined by visual inspection of the correlation matrix. It revealed substantial number of correlation coefficients greater than 0.30, thus suggesting that the PCA is applicable.

The following assumptions about factor analysis based on postulations in [20-22] were made:

(a) Normality (shape of data distribution for individual matrix variable)

(b) Homoscedasticity (equal dispersion of variance across variables) and

(c) Linearity (columns of data matrix are seen as column vectors with linear characteristics)

The fifty variables obtained from literature are as depicted in Table 1.

Table 1: Fifty Variables of Contractors Selection Decision support

Item No	Scale Item
1	Competitive pricing
2	Contractors Financial position
3	Technical capability
4	Quality Assurance
5	Contractors inter personal relations
6	Cognate Experience
7	Equipment Dependability
8	Maintenance culture
9	Personnel Experience
10	Installation ability
11	Past Failure Records
12	Contractors Geographic Location
13	Delivery capabilities
14	Assurance of supply
15	Sub-contractors Involvement
16	Sub-contractors Skill
17	Outsourcing Arrangement
18	Strong Managerial capability
19	Workers Welfare and safety records
20	Health, security and safety procedure
21	Contractors Responsiveness
22	Project Management Skill
23	Site Organization
24	Operational Procedures
25	Earliest Finish Time Passion
26	Communication Management
27	Team Playing
28	Company's Litigation History
29	Country of Origin
30	Duration of work
31	Standard of workmanship
32	Genuine Organizational structure
33	Host community Relations

Item No	Scale Item
34	Delegation of Authority
35	Management Flexibility
36	Category of Company
37	Innovations
38	After completion services
39	Earliest start Time Passion
40	Worker Motivation
41	Financial Mobilization
42	Client/Contractor Relationship
43	Worker Permit Familiarity
44	Insurance Coverage
45	Technical Alternatives
46	Work Order Adherence
47	Effective Communication
48	Employee-Management Relationship
49	Trouble-Shooting Skill
50	Environmental Management

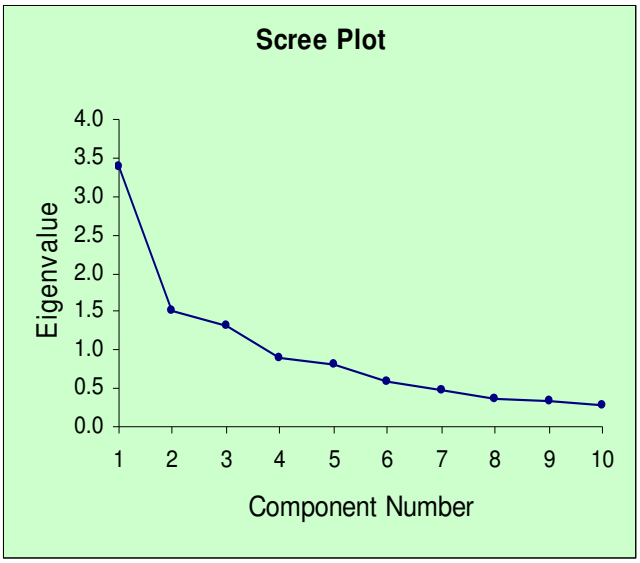
Table 2: Ten Variable for Information Sources

S/N	Variable
1	Past Records
2	Salesmen Involvement
3	Visiting Contractors Plant
4	Catalogues
5	Purchasing Directories
6	Contractors Financial Performance
7	Information Sharing
8	Advertisements
9	Trade Fairs Exhibitions
10	Pan-Departmental Commitment

3. RESULTS

The PCA analysis clustered the 50 contractor selection variables into 14 dimensions. Similarly, the 10 variables for information sources were reduced to mere three platoons. Varimax rotation made this reduction possible. However, the scree plot application suggests that the fourteen factors meet the requirements for factorability and interpretability. Appendix shows the unrotated factor matrix, Varimax rotated factor loading while Table 3 shows the explained variance (eigenvalue) see appendix. The scree plot showing the relationship between the eigenvalues and the variables is depicted in Figure 1. It is instructive to note that eigenvalue of unity (1) set the threshold for determining the candidacy of variables to be retained in the factor space.

Following is the first cluster of variables Tables 3 to 19 shows the factor platoons and their creative labelling



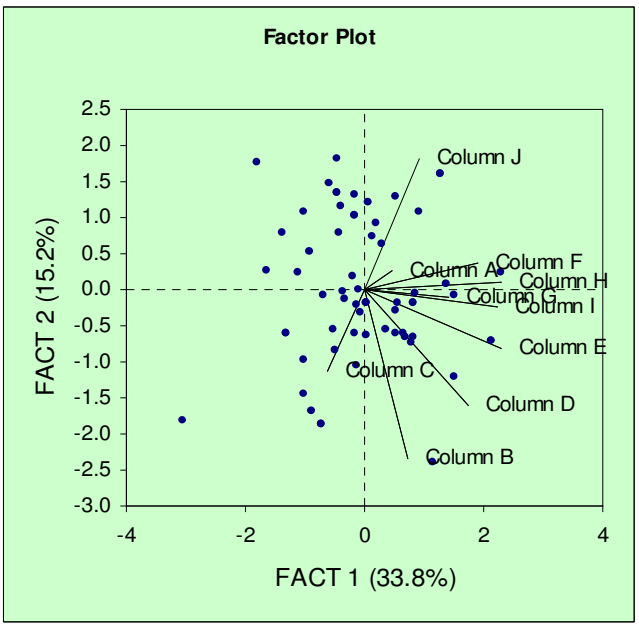


Figure 1: Scree Plot

Table 3: Cluster 1 (safety- critical consideration)

Variable No.	Factor Loading	Variable Description
20	0.822	Health, security and safety procedures
19	0.694	Workers Welfare and safety Records

This is a duplex factor wielding meritorious and substantial loadings respectively. The duplex emphasizes the critical nature of safety consideration.

Table 4: Cluster 2 (Logistics)

Variable No.	Factor Loading	Variable Description
13	-0.821	Delivery Capabilities
14	-0.782	Assurance of Supply
10	-0.677	Installation Ability

The first two factors are meritorious while the third is substantial – they deal with logistics. All the three factors are negative.

Table 5: Cluster 3 (Managerial Capability)

Variable No.	Factor Loading	Variable Description
25	0.799	Demonstration of ability to complete work within budget
18	0.797	Strong Managerial Capability
17	0.564	Methodology for managing Sub-contractors

This study factor is crucial in the sense that management skill or managerial savvy plays important role in project management. A vendor with good management skill is needed in projects. Such vendors can identify hazards and risks that lurk in stillness only to spring up when it is least expected. However, with good management such risks can be planned for ahead of its occurrence. Again, such vendors can outsource jobs and coordinate them properly towards attainment of goals. Overall, the vendor will be able to deliver at the clients expected or scheduled time.

Table 6: Cluster 4 (Readiness)

Variable No.	Factor Loading	Variable Description
2	-0.715	Financial position of the Contractor
5	-0.705	Contractor Inter-personal relations
3	-0.699	Technical Capability
7	-0.480	Equipment dependability
8	-0.415	Maintenance Culture
9	-0.408	Personal Experience

This factor, creatively labelled readiness is a slender factor on account of the fact that all the variables under it are negative. Each of the variables contributes towards vendors' readiness to deliver. The relative importance of each factor is determined by the magnitude of its factor loading in the merit order.

Table 7: Cluster 5 (Pricing)

Variable No.	Factor Loading	Variable Description
1	-0.673	Competitive Pricing

This is a variable with substantial, negative factor loading. Vendors should quote competitively, otherwise through price fixing; they stand the risk of losing out and lose ground.

Table 8: Cluster 6 (Corporate Reputation)

Variable No.	Factor Loading	Variable Description
11	-0.824	Past failure records
28	-0.454	Company's Litigation History

Again, this is a duplex factor wielding negative loadings – one substantial and the other middling

Table 9: Cluster 7 (Goodwill)

Variable No.	Factor Loading	Variable Description
42	0.780	Clients/Contractor Relationship
41	0.745	Advance payment prior to work commencement

Further, another duplex factor is considered. Both are substantial and positive. Good client- vendor relations can enable a contractor obtain mobilization fund.

Table 10: Cluster 8 (Management by objective)

Variable No.	Factor Loading	Variable Description
37	0.741	Innovations
15	0.670	Sub-contractors Involvement
35	0.623	Management Flexibility
16	0.605	Sub-contractors Skill
34	0.496	Delegation of Authority

This is a quincucial factor (5-variable) creatively labelled authority delegation. The first has a substantial factor loading, the next three are near substantial while the last is a middling. This is akin to management by objectives in the sense that there is general flexibility on the part of the contractor which enables them to commit subcontractors through empowered delegation. Innovations are also introduced either by the vendor or the committed subcontractors.

Table 11: Cluster 9 (Performance)

Variable No.	Factor Loading	Variable Description
38	0.731	After completion services
30	0.693	Duration of work
45	0.644	Technical Alternatives

A triple factor is recorded in this regime: the first two are substantial while the last is a middling. All the three variables are positives. The variables deal with management of jobs during and after completion of jobs. It also considers good technical alternatives to adopt in the course of job execution.

Table 12: Cluster 10 (Corporate competence)

Variable No.	Factor Loading	Variable Description
21	0.810	Contractors Responsiveness
22	0.559	Project Management Skill
49	0.477	Trouble-shooting Skill
48	0.442	Employee-management Relationship

The next platoon of variables is a foursome factor creatively labelled corporate competence. It deals with issues relating to responsiveness in addressing defects arising from their performance.

Table 13: Cluster 11 (Organizational culture)

Variable No.	Factor Loading	Variable Description
39	0.745	Earliest-Start-Time Passion
32	0.636	Genuine organizational structure
31	0.561	Standard of workmanship
23	0.553	Site organization
40	0.521	Worker motivation
33	0.495	Host community Relations

A hexodic factor is considered here.The factor suggests that positive enthusiasm to commence work following an award is quite important.Again, the contractor must show quality workmanship,motivate staff and maintain cordial relationship with host community. All these will happen if a good organisational structure is put in place. It is only by so doing that corporate culture can resonate in all their undertakings.

Table 14: Cluster 12 (Quality)

Variable No.	Factor Loading	Variable Description
4	0.809	Quality Assurance

The principal component Analysis (PCA) Model adopted suggests that quality assurance is important in tendering. A Vendor that is well known for this attribute is always considered in contract jobs.

Table 15: Cluster 13 (Contiguity)

Variable No.	Factor Loading	Variable Description
29	0.875	Country of origin
12	0.524	Contractors Geographic Location
47	0.431	Effective Communication

Here another triple factor is encountered. It emphasizes strategic integration to local tradition - acculturation. This can be promoted through communication in local language. It tends to confer in the contractor some kind of provinciality.

Table 16: Cluster 14 (Knowledgeableness)

Variable No.	Factor Loading	Variable Description
43	0.745	Work Permit Familiarity
46	0.699	Work Order Adherence
27	0.593	Team Playing
26	0.562	Communication Management
50	0.559	Environmental Management
24	0.532	Operational Procedures
44	0.515	Insurance Coverage
6	0.483	Cognate Experience
36	0.439	Category of Company

This is a novenary factor dealing with adherence to clients work culture and also playing along with the client.The loading are generally middling and are positive.

Information Sources

In this category, ten variables are reduced into three dimensions or factor

Table 17: Cluster 1 (Business directory)

Variable No.	Factor Loading	Variable Description
5	0.760	Purchasing Directories
8	0.755	Advertisements
9	0.736	Trade Fairs Exhibition
6	0.629	Contractors Financial Performance
4	0.577	Catalogues

This dimension treats sources of obtaining information about the vendor. The sources are outlined in this factor, the most important being purchasing directories.

Table 18: Cluster 2 (Personal Contact)

Variable No.	Factor Loading	Variable Description
2	-0.806	Salesmen Involvement
10	0.624	Pan-Departmental Commitment

This is another duplex factor comprising the salesmen involvement and pan- departmental commitment. The first variable is negatively and meritoriously loaded while the second is middling.

Table 19: Cluster 3 (Physical Inspection)

Variable No.	Factor Loading	Variable Description
1	0.756	Past Records
3	0.749	Visiting Contractors Plant
7	0.587	Information Sharing

In this regime, reliance upon contractors' records coupled with updating of such information through plant visit to contractors' factory is expedient. Moreover, information sharing with other companies can help vendors update their information.

4. DISCUSSION

The results of this study showed that corporate reputation is key to tender selection criteria of which history of vendor performance plays a major role in deciding which vendor to select. Usually, vendors with bad track records are blacklisted even before the real tender commences. This is the major reason why the PCA model used trumped it as the most offending variable with a negative factor loading of -0.824. The implication is that vendor should strive towards doing their best in executing projects in order not to be in the black book of their client.

The study also identified delivery capability, adherence to clients HSE program, contractors responsiveness, quality assurance, acculturation, installation skill, worker welfare, outsourcing, innovations and drive to complete work early, Duration of work as the key variables that influence vendor selection. Contractors who possess the above traits would invariably be selected given that they will meet other criteria contained in the other platoons.

The research question addresses variation on contract selection criteria on routine services using the information sources. The study provided opportunity for the researcher to discover how to proffer solution and handle contractors selected through corrupt practices (bribery, kick-backs and connection to the powers that be).

Only 17.5% of the respondents claimed to have used multi-criteria decision analysis in selecting contractors. The awareness of this knowledge could be said to be relatively low in the construction industry. The management of oil companies are therefore enjoined to encourage and train their staff in the use of multi- criteria decision analysis model. One of such models is the analytical hierarchy process (AHP).

5. CONCLUSION

This study has been successful in providing broad guidelines for selection of contractors and vendors for service delivery in the oil and gas industry. The most important criteria for such selection have been highlighted. For managing contractors' selection based on corruption, the best bet is to make the contractor to source for funds in order to remain focused and implement the contract to a reasonable level prior to the release of milestones or stage payment. By so doing, pay-offs to benefactors are eliminated and contractors are discouraged from paying their way into the bidders list.

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APPENDIX

Variable Range = Sheet1!$A$1:$J$63										
Factors were extracted by the Principal Component method										
from the correlation matrix										
All factors with eigenvalues > 1 were extracted										
Descriptive Statistics										
Variable	Mean	Std Dev.	Std Err	N						
Past Records	4.619	0.551	0.069	63						
Salesmen Involvement	2.857	1.148	0.145	63						
Visiting Contractor;s Plant	3.984	0.793	0.100	63						
Catalogues	3.111	0.882	0.111	63						
Purchasing Directories	3.127	1.070	0.135	63						
Contractor's Financial Perrformance	3.889	0.900	0.113	63						
Information Sharing	3.397	1.171	0.148	63						
Advertisements	3.317	0.981	0.124	63						

Trade Fairs Exhibitions	2.683	1.060	0.134	63						
Pan-Departmental Commitment	3.730	0.807	0.102	63						
Correlation Matrix										
	Column A	Column B	Column C	Column D	Column E	Column F	Column G	Column H	Column I	Column J
Past Records	1.000	0.091	0.392	0.155	0.111	0.108	0.288	0.287	0.286	0.164
Salesmen Involvement	0.091	1.000	0.405	0.558	0.370	0.031	0.307	0.170	0.267	-0.147
Visiting Contractor;s Plant	0.392	0.405	1.000	0.118	0.059	0.020	0.267	-0.014	-0.044	-0.032
Catalogues	0.155	0.558	0.118	1.000	0.446	0.239	0.394	0.313	0.504	-0.003
Purchasing Directories	0.111	0.370	0.059	0.446	1.000	0.450	0.294	0.560	0.420	0.059
Contractor's Financial Perrformance	0.108	0.031	0.020	0.239	0.450	1.000	0.211	0.333	0.284	0.180
Information Sharing	0.288	0.307	0.267	0.394	0.294	0.211	1.000	0.352	0.415	0.337
Advertisements	0.287	0.170	-0.014	0.313	0.560	0.333	0.352	1.000	0.502	0.171
Trade Fairs Exhibitions	0.286	0.267	-0.044	0.504	0.420	0.284	0.415	0.502	1.000	0.181
Pan-Departmental Commitment	0.164	-0.147	-0.032	-0.003	0.059	0.180	0.337	0.171	0.181	1.000
Explained Variance (Eigenvalues)										
Value	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
Eigenvalue	3.382	1.522	1.327	0.891	0.811	0.598	0.479	0.377	0.330	0.282
% of Var.	33.818	15.224	13.267	8.906	8.108	5.985	4.794	3.771	3.304	2.823
Cum. %	33.818	49.042	62.309	71.215	79.323	85.308	90.102	93.874	97.177	100.000
Communalities										
	Variable									
Past Records	0.601									
Salesmen Involvement	0.780									
Visiting Contractor;s Plant	0.756									
Catalogues	0.659									
Purchasing Directories	0.660									
Contractor's Financial Perrformance	0.411									
Information Sharing	0.565									
Advertisements	0.592									
Trade Fairs Exhibitions	0.583									
Pan-Departmental Commitment	0.624									
Unrotated Factor Loadings										
Variable	Factor 1	Factor 2	Factor 3							
Past Records	0.439	-0.177	0.614							
Salesmen Involvement	0.552	-0.623	-0.295							
Visiting Contractor;s Plant	0.278	-0.713	0.412							
Catalogues	0.713	-0.209	-0.327							
Purchasing Directories	0.722	0.150	-0.341							
Contractor's Financial Perrformance	0.500	0.396	-0.068							
Information Sharing	0.671	-0.052	0.334							
Advertisements	0.695	0.328	-0.038							
Trade Fairs Exhibitions	0.730	0.213	-0.070							
Pan-Departmental	0.248	0.465	0.589							

Commitment										
Varimax Rotated Factor Loadings										
Variable	Factor 1	Factor 2	Factor 3							
Past Records	0.147	0.090	0.756							
Salesmen Involvement	0.234	-0.806	0.277							
Visiting Contractor;s Plant	-0.202	-0.392	0.749							
Catalogues	0.577	-0.551	0.151							
Purchasing Directories	0.760	-0.286	-0.006							
Contractor's Financial Perrformance	0.629	0.123	0.005							
Information Sharing	0.467	-0.041	0.587							
Advertisements	0.755	0.032	0.144							
Trade Fairs Exhibitions	0.736	-0.084	0.184							
Pan-Departmental Commitment	0.300	0.624	0.381							
Rotation completed in 7 iterations										
Rotation was normalised										
Casewise Factor Scores										
Case	Factor 1	Factor 2	Factor 3							
1	0.040	-0.182	-0.879							
2	0.038	-0.625	-0.278							
3	1.511	-0.068	0.130							
4	-0.063	-0.327	0.063							
5	-0.403	1.145	-0.582							
6	-0.322	-0.123	1.296							
7	0.294	0.632	1.517							
8	-0.420	0.800	1.013							
9	1.377	0.069	0.767							
10	2.306	0.233	0.774							
11	-1.000	-0.966	0.189							
12	-0.205	0.175	-0.542							
13	-1.018	1.078	0.476							
14	-0.122	-1.044	-0.766							
15	0.366	-0.558	-0.023							
16	-0.356	-0.037	0.263							
17	0.523	-0.597	-0.728							
18	0.147	0.726	1.431							
19	-1.001	-1.451	0.223							
20	-0.509	-0.551	1.272							
21	0.668	-0.593	0.200							
22	0.557	-0.193	0.505							
23	0.820	-0.652	-0.264							
24	1.162	-2.384	-0.328							
25	-0.701	-0.086	-1.075							
26	-1.110	0.226	1.064							
27	1.504	-1.201	0.749							
28	-0.114	-0.007	0.738							
29	-0.153	-0.593	-1.103							
30	0.917	1.066	-1.189							
31	-1.654	0.266	0.603							
32	0.511	-0.295	0.386							

33	-0.152	1.303	0.636							
34	-0.132	-0.211	-0.072							
35	0.836	-0.063	0.655							
36	0.790	-0.733	1.316							
37	1.268	1.595	-2.983							
38	-0.176	1.037	0.590							
39	0.805	-0.178	0.502							
40	0.704	-0.668	0.547							
41	-3.052	-1.803	-0.077							
42	-0.502	-0.838	0.637							
43	-0.445	1.342	-1.207							
44	-0.706	-1.864	-2.425							
45	2.115	-0.710	0.414							
46	-1.300	-0.609	-0.700							
47	0.805	-0.178	0.502							
48	-0.176	1.037	0.590							
49	1.268	1.595	-2.983							
50	-0.445	1.342	-1.207							
51	0.040	-0.182	-0.879							
52	-0.706	-1.864	-2.425							
53	2.115	-0.710	0.414							
54	-1.300	-0.609	-0.700							
55	-1.802	1.755	0.711							
56	-1.390	0.784	0.281							
57	-0.914	0.526	0.537							
58	-0.593	1.485	-0.172							
59	0.069	1.217	0.601							
60	0.185	0.921	0.901							
61	-0.446	1.808	-0.204							
62	0.538	1.276	-0.536							
63	-0.892	-1.686	0.831							