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FACTORS CAUSING VARIATION ORDERS IN BUILDING PROJECTS IN KHARTOUM STATE- SUDAN

Eltahir Abu Elgassim Mohammed [1] *, Salma Yahia Mohammed [2], Awad Saad Hassan[3]
* 1 Lecturer & Head of Construction Department, Civil Engineering, Faculty of Engineering, Sudan University of Science and Technology , Khartoum – Sudan
2 Associate Professor & Head of Civil Engineering Department, Faculty of Engineering, University of Science and Technology ,Khartoum – Sudan
3 Associate Professor &Dean of the Faculty of Architecture, Sudan University of Science and Technology, Khartoum – Sudan

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ABSTRACT
The optimum project performance would be achieved if the work invariably flows smoothly within time limits and anticipated budget. Variation orders result in time delay, cost overrun, quality defects, and other associated negative impacts. The main objective of this study was to analyze the factors causing variation orders in Building projects in Khartoum state-Sudan. The investigation process comprised a 10 cases analysis study coupled with a questionnaire survey for a sample including 130 participants: 47 consultants, 53 Contractors, 23 owners and 7 project managers. 28 causes of variation orders were recognized from literature review. The study results identified the top ten most significant factors that cause variation orders in the building project in Khartoum state – Sudan. They included (1) Lack of stability of prices and the exchange rate change , (2) New government regulations (3) Non availability of construction manual and procedure for construction project in Sudan , (4) Errors and omissions in design ,two factors in the same ranking (5) Owner fails to make decisions or review document at the right time and Owner's needs during the design stage are not well-defined or variably , (7) Owner's financial problems ,two factors in the same ranking (8) Contractors financial difficulties and The lack of coordination between consultant and contractors and subcontractors and (10) Non-use value engineering in design stage to find the best alternatives and providing cost . In general, the study showed an agreement among owners , consultants , contractors , and project managers regarding the ranking of factors .

KEYWORDS: Contractors, Variation Orders, Khartoum, Building projects, Consultants, Owners.

I. INTRODUCTION
Variation orders have long been an inherent part of the construction industry. It is seldom to spot a construction project being executed without a change which normally arises as a result of some causes attributed to the different parties involved in the project execution. Upon acknowledging its existence, the change – or variation is formally regularized by the issuance of a change order which is a document describing the scope of the change and its impact on both cost and / or time. If no agreement is reached between the parties of the project on the change, it turns into a claim or dispute that may negatively affect the execution of the project and curtail its chances of successful completion. A number of researchers gave several definitions to be change order. It is work that added to or deleted from the original scope of work of a contract which alters the original contract amount or completion date(Zawawi, et al. 2010, [1]). Osman et al. (2009) [2] defined the change as any deviation from an agreed upon well-defined scope and schedule. The words "Variation Order" conjure strong feelings of negativity for all involved in construction projects .Owners do not like them because they generally feel they are paying for other"s mistakes. In some cases, contractors believe that Variation Orders disrupt workflow and require additional paperwork and time. In other cases, contractors would find the Variation orders a mean to improve their outcome of the project. However, it is generally accepted that consultants, contractors and owners agree that projects would be better without Variation orders.

Variation Orders strain the relationships of the owners, engineer, contractors, subcontractors, and others involved in the construction process as well as add cost and schedule delay. Changes on one project can also affect other unrelated projects by tying up resources that are committed elsewhere. Negative relationships between the parties are another byproduct of changes on a project. Not only is workflow disrupted, but also trying to get quick responses quotes, shop drawings, and many other things required to get back schedule causes a strain on working relationships (Rashid, et al. 2012,) [3]. Homaid et al. (2009) [4] investigated 21 causes and 11 potential impacts of change orders. Also, nine practices reported to management and control of change orders. The study identified eleven important causes and seven important impacts. It is further concluded that the consultant is the most responsible party for the change orders. The overall average increase in total cost of construction projects due to change orders was found to be 11.3%. The research concluded that change of project scope due to owner requirements is the most important cause and cost overruns are the most important impacts of change orders in those projects. According to Aljeshi and Almarzouq (2008) [5], Aldubaisi (2000) [6] and Zawawi (2010) [1], changing the plans by the owners is the main source of change orders, change in mind, substituting materials and/or procedures is the second source of change orders and errors and omissions in design is another source. Increase in project cost and duration were founded as the main two effects of change orders. In another study it was concluded that the best way to manage change orders is to reach a negotiated .

In general, Variations orders present problems to all parties involved in the construction process. Variations are the major cause of project failure. From some interviews which was done with some construction managers in Sudan Construction Field, Variation orders were the main cause of increasing in contract value and/or the extension of time. This study aims to determine factors causing variation orders in Building construction projects in Khartoum – Sudan.

II. MATERIALS AND METHODS

DATA COLLECTION

1. From studied cases

Initially, a study and analysis for 10 projects was conducted where detailed information was collected (contract documents, monthly reports and weekly reports).This was followed by face-to-face interviews with projects participants with the aim of determining the factors causing (Variation Orders) in the studied cases

2. From questionnaire

Data were gathered through a questionnaire administered to owners, contractors, consultants and project managers. They were requested to answer questions pertaining to their experience with building Project and their opinions about variation orders. The participants were (23) engineers working in government entities represented owner,(53) engineers in contractors companies,(47) were engineers working in consultant firms and 7 were engineers working as project managers. The questionnaire was divided into two sections. Section one included the information about respondents. Section two included a list comprising twenty eight factors causing variation orders. in table 1 for factors were selected from the previous studies and highlighted as the most important factors were presented.

Table 1, Factors causing Variation Orders

Factor No	Factor Description	Factor No	Factor Description
Factor 1	Owner's financial problems	Factor 15	The required labor skill are not available
Factor 2	Change of plan by Owner	Factor 16	The required equipment and tools are not available
Factor 3	Change of Scope by Owner	Factor 17	Material not meeting the specifications
Factor 4	Owner fails to maintain hold on the project schedule.	Factor 18	Contractor desire to improve his financial conditions
Factor 5	Owner fails to make decisions or review document at the right time.	Factor 19	construction delay by other contractors working on different contracts
Factor 6	Owner's needs during the design stage are not well-defined or variably.	Factor 20	Acceleration of work Safety consideration / emergency field conditions
Factor 7	Change in design by engineer or consultant	Factor 21	Weather conditions

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Factor 8	Conflict between contract documents	Factor 22	Demolition and re-work
Factor 9	Errors and omissions in design	Factor 23	Difference between the design and the actual construction on site
Factor 10	The scope of work for the contractor is not well defined	Factor 24	New government regulations
Factor 11	Technology changes	Factor 25	Lack of stability of prices and the exchange rate change
Factor 12	The lack of coordination between consultant and contractors and subcontractors	Factor 26	Non-use value engineering in design stage to find the best alternatives and providing cost
Factor 13	Differing site conditions	Factor 27	Non availability of construction manual and procedure for construction project in Sudan
Factor 14	Contractors financial difficulties	Factor 28	Obstinate nature of owner and consultant

Statistical analysis of questionnaire

The data was presented in ordinal scale. This scale was transformed into an interval scale by assigning a weight to each interval. Considering intervals from (never) to (very often) as an interval scale from (one to five): (Very often = 5, Often = 4, Sometimes =3, Seldom = 2 and Never equals =1). Then weighted average for each factors was calculated according to the equations (1) & (2) Zaneldin (2006) [7

$$Weighted\ Average = (Wi\ x\ Xi)/\ N \quad .(1)$$

Where Wi the weight is assigned to the it option of factor; Xi is the number of respondents who selected the it option of factor; and N is the total number of respondents. To better understand Weight average,

$$\text{Weight average} = 5\ (x5) + 4\ (x4) + 3\ (x3) + 2\ (x2) + 1\ (x1) / (N) \quad (2)$$

III. RESULTS AND DISCUSSION

Studied Cases Results

Table 2, Factors causing VOs from studied cases

Case study no	Variation order no	Justification	% of executed Variation order	Factors causing variation orders
Case no (1)	1	Change the design of electrical Wiring	100	Change in the use of the building
	2	concrete of additional elevators	100	
Case no (2)	1	Addition Asphalt street in the compound by length 3 kilometer	100	Client's changing needs, Design Changes, Instability of prices
Case no (3)	1	Change the Interface building to cladding works	100	Client's changing needs, Design Changes, Error in design
	2	Increase building lighting	100	
	3	Change the External Surface of Building from Tiles to Landscape	100	
Case no (4)	1	Change the foundation of building	100	Client's changing needs, Design Changes

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Case no (5)	1	Change the location of project by Ministry of Physical Planning after working start by 9 months	100	Changing government regulations and legislation
Case no (6)	1	Convert the usability of the building	100	Client's changing needs , Change use of building, Design Changes
	2	Increase the Capacity of electricity of building	100	
	3	1.Addition the entrance of interface building. 2.Addition the drainage system	100	
Case no (7)	1	Convert the usability of the building from Laboratories	100	Client's changing needs, Change use of building, Design Changes
	2	Increase the Capacity of air condition of building	100	
	3	1.Addition another small Building as Laboratory	100	
Case no (8)	1	Add Additional Floors	100	Client's changing needs, Design Changes
Case no (9)	1	Increase the height of suspended slab	100	Client's changing needs, Design Changes
	2	Change the type of intervals	100	
	3	Change the monitoring system	100	
Case no (10)	1	Change the type of electrical connections	100	Change the Scope of Work , Design Changes

The results from table (2) showed that for projects executed during the years (2007-2017) at least a substantial (70%) majority of the recorded causes for (V.O) in building projects were related to (client's changing needs, client's changing scope of work, design changes, instability of prices of material in local Market, Changing government regulations and legislation and Change the use of the project) were the most influential. This result goes in line with the international experience.

Questionnaire Results

General Information

The configuration of the participant was as presented in fig (1) 5.4% of the respondents were working as project managers, 40.8% were working as contractors, 17.7% were owners and 36.2% were working as consultants.

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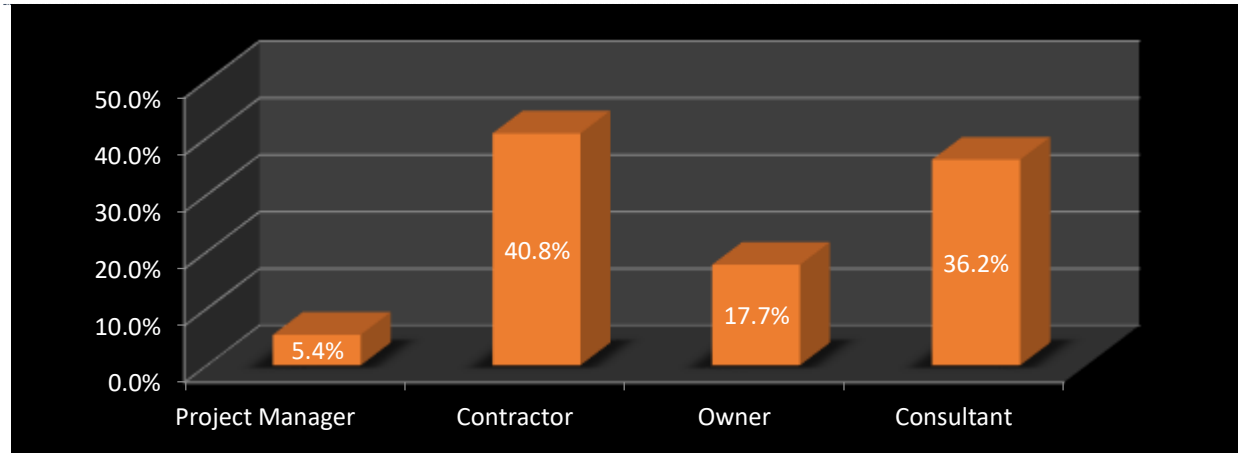

Fig1. Work area

Regarding to the work area that were involved in , 27.7 % classify themselves as public sector org(s) while 72.3% were private sector (refer to fig 2)

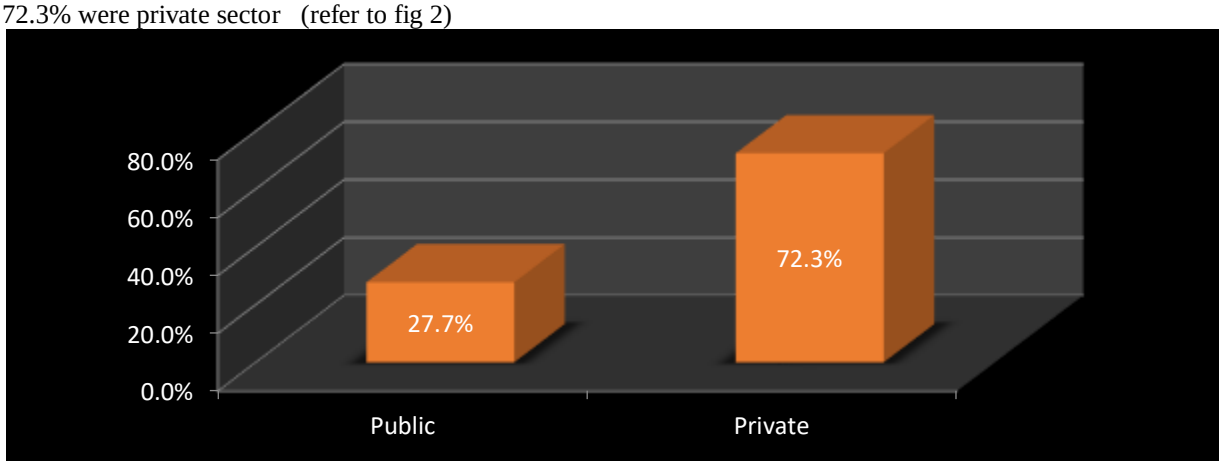

Fig2. Work Sector

When asked respondents to specify their specialization, 79.2% were civil engineering while 20.8% were architect engineering as shown in fig 3.

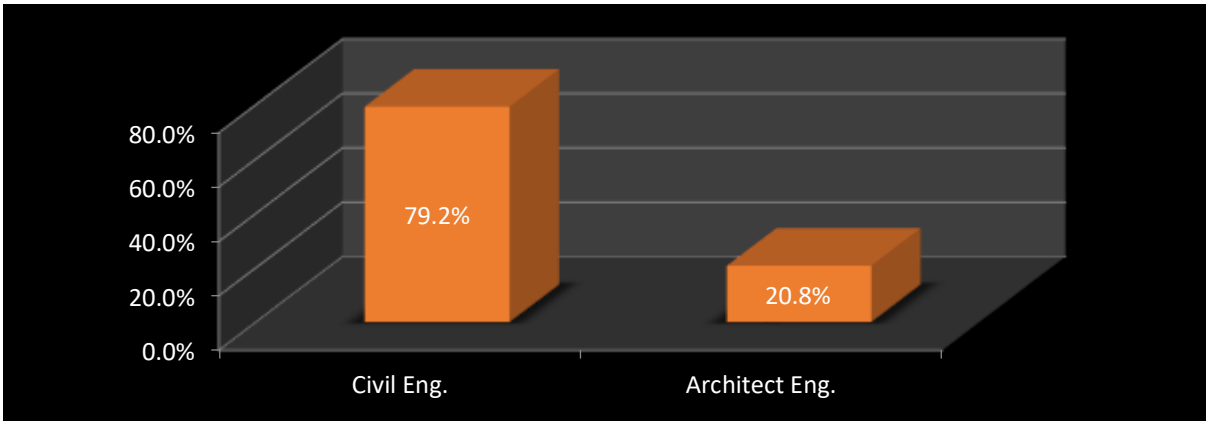

Fig3. Specialization

To evaluate the respondents experience, 12.3% admitted to be working in the field less than 5 years, 20.8% were working for (5 – 10) years, 32.3% for (10-15) years and 34.6% for more than 15 years. This confirms that the participants have been working for more than 15 years which implies a good experience to give reasonable consent. (refer to fig 4)

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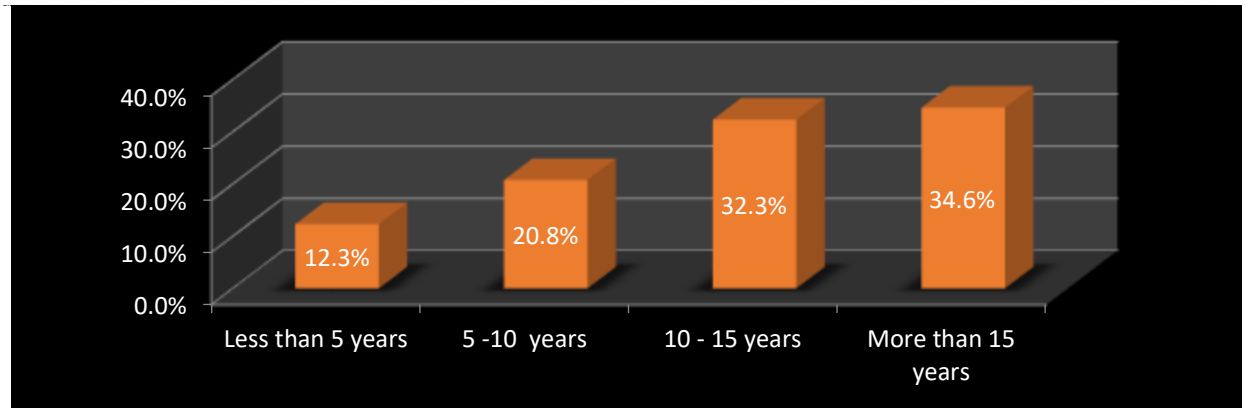

Fig4. Number of experience years

To gauge the frequency of occurrence of VOs in building projects. VOs are witnessed in all executed projects , 20% said that happened less than 5 projects, while 14.6% said (5 –10) projects , 36.9 % said (10-15) projects and 28.5 % said for more than 15 projects. This confirms the fact that about (2/3) of the respondents (65.4%) confirmed having at least 10 projects having VOs.(refer to fig 5)

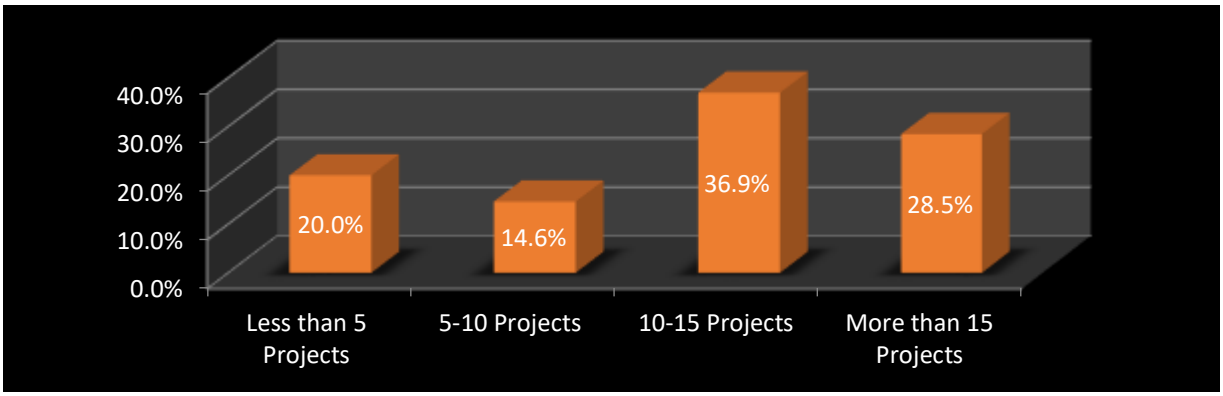

Fig5. Number of projects executed with witness VOs

Occurrence of factors causing variation orders

Owing to the fact that VOs could be caused by several factors with a variable impact level, respondents were asked to give their opinion ranking the occurrence of each of the highlighted 28 factors. The results presented in fig 6 showed that at least 46.15% of the respondents confirming that all 28 factors occur very often during project execution.

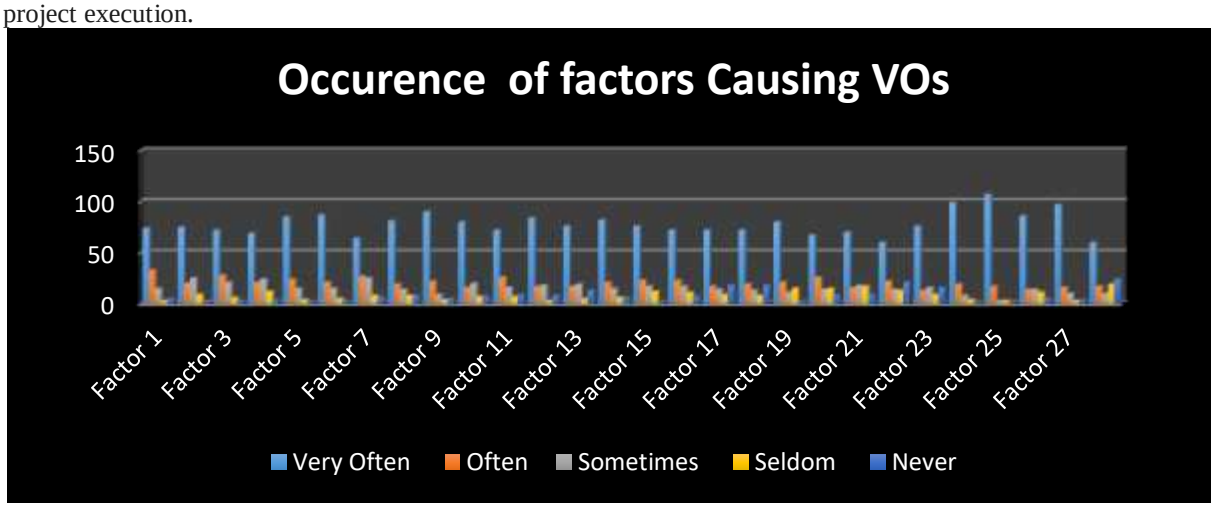

Fig6. Occurrence of factors causing VOs

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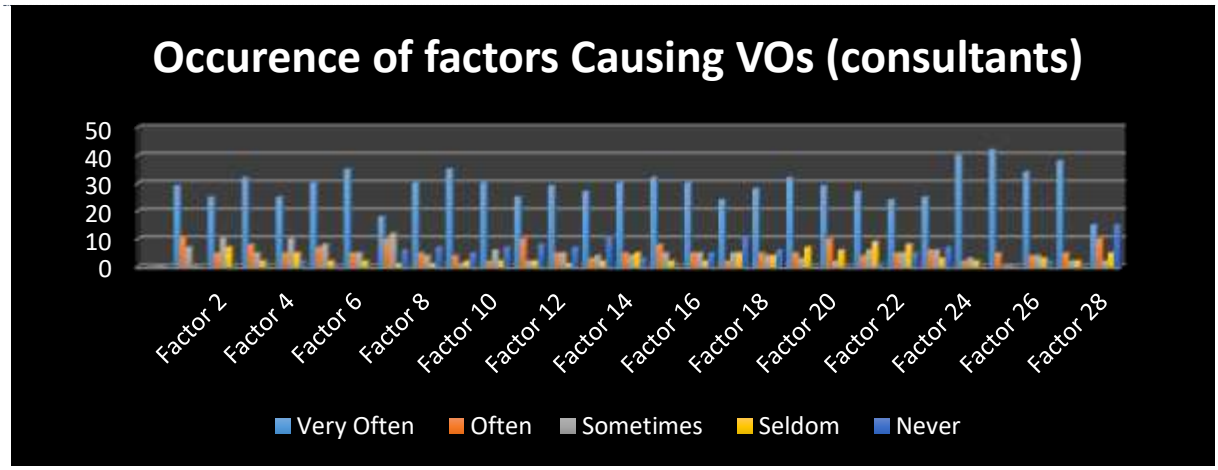

Fig7. Occurrence of factors causing VOs (Consultants)

Upon checking the same result from the perspective of the different participants, about third (31.9%) of consultants confirmed that all 28 factors occur very often. as shown in fig 7

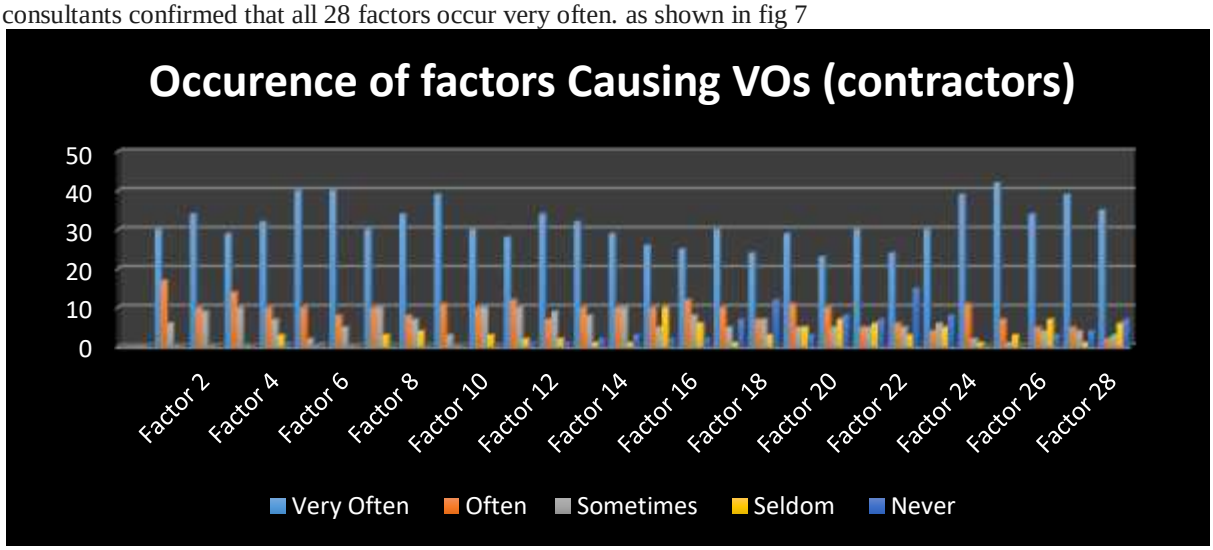

Fig8. Occurrence of factors causing VOs (Contracts)

Upon checking the same result from the perspective of the different participants, about (43.4%) of contractors confirmed that all 28 factors occur very often. as shown in fig 8

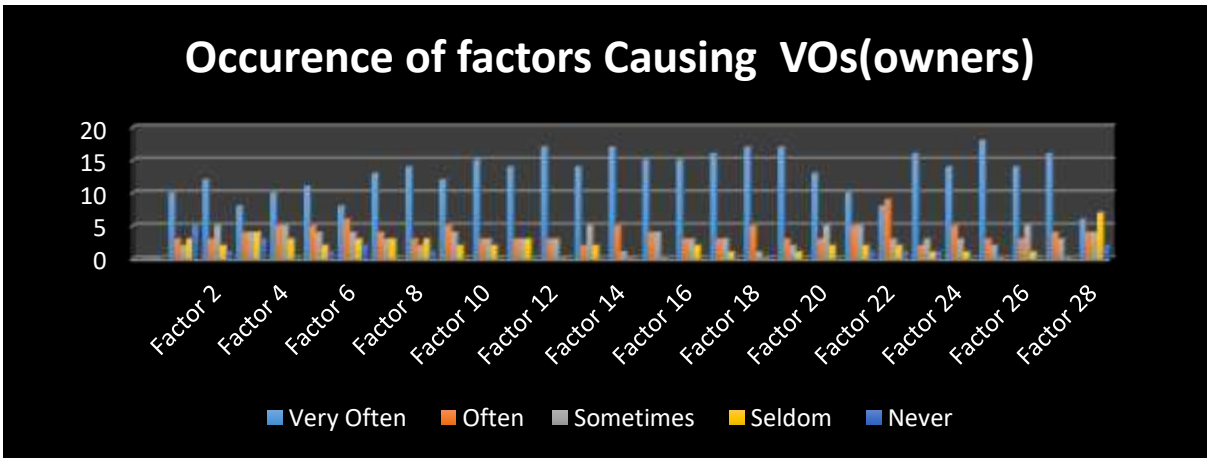

Fig9. Occurrence of factors causing VOs (Owners)

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Upon checking the same result from the perspective of the different participants, about third (20.09) of owners confirmed that all 28 factors occur very often. as shown in fig 9

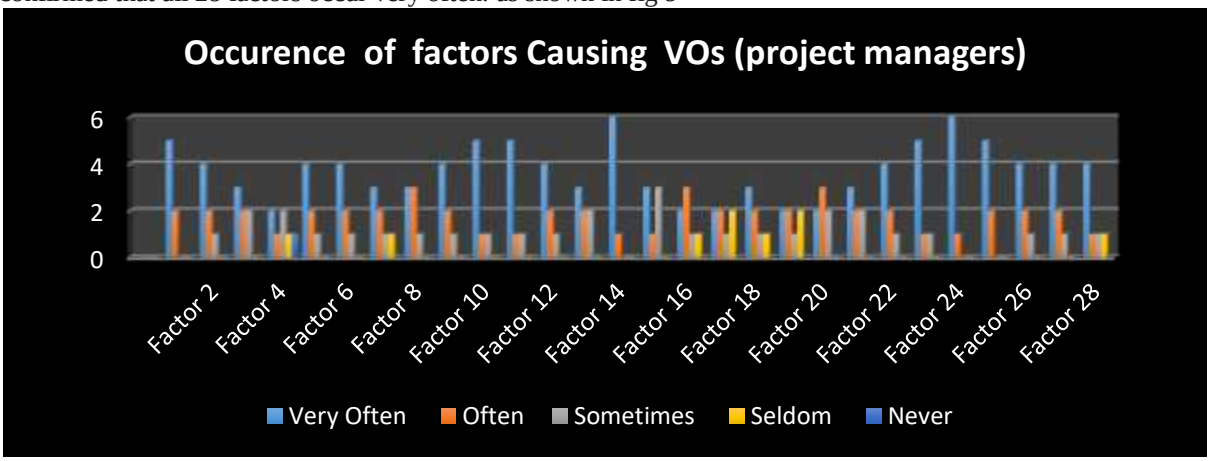

Fig10. Occurrence of factors causing VOs (Project Managers)

Upon checking the same result from the perspective of the different participants, about third (28.57%) of project managers confirmed that all 28 factors occur very often. as shown in fig 7

Weighted avearge of factors causing VOS

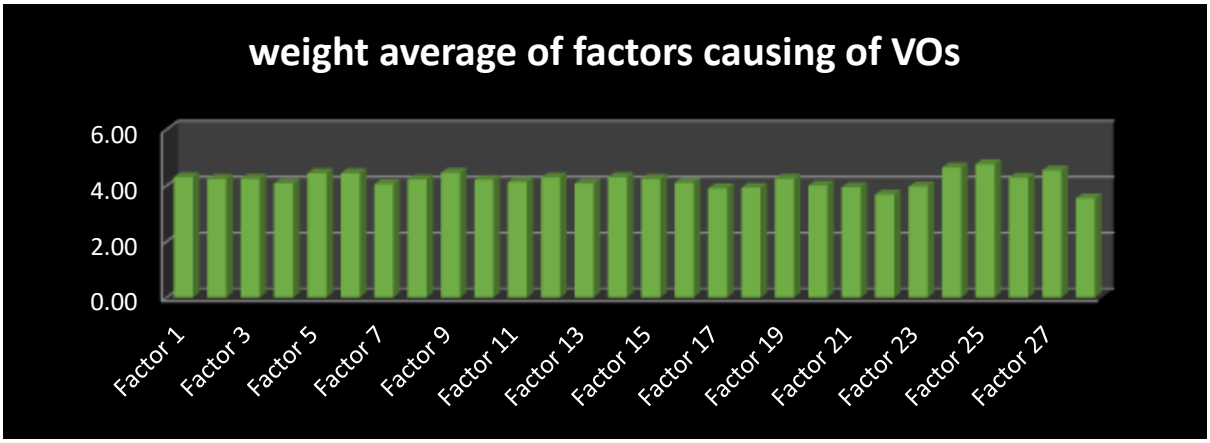

Fig11. Weight average of factors causing VOs

The results from figure(11) showed that weight average of factors causing VOs up 4.75 of Lack of stability of prices and the exchange rate change to 3.54 of Obstinate nature of owner and consultant.

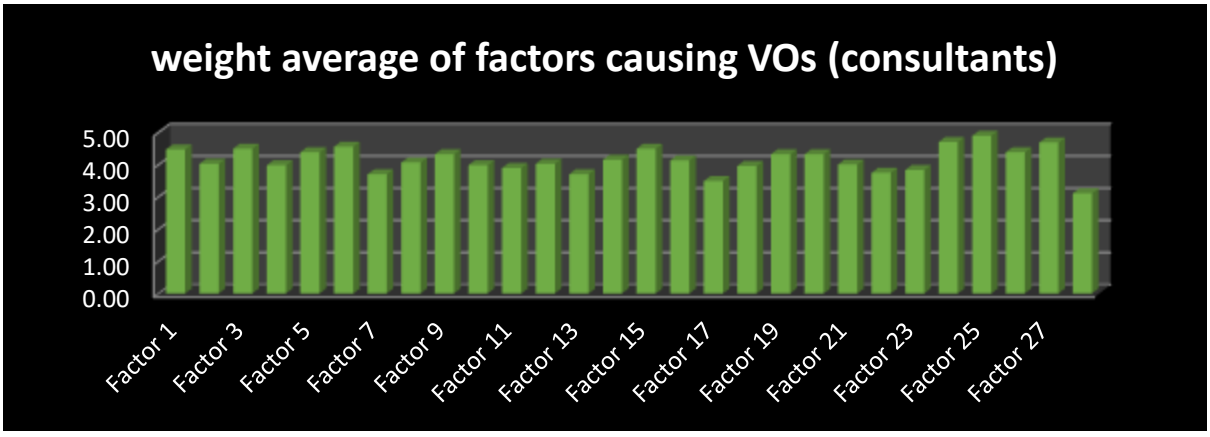

Fig12. Weight average of factors causing VOs (Consultants)

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The results from figure(12) showed that weight average of factors causing VOs up 4.89 of Lack of stability of prices and the exchange rate change to 3.11 of Obstinate nature of owner and consultant.

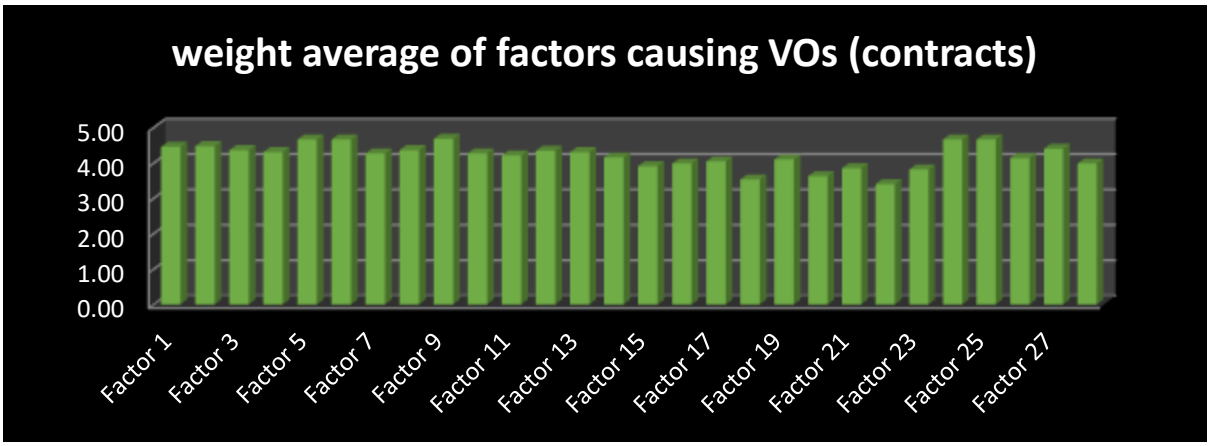

Fig13. Weight average of factors causing VOs (Contractors)

The results from figure (13) showed that weight average of factors causing VOs up 4.68 of Errors and omissions in design to 3.40 of Demolition and re-work.

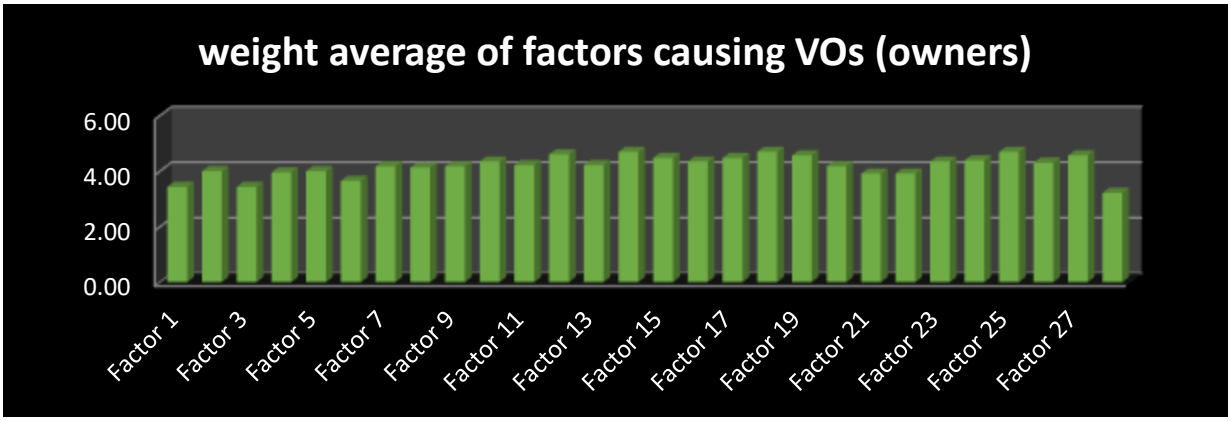

Fig14. Weight average of factors causing VOs (Owners)

The results from figure (14) showed that weight average of factors causing VOs up 4.7 of Contractors financial difficulties , Contractor desire to improve his financial conditions and Lack of stability of prices and the exchange rate changed to 3.22 of Obstinate nature of owner and consultant.

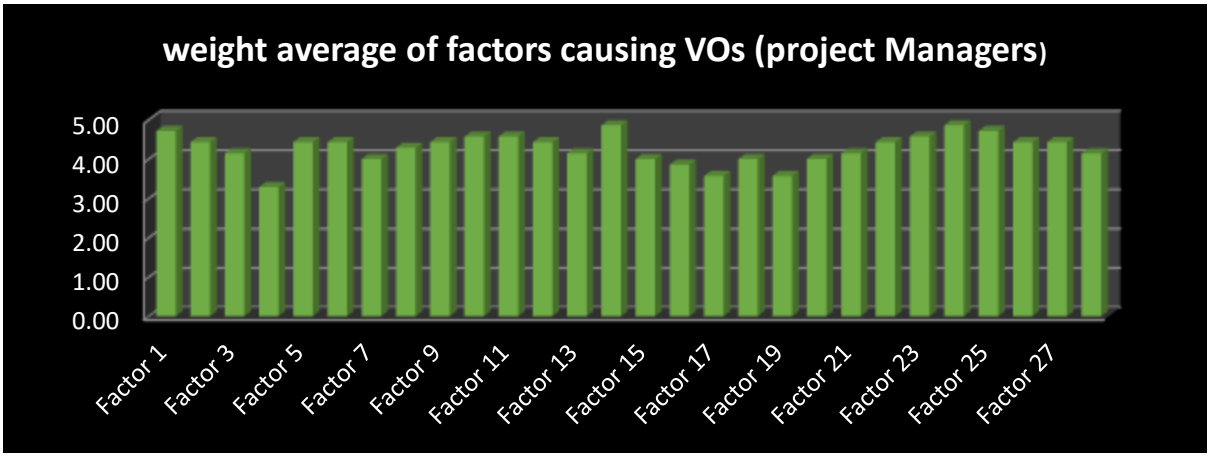

Fig15. Weight average of factors causing VOs (Project Managers)

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The results from figure (15) showed that weight average of factors causing VOs up 4.86 of Contractors financial difficulties to 3.29 of Owner fails to maintain hold on the project schedule..

Ranking of factors causing VOs

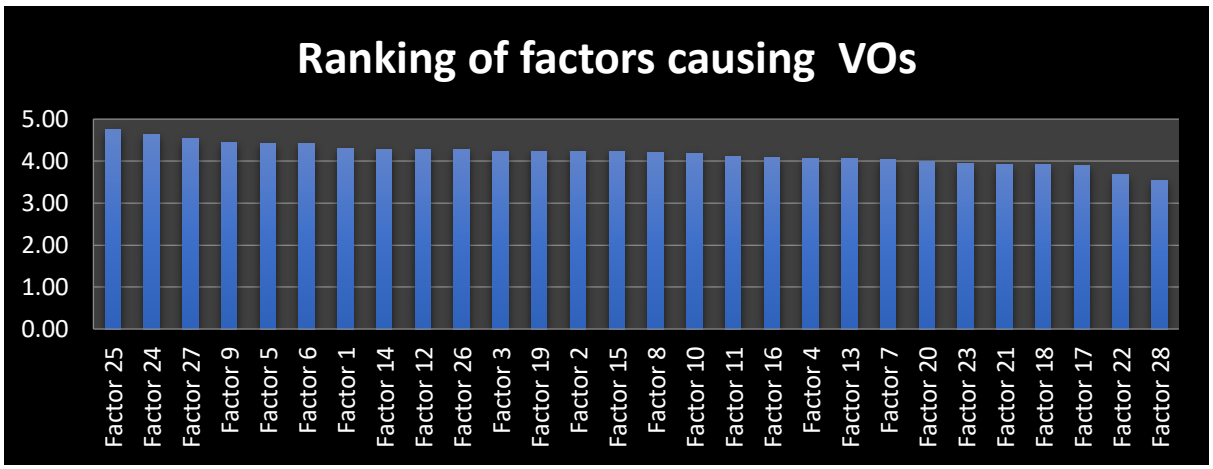

Fig16. Ranking of factors causing VOs

The results from figure(16) showed that the top ten factors causing VOs are :(1) Lack of stability of prices and the exchange rate change , (2) New government regulations , (3) Non availability of construction manual and procedure for construction project in Sudan , (4) Errors and omissions in design ,two factors in the same ranking (5) Owner fails to make decisions or review document at the right time and Owner's needs during the design stage are not well-defined or variably , (7) Owner's financial problems ,two factors in the same ranking (8) Contractors financial difficulties and The lack of coordination between consultant and contractors and subcontractors and (10) Non-use value engineering in design stage to find the best alternatives and providing cost

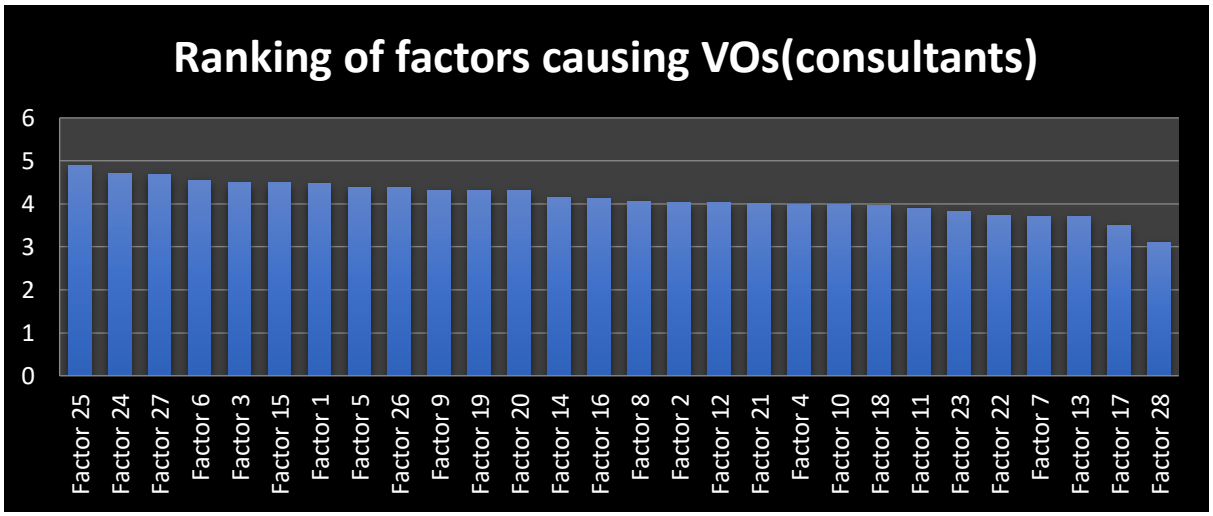

Fig17. Ranking of factors causing VOs (Consultants)

According to the consultants views, the results from figure(17) showed that the top ten factors causing VOs are :(1) Lack of stability of prices and the exchange rate change , (2) New government regulations , (3) Non availability of construction manual and procedure for construction project in Sudan , (4) Owner's needs during the design stage are not well-defined or variably, two factors in the same ranking (5) Change of Scope by Owner and The required labor skill are not available , (7) Owner's financial problems , two factors in the same ranking (8) Owner fails to make decisions or review document at the right time and Non-use value engineering in design stage to find the best alternatives and providing cost and (10) Errors and omissions in design.

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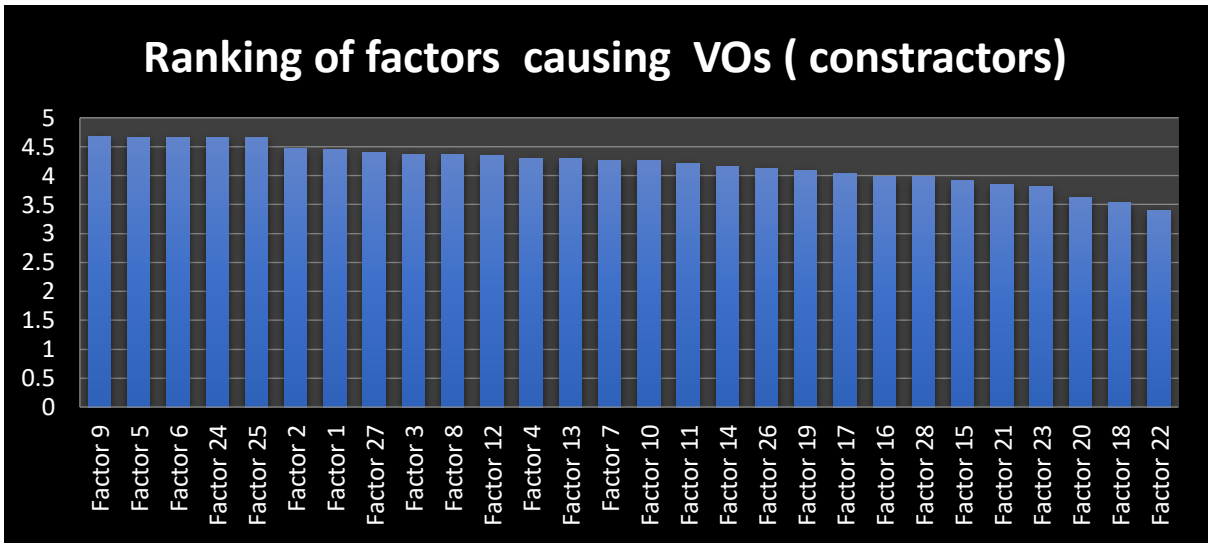

Fig18. Ranking of factors causing VOs (Contractors)

The results from figure(18) showed the contractors views which admit that the top ten factors causing VOs are :(1) Errors and omissions in design ,four factors in the same ranking (2) Owner fails to make decisions or review document at the right time, Owner's needs during the design stage are not well-defined or variably, New government regulations and Lack of stability of prices and the exchange rate change , (6) Change of plan by Owner , (7) Owner's financial problems , (8) Non availability of construction manual and procedure for construction project in Sudan ,two factors in the same ranking (9) Change of Scope by Owner and Conflict between contract documents.

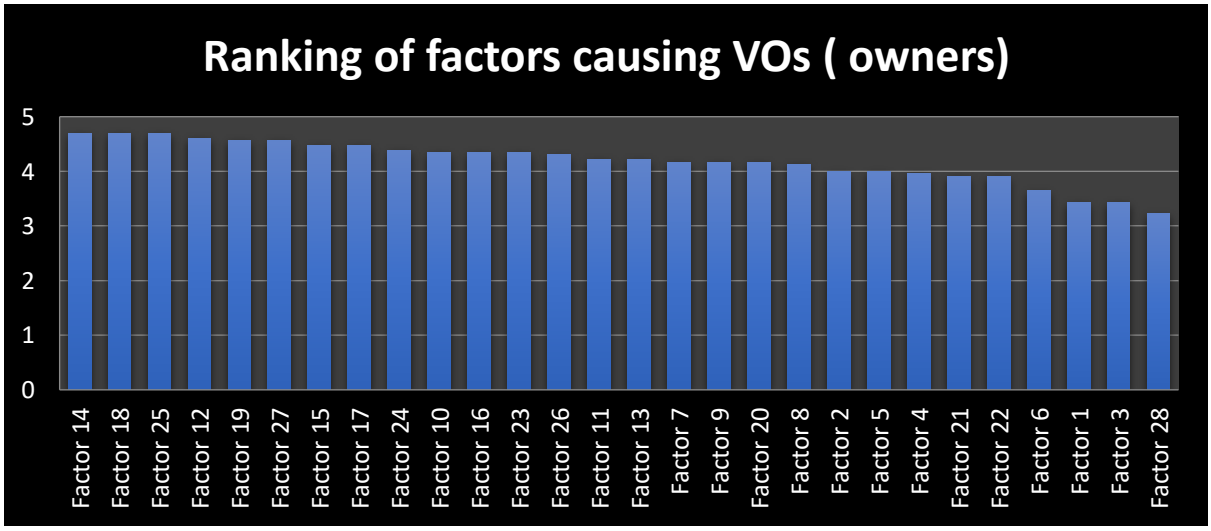

Fig19. Ranking of factors causing VOs (Owners)

According to the owners views, the results from figure(19) showed that the top ten factors causing VOs are :Three factors in the same ranking (1) Contractors financial difficulties , Contractor desire to improve his financial conditions and Lack of stability of prices and the exchange rate change , (4) The lack of coordination between consultant and contractors and subcontractors , two factors in the same ranking (5) construction delay by other contractors working on different contracts and Non availability of construction manual and procedure for construction project in Sudan , two factors in same ranking (7) The required labor skill are not available and Material not meeting the specifications , (9) New government regulations and (10) The scope of work for the contractor is not well defined .

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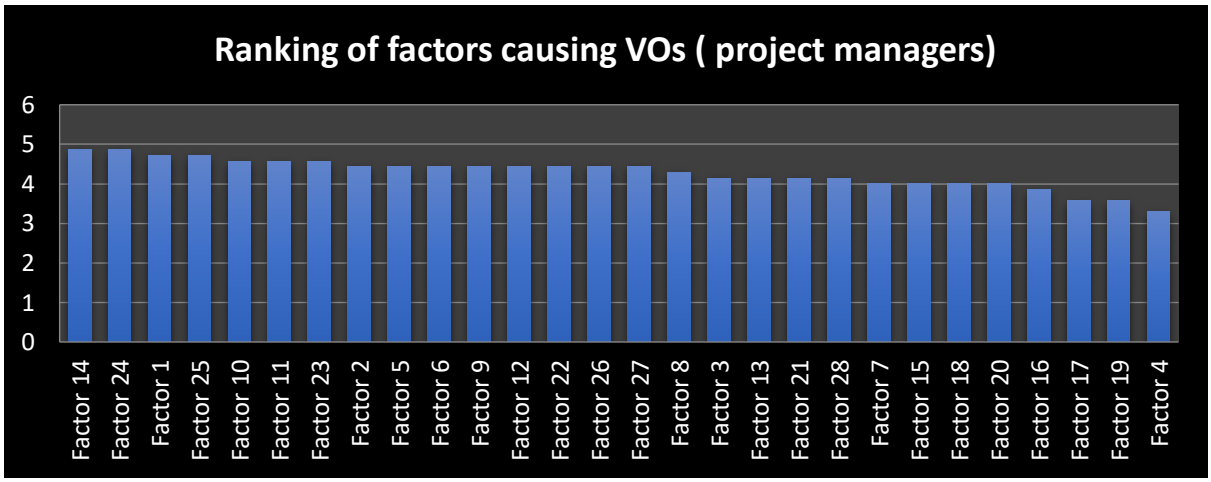

Fig20. Ranking of factors causing VOs (Project Managers))

The project managers also confirmed similar result from figure(20) showed that the top ten factors causing VOs are :two factors in the same ranking (1) Contractors financial difficulties and New government regulations , two factors in the same ranking (3) Owner's financial problems and Lack of stability of prices and the exchange rate change ,three factors in the same ranking (5) The scope of work for the contractor is not well defined, Technology changes and Difference between the design and the actual construction on site, eight factors in same ranking (7) Change of plan by Owner , Owner fails to make decisions or review document at the right time , Owner's needs during the design stage are not well-defined or variably, Errors and omissions in design , The lack of coordination between consultant and contractors and subcontractors , Demolition and re-work , Non-use value engineering in design stage to find the best alternatives and providing cost and Non availability of construction manual and procedure for construction project in Sudan .

IV. CONCLUSION

The results obtained from literature review and previous studies, the preliminary study (cases analysis) and the detailed survey were consistent confirming the fact that the selected 28 factors causing VOs are of great important as they impact of the project execution .

With the consent of all the parties involved in the project execution process of building projects in Khartoum state- Sudan, The most (10) influential factors causing VOs were to be :(1) Lack of stability of prices and the exchange rate change , (2) New government regulations , (3) Non availability of construction manual and procedure for construction project in Sudan , (4) Errors and omissions in design ,two factors in the same ranking (5) Owner fails to make decisions or review document at the right time and Owner's needs during the design stage are not well-defined or variably , (7) Owner's financial problems ,two factors in the same ranking (8) Contractors financial difficulties and The lack of coordination between consultant and contractors and subcontractors and (10) Non-use value engineering in design stage to find the best alternatives and providing cost

V. ACKNOWLEDGEMENTS

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