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Participation of Construction Professionals in the Environmental Impact Assessment of Heavy Engineering Projects

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Abstract - **Synergy and collaboration among various experts and stakeholders, including construction professionals, play a crucial role in reducing the negative environmental impacts of heavy engineering projects. While the heavy engineering industry significantly contributes to national economies, it also poses a threat to the environment through air, land, and water pollution. Therefore, the influence of multidisciplinary experts should be prioritized. However, there are significant challenges to be addressed in this regard, particularly concerning construction professionals. Hence, this paper extensively discusses the stakeholders involved in the Environmental Impact Assessment (EIA) of heavy engineering projects and their participation. A well-structured questionnaire was distributed to construction professionals in the study area, including architects, builders, engineers, estate surveyors, quantity surveyors, and urban and regional planners. Convenience sampling techniques were used to select these professionals. Additionally, six heavy engineering projects were purposively selected as case studies. Descriptive and inferential statistics were employed to analyze the retrieved data. The study concluded that architects, urban and regional planners, engineers, and quantity surveyors are the construction professionals most commonly involved in the EIA of heavy engineering projects. However, their level of involvement was found to be low. This study is crucial at a time when construction professionals are expanding their horizons beyond building projects alone to align with global trends. It is essential for construction professionals, government agencies, professional bodies, and private organizations to prioritize the outcomes of this study by promoting increased participation and improving awareness and knowledge among construction stakeholders regarding their roles and required skills for effective participation. This could lead to job creation, diversification, and improved environmental impacts of heavy engineering projects, particularly in developing countries. Given the global experience of climate change, multidisciplinary involvement and synergy between different experts and stakeholders in heavy engineering projects are vital for mitigating negative environmental impacts on air, land, and water. Addressing this issue will not only enhance the inclusivity of construction professionals in the journey to achieving Net-zero emissions but also ensure the effectiveness of heavy engineering projects, especially in the global south. While the findings of this research are valuable, there are limitations due to the lack of access to qualitative information from some intended interview respondents. Despite these limitations, the study identifies a knowledge gap that can be explored in developing countries, particularly in Africa, to improve the participation of construction experts in the EIA of heavy engineering projects. The study adopts an empirical approach to map out research focus on environmental sustainability for construction professionals in the heavy engineering industry - an aspect of sustainable development that has not received considerable attention in recent studies on sustainability.**
Keywords: **Stakeholders, EIA Participation, Heavy Engineering Projects**

I. INTRODUCTION

The reduction of environmental effects of construction projects requires a collective effort from different stakeholders, the construction professionals inclusive (Ojo, 2016). Environmental issues are raised when a project plan is discussed and addressed as a project progresses from inception to implementation in the EIA process (Barasa, 2014; Posiva, 2018). This process helps in the determination of significant impacts for approvals to be integrated into the analysis without causing major disruptions or enlarged project outlays early in the project cycle. Thus, for the building and civil engineering works incidental to heavy engineering works, construction professionals' roles should not be underestimated in bringing into light the purpose of the assessment. Construction projects involve a lot of activities such as the clearance of vegetation, disruption of habitats, dredging and so on. These projects if not regulated and moderated right from the time of idea conception could prove inimical to themselves and the surroundings. An example is the tragic collapse of a 3-storey building in Ita-Faaji, Lagos sland, that resulted in the injury and death of several pupils.

In the dailies, no post-mortem cause has been carried out by the Lagos state environmental protection agency however, some residents laid claim to an ongoing dredging work around the area which might have affected the building foundation (Aljazeera and News Agency, 2019). Similarly, several other construction failures have been recorded earlier in the years 2014 and 2016 respectively as stated in the same report. Thus, reinforcing the need for EIA as expounded by Anago (2002), that it is an instrument for attaining the anticipated equilibrium for innovative development short of altering the natural component of the environment.

Past researchers, the likes of (Lohani, Evans, Ludwig, Everitt & Carpenter, 1997; Wood, 2003; Eneh, 2011 & Ojo, 2016) laid emphasis on the benefits of EIA to the construction industry in several ways; including ensuring the integration of environmental concerns into the development project or programme planning process. Similarly, it helps to achieve the desired balance for developing resourcefully without compromising the inherent veracity of the environment, which thus makes it an environmental management tool in respect of core infrastructural projects (Anago, 2002). In the same vein, it helps to overcome the challenge to harmonize development with sound environmental management principles; and also used as an instrument in planning projects for environmental fortification and achieving sustainability (Tahir, 1999; Khadka and Shrestha, 2011).

II. CONSTRUCTION STAKEHOLDERS IN THE EIA OF HEAVY ENGINEERING PROJECTS

EIA abets the assessment of the proposed envisaged cost of such developments to its benefits to the environment, therefore aiding informed decisions. On the global scene, it aids the identification of the influence of proposed projects on climate change and other environmental issues (Leonard and Anne, 1995). Also, EIA is beneficial to the construction industry in that it will help in averting conflict over project implementation when it tackles issues arising from public consultation most importantly in the developing world; where historical and cultural traditions and respecting rights and curiosity of stakeholders are highly esteemed (EIA Act, 1992).

Similarly, EIA affords the local planning authority with improved facts about certain types of projects, thereby allowing for the making of an informed decision about the granting of permission imposition of more appropriate conditions and requirements to mitigate likely negative impacts. The EIA report according to the EIA procedural guidelines (1995) requires that the project be defendable in terms of the need for it, the value and the envisaged sustainability. Similarly, the description of the project and/ or process includes the type, input and output of raw materials and products, site, technological outline, manufacturing process, project operation and maintenance, and project schedule. This aspect reveals the dire need for the expertise of construction professionals such as the builder, engineer, quantity surveyor, architect and others who through their acquired skills would either encourage or discourage the use of some building materials and elements to preserve the project and the environment.

Also, this would translate to the financial aspect which would call for the utilization of the quantity surveyors' expertise to quantifying the cost of the proposed project, leading to cost-benefit analysis as a means of checkmating every decision taken by the other professionals.

Furthermore, in the procedural guidelines, the associated and potential environmental impacts comprise of the preparation of site and impacts of construction, transportation and raw materials, hazard or beneficial effects specific to the project, which are still within the purview of the construction professionals. In the same vein, the mitigation measures and alternatives highlighted in these guidelines include the use of best available control and practicable technology; alternative sites, location or routes; no project option; compliance with health and safety hazards requirements; also, all these require the input of construction professionals. Moreover, the environmental management plan and monitoring require the input of the experts to determine the choice, parameters, procedure and schedule of monitoring. (Zolfagharian *et al.,* 2012).

In addition, EIA is important to construction projects in that it might help in averting conflict over project implementation when it tackles issues arising from public consultation most importantly in the developing world; where historical and cultural backgrounds and regarding rights and interests of participants are highly esteemed (EIA Act, 1992). Moreover, it could help to forestall embarking on a project whose cost greatly outweighs the benefit envisaged or allow for the suggestion of alternative route or designs to the project (Noorbakhsh & Ranjan, 1999).

The stakeholders identified in research as prominent in the EIA of heavy engineering projects include the professional chartered environmentalist, architect, water scientist, soil scientist, structural engineer, urban and regional planner, geologists, estate surveyor, civil engineer, quantity surveyor, botanist among others. It is noteworthy that many consultants are usually involved in the EIA process because the impact of the proposed project or development transcends all aspects of the environment, which should be investigated before the project is allowed to take off (Wang, 2007). Thus, for construction projects, the full involvement of all necessary stakeholders including the construction practitioners would help in accomplishing the importance of the assessment. Moreover, EIA abets the assessment of the proposed envisaged cost of such developments to its benefits to the environment, therefore aiding informed decisions. The submission of Keftin (2009) is that it is expedient for the careful incorporation of EIA in the project cycles processes. It further opined that to achieve a considerable level of execution, the allied professionals involved in the process should be updated with the workings and current challenges of EIA.

III. RESEARCH METHODS

This research adopted a mixed method of both quantitative and qualitative approach, where questions were asked and rated in the order of rank in multiple boxes for the quantitative method (Spratt, Walker & Robinson, 2004; Molina-Azorin, 2016). Thus, the mixed method approach is

adopted in this study to complement each other and to avoid the overlay of weaknesses of the research methods.

Three divisions of quantitative research design exist which are survey, experimental and ex post facto research design in accordance with the submission of Asika (1991). Survey design was adopted in this study because it does not give room for manipulation or control of the observed variables. Furthermore, the Alzheimer Europe (2009) opined that the types of research include experiments, surveys, questionnaires, interviews, case studies, participant and non-participant observation, observational trials and the use of Delphi method.

Likewise, there are five possible approaches to research according to Simron (2017), and these consist of the methodological, historical, descriptive, explanatory and remedial approaches. Questionnaire and interview were used to collect data for the quantitative and qualitative research respectively. Respondents to the questionnaire were selected through the random sampling technique, while convenience sampling was used to select the respondents that responded to the drafted interview guidelines as the interviewees.

This study gives greater insights for further research based on the findings. This research utilized quantitative data sourced via a questionnaire survey to the targeted population to get the views of professionals on the roles of construction professionals in the EIA of heavy engineering projects in great depth. A 6-point Likert scale was used for ranking the variables for the roles of construction professionals in the EIA of heavy engineering projects (6= Architect, 5= Builder, 4= Engineer, 3= Estate Surveyor, 2=Urban and Regional Planner, 1= Quantity Surveyor). The population is a collection of elements being studied and conclusions to be drawn (Okoko, 2001). The population of the professionals is architects, builders, engineers, builders, estate surveyors, quantity surveyors and urban and regional planners in the study area.

According to Andale (2017), sample frame is defined as the selected list(s) from individuals or households also known as sample size. All individuals in the target population make a reputable sample frame and removes all entities not in the precise population. Likewise, a sample is the subdivision of a population got using some processes like random selection or based on some specific established criteria. The population and sampling frame employed discussed hitherto is applicable to the choice of respondents for questionnaire administration. The outcome of the preliminary survey conducted on the selected construction professionals in the study area is presented as follows; 125 quantity surveying firms (QSF); 48 planning firms (PF), 345 architectural firms (AF), 63 estate surveying firms (ESF), 148 engineering firms (EF) and (70) building firms (BF) exist in Lagos State (QSRBN, 2017; ATOPCON, 2016; ARCON,2018; ESVRABON,2016; COREN,2016; CORBON, 2016).

Purposively, a sample size of 30% was considered for firms such as the quantity surveying, architectural and engineering having a total population more than 100; while total enumeration was used for the planning, estate surveying and building firms with less than 100 population size as employed in a previous study (Ebunoluwa,2019). This was done to allow for a fair representation of the data gathered, giving a sample size of 38, 104, 45, 48, 63 and 70 firms respectively and totaling three hundred and sixty-eight (368) firms. The questionnaires were distributed by hand and 282 respondent firm responses were found suitable for analysis. This shows a response level of 76.63% which is above the normal response rate of 20–30% as stated by Akintoye (2000).

Moreover, case studies were used to corroborate the findings from the questionnaire respondents so as to reveal what the real situation is in relation to their experience in handling those projects. The sampling method for these projects is more of purposive for the selected heavy engineering construction projects were selected; with some of the construction professionals on these projects were interviewed. Descriptive and inferential statistics as descriptive frequencies and best option analysis (BOA); content analysis and OTTR “observe,” “think,” “test,” and “revise” for the case study projects were used for analysis.

IV. FINDINGS AND DISCUSSION

Table I displays the profile of the respondent firms comprising 26.6% architectural firms, 18.4% building firms, 13.1% engineering firms, 18.1% estate surveying firms, 9.6% quantity surveying firms and 14.2% urban and regional planning. The number of employees working in a firm is an indicator of size and type of projects been handled (OECD, 2019 & Abosede *et al.,* 2019). In this study, more than 40.0% of the responding firms have over 10 employees working with them, which is an indication that some of these firms are handling medium-sized civil engineering projects and the information needed on the subject matter in this study will be duly addressed. Likewise, the EIA Act was passed into law in the year 1992 in Nigeria which is barely 20 years ago, therefore, having about 30% of the respondent firms been in existence for more than 10 years gives a reassurance that the supplied information by the respondents is dependable.

1. Profile of the Interviewees and EIA-Based Heavy Engineering Case Study Projects

The use of a structured pro-forma was employed to obtain qualitative primary data via the conduct of an open-ended interview. With the consent of the interviewees, the interview was audio -taped, recorded and transcribed, and analysed using content analysis. Two interviewees on the selected heavy engineering projects were interviewed (Table II & III).

TABLE I PROFILE OF RESPONDENT FIRMS

Type of Firms	Frequency	Percentage (%)
Architectural Firms	75	26.6
Building Firms	52	18.4
Engineering Firms	37	13.1
Estate Surveying Firms	51	18.1
Quantity Surveying Firms	27	9.6
Planning Firms	40	14.2
Total	282	100.0
Years of Existence of Firm		
1-5	63	22.3
6-10	80	28.4
11-15	45	16.0
16-20	25	8.9
>20	9	3.2
No Response	60	21.3
Total	282	100.0
Mean		12 Years
Number of Employees in the Firm		
5 or Less Employees	47	16.7
6-10 Employees	71	25.2
11-15 Employees	58	20.6
16-20 Employees	38	13.5
21 Employees and Above	26	9.2
No Response	42	14.9
Total	282	100.0

TABLE II PROFILE OF THE INTERVIEWEES

Sl. No.	I.C	Designation of Respondent	Years of Existence of Project/Firm	Professional Affiliation	Years of Respondents Professional Experience	Position in the firm	No. of Employees working with the company	Type of Project	Have you been Engaged in EIA before?	Level of Involvement
1	CP_1	Architect	>30 Years	Member NIA	16-20 Years	Head of Design	>20	Building and Civil Engineering Works	Yes	Always
2	CP_2	Quantity Surveyor	11-20 Years	Member NIQS	11-15 Years	Consultant QS	>20	Building and Civil Engineering Works	Yes	Often

Note: I.C=Interviewee Code, CP_1= Construction Professional 1

TABLE III EIA-BASED HEAVY ENGINEERING CASE STUDY PROJECTS

Sl. No.	Code Name	Project Name	Client	Project Type
1	C.S.P_1	Lagos Light Rail Project	Lagos Government	Public
2	C.S.P_2	Egbin Thermal Power Station, Ijede/Egbin in Ikorodu, Lagos	Lagos Government	Public
3	C.S.P_3	Second Phase of Lagos Urban Transport Project. Proposed Road Rehabilitation at Aboru Pipeline Road under LUTP 2	Lagos Government (Lagos Metropolitan Area Transport Authority)	Public
4	C.S.P_4	Eko Atlantic City Development		Public Private Partnership
5	C.S.P_5	Lekki-Tolaram Port Project		Public-Private Partnership
6	C.S.P_6	Ajaokuta-Obajana Gas Pipeline Project	Dangote Group	Private

Note: C.S.P_1=Case Study Project 1

2. Stakeholders Involved in the Environmental Impact Assessment of Heavy Engineering Projects

The utilization of less qualified people rather than engaging suitable professionals usually result in monetary loss according to Atilola (2013) in Ojo (2016); therefore, the involvement of construction professionals to perform their EIA roles in heavy engineering projects as discoursed in this study is desirable to the industry at large. Construction professionals include the urban and regional planner, architect, quantity surveyor, estate surveyor, engineer, builder among others (Sant & Brenda, 2009; Hussin, 2009; Dada & Jagboro,2012; Anyawu, 2013). This study identified and examined the stakeholders involved in the environmental impact assessment of heavy engineering projects in the construction industry in Lagos, Nigeria. From literature, twenty-one (21) stakeholders were identified to be involved in EIA of heavy engineering projects.

Twelve (12) consultant stakeholders were observed to have mean values above the average 3.64 on Table IV, it is perceived by the respondents that the urban and regional planner had the highest ranking with a mean value of 4.09 in terms of involvement in EIA of heavy engineering projects, while the values of others are stated as civil engineer (4.08), project manager (4.07), architect (4.06), structural engineer (3.99), quantity surveyor (3.97), professional chartered environmentalist (3.95), environmental scientists (3.91), electrical and mechanical engineer (3.76), soil scientist (3.75), estate surveyor (3.66) and GIS professional (3.65) in descending order respectively. It can be inferred from this result that construction professionals perceive themselves to have input in the EIA of heavy engineering projects such as the review and comment on the EIA report of a proposed project, management and monitoring of the mitigation measures proposed for the predicted impacts.

TABLE IV EXTENT OF INVOLVEMENT OF STAKEHOLDERS IN EIA OF HEAVY ENGINEERING PROJECTS

Sl. No.	Stakeholders to EIA	Mean	Std. Deviation	Rank
1	Urban and Regional Planner	4.09	1.135	1
2	Civil Engineer	4.08	1.052	2
3	Project manager	4.07	1.030	3
4	Architects	4.06	1.112	4
5	Structural engineer	3.99	1.143	5
6	Quantity Surveyor	3.97	1.091	6
7	Professional Chartered Environmentalist	3.95	1.211	7
8	Environmental Scientists	3.91	1.048	8
9	Electrical and mechanical engineer	3.76	1.214	9
10	Soil scientist	3.75	1.111	10
11	Estate Surveyor	3.66	1.165	11
12	GIS professional	3.65	1.153	12
13	Geologist	3.64	1.146	13
14	Ecologists	3.59	1.229	14
15	CAD Technician	3.54	1.265	15
16	Hydrologist	3.48	1.154	16
17	Water scientist	3.32	1.421	17
18	Botanist	3.13	1.288	18
19	Biologist	2.99	1.139	19
20	Agricultural experts	2.99	1.210	20
21	Acoustician	2.87	1.203	21
MWA=3.64				

On Table IV above, the urban and regional planner ranked highest among the construction professionals in the EIA of Heavy Engineering Projects. The four mostly engaged construction professionals in the EIA of heavy engineering projects are the architect, engineer, quantity surveyor and urban and regional planner had 32.32%, 22.56%, 18.30% and 26.83% levels of engagement respectively as revealed in Fig. 1 below. It is however surprising how the architect appears to have a higher level of engagement than the urban and regional planner who ranked highest on the stakeholder's table. This study hopes that the respondents did not have this perception based on the traditional mindset that the architect leads the other professionals in the construction industry even with the trend in role changes (Duncan, 2006).

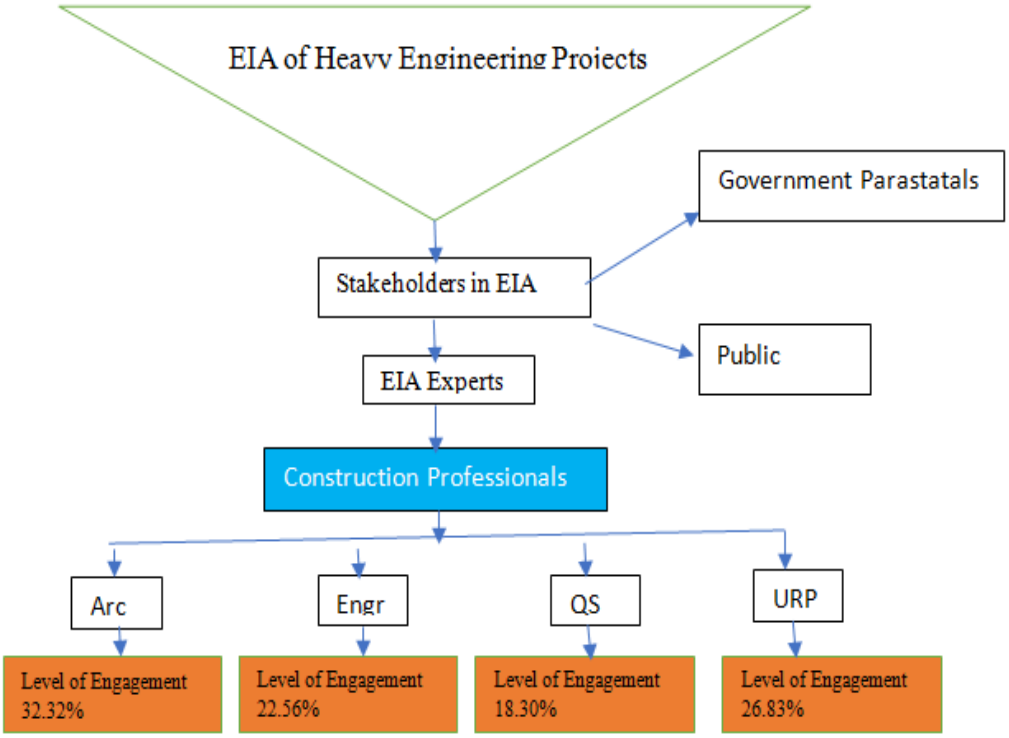

Fig. 1 Flowchart of the Construction Professionals Involved in the EIA of Heavy Engineering Projects

The basis for stakeholder involvement as contained in Sections 7 and 22 (3) of the EIA Act No. 86 of 1992 requires government agencies, members of the public, experts in any relevant discipline, and interested groups to be given the chance to review and comment on the EIA report of a proposed project. Therefore, the result of EIA report analysis of the case study projects revealed that the stakeholders involved are environmental specialists, development specialists, senior Investment officer, marine biologist, ocean engineer and the architect for C.S.P_1. Also, the project manager/impact evaluation expert, air quality/noise studies expert, vegetation & wildlife studies/impact evaluation expert, GIS mapping/socio-economics/impact evaluation expert, socio-economic consultant, soil studies/ land use / impact evaluation expert existed for C.S.P_3. The stakeholders of C.S.P_4 included the project coordinator, project manager/impact evaluation expert, air quality/noise studies expert, vegetation/wildlife studies expert, GIS mapping/socio-economics expert, soil studies/land use expert.

Similarly, the results of the interview analysis about the stakeholders involved in the EIA of heavy engineering projects in the words of the interviewees is as follows: CP-_2: They are the survey specialists, project engineers, environmental specialists, quantity surveyors, development manager and architect. CP_1: The team members involved in the EIA of heavy engineering projects such as this one includes port specialists, civil engineers, marine engineers, water engineers, coastal engineers, noise specialists and air quality specialists. Furthermore, the involvement of the interviewed construction professionals is on the positive side of the likert scale, where the first interviewee (CP_1) claimed to always been involved, while the second (CP_2) has often been involved. For instance, CP_1 opined that he is always involved; in fact, his involvement level has been from the very first day of the project. He however said that because the Lekki port project is more of marine projects, the construction professionals do not have much roles to perform because it is more of marine projects, especially because most of them are not trained in the marine field in Nigeria. Similarly, CP_1 stated that most construction professionals are not really needed for this type of project; however, it was opined that he was fortunate to be involved as an architect and because he had interest in knowing it.

This study inferred that even some of the construction professionals do not have an idea of their relevance in EIA of heavy engineering projects. This inference could be one of the reasons why the study of the final EIA report of one of the on-going heavy engineering construction projects (CSP_2) revealed that the technical and project planning information was provided by other project consultants and survey experts without preference for construction professionals who bring to reality the proposed construction of the buildings and civil engineering works incidental to the heavy engineering projects in the proposed city.

CP_1 further stated that he learnt wave-modelling study and also did air quality assessment. Some of the submissions of the interviewees is as follows: "*The type of contract determines the involvement; as this is an Engineering Procurement and Construction (EPC) contract like Turnkey, the company informs TOLARAM of what is*

required and they design, procure and construct and just hand over to us. We do not really have much of our professionals in the marine area in Nigeria. Do we really need the URP for this type of project? No. As an Architect, I am just fortunate to be involved and because I have interest in knowing about it (wave-modelling studies)". However, qualitative analysis for similar projects onshore and offshore revealed little or no relevance. More so that the interviewed architect opined to only be fortunate to have been involved in the EIA of the marine project and it was due to his tenacity that he learnt wave-modelling study on the project. There appears not to be a convergence in the quantitative and qualitative analyses on the stakeholders to be involved and the extent of involvement in the EIA of Heavy Engineering Projects.

IV. CONCLUSION AND RECOMMENDATION

The study concludes that some of the Nigerian construction professionals have little involvement in the EIA of heavy engineering project. It is quite surprising that the disposition of some of them towards this poor extent of involvement is an unperturbed one. Therefore, it is suggested that better awareness be done through the organization of workshops and seminars; and that the curriculum for professional practice in relation to EIA study in the industry be improved upon. The construction professional's involvement in the EIA of heavy engineering projects should be introduced to the students' curriculum so as to improve the needed knowledge and create awareness at the early stage of career. The tools for construction professional practice like the building and engineering standard method of measurement (BESMM) for the quantity surveyors should take cognizance of this level of involvement and ensure the applications at the various stages of construction. These would help achieve environmentally effective heavy engineering projects.

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