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Scaling Up: The Challenges of eHealth Systems in Developing Countries

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Abstract: ***Clinicians want a very useful, portable, and handy tool to use in their practice, which improves workflow and becomes a convenient connectivity channel for applications and information resources. Mobile devices respond to this need by allowing physicians anywhere and anytime, but there are few guidelines to help decide on the acquisition and implementation of large-scale technology in healthcare systems. Upon review of the literature on eHealth, a critical question is raised: why has eHealth projects not been scaled-up across several developing countries? Although research has established that eHealth tools have the potential to affect the healthcare outcomes positively. Using the case of Mobile Technology for Community Health (MOTECH) in Ghana, a theoretical model is used to appraise the critical factors affecting the scalability of eHealth systems. This study focused on the problems from medical officers, community health nurses, volunteers and beneficiary patients' perspective and tried to bring out the issues that are fundamental in rolling out a successful eHealth solution to the public. The study did not focus only on the technological aspect, but also on the behavioural aspect of eHealth technology, in which the Technology Acceptance Model (TAM) was extended to appreciate the challenges. The model identified technical support, resistance to change and financial constraints as the main obstacles to the adoption and scalability of eHealth systems. The research contributes to the literature by identifying important areas where results can have a positive effect or can be used by health policymakers in Ghana and other developing countries. This can help them understand their concerns and weaknesses when planning the adoption and implementation of m-health systems.***
Keywords: Scalability, eHealth, Developing Countries, Ghana Health Service.

I. INTRODUCTION

Many studies have shown that the integration of eHealth technology in the healthcare process promotes better health communication, improve the decision-making process of healthcare professionals (and patients), improve access to quality healthcare information and facilitate direct communication to under-served areas where this was not possible before (1). According to Speciale & Freytsis (2) and Obasola, Mabawonku, & Lagunju, (3), Information Communication Technology (ICT), especially mobile phones, can help patients and health professionals overcome institutional barriers by reducing travel time to consult specialists. (4; 5), thus effectively increasing the number of available healthcare options. Vandelanotte et al. (6), examined the impact of mobile health interventions in low and middle-income countries, found that there is growing evidence of the effectiveness of mobile health interventions, particularly in improving patient compliance, appointment meeting, data collection and support networks for health workers; however, the quantity and quality of the evidence are still limited in many aspects. Despite numerous studies and research demonstrating the emerging need for these kinds of services and the recognized potential of national health authorities in several different countries, mobile applications are not yet widely used in the health sector as a standard way of providing health services to patients, health professionals and to the administration of health-related information. Although challenges in the context of eHealth have been studied, for example, by (7; 8; 9; 10), more evidence is needed in a country-application context.

This study draws upon prior work, ranging from reviewed articles, a eHealth intervention system Mobile Technology for Community Health (MOTECH) for Ghanaian healthcare workers within the medical infrastructure, to a text-messaging project in Kassena-Nankana West and Awutu Senya focused on improving access to maternal health education (11; 12; 13). In a developing country, like Ghana, there is a proliferation of eHealth pilots, with few moving forward to being scaled up and little evidence to inform researchers on, when, and how these pilots might expand countrywide (14). With this background, it is imperative to investigate why eHealth projects fail to scale-up. This critical investment question requires evidence-based investigation at the root of the current healthcare resolution (15; 16; 10). This study in identifying the main factors and challenges of eHealth scalability can create a favourable environment in Ghana to promote scaling up of eHealth project.

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II. PROPOSED RESEARCH MODEL

The proposed research model to be tested in this study is not a replica of the Technology Acceptance (TAM) Model in Figure 1. In this model, four variables were incorporated into the original TAM model, Technical Support, Financial Factors, Resistance to Change and Information Security issues. This research hypothesized the four variables as determinants of adoption and Scalability of eHealth Systems. The proposed variables and hypotheses are supported by previous literature (17).

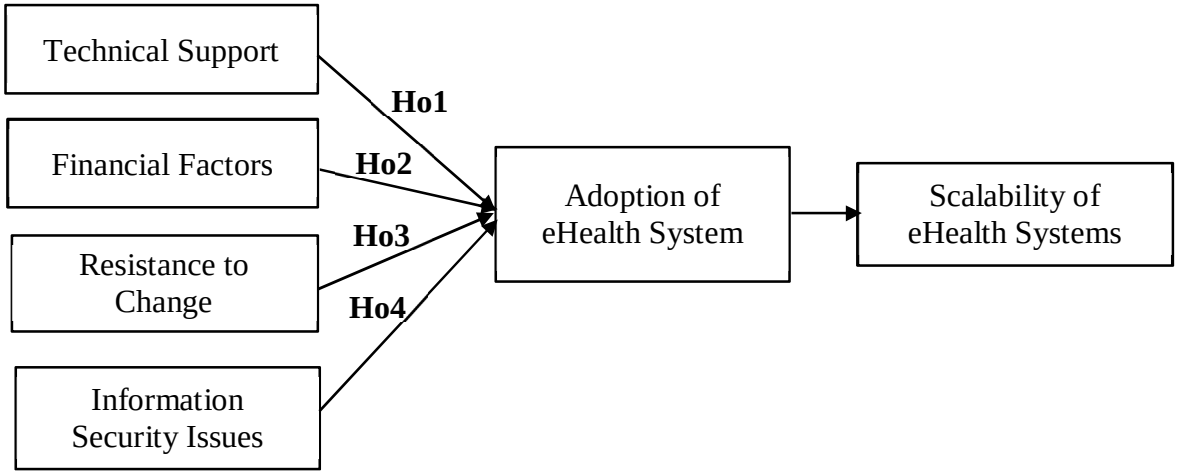

Figure 1: Author's model **(2019)**

III. STUDY HYPOTHESES

1) *H01:* There is no significant impact of technical support on eHealth scalability in Ghana.
2) *H02:* There is no significant impact of financial factors on the scalability of eHealth in Ghana.
3) *H03:* There is no significant impact of the resistance to change on the scalability of eHealth in Ghana.
4) *H04:* There is no significant impact of information security issues on eHealth scalability in Ghana.

IV. METHODS AND PROCEDURES

A case study design was used to determine factors associated with adoption and scalability of eHealth system. It was used because the study described a contemporary phenomenon within a real-life context.

V. STUDY POPULATION

The population for the collection of data for the research was 217 from administration record. Specifically, the medical officers, community health nurses, volunteers and beneficiary patients of their respective units. The Kassena-Nankana West and Awutu Senya District were chosen as the case study since these districts serve as the trailblazer for the piloting of these eHealth projects in Ghana.

VI. SAMPLING TECHNIQUE

The adoption of Slovin's sampling techniques helped the researcher to select a sample devoid of biases and sampling errors. The sample size was calculated using the standard formula for the estimated sample size as follows:

$$n = \frac{N}{1 + N(\alpha)^2}$$

[Where n=sample size, N=Sample frame (217) and α=margin of error (0.05) or 95% Confidence level]
This is equal to

⇨ 217÷1+217(0.05)2
⇨ 217÷1+217(0.0025)
⇨ 217÷1+0.5425
⇨ 217÷1.5425
= 140.1

VII. DATA COLLECTION TECHNIQUES/METHODS

In soliciting for information for this study, a methodological triangulation approach was used involving questionnaires, personal observations and interviews. This research is conducted in the following stages:

1) *Stage 1:* The quantitative approach includes a questionnaire developed based on literature review and was refined with results and information collected from observational studies. Questionnaires for the respondents were provided with close-ended questions that made quantification of the data collected easy. The questionnaire sort of soliciting responses to the objectives of this study. The researcher undertook personal observation through the hospital's environment to understand their work processes, challenges, the education given to eHealth administrators and users, among others. Interview solved the problem of a misunderstanding of questions in the questionnaires. This is because; the interviewer was present to explain any question that the interviewee did not understand.
2) *Stage 2:* A team comprising, two individuals; the researcher, and the staffs of the district conducted the field data collection on the study. The staffs of the district were chosen based on their knowledge in eHealth (MOTECH) due to their constant use of the system. The team members were given the required orientation to be able to understand the rationale of the research. After written and verbal consents were obtained from authorities of institutions, and individuals involved in the study, the team started with the data collection process, which lasted for 14 days.
3) *Stage 3:* The data collection tools were pre-tested for its validity and reliability of the questionnaire, eliminating any uncertainty, and making appropriate changes according to respondents' suggestions. Questionnaires for the study were pre-tested with ten staff at Kassena-Nankana West, which shares similar characteristics with the study area.

a) *Validation:* To test for survey clarity and coherency, a macro review covering all research components was performed by academic reviewers - from Kwame Nkrumah University of Science and Technology (KNUST) - specialized in business, information technology and statistics. Therefore, some items were added based on their recommendations, while some others were modified. The survey was reviewed by a total of (7) academic reviewers, and the overall percentage of response was 100%.

b) *Reliability:* To test the survey reliability, Cronbach Alpha (α) analysis was used to measure internal consistency. A minimum acceptable level (Alpha ≥ 0.65) was suggested and adopted by (Revelle &Zinbarg, 2009). Results show that overall Cronbach Alpha (α) =equaled (97.83), and the results of Cronbach Alpha (α) are shown in Table (1).

TABLE (1) RELIABILITY OF SURVEY DIMENSIONS

Number	Variable	Alpha
1	The adoption of eHealth	.869
2	Technical Support	.781
3	Financial factors	.710
4	Employees perception	.674
5	Information Security issues	.722
6	All Surveys and Documentations	0.89

4) *Stage 4:* Since the study involves human participants, ethical clearance was therefore necessary. Ethical clearances for the study were sought from the regulatory bodies and the two-district health directorates. The nature, purpose and procedure of the study were explained to each respondent. Respondents were given the opportunity to respond or refuse to answer the questionnaires. Respondents were assured of confidentiality and anonymity before the interview sessions.

VIII. STATISTICAL ANALYSES

To determine statistical significance, the researcher used a suitable statistical treatment for each question and hypothesis depending on the following tests:

A. Cronbach Alpha (α) was used to test Reliability.
B. Arithmetic Means and Standard Deviations to answer the study questions.
C. The T-test and the ANOVA table were used to measure the impact of the user characteristics on the usage level
D. Simple Linear and Multiple Regression analysis with (F) test
E. Relative importance, that is assigned using:

$$Class\ Interval = \frac{5-1}{3} = \frac{4}{3} = 1.33$$

$$Class\ Interval = \frac{Minimum\ Class - Maximum\ Class}{Number\ of\ Levels}$$

The Low degree is less than 2.33; The Average degree is from 2.33 – 3.66, The High degree is from 3.67 and above.

IX. RESULTS AND HYPOTHESES TESTING

ANOVA was used to determine statistical significance between the independent factors and scalability of eHealth in Ghana. The results were:

Table (2): The results show the differences between the independent factors and scalability of eHealth projects or systems in Ghana using ANOVA

Mode	Sum of Squares	Mean Square	F	Sig.
Technical support	3.257	3.257	6.824	.011(a)
Financial factors	3.165	3.165	6.610	.013(a)
Resistance to Change	1.4414	1.444	2.839	.097(a)
Information security issues	.488	.488	.929	.339(a)

1) Predictors: (Constant), Technical Support, Financial *factors, Resistance to Change and Information Security Issues*

2) Dependent Variable: scalability of eHealth, * The impact is significant at level (α≤ 0.0 1)

In Table (2), It is apparent that the absolute value of F calculated (6.824) which is more than F tabulated at level (α ≤ 0.01). This indicates Ho1 is valid. Therefore, there is a significant statistical impact of technical support on the scalability of eHealth in Ghana. In the table (2), the absolute value of F calculated (6.610) is more than F tabulated at level (α≤ 0.01). This indicates that (Ho2) is valid. Therefore, there is a significant statistical impact of financial factors on eHealth scalability in Ghana, also, on the same table (2) it is observed that the absolute value of F calculated (2.839) which is less than F tabulated at level (α≤ 0.01), indicates that (Ho3) is valid. Therefore, there is no significant statistical impact of the resistance to change on eHealth scalability in Ghana. Finally, by looking at Table (2) It is evident that absolute value of F calculated (.929) which is less than F tabulated at level (α≤ 0.01), indicates that (Ho4) is valid. Therefore, there is no significant statistical impact of information security issues on eHealth scalability in Ghana.

X. COEFFICIENT OF DETERMINATION

Table (3): coefficient between independent factors and the adoption of eHealth

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate
Technical Support	.324(a)	.105	.090	.69081
Financial Factors	.320(a)	.102	.087	.69195
Resistance to Change	.216(a)	.047	.030	.71307
Information security issues	.126(a)	.016	-.001	.72454

a) Predictors: (Constant), technical support, financial factors, Resistance to Change and Information security issues

The respondents in the study rated the challenges as seen in table 3, **[1.]** the R coefficient between technical support and the scalability of eHealth in Ghana, which indicate a significant impact of the predicting variables (technical support) on the dependent variables (scalability of eHealth). The R2 value = 0.105, which means part of the variance of scalability of eHealth was explained by technical support. **[2.]** The R coefficient between financial factors and the scalability of eHealth in Ghana 0.320 which indicate a significant impact of the predicting variables (financial factors) on the dependent variables (scalability of eHealth). The R2 value = 0.102, which means financial factors explained part of the variance of scalability of eHealth. **[3.]** The R coefficient between employee's perception and the scalability of eHealth in Ghana which indicates a no significant impact of the predicting variables (employee's perception) on the dependent variables (scalability of eHealth). The R2 value = 0.047, which means employees' perception explained part of the variance of scalability of eHealth. **[4.]** Finally, the R coefficient between Information security issue and the scalability of eHealth in Ghana 0.126, which indicate a no significant impact of the predicting variables (information security issues) on the dependent variables (scalability of eHealth). The R2 value = .0.016, which means information security issues explained part of the variance of scalability of eHealth.

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XI. DISCUSSIONS

This result of the study was summarised to answer the critical research questions

A. Identifying Technical Support which Encourages or limit the Adoption and Scalability of eHealth in Ghana.

Table (4): level of importance for the first-factor technological support

Items	Means	STD	level of importance	level of importance
Lack of adequate IT staff	2.13	0.77	1	Medium
Issues with interoperability and appropriate infrastructure to support eHealth initiatives to scale	1.83	0.64	2	Medium
Concerns about a lack of management support from vendors for upgrading and maintaining the system	1.73	0.63	3	Medium
Lack of expertise to select, contract for, and use an e-Health	1.43	0.56	4	Low

In table (4), it is noticeable that means ranged from (1.43 - 2.13) The highest mean was for "level 1" with means of (2.13) and STD (0.77). The lowest mean was for "level 4" with means of (1.43) and STD (0.56). All mean levels were above medium except the level (4) which was the lowest. The outcome of the paper indicates that majority of the respondents the health facilities lacks adequate IT skills and had no interoperability and infrastructure support. This result corresponds to that obtained by (18; 19), which confirmed that adequate IT staff and appropriate infrastructure to support eHealth initiatives have a significant impact in scaling eHealth applications. In the same vein, (20; 21) in their research on the challenge of health professionals using IT to manage patients, they found that health professionals with management support facilitates adoption because of factors, such as strategic alignment, resource allocation, and supportive behaviors for the use of new technologies such as eHealth technology applications.

B. Exploring the impact of financial factors on eHealth adoption in Ghana

Table (5): level of importance for the economic impact (financial)

Items	Means	STD	level of importance	level of importance
The capital needed to procure and implement an eHealth	2.60	0.62	1	Medium
I am not certain about the return on investment (ROI) from an eHealth	2.20	0.84	2	Medium
Excessive rising cost of maintaining an eHealth system	1.73	0.63	3	Medium

In the table (5) it is noticeable that means ranged from (1.73- 2.60), the highest mean was for "level 1" with means of (2.60) and STD (0.62), and the lowest mean was for level 3" with means of (1.73) and STD (0.63). All mean levels were above medium.
Findings from the literature identified that there is low funding for the health sector. Therefore, the study recommends an improvement in line with the recommendations of at least 15% of their annual budget to expand the healthcare sector as approved by the African Union countries (22). However, Ghana budgeted only 8% in 2016 and 2017 to 7.1% in 2018 for the health sector (23). This is less the Abuja Declaration's target of 15% total budgetary allocation, which is totally inadequate to grow such a promising system in the healthcare industry. This study identified that there are low budget and funding for the healthcare sector in Ghana, which needs to more capital injection as reported by other researcher (24; 25). This finding corresponds to the findings of (26; 27; 28), who stated that developing countries have a very low per capita health spending for healthcare delivery. Offering a free-of-charge service can quickly grow the customer base and scale the venture, but eventually, a financially sustainable revenue model needs to be established. Given these financial constraints, this result is consistent with that report by (29; 30; 31), which establishes that the allocation of limited resources to health expenditure represents the greatest challenge for policymakers, which in turn affects scalability, health status and national productivity.

C. Exploring the Impact of Resistance change on eHealth adoption in Ghana.

Table (6): level of importance for the change resistance

Items	Means	STD	Level of importance	Level of importance
Resistance to implementation from physicians	2.47	0.81	1	Medium
Resistance to implementation from other providers	2.23	0.77	2	Medium
Disruption in clinical care during implementation	1.57	0.56	3	Low

In the table (6) it is noticeable that means ranged from (1.57-2.47), the highest mean was for "level 1" with means of (2.47) and STD (0.81), The lowest mean was for the "level 3" with means of (1.57) and STD (0.56). All mean levels were above medium except for level (3) which was the lowest.

This finding corresponds with (32; 33; 34) who stated that Healthcare's strong resistance to change would slow adoption of innovative eHealth. Widespread use of m-health requires behavioural changes of actors who want to protect their interests. The challenge will be even greater for eHealth innovators, because the improvements that eHealth can offer, such as patient care and more attention to prevention, will include a break in the way health care is delivered. To succeed, eHealth innovators must manoeuvre through culturally conservative, highly regulated and fragmented, often monopolistic systems that often offer contradictory incentives.

D. Exploring the impact of information security issues on eHealth adoption in Ghana.

Table (7): level of importance for the information security problems

Items	Means	STD	Level of importance	Level of importance
Concerns about illegal record tampering or "hacking"	1.73	0.45	1	Medium
Issues in relation to the legality of donating a system to associated physician	1.50	0.57	2	Low
Challenges with inappropriate disclosure of patient information	1.50	0.50	3	Low

Looking at the table (7) the means ranged (1.73), the highest means were for "level 3" with means of (1.73) and STD (0.45), the lowest mean was for the "level 2" with means of (1.50) and STD (0.50). All mean levels were above medium except for levels (1 and 2) which were the lowest. A few respondents showed concerned about the confidentiality of their health information, while others were unconcerned about security breaches. Those who were concerned expressed worry about hackers tampering with their sensitive medical information. Nevertheless, the others who were not bothered felt hackers would find little worth in their private information because they felt insignificant in society or lacked employment for which the leak of sensitive information would be a threat. Although respondents' perception of information security was not observed as a severe barrier to eHealth scalability, IT professionals are much concerned about the security and confidentiality of the sensitive data transferred through these technologies, as well as potential device theft as agreed by (35; 18).

XII. SUMMARY

Offering a free-of-charge service can quickly grow the customer base and scale the venture, but eventually, a financially sustainable revenue model needs to be established. Several eHealth intervention programs provide free services but are dependent on donations. Shifting from cost-free services to paid services presents several risk factors when consumers are not accustomed to paying for (normally free or subsidized) health services, which may eventually lose patronage. Operational expenses can increase exponentially as the user base grows. Pilot projects are used to gauge the amount of data/storage needed, or to develop mechanisms that send data to a central server as soon as the user reaches an area with adequate network coverage to ensure secure and robust data backup. Mobile phones and other battery-operated devices need to be charged on a regular basis; the inability to charge devices can severely impact customer sentiment. Other alternative modes of charging that are convenient, reliable and inexpensive need to be identified.

This tendency of resistance to change is much more severe in developing countries where computer anxiety is very high, and health workers perceive eHealth systems as interfering with clinical workflow, reducing productivity, and introducing disruptive changes to the workplace, therefore creating a potential security challenge (36). This happens because, most pre-implementation assessments failed to include the health professionals' attitude (readiness) which might be also a determining factor for the success of the implemented eHealth System (37; 38)

In summary, this result is consistent with other published literature (39; 40; 41; 42), which stated that the scaling up of an intervention is not an isolated process, a deeper understanding of the context and the presence of strong value propositions can help design stronger business models that are able to scale beyond the pilot phase and realize their full potential. Its failure or success is closely related to a complex range of contextual factors, such as the organization's will, financial involvement, regulation, donor environment (including whether donors coordinate their efforts or act isolated) (43; 31) and technical support.

XIII. CONCLUSION

The results obtained by the statistical analysis of the correlation coefficient for the hypothesis test to determine the degree of relationship between the variables indicate the significant positive correlation between the eHealth-dependent variable and the independent variables of the hypothesis of the study (see table 2). These findings are consistent with the results of other published studies (44; 45; 46; 31) that indicate that financial factors, resistance to change and technical support are the main barriers that limit the scalability of mobile health systems. Although the results agree that resistance to change and information security issues are not one of the major barriers to the scalability of mobile health systems, the R-squares test statistics of 0.47 and 0.16 respectively shows an indication of further research into the two factors as agreed by (47; 48).

XIV. RECOMMENDATIONS

Disruption of the traditional health system is not an easy process. However, eHealth is being adopted in emerging markets where the need is huge. This study is useful for policymakers and researchers who face implementation problems in the global health field. This study recommends: simplifying interventions; training future leaders of "expansion"; build and incentivize an implementation workforce; reach and involve the beneficiary communities, especially the poorest ones; apply the most effective information technology diffusion techniques for scaling up eHealth projects at the right time and at the right place.

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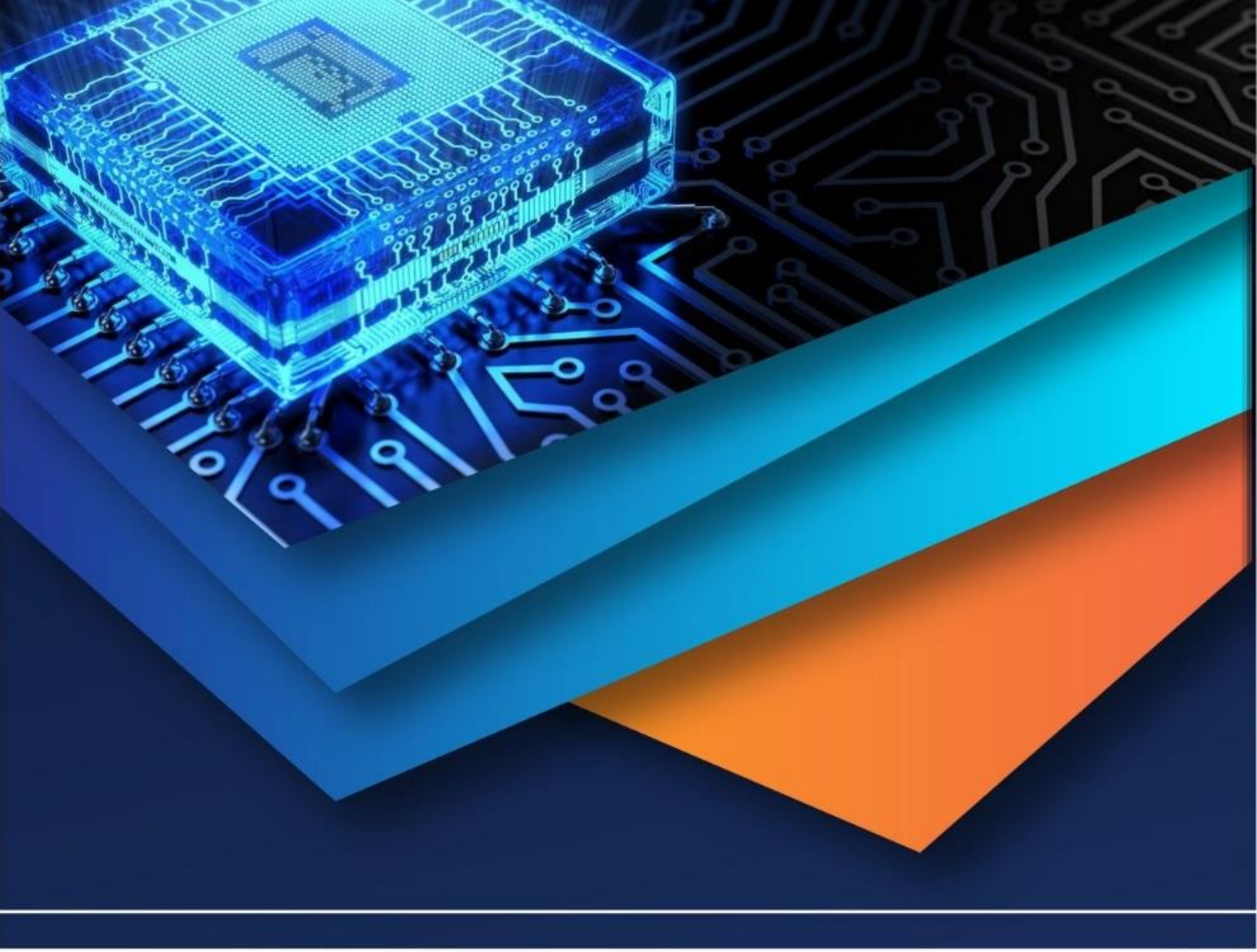

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