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Rework Management in Construction Projects

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Abstract: Rework, are activities in the field, which have been completed, but were required to be repeated or undertaken again as a result of some impeding correction that was necessary to be carried out during the project. This is regardless of source, or effecting a change, not due to change of scope by the owner. Fundamentally, rework becomes necessary either when an element of building works fails to meet customer requirements, or when the completed work does not conform to the contract documents. In either scenario, the product is altered so as to ensure conformity. At a certain moment during construction, for example due to an error, rework is necessary. But the rework might not be discovered until some form of quality control check is done, after which it can be concluded as to what kind of rework needs to be done. Rework can also have internal or external origins. Changes in clients' expectations are an example of an external factor that might lead to rework. Rework can cause many costs to be higher than calculated at the start of the project. Rework can result from various sources such as errors, omissions and changes.

Keywords: Rework, quality, productivity, resources, errors, work injuries.

I. INTRODUCTION

Over the centuries, construction work across the globe has been a means for countries increasing their national economies. The construction industry has faced with the significant problems of high cost of project delivery, bad financial performance and inability to deliver value to customers on time to time. As a result, the industry has been criticized extensively for poor performance and inefficient output. A major factor contributing to this failure is rework. Rework is defined as the unnecessary effort of redoing an activity that was inaccurately done for the first time or the process by which an item is made to conform to the original requirement by completion or correction. Rework is a major contributor to time wastage and schedule overruns which eventually impact on cost, resources and quality. The adverse consequences of rework include reduced profit, loss of market share, worker injuries, damaged reputation, increased turnover of management and workforce, lower productivity, higher costs, and finally, costly litigation between participants over responsibility for overruns and delays. Most construction projects have got an assortment of causes that leads to rework, this include; omissions, alteration, failures, proper communication, and inadequate coordination and collaboration between stakeholders. Invariably, the impact of rework has badly impacted on the productivity, performance, and finance of a project. The researchers has declared that construction professionals do recognise that rework contributed significantly to poor construction project performance. In the process of construction, errors, omissions and changes frequently occur and lead to rework in different stages of construction. Many studies, which were conducted in many countries, indicated that rework increased the cost of the differrent work categories between 3% to 30% and caused delays in the different work categories resulting in the increase of their original duration from 10% to 77%. Adjacent to, rework caused client's and contractor's dissatisfaction.

A. Rework Sources

Basically, rework can be obtained from various sources like errors, changes and omissions.

1) *Errors:* The Researchers has indicated that rework is worsen by errors made during the design process, errors which then appear downstream in the procurement process. The Researchers has argued that the longer an error goes undetected, the greater the possibility of rework occurring that significantly impacts cost and schedule. The Construction Industry Institute (CII) (1989) study of nine large industrial construction projects found that rework due to design error contributed an average of 79% of total rework cost. In relation to Busby and Hughes (2004) and Cooper (1993), errors are often not readily identifiable and often only become manifest after a period of incubation in the system. The extent of rework required, then, depends on how long the error has remained unnoticed.
2) *Changes:* Many of them stated that a change is in essence a directed action that alters current established requirements. Changes can have an effect on the aesthetics and well-designed aspects of the building, the scope as well as the nature of work, or its working aspects. According to CII, rework, exclusively in the form of changes can have a negative impact on productivity and project performance. Moreover, stated that a design-change client, for example, would indicate that a client would initiate a

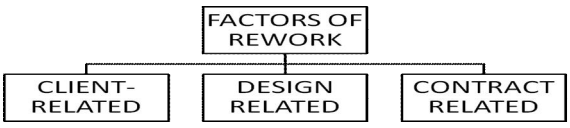
change to the design of the building and therefore require rework due to redesign. Design-related rework in the form of change orders is the major source of rework in construction projects.

3) *Omissions:* According to Reason (2002), omission errors arise when the mental process of action control is subjected to strain or distraction. Reason (2000) opined that omission errors are a result of pathogens within a system that translate into error-provoking conditions within the firm and project. Examples include time pressure, understaffing, fatigue and inexperience. He further lamented that pathogenic influences contribute to unworkable relationships and procedures as well as design and construction deficiencies which consequently contribute to rework.

B. Preliminary Review Of Literature

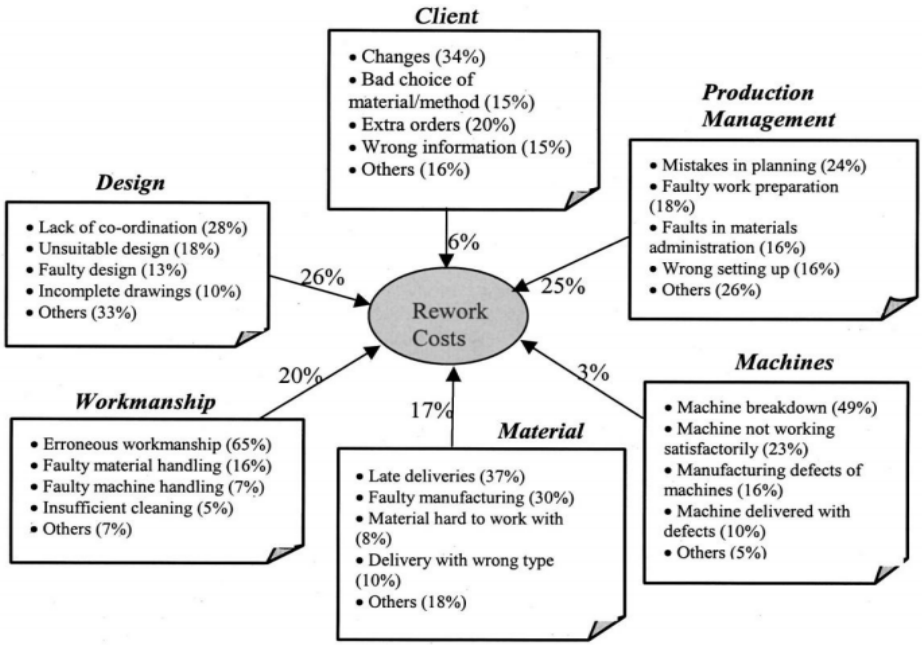
1) *Rework Factors:* According to Love and Edwards (2004a), the root causes of rework can be categorised into three different groups: 1) client-related, 2) design-related and 3) contractor-related factors, including site management and subcontractor factors.

A basic overview of such rework factors is as follows:



2) *Client Related Factors:* Palaneeswaran (2006) identified some client-related factors: a lack of experience and knowledge of design and of the construction process; a lack of funding allocated for site investigation; a lack of client involvement in the project; inadequate briefing; poor communication with design consultants; and inadequacies in contract documentation. Deficiencies in communication flow between the client and design team members can result in documentation errors and omissions occurring (Dalty and Crawshaw, 1973). Walker (1994) stressed that clients and their project team members must communicate and work together harmoniously if projects are to be delivered on or ahead of time

3) *Design Related Factors:* Lack of design coordination and integration on the part of the design team leads to design deficiencies and exacerbates the causes of rework. This opinion is supported by Josephson and Hammarlund (1999) who pointed out that the source of design-related rework in construction is primarily communication problems. Similarly, Austin, Baldwin and Newton (1994) pointed out that the ineffective use of information technology in managing and communicating information aggravates the amount of rework that occurs in a project.



4) *Contract Related Factors:* The inability of many supervisors to plan work, communicate with workers and direct activities adequately is fundamentally linked to increasing amounts and costs of rework Other factors contributing to rework included:
1) Setting-out errors
2) Disturbances in personnel planning
3) Failure to provide protection to works

C. Objectives Of Rework

Specific objectives include the following:
1) To determine the influence different project types have on the causes of rework in
2) construction projects;
3) To determine the impact of rework on organisational and project performance;
4) To determine the influence various project types have on rework costs (direct and
5) indirect) in construction projects;
6) To determine the influence various procurement methods have on total rework costs
7) and construction projects;
8) To design and develop rework reduction and containment strategies

D. Scope And Limitations

The study was limited to data gathered from the construction industry in the Gaza Strip in Palestine. Information will be gathered from the following stakeholders in both construction and consultancy firms: contractor, site managers, architects, quantity surveyors, project managers and engineers.

In order to comply with internationally accepted ethical standards, the name of participant organizations and individuals will not be recorded on research instruments. No compensation will be paid to any respondent or participant in the study. Quality assurance will be made with respect to the following aspects:
1) General conduct and competence of interviewers
2) Quality of data captured
3) Accuracy in calculations
4) Correctness and completeness of questionnaires, especially with open-ended questions.

II. LITERATURE REVIEW

A. Introduction

In this chapter, the literature review includes the definition of rework, the determination of rework in construction industry, methods of measuring rework, classification of the causes of rework, rework impact on construction projects performance, and measures for reducing the occurrence of rework in construction projects.

Based upon the preliminary exploratory study conducted which provided the basis for the main study, an operational definition of rework was required to clearly indicate what is and what is not considered rework from the researcher's perspective as well as from an industry-wide perspective. For the purposes of the research, the operational definition for rework is as follows: ''the unnecessary effort of redoing a process or activity that was incorrectly implemented the first time". Rework will include the following: design errors and changes that affect construction activities, constructability errors, additional or missing scope due to designer or constructor errors and on-site fabrication errors that affect construction activities.

B. Nature Of Rework

Rework is a major contributor to time wastage and schedule overruns which eventually impact on cost, resources and quality. They stated that rework emerges as overtime, the additional hiring of resources such as labour and plant workers, schedule slippage, and reductions in project scope and quality. The adverse consequences of rework include reduced profit, loss of market share, damaged reputation, increased turnover of management and workforce, lower , higher costs, and finally, costly litigation between participants over responsibility for overruns and delays (Williams and Howick, 2000). Due to complex characteristic of construction, amendments may be deemed inevitable in some instances; however, uncontrolled occurrences of rework and wastages should actually be more effectively controlled (Simpeh, 2012). This will essentially improve various targeted objectives of construction project management with respect to timeliness, cost targets and product and service quality (Palaneeswaran, 2006).

Rework may happen because of the lack of quality control, insufficient maintenance, using unskilled workers and inadequate tools, etc. The reworks sometimes are happening as demolishing and rebuilding and sometimes as requirement of extra works

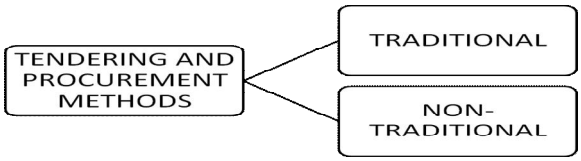
According to Love and Wyatt (1997), construction projects involving refurbishment and renovations are prone to considerably higher rework costs than new build projects because of the degree of uncertainty and complexity associated with the building work undertaken.

C. Rework Pervasiveness

The construction industry has the iniquitous reputation of being fragmented, lacking co-ordination and communication between parties, creating adversarial contractual relationships and lacking customer focus (Love, Edwards and Smith 2005). Besides, there is generally an absence of systems within projects to monitor and control rework (Hwang, Thomas, Haas and Caldas, 2009). This combination of problems has meant that rework has become an insidious problem and consequently, the costs of rework have been found to be considerable (Love et al, 2005). Love, Holt, stated that both the internal and external environments of construction projects are dynamic and relatively unstable. Tasks performed in construction projects are typically divided between professional disciples (architect, structural engineer, project manager) and trade disciplines (the contractors' and sub-contractors' carpenters, bricklayers, plumbers), which frequently operate independently of one another.

D. Tendering And Procurement Methods

Those involved in the procurement of buildings invariably do not realize the extent of rework that actually occurs. They conceded that there is an escalating need to improve the quality of operations throughout the procurement process in order to reduce the occurrence of rework. The type of procurement method may then influence the extent of rework that might occur in a project. For instance, non-traditional methods are subject to higher rework levels than traditional methods, especially when errors, omissions, or changes occur (Love, 2002a). Traditional methods can provide clients with cost certainty, whereas non-traditional methods are often used when the pressure of early completion is imposed on the project (Holt, Proverbs and Love, 2000). Maizon (1996) concluded that one of the principal reasons for the construction industry's poor performance is the inappropriateness of the procurement systems selected for construction projects.



1) *Traditional Method:* Morledge (2002) stated that under traditional methods (design-bid-build), such as traditional lump sum and traditional with provisional quantities, the cost can be determined with reasonable certainty before construction starts. Moreover, under traditional methods, design and documentation are supposed to be complete, or at least largely complete, before construction commences on-site, so in theory there should be less rework attributable to design-related sources (Love, 2002a). However, traditional methods of procurement have been heavily criticised for their sequential approach to project delivery, as they have contributed to the so-called ''procurement gap'' whereby design and construction processes are separated from one another (Love, Gunasekaran and Li, 1998a). As a result, Love et al. (1998) suggest that behavioural, cultural and organisational differences exist between project individuals. Inaddition, the procurement gap that exists between design and construction inhibits communication, coordination, and integration among project team members which can subsequently cause rework and adversely affect project performance (Lahdenpera, 1995; Evbuomwan and Anumba, 1996). As a result, traditional procurement is not entirely suitable for fast-track projects (Construction Excellence, 2004).
2) *Non-Traditional Method:* Hanna, Russell, Gotzin and Nordheim (1999) asserted that to satisfy the requirement of time, a plethora of non-traditional procurement methods have surfaced in the marketplace resulting in the compression of design and construction schedules and construction commencing before the final design is complete. As design and construction time is compressed, the degree of overlap, or concurrency, between activities increases which in turn increases project complexity as activities are sub-divided into trade packages (Love,2002a). For instance, under design and build procurement method, a single contractor assumes the risk and responsibility for designing and building the project (Morledge, 2002). Design and build method (D&B) is imputed with a time-saving mechanism which makes many activities overlap thereby minimising delay in

completion time and reducing frequent adjustments in design (Ibiyemi, Adenuga and Odusami, 2008). One key advantage of using D&B is the opportunity to integrate the design and construction components; Saxon (2000)and Banik (2001) argued that integration of design and construction offers better performance in time and cost resulting in fewer defects. With construction management procurement method, the client employs the design team and a construction manager is paid a certain fee to programme and coordinate the design and construction activities and to improve the build-ability of the design (Morledge, 2002). The management contracting, also known as a "fast-track" strategy, is suitable where all design work will not be complete before the first works contractors start work, although the design necessary for those packages must be complete. As design is completed, subsequent packages of work are tendered and let (Morledge, 2002).

E. Complexity of Project

NEDO (1988) and Naoum and Mustapha (1994) indicated that facility types are linked to the concept of complexity and thus have influence on project performance. Baccarini (1996) declared that project complexity consists of many varied interrelated parts. Ireland (2007) stated that complexity involves an item having two or more components or two or more variables. Love, Li and Mandal (1999b) stated that in construction projects, activities are typically divided into functional areas performed by different disciplines such as architects, engineers, and contractors and that therefore operate independently. Customarily, each discipline makes decisions without considering the impact on others. Love and Irani (2002) maintained that these functional disciplines often develop their own objectives, goals and value systems. So, each discipline has become dedicated to the optimisation of its own function with little regard to its effects on the performance of the project as whole with which they are involved.

III.CONCLUSIONS

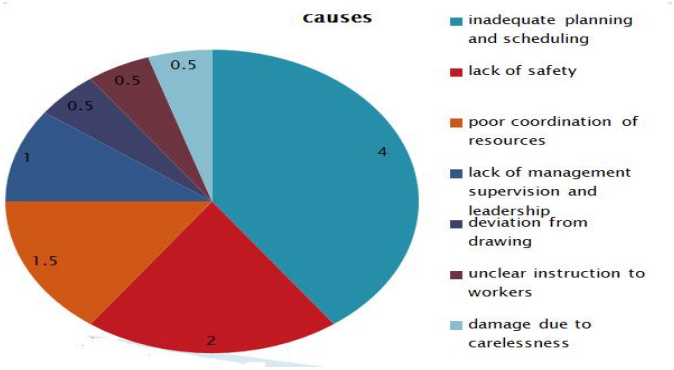
A. General

Rework is one of the important factor that needs to be controlled to achieve project success. This chapter summarizes the conclusion of the study and highlights the causes and its impacts on construction based on the survey conducted in various construction companies .

B. Conclusion Of Study

The aim of this thesis was to determine the underlying causes of rework during construction, and its impact on the overall project performance in order to develop effective prevention strategies. The study suggests that rework is a problem faced in most of the construction industry and better understanding of the causes will assist the project managers to identify the methods to improve or eliminate rework. A literature review was performed in order to analyze the major factors that leads to rework in construction .After having analyzed the data, a questionnaire was designed and sent to construction professionals, both with engineering firms and contractors firms. The questionnaire mainly concentrated on identifying the main causes of rework and how it had impact on the construction projects as well as the organisation. The outcome reveals the top rework causes occurring in the construction industries, the impacts and its effects on the organisation.

1) *Causes of Rework in Construction Projects:* The changes made at the request of the client and design team contributed to rework. Love, Edwardsand Smith (2005) established that variations during the design process are often captured too late because of the sequential communication structure of supply chains, and the lack of coordination and integration between design team members.This was apparent in the case study, where the lack of coordination among design consultants led to major design-related changes which affected all the design firms involved. This subsequently resulted in changes on site, which affected most of the subcontractors. In addition, inexperience on the part of the leading hand and trades foremen and their inability to interpret the structural drawing contributed to rework during construction. Similarly, the analysis of the research instrument found that the most predominant source of rework included non-compliance with specification, setting out errors, changes made at the request of the client, poor communication with design consultants and low labour skill levels. Nevertheless, the causes of rework were found not to vary significantly with various project types.



2) *Impact of Rework:* The analysis of the comparative study revealed that reworks caused inter-organisational conflict that led to decrease in supervision and resulted in the de-motivation of workers. The study also revealed that the incidence of rework increased project cost. This was due to additional materials for rework, subsequent wastage handling, costs for covering rework occurrences and additional labour to rectify activities. Besides, additional time to rework and related extensions of supervising manpower were also identified, ultimately leading to customer dissatisfaction and reduced profit for contractors.

IV. SUGGESTION AND RECOMMENDATION

A. Suggestions

It was found during the questionnaire survey that the majority of the respondents do not have systems to track and record incidences of rework and its cost impact, as it is difficult to accurately calculate. This was also apparent in the case studies, where the respondents revealed they had experienced lots of rework on site. However, there were no mechanisms in place for recording incidences of rework and capturing their costs. To eliminate rework it is important that the events are identified early and they are evaluated. From the study it is seen that the reduction of rework in construction projects must be a continuous process. Now improvements have to be introduced to avoid these failures from happening again in future projects.

Some suggestions based on the data analysis for the reduction of rework in the construction project are as follows:

1) Rework can be reduced by developing adequate awareness about the root causes and what constitutes rework and implementing systematic approach to measure rework
2) A fulltime supervisor is to be placed in site who is very well trained to avoid mistakes made by the unskilled labourers
3) The employment of unskilled labour should be limited and if employed they should be given proper training so that the errors are minimised.
4) Inspections must be conducted on a daily or weekly basis by the senior managers or senior staffs so as to avoid the errors in the early stage.
5) Proper inspection of the materials being supplied should be made compulsory so that defective materials can be identified
6) Improvement and total commitment to quality management would render and assure reduction in rework
7) Site documentation should be carried out as early as possible and at every stage to check work done and highlight rework. Formal training must be given to supervisors to improve supervisor's skills like planning work, communication, leadership, motivation.

Work Monitoring On My Site.

B. Recommendation

Improper differentiation between terms such as quality failure, defects and error with rework has led to inaccurate and incomplete measurements for rework, and possibly inappropriate strategies for reducing its occurrence (Somerville, 2007). Rework has become the norm and as such it has become inevitable and acceptable in the construction industry. Therefore, rework reduction and containment strategies can be developed only if a clear distinction is made between what constitutes rework and what does not. Besides this, the industry must change its mindset that rework is inevitable.

Creating the awareness as to the impact rework can have on project performance is probably the most obvious intervention and the starting point for establishing an in-depth knowledge of the root source of rework. Therefore, the understanding of the causal structure of rework is an immediate issue that consulting firms and contractors need to grapple with, in order to reduce the causes of rework and its impact on construction project performance.

From the findings, respondents suggested that to reduce rework during the design stage the following strategies ought to be implemented: team building, as well as the involvement of subcontractors, suppliers and designers for construction (e.g. standardised components). In the case of site management strategy, respondents suggested involvement of subcontractors during construction, quality control and with site quality management systems. Therefore, studies are needed to establish how both design firms and contactors can be assisted to implement these strategies. Rework study should also be done for smaller projects along with large construction project.

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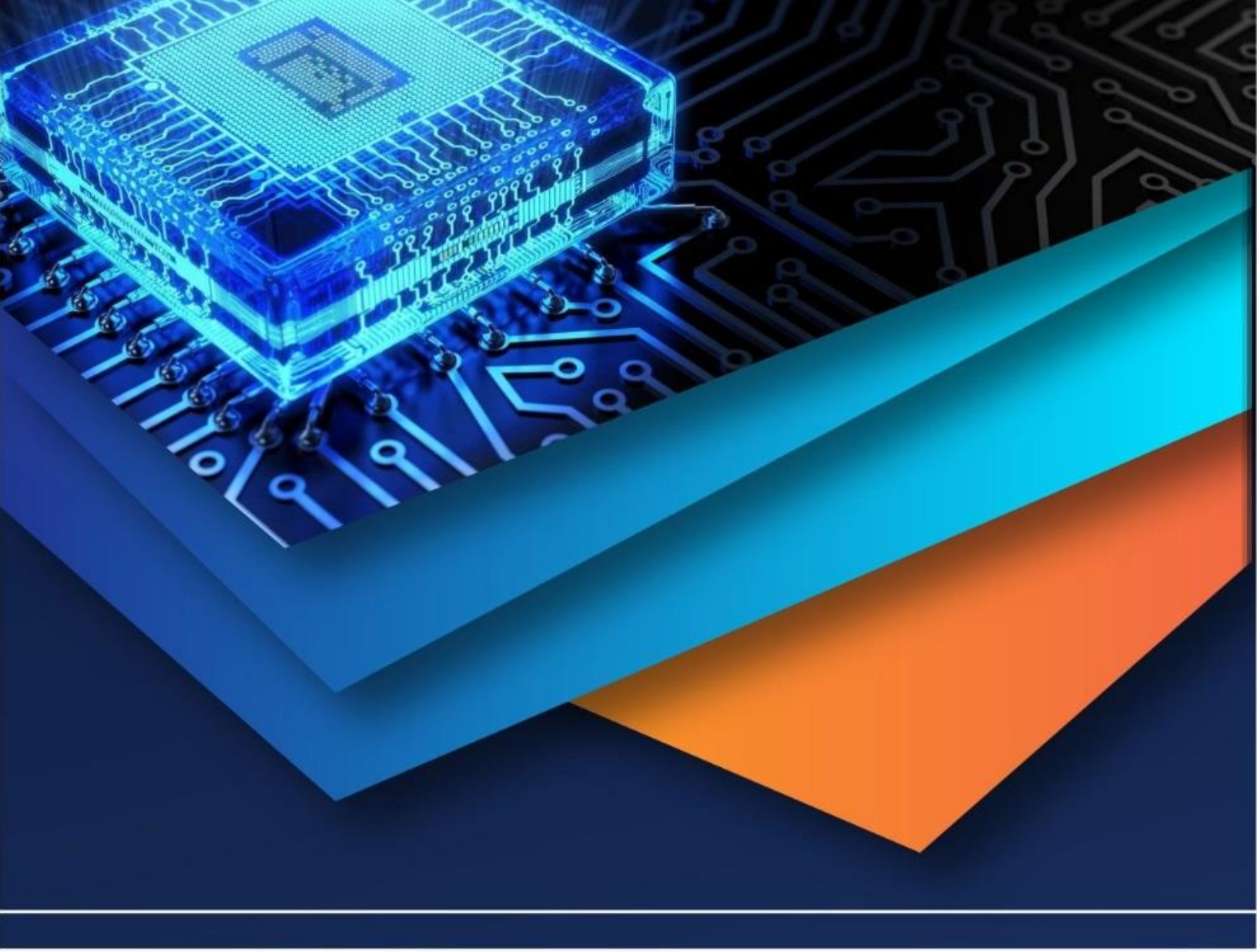

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