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META-ANALYSIS OF FACTORS AFFECTING TIME OVERRUN OF HEALTHCARE FACILITIES IN EGYPT

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ABSTRACT

Construction delays are a major issue in Egyptian construction projects. Delays are the costliest part, and finishing a project on schedule benefits all project partners. Healthcare facilities developments in Egypt, like all other construction projects, are usually delayed. Buildings for healthcare facilities are regarded as one of Egypt's most important construction projects. Therefore, it's essential to study and analyze factors causing delays in these buildings' construction. This study retrieved from the literature a list of delay factors in developing countries, especially Egypt. From 2000 to 2022, 127 relevant documents were discovered in Scopus and Web of Science databases and submitted to PRISMA protocol criteria. A list of factors was compiled from nine studies that met the effect summary analysis requirements. construction experts' feedback was obtained through interviews. This list was exposed to a questionnaire from experienced consulting engineers.Findings were compared to previous Egyptian researches. Accordingly, financial considerations, change orders, pricing variations and fluctuations, and a lack of contractor expertise were the most significant contributors.

KEYWORDS: Construction time overrun CTO, Factors of delay, Egypt, developing countries, Healthcare facilities construction.

تحليل العوامل التي تؤثر على تجاوز الوقت لمشروعات الرعاية الصحية في مصر

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الملخص

تأخيرات البناء هي قضية رئيسية في مشاريع البناء المصرية. التأخيرات هي الجزء الأكثر تكلفة، وإنهاء مشروع في الموعد المحدد يفيد جميع شركاء المشروع. عادة ما تتأخر مشاريع الرعاية الصحية في مصر، مثل جميع مشاريع البناء الأخرى. تعتبر مباني الرعاية الصحية أحد أهم مشاريع البناء في مصر. لذلك، من الضروري دراسة وتحليل العوامل التي تسبب زيادة الوقت والتأخير في بناء هذه المباني. استخلصت هذه الدراسة من الأدبيات قائمة بعوامل التأخير في البلدان النامية، وخاصة مصر. من عام 2000 إلى 2022، تم اكتشاف 127 وثيقة ذات صلة في قواعد بيانات سكوبس وشبكة العلوم وتم تقديمها إلى معايير بروتوكول المنشور. تم تجميع قائمة بالعوامل من تسع دراسات استوفت متطلبات تحليل موجز الأثر. تم الحصول على تعليقات احد خبراء البناء من خلال مقابلة لتقييم قائمة العوامل تم عمل استبيان يستهدف المهندسين الاستشاريين لتقييم مدي تاثير و خطورة هذه العوامل .تمت مقارنة هذه النتائج بالبحوث المصرية السابقة. وبناء على ذلك، فإن أهم العوامل المساهمة في زيادة وقت البناء هي الاعتبارات المالية، وتغيير الطلبات، وتباين الأسعار، والافتقار إلى خبرة المقاولين.

الكلمات المفتاحية : تجاوز وقت البناء، عوامل التأخير، مصر، البلدان النامية، انشاء مباني الرعاية الصحية.

1. INTRODUCTION

Every country has its factors of efficiency of the work. These factors are measured by the performance of the project in this country and its ability to accomplish ambitions of development [1]. According to most countries' experiences and literature, the success of a construction project is defined as being completed before the project's due dates and in the range of the pre-estimated budget [2]. It has been observed that causes and factors of delay and time overrun, as well as their effects on project budget set, differ between developed and developing countries [3]. A project can be successful when it fulfills the indicators of the efficient construction industry factors, which are time, cost, and quality [4]. Many researchers defined time overrun as the increase of the scheduled time away from the completion date mentioned in the contract or the parties agreed upon as a delivery date and time for the project, or the need for additional time after the planned delivery date [5, 6]. In addition, [7-10] defined the delay as an operation or action that extended the required time to achieve or complete the work, and the terms of the contract manifested itself as additional workdays.

2. POPULATION AND HEALTHCARE FACILITIES

Hospitals are recognized for multiple building components, systems, different stakeholder requirements, continuous technological innovations, specific functions, and specific building codes and regulations to comply with. Because of these characteristics, the construction of such facilities is complicated and difficult for project participants [11]. Hospital construction necessitates the entire integration of specialized and detailed construction works in the design process. A precise and complete design can help to avoid clashes during project implementation, and effective project management can help to facilitate the coordination of multiple departments. As a result, designers and project managers play critical roles in the successful implementation of such projects. All these qualities make such project execution challenging. Hospital beds per 1,000 inhabitants in 2021 - Rankings by country: Based on 9 nations, the average for 2021 was 3.49 hospital beds. The greatest number was 6.82 hospital beds in Hungary, while the lowest value was 1.95 hospital beds in Chile [12].

Egypt had 1.3 beds per 1,000 population according 2021/2022 static [13] and there were 1782 hospitals with around 128344 beds spread across the country. Fig. 1 shows the overall percentages of number of beds per hospital in the government sector which was 37220, and 55188 in the public or parastatal sector, and only 35936 beds in the private sector [14]. Egypt's healthcare market is being driven by the private sector. Unfortunately, this number of beds, (1.3 beds per 1,000 people in 2021), means one bed for every 770 Egyptians compared to one for every 455 Egyptians in 2001. remains low compared to other countries, and lower than developed countries [13, 15]. On the other hand, this number of beds is lower than the global average is 2.7 beds per 1,000 people suggesting room for development [13, 14].This national average number of beds is larger than some nations, such as Pakistan and Iraq, but lower than middle-income's countries[15, 16]. In 2017, the Egyptian population grew at a rate of 1.7 %. A comparisons of Egypt with other nations with larger and lower population densities according to Egypt, indicating their number of population, percentage of GDP spent on health, population gross rate, and number of beds per 1000 residents [17].

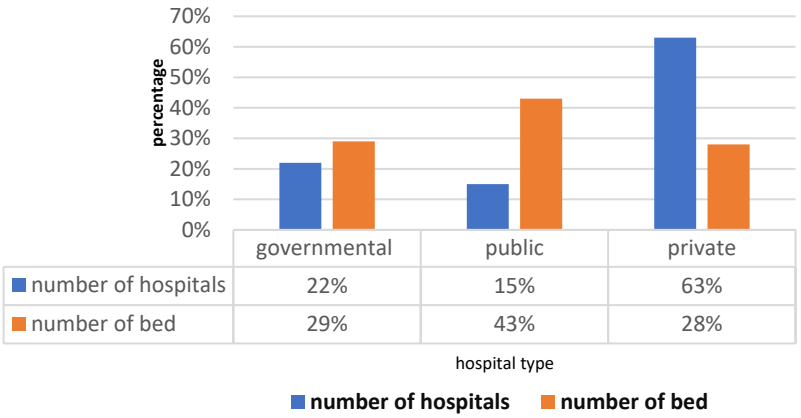

Fig. 1: Number of hospitals and beds per sector [14]

Thus, offering an opportunity for expansion. With the purpose of government, this number is extremely low. This case was the result of numerous issues. However, two major reasons exist: (1) the investment for the hospital projects does not match the rate of population growth and resident needs, and (2) the hospital project's progress is behind schedule. There was a decrease in the number of healthcare facilities in 2014 compared to 2001. This decrease was caused by rapid population growth. Government spending on health and population is relatively low, accounting for only 2% of GDP. However, the 2014 constitution affirmed that the universal right to healthcare required the state to allocate at least 3% of GDP to healthcare facilities. Unfortunately, this number is nearly twice the current governmental spending [15].

Egypt's healthcare system requires extensive reform due to its inadequacy and shortage of hospitals and facilities. The government needs to improve the healthcare system to address the issue. Egypt can't afford delays and cost overruns in hospital construction. Delays and cost overruns in hospital construction can impact Egyptian healthcare by causing resource shortages. Plan and budget accordingly. So, studying the factors affecting construction time overruns in healthcare facilities in Egypt is important to help the government mitigate the risks of delays and cost overruns in future projects.

Table 1: Comparison between countries according to their population number, growth rate, number of beds per 1000 citizen [17]

country	Population number	% Of GDP	Population Rate	the number of beds per 1000 citizens
China	1,412,360.00	5.35	0.1	4.3 in 2017
India	1,407,563.84	3.01	0.8	0.5 in 2017
United States	331,893.74	16.77	0.1	2.9 in 2017
Indonesia	273,753.19	2.9	0.7	1.0 in 2017
Pakistan	231,402.12	3.38	1.8	0.6 in 2017
Brazil	214,326.22	9.59	0.5	2.1 in 2017
Nigeria	213,401.32	3.03	2.4	0.5 in 2004
Bangladesh	169,356.25	2.48	1.1	0.8 in 2016
Russia	143,449.29	5.65	-0.4	7.1 in 2018
Mexico	126,705.14	5.43	0.6	1 in 2018
Japan	125,681.59	10.74	-0.5	13 in 2018
Ethiopia	120,283.03	3.24	2.6	0.3 in2016
Philippines	113,880.33	4.08	1.5	1 in 2.14
Egypt	109,262.18	4.74	1.7	1.5 in 2017
Vietnam	97,468.03	5.25	0.8	2.6 in 2014
Congo	95,894.12	2.08	2.3	1.6 in 2005
Iran	87,923.43	6.71	0.7	1.6 in 2017
Turkey	84,775.40	4.34	0.8	2.9 in 2018
Germany	83,196.08	11.7	0	8.0 in 2017
Thailand	71,601.10	3.79	0.2	2.1 in 2010
France	67,749.63	11.06	0.3	5.9 in 2018
United Kingdom	67,326.57	10.15	0.4	2.5 in 2019
Tanzania	63,588.33	3.83	3	0.7 in 2010
South Africa	59,392.25	9.11	1	2.3 in 2010
Italy	59,109.67	8.67	-0.6	3.1 in 2018
Myanmar	53,798.08	4.68	0.7	1.0 in 2017
Kenya	53,005.61	4.59	1.9	1.4 in 2010

3. REVIEW OF FACTORS AFFECTING TIME OVERRUNS IN CONSTRUCTION

Several studies on factors affecting construction time overrun (CTO) are presented in this part of the paper to obtain the main data in the research field.

3.1 Most Used Process for Identifying Factors of Construction Time Overrun

Delay factors studies have primarily used empirical research methods to identify factors affecting CTO. The main research approach was a survey and questionnaire and a few case studies. Since different projects face different problems, generalizable results are not possible with case studies. The most used processes for identifying CTO factors were based on a review of existing literature, focus groups, interviews or case studies, and pilot tests. These factors are ranked based on different statical analyses such as relative importance index (RII), risk score (RS), mean and correlation, frequency index (FI), severity index (SI), average index (AI), overall ranking index (ORI), fitness indices, and Cronbach's alpha. It was remarkable that the questionnaire Survey method is the most dominant approach used [18-20], maybe, this is related to the dominance of quantitative (survey) research in the field of construction management. According to [21], using surveys only allows the current factors in the literature to revolve, giving no fresh insight or verification of the problem and leads to errors in these studies. More through A questionnaire was used to collect factors from industry practitioners [22-24]. But [1] indicate that with the identification of time overrun elements based on focus group meetings and industry contribution, the results are more robust and relevant in their national context. Researchers have largely sought the perspectives of various project parties (owner/client, consultant, and contractor) [25, 26]. Others investigated the perception of project management professionals [27], consultants [28].The ranking of factors affecting CTO differs by country and region [26, 27, 29].

3.2 Number Of Factors of Time Overrun.

Across research in developed and developing countries, the number of CTO factors varied. For example, [1] chose 50 factors in Saudi Arabia, [27] identified 33 factors in Australia, [30] cited 48 factors in Oman , and [24] , in Iran, identified a comprehensive list of 78 factors. A list of the most influential CTO factors was determined and reported in each study. CTO research is conducted in both developed and developing countries, including Malaysia, Pakistan, Ethiopia, and the Emirates. Saudi Arabia and Oman were among the leading countries in terms of CTO research publications. The factors identified in various studies have some differences due to the circumstances available on each construction project as shown in Table 2.

3.3 Different Types of Construction Projects

Some studies investigated factors influencing CTO in building and industrial projects, as well as specific project types such as road construction projects.[31-33]. Some studies have taken into consideration Subway Tunnel [34], Oil and gas [35, 36] and electrical construction projects [37]. It was observed that various other sorts of construction had nearly the same factors as building construction projects.

3.4 Factors of Construction Time Overrun in Developing Countries

Financial problems have considerable influence on project time overrun. As a result, technical and financial support are essential and vital steps for construction investments [23]. It is important to have an accurate initial cost estimate, including all variables [38]. Financial matters should have the highest importance, especially when dealing with contractors, and clients [8]. Even though, studies showed a diverse group of studies' participants sharing a general perception of factors affecting CTO. Client, consultant, and contractor perceptions of differences in factors affecting CTO were highlighted. According to [39], the most significant factors in Afghanistan's construction industry are inefficient contractor planning and scheduling, client delays in progress payments, poor site management, and poor contractor supervision by consultants

and clients. From a managerial viewpoint, in Brazil, Brazil, [13] noted that the top four factors affecting CTO were linked to labor such as rework, low labor productivity, lack of skilled labor, and their low qualification. Changes in price and inflation were the top ranked factor resulting from this study [40]. Furthermore, in contrast to major construction firms in developing countries, there is dominant and increasing business failure in construction due to various issues such as financial challenges. More empirical research that explores factors influencing CTO is becoming more relevant than ever.

3.5 Factors related to healthcare and hospitals.

Few studies have investigated healthcare construction delays compared to extensive research in other areas. 35 projects over time and cost overruns have been investigated [41]. It showed that more than 65% of projects had time overruns ranging from 21% to 248%, and just 11% suffer from cost overruns ranging from 0.58% to 19.62%. However, [42] recommend that decision-makers should consider alliances and integrated project delivery for hospital construction projects to prevent cost and time mis-performance . But it's essential that the public sector must actively involve in hospital delivery and selecting design and construction companies. [43]'s study analyzed hospital cost performance, comparing planned timetable with actual work progress, comparing expected cost with actual cost. Addressing that labor shortages, weather, design changes, construction materials, worker insecurity, and mechanical issues are the main causes of delay. Also, Studying construction of healthcare infrastructure, [11] discovered a lack of expertise and competence of consultants, scope modifications, litigation, judgment, obtaining governmental permissions, and lack of communication among parties are the main causes of delays. Delay Analysis of a Healthcare and an Infrastructure Construction Projects by [44] using primavera and SPSS software, factors were ranked respectively as labor shortages, payment delays, acts of GOD, non-availability of materials and equipment, and poor planning and scheduling. [45] indicated that if there were no financial shortages or cost overruns in projects, requested funds would be promptly released. Possible explanations for the delay include legislative permissions, political interference, communication barriers, faulty planning, late project officer insertion, safety concerns, and the COVID-19 epidemic.

4. MATERIAL AND METHODS

A systematic approach to the preferred reporting items for systematic review and meta-analyses (PRISMA) protocol guidelines was used to conduct a literature search. PRISMA generates evidence-based results while also improving review reporting quality through a transparent literature selection process [46] .Scopus and Web of Science databases were searched for research studies in the CTO domain. They were chosen for this study as they provide extensive publication coverage from a wide range of fields of study [47].

4.1 Material

The online search began in April 19, 2022. The first database search, which produced 79 research articles from Scopus and the 48 web of science databases, was conducted with search phrases that included the title (" construction AND ("time overrun" OR delay))) And (limit-to (OA, "all")) AND (limmit-to(subjarea, "engi") OR limit-to (SUBJAREA, "BUSI")) AND (LIMIT-TO (DOCTYPE,"ar")) AND (LIMIT-TO(LANGUAGE,"ENGLISH")). Between 2000 and 2022, 127 documents were published. The database was subjected to the necessary filtering processes to obtain the most relevant research articles as shown in Fig. 2. A total of 127 documents were reviewed from both databases. It was concluded that 19 relevant documents obtained from the Web of science database were same as in Scopus database. It was also found 41 documents as irrelevant in the Scopus database and 22 in the Web of Science. 45 research were studied carefully. The construction delay was studied in many construction project types. Research discussing the electrical, oil, and gas reservoirs, and road construction were considered as secondary sources presented in 15 research which are out of the study scope. 30 research articles that investigated factors

affecting CTO were found to be relevant and were considered for systematic review. These research articles were divided into 21 studies in the developing countries and 9 articles for developed countries using the RII analysis.

4.2 Meta-Analysis

Since the goal of this study was to investigate factors that affect CTO, only nine studies were chosen for meta-data analysis. Meta-data analysis requires the formulation of research questions. This study seeks to answer the question, "What factors affect CTO in developing countries, particularly Egyptian healthcare facilities?". A systematic meta-analysis was carried out, with a pool of quantitative analytical data. Combining data from several research statistically might result in a more precise forecast of the underlying effects than would be possible from a single publication. Thus, a meta-analysis in this study overcomes the disadvantages of small sample sizes by extrapolating from a larger population. Given the variety of factors influencing CTO, combining data from many sources will address some of the gaps in individual research. These factors were classified into eight categories: owner, contractor, design, project, materials, equipment, labor, and external influencing factors. The classification is consistent with [2, 19, 48].

The availability of relevant and comparable information influenced the selection of research articles for meta-data analysis. The articles examined were only about building construction projects in developing countries. The RII values in the previously mentioned articles are required for the meta-data analysis in this study. Most studies use the RII method to present the results of factors influencing CTO. A meta-analysis produced the "effect" summary [49]. The effect summary calculation determined the model to be used which is detailed below.

4.3 Identification of Factors Affecting Construction Time Overrun.

Delays are a common issue in all construction projects, from the simplest to the most complex [40]. It is still a difficult task in many countries around the world to furnish a project in time [26]. Today, most developed countries are looking for causes of delays and CTO in previous projects in order to mitigate them. To reduce the time lag from contract completion date or cost overrun during the construction project, the causes of delays must first be identified [38]. Tables 2 summarize the main findings of the nine previously mentioned studies. Construction productivity in developing countries is impacted by several internal and external variables. However, a close examination of prior studies reveals that the relative frequency of occurrence of certain factors is more relevant than others [50].

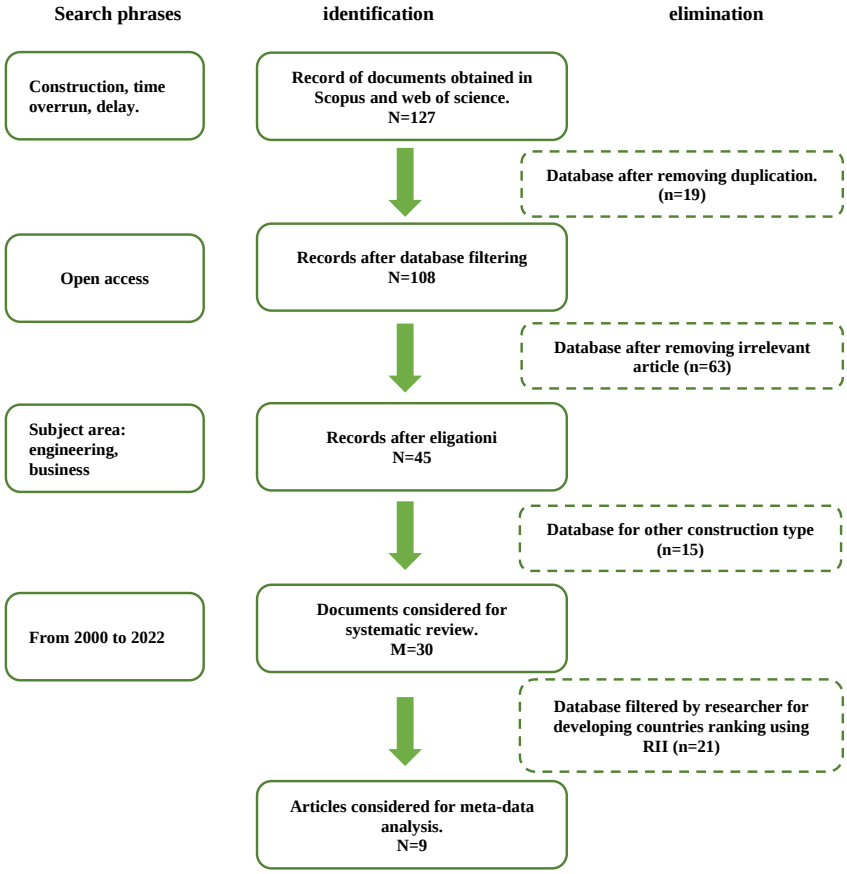

Fig. 2: PRIZMA flow chart (author)

4.4 Meta Analysis and Effect Summary

Following the sampled articles investigation, Meta-data analysis was performed on CTO research studies in developing countries. The articles were chosen based on a search of the Scopus and Web of Science databases over the last 20 years, articles studying building construction, research done in developing countries, discussing the building industry, and the availability of RII values for meta-data analysis. The RII was utilized to rank the discovered variables in most research that examined factors impacting CTO. However, several factors affecting CTO were reported in selected articles. The factor selection criteria was set as factors appearing in at least three articles to obtain salient factors affecting CTO in developing countries studies. Following an examination of the selected articles, 9 studies that met the criterion were identified and presented in Table 2. The effect summary formulas extracted the RII values from the selected studies for meta-data analysis. However, several studies did not match the RII selection criteria. For example, [29] computed factors affecting CTO use severity index and Spearman rank correlation coefficient. [47] used significance index of delay parameters (SIDP) analysis to estimate the importance of each factor in relation to building project delays. Also, [40] the used TOPSIS approach to determine the priority of each element from the perspective of each project party. Due to the unavailability of RII as the common denominator for data analysis in this investigation, these papers were excused from meta-analysis. The RII calculation method proposed by [51] was used in this investigation. Formulas are recommended by [49] for computing the effect summary for the meta-data analysis and produced spreadsheets that are useful for calculating confidence ranges and effect summaries of quantitative.

The literature revealed several factors influencing project time and schedule. Table 2 shows that the average number of factors of CTO is 43. Several factors, however, were highlighted consistently in numerous studies. In contrast, multiple factors were uncovered in a few studies. These identified variables were thoroughly inspected, and because of factors widely reviewed and stated in at least three studies, a list of 38 factors was developed.

4.5 Expert Interview

An Egyptian construction company CEO, specialized in hospitals, reviewed meta-data analysis results. He shared his opinion in a structured interview on 38 critical factors regarding his CTO's ongoing projects. The company has built over 20 hospitals in the past decade. CTO is repetitive, but project CTO factors vary due to unique conditions. Financial considerations have the biggest impact on project duration, as they are linked to both the owner and contractor's financial resources. Inadequate contractor experience, design changes, price fluctuations, unexpected site conditions and ground conditions can lengthen the project duration. Good contractor choice, contractual management, and site supervision are necessary to achieve expected outcomes. The CEO said labor scarcity won't affect project length. 38 elements were considered important for CTO in building projects, with varying percentages in each project.

4.6 Consultants Questionnaire for CTO factors

At this stage, a questionnaire was created and distributed to key players in the Egyptian construction sector. A survey questionnaire is often used to acquire the desired data. It allows for the collection of structured or unstructured information from respondents, either during an interview or by self-completion [52]. There are four different types of questionnaire design which are applied according to the purpose of the survey [53]. We used structured questions, including matrix and closed-ended questions, to ensure reliable and accurate responses in our survey. Our aim was to pinpoint the key delay factors for healthcare development in Egypt. The questions were split into two main sections: (1) participant basic information (2) Measuring factors that cause time overrun.

Table 2: Review of studies investigating factors affecting CTO in developing countries (author).

reference	region	number. of factors identified	Major findings	Nb. Of citation (3/2023)
[19]	Malaysia	28	(1) contractor's improper planning, (2) contractor's poor site management, (3) inadequate contractor experience, (4) inadequate client finance and payments for completed work, (5) problems with subcontractors.	2110
[2]	Egypt	99	(1) payment delays, (2) different tactics patterns for bribes, (3) limited equipment (4) poor planning and scheduling, (5) unsatisfactory site management and control.	311
[54]	Pakistan	27	(1) law and order issues, (2) conflicts and terrorism, (3) local currency inflation, client involvement in design revisions, (4) inappropriate funding availability, (5) payment delays.	128
[48]	Cambodia	31	(1) limited materials on site; (2) imposing of an unrealistic schedule, (3) late delivery of materials, (4) limited of skilled labor, (5) complexity of project.	161
[24],	Iran	78	(1) owner's change orders during construction, (2) underestimation of project costs, (3) underestimation of project duration, (4) impact of subsurface conditions, (5) owner-initiated delays in providing and delivering the site to the contractor.	85
[55]	Afghanistan	30	(1) poor planning and scheduling, (2) late payments from the client, (3) inadequate supervision, site control, and management by the consultant and the client, (4) contractor financial troubles, (5) inadequate controlling & monitoring by the consultant and the client.	4
[56]	Pakistan	60	(1) change orders, (2) client or his representative making design modifications during construction, (3) inadequate project planning and controlling.	5
[13]	Brazil	24	(1) rework, (2) poor labor productivity, (3) a lack of competent workers, (4)a low level of labor qualification, (5) low labor productivity, (6) project revisions and changes.	4
[57]	Egypt	15	(1) slow decision-making, (2) change of scope orders during construction, (3) owner payment delays, (4) difficulty in coordinating between the many parties, (5) incompetent site monitoring and management.	16

4.6.1 Sampling

Our survey targeted engineering consulting firms grouped by the Egyptian Syndicate of Engineers into three categories based on experience and service type, totaling around 400 firms [57]. Collecting data from every member of a population is impractical, costly, and time-consuming [58]. A sampling frame is the current cases from which a sample is taken [59]. The sampling frame should represent the target population by selecting a limited number of people who accurately reflect the entire community. According to [60] "The probability sample, each unit from the total population has a known and nonzero chance of being included in the sample, such that the sample data can be used to construct unbiased estimates of population parameters that are linear functions of the observations." Non-probability sampling, on the other hand, lacks these qualities, and the user lacks a clear and adequate method for evaluating the validity and reliability of the findings. [61], in non-probability sampling, the selection approach is informal; knowledge about the population is limited, therefore the chances of picking any specific unit of the population cannot be determined. Estimates of possibility must be statistically analysed with likely values and standard deviations in sample surveys [60]. Our questionnaire included engineering consulting firms in the first category as the selected sampling frame. For the objectives of this study, stratified simple sampling procedures were used to choose an acceptable number of respondents based on a probability sample following [62].

4.6.2 Survey sampling techniques

Samples were ordered for this study to involve members of the group. Various sampling methods, including clustering, random, and judgmental, may be used depending on the study's goals, context, and constraints. The goal was to obtain unbiased information, which dictated how respondents for the survey were chosen. 60 questionnaires were sent to consulting engineering offices between May and June 2023. 50 replies were received, resulting in a 85% response rate. Questionnaire and interviews were conducted with senior members of reputable organizations and hospitals project participants, who were purposively selected based on their senior management role in a reputable organization and/or involvement in a hospital construction project.

4.6.3 Survey basic information analysis

Survey respondents' profile: There were 27.5 design engineers, 23.5% site engineer and supervisor, 23.5% technical office engineers, and 25.5% project managers among the valid responders. Discipline :Participants were asked to choose a discipline. This question was answered by all the participants. The majority (41.2%) were structural engineers, followed by 25.5 % architectural engineers, then 17.6% mechanical engineers, 7.8%, 5.9%, and 2% to BOQ, electrical, and Project managers respectively. Experience years: They were then asked about their years of experience. It was clear that 39.2% had 11 to 20 experience years and 23.5% were more than 20 years, and 29.4% were from 6 to 10 years and none of the respondents had less than 3 years of experience as it was mainly targeted. Number of hospitals participating in: 37% of respondents participated in more than 13 hospital projects, which is effective and valuable. 25.5%, 17.7,11.8, and 7.8 were associated with 4 to 6 projects, 1 to 3 projects, 10 to 12 projects and 7 to 9 hospital construction projects respectively.

4.6.4 Analysis method used for the questionnaire survey

The participants were asked to score a list of issues impacting the CTO sector that had been established through a survey of literature. They were asked to rate their level of influence on a five-point Likert scale, with an extremely influential = 5, influential = 4, average influence = 3, ineffective = 2, and a not very effective = 1. All the participants responded to these questions and scored the outcomes. CTO factors were separated into ten sections to represent the various categories of factors (owner, contractor, consultant, designer, materials, equipment labor, external factors, contract, and common).

5. RESULTS AND DISCUSSION

For several reasons, it is important to analyze CTO factors in developing nations. First, schedule overruns can cause significant financial losses because building projects are frequently essential to a nation's development. Second, time overruns can also result in increased project costs, which can have significant financial implications for the stakeholders. Finally, understanding the factors that contribute to time overruns can help identify solutions to improve project management practices and reduce delays in the future.

5.1 Most Effective CTO factors in Developing Countries

Through studying and analyzing the related literature, according to the available data of RII analysis results, it was found that there are some equivalent results and requirements in research, which have been clarified and confirmed by many researchers. According to the summary effect method, the top 10 highlighted factors in developing countries were, in order, a lack of skilled labor, a conflict or war, and discontent, a delay in subcontractor work, poor site management and supervision, slowness in decision-making, change orders, a short or unrealistic original contract duration, unfavorable weather, a lack of construction materials, and poor coordination and communication between owner and contractor. While the least significant factors were Lack of communication and cooperation between the owner and consultant, Obsolete technology, Poor/late procurement of construction materials, price fluctuations, absence of incentives for the contractor to complete the project on time.

5.2 Egyptian Studies and Interviews

At the beginning of the interview, the CEO was asked to answer the interview’s questions based on his extensive experience in establishing public governmental hospitals, to determine the factors that affect the increase in time in hospital construction projects, particularly those involving public governmental hospitals whose beds range from 100 to 150 beds.

The interviewed CEO indicated that the financial related factors are the most effective factors presented in delay in progress payment from owners, and the contractor-poor financial control. However, conflicts, protests, legal disputes between project participants, and war all have a negative impact on and even postpone the construction. Moreover, the contractor experience has a significant impact on the construction progress, and various design changes and variation orders have a great effect on the project timeline.

5.3 Consultants survey analysis of Hospitals delay causes

The questionnaire analysis in this section aimed to rank the factors causing CTO. Using the relative importance technique, the RII and ranking for the various delay causes were identified. The RII was estimated based on the scores provided by the respondents for each of the examined. attributes. The RII normally ranges from 0 to 1 and the higher the index value the more important is the attribute. Examining although all indices are greater than 0.412, 25 out of 38 delay causes have indices greater than the mean (i.e., 0.844 in our case). The top two most significant delay causes, scoring 0.932, were Shortage of construction materials and Conflict, war, and discontentment from the public (Ranking 1st). Price fluctuations and Design errors and omissions made by designers, having all an equal RII of 0.928. On the other hand, the delay cause related to the Lack of incentives for contractors to finish ahead of schedule ranked last with RII of 0.412.

Table 3: Ranking of factors affecting Egyptian hospital construction according to RII

factors	RII	rank
Shortage of construction materials	0.932	1
Conflict, war, and discontent from the general public	0.932	1
Price fluctuations	0.928	3
Design errors and omissions made by designers.	0.928	3
Rework due to errors	0.928	3
Inadequate contractor experience	0.924	6
Poor financial control on site	0.92	7
Design changes by the owner or his agent during construction	0.908	8
Delay in progress payment by owner.	0.908	8
Shortage of skilled workforce	0.904	10
Poor communication and coordination between owner and consultant	0.888	11
Poor communication and coordination between owner and contractor	0.884	12
Mode of financing and payment for completed work.	0.884	12
Unexpected surface& subsurface conditions (soil, water table, etc.)	0.884	12
The original contract duration is short / unrealistic.	0.884	12
Late delivery of materials	0.88	16
Ineffective project planning and scheduling	0.872	17
delay in subcontractor’s work	0.868	18
Poor/late procurement of construction materials	0.868	18
Delay in approving major changes in the scope of work by the consultant.	0.864	20
Slowness in decision making.	0.864	20
Poor site management and supervision	0.86	22
Change orders.	0.856	23
Low productivity of labor	0.852	24
Delay in approving design documents	0.848	25
Inappropriate construction methods	0.836	26
Legal disputes between project participants	0.832	27
Shortage of equipment	0.812	28
Delay in performing inspections and testing.	0.812	28
Complexity of the project (project type, project scale, etc.)	0.808	30
Changes in material types and specifications during construction	0.8	31
Delay in obtaining permits from municipality.	0.788	32
Frequent equipment breakdowns	0.784	33
Obsolete technology	0.78	34
Changes in government regulations and laws	0.756	35
Accidents during construction	0.708	36
Unfavorable weather conditions	0.692	37
Lack of incentives for contractors to finish ahead of schedule.	0.412	38

These results are in line with several earlier Egyptian studies Table 4 that used the same factor categorization in this field of study. For example, [2, 7, 63] found that financial issues such as delay in progress payment during construction are the most significant factor affecting CTO. Another research about critical success factors, [64] has discovered the same outcomes by adding factors such as the necessity for excellent leadership and improving managerial skills. Furthermore, considering the available resources and paying attention to professional costs, quality, time, and risk manager. However, in our study, after shortage of materials and conflicts and war that can completely interrupt the whole project progress, also the financial issues have a great impact as price fluctuation as in Egypt prices identification are based on many factors which are local and international and lead to delays until the required fund presents. However, it was determined that unqualified or inadequate experienced labor was the least significant cause, which is ranked as tenth factor in the findings of this inquiry. Although 25 of the 38 factors have a RII value greater than their means, which emphasizes their importance and great impact on the project timeline. In addition, The cost and time involved with the resolution of construction disputes have immense increase [65]. As a result, a great effort must be addressed to contracts and their procedures as there is a great issue that must be solved.

Table 4 previous studies (author)

factors of time overrun	2013	2013	2015	2016	2021	2023
	[2]	[7]	[5]	[63]	[66]	current study
	rank	rank	rank	rank	rank	rank
Owner's late progress payments	1	1	7	1	2	8
Various strategies and methods for brides	2	-	5	-	8	-
Limited equipment	3	-	-	2	12	28
Inadequate project scheduling and planning	4	5	-	-	5	17
Inadequate site management and monitoring	5	-	8	10	6	22
Weak on-site financial management	6	6	-	8	5	7
Rework due to errors and defects in construction material	7	-	9	9	10	3
Inadequate contractor experience	12	-	17	3		6
Frequent equipment breakdown	13	-	12	5	13	33
Change order or changes in design by owner	17	2	2	17	4	23
Unqualified/inadequate experienced labor	19	10	6	13	7	10
Limited construction material in the market	-	8	-	4	11	1
Late in revising and approving design documents	-	9	11	19	-	20

Fig. 3 shows the RII of groups of factors that can lead to construction time overrun. As we can see, the most important group of factors leading to construction time overrun is design related factors. This is followed by labor related factors, contractor related factors, and then material related factors.

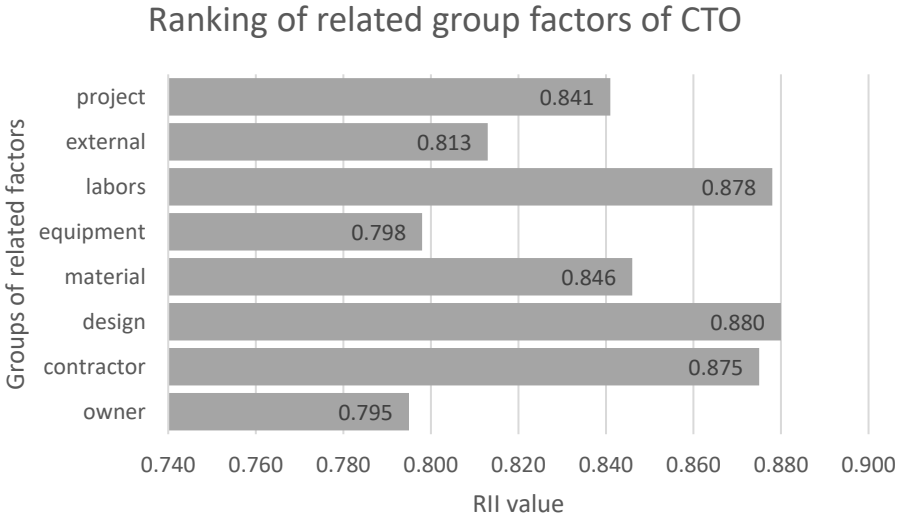

Fig . 3: RII of related group factors of CTO (author)

SUMMARY AND CONCLUSIONS

Identifying critical factors impacting project time delay, a major objective of CTO studies, has been achieved. Despite the study's limitation in covering the entire CTO topic, a comprehensive summary of significant studies was provided. CTO factors are similar worldwide but differ in impact, occurrence, severity, frequency, and overall count between developed and developing nations. Researchers are crucial in identifying delays in construction that can happen in both developed and developing countries. However, there is a lack of review articles and meta-data analysis evaluations in the literature on construction time management for Egyptian healthcare buildings. A systematic review and meta-analysis provide evidence-based answers on factors influencing CTO in construction. The analysis found that financial issues, delays, change orders, design modifications, and lack of contractor expertise affect CTO in hospital construction. Material unavailability, conflicts, and war disrupt project progress. Contractor-related factors have the greatest impact on CTO, as supported by prior research. According to the CEO of a specialized Consultant office for hospitals designs, finance-related factors such as insufficient financial control and delayed owner payments are the main causes of delays. Through a 50 valid distributed questionnaires, factors were ranking according to consultants prespective as Shortage of construction materials, Conflict, war, and discontent from the general public, Price fluctuations, Design errors and omissions made by designers, Rework due to errors . Understanding hospital building delays is crucial as a such building type is always critical in any country.

FUTURE RESEARCH

The report proposes undertaking a more extensive analysis into other project types in the future by determining the factors which can lead to CTO utilizing different approaches and by interviewing professionals who have in-depth understanding of each type of construction project.

List of abbreviations

CTO: Construction time overrun.

GDP: Gross Domestic product

CEO: Chief executive officer

RII: Relative importance index

RS: Risk score

FI: Mean and correlation, frequency index.

SI: Severity index

AI: Average index

ORI: Overall ranking index

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CONFLICT OF INTEREST

The authors have no financial interest to declare in relation to the content of this article.

REFERENCES

[1] Alsuliman, j.a., "causes of delay in saudi public construction projects", alexandria engineering journal, 58(2): pp. 801-808, 2019.
[2] Aziz, r.f., "ranking of delay factors in construction projects after egyptian revolution", alexandria engineering journal, 52: pp. 387–406, 2013.
[3] Famiyeh, s., et al., "major causes of construction time and cost overruns: a case of selected educational sector projects in ghana", journal of engineering, design and technology, 15(2): pp. 181-198, 2017.
[4] Akogbe, r.k.t.m., x. Feng, and j. Zhou, "importance and ranking evaluation of delay factors for development construction projects in benin", ksce journal of civil engineering, 17(6): pp. 1213-1222, 2013.
[5] Shibani, d.a., "time and cost overrun in construction projects in egypt", international journal of managerial studies and research, 3: pp. Issn 2349-0349, 2015.
[6] Subramani, t., et al., "time overrun and cost effectiveness in the construction industry": pp. 111-116, 2014.
[7] Marzouk, m.m. and t.i. el-rasas, "analyzing delay causes in egyptian construction projects", journal of advanced research, 5(1): pp. 49-55, 2013.
[8] Rashid, y., "analysis of delay factors and their effects on construction projects", management science letters, 10(6): pp. 1197-1204, 2020.
[9] Doloi, h., "cost overruns and failure in project management: understanding the roles of key stakeholders in construction projects", journal of construction engineering and management, 139: pp. 267-279, 2013.
[10] Eastman, c.m., building product models: computer environments supporting design and construction. 2018.
[11] Mittal, y.k., et al., "delay factors in construction of healthcare infrastructure projects: a comparison amongst developing countries", asian journal of civil engineering, 21(4): pp. 649-661, 2020.
[12] Economy, t.g. hospital beds per 1,000 people - country rankings. 2021 [cited 2023 2/6/2023]; available from: https://www.theglobaleconomy.com/rankings/hospital_beds_per_1000_people/.

[13] De almeida, e.l.g., et al., "study of delays in constructions: a managerial point of view of private companies in brasilia, brazil", gestao e producao, 28(3), 2021.
[14] International, c., the pulse. 7th edition egypt healthcare. 2017.
[15] Radwan, g. And a. Adawy, "the egyptian health map: a guide for evidence-based decision-making", eastern mediterranean health journal, 25, 2018.
[16] Washington, w.d.i., "dc: world bank ", 2017.
[17] Bank, w. Hospital beds (per 1,000 people). 2020 9/2022]; available from: https://data.worldbank.org/indicator/sh.med.beds.zs.
[18] Kazaz, a., et al., "causes of delays in construction projects in turkey", journal of civil engineering and management, 18(3): pp. 426-435, 2012.
[19] Sambasivan, m. And y.w. soon, "causes and effects of delays in malaysian construction industry", international journal of project management, 25(5): pp. 517-526, 2007.
[20] Umar, a.a., r.k.a. rizeiqi, and a. Badr, "major causes assessment of construction delays", journal of engineering, project, and production management, 10(3): pp. 179-186, 2020.
[21] Mensah, g.a. and a.d. knight, "the professionals' perspective on the causes of project delay in the construction industry", engineering, construction and architectural management, 24(5): pp. 828-841, 2017.
[22] Yap, j.b.h., et al., "revisiting critical delay factors for construction: analysing projects in malaysia", alexandria engineering journal, 60(1): pp. 1717-1729, 2021.
[23] Alaghbari, w.e., et al., "the significant factors causing delay of building construction projects in malaysia", engineering, construction and architectural management, 14(2): pp. 192-206, 2007.
[24] Shahsavand, p., a. Marefat, and m. Parchamijalal, "causes of delays in construction industry and comparative delay analysis techniques with scl protocol", engineering, construction and architectural management, 25(4): pp. 497-533, 2018.
[25] Al-kharashi, a. And m. Skitmore, "causes of delays in saudi arabian public sector construction projects", construction management and economics, 27(1): pp. 3-23, 2009.
[26] Mpofu, b., et al., "profiling causative factors leading to construction project delays in the united arab emirates", engineering, construction and architectural management, 24(2): pp. 346-376, 2017.
[27] Derakhshanfar, h., et al., "a cartography of delay risks in the australian construction industry: impact, correlations and timing", engineering, construction and architectural management, 28(7): pp. 1952-1978, 2020.
[28] Mahamid, i., a. Al-ghonamy, and m. Aichouni, "risk matrix for delay causes in construction projects in saudi arabia", research journal of applied sciences, engineering and technology, 9(8): pp. 665-670, 2015.
[29] Dolage, d.a.r. and t. Pathmarajah, "mitigation of delays attributable to the contractors in the construction industry of sri lanka - consultants' perspective", engineer-journal of the institution of engineers sri lanka, 48(1): pp. 21-30, 2015.
[30] Latif, q.b.a.i., a.m.d. al saadi, and i.a. rahman, "identification of delay factor in oman construction industry", international journal of sustainable construction engineering and technology, 10(1): pp. 34-45, 2019.
[31] Mohajeri borje ghaleh, r., et al., "delays in the road construction projects from risk management perspective", infrastructures, 6(9), 2021.
[32] Youniss, a., a. Ismail, and m.a. khoiry, "the effects of delays in road construction projects in tripoli, libya", international journal of technology, 9(4): pp. 766-774, 2018.
[33] Indhu, b., k. Yogeswari, and d. Dhivya, "ranking of delay factors in road construction project due to improper construction equipment management", international journal of recent technology and engineering, 8(3): pp. 1962-1971, 2019.
[34] Zhang, d., h. Zhang, and t. Cheng, "causes of delay in the construction projects of subway tunnel", advances in civil engineering, 2020, 2020.
[35] Kazemi, a., e.s. kim, and m.h. kazemi, "identifying and prioritizing delay factors in iran's oil construction projects", international journal of energy sector management, 15(3): pp. 476-495, 2020.

[36] Suppramaniam, s.u.k., s. Ismail, and s. Suppramaniam, "causes of delay in the construction phase of oil and gas projects in malaysia", international journal of engineering and technology(uae), 7(2): pp. 203-209, 2018.
[37] Chiu, b.w.y. and j.h.k. lai, "project delay: key electrical construction factors in hong kong", journal of civil engineering and management, 23(7): pp. 847-857, 2017.
[38] Hasmori, m.f., et al., "significant factors of construction delays among contractors in klang valley and its mitigation", international journal of integrated engineering, 10(2): pp. 32-36, 2018.
[39] Hosaini, s.b. and s. Singla, "significant factors of delay in construction projects in afghanistan", international journal of innovative technology and exploring engineering, 8(9 special issue): pp. 1060-1069, 2019.
[40] Saeb, s., n. Khayat, and a. Telvari, "causes of delay in khuzestan steel company construction projects", industrial engineering and management systems, 15(4): pp. 335-344, 2016.
[41] Yadav, s. And a. Mishra, "status of time and cost overrun of health building construction projects in nepal", 2019.
[42] Love, p.e.d. and l.a. ika, "making sense of hospital project misperformance: over budget, late, time and time again—why? And what can be done about it?", engineering, 12: pp. 183-201, 2022.
[43] Mishra, a. And e. Koju, "cost performance assessment of high rise hospital building construction project", east african scholars journal of economics, business and management, 3, 2020.
[44] Nifla majnoor p, a.c.j., "planning, scheduling and delay analysis of a healthcare and an infrastructure construction projects", international research journal of engineering and technology (irjet), 07(07/7/2020), 2020.
[45] S, p., et al., "predicting timelines in healthcare infrastructure projects: learnings from an apex tertiary care teaching hospital in north india", cureus, 14(5): pp. E24684, 2022.
[46] Alaloul, w.s., et al., "productivity monitoring in building construction projects: a systematic review", engineering construction architectural management, 29(7): pp. 2760-2785, 2022.
[47] Egwim, c.n., et al., "extraction of underlying factors causing construction projects delay in nigeria", journal of engineering, design and technology, 2021.
[48] Durdyev, s., m. Omarov, and s. Ismail, "causes of delay in residential construction projects in cambodia", cogent engineering, 4(1), 2017.
[49] Neyeloff, j., s. Fuchs, and b. Moreira, "meta-analyses and forest plots using a microsoft excel spreadsheet: step-by-step guide focusing on descriptive data analysis", bmc research notes, 5: pp. 52, 2012.
[50] Hasan, a., et al., "factors affecting construction productivity: a 30 year systematic review", 2018.
[51] Dey, s., s. Prabhu, and g. Subramani, "identification and mitigation of factors affecting human resource productivity in construction", 8: pp. 123-131, 2017.
[52] Taherdoost, h., "how to design and create an effective survey/questionnaire; a step by step guide", international journal of academic research in management, 5: pp. 37-41, 2016.
[53] Roopa, s. And r. Menta satya, "questionnaire designing for a survey", the journal of indian orthodontic society, 46: pp. 37-41, 2012.
[54] Gardezi, s.s.s., i.a. manarvi, and s.j.s. gardezi, "time extension factors in construction industry of pakistan", procedia engineering, 77: pp. 196-204, 2014.
[55] Niazi, g.a. and n. Painting, "significant factors causing cost overruns in the construction industry in afghanistan", procedia engineering, 182: pp. 510-517, 2017.
[56] Khan, r.a. and m. Umer, "impact of delays on cost of construction project- a cross sectional study of pakistani construction industry", mehran university research journal of engineering and technology, 39(4): pp. 815-825, 2020.
[57] Elhusseiny, h.o., i. Nosair, and a.s. ezeldin, "systematic processing framework for analyzing the factors of construction projects' delays in egypt", ain shams engineering journal, 12(2): pp. 1501-1511, 2021.
[58] Levy, p.s. and s. Lemeshow, sampling of populations : methods and applications. 3rd ed ed. Wiley series in probability and statistics. 1999, new york: wiley.
59] Taherdoost, h., "sampling methods in research methodology; how to choose a sampling technique for research", international journal of academic research in management, 5: pp. 18-27, 2016.

[60] Levy, p.s. and s. Lemeshow, sampling of populations : methods and applications. 2008, wiley: hoboken, n.j.
[61] Rea, l.m. and r.a. parker, designing and conducting survey research : a comprehensive guide. 3rd ed ed. 2005, san francisco: jossey-bass.
[62] Mayar fekry youssef, a.f.e., laila mohamed khodeir, designing a framework for managing virtual team in construction projects in egypt, in architectural engineering. 2022, ain shams university. P. 161.
[63] Aziz, r.f. and a.a. abdel-hakam, "exploring delay causes of road construction projects in egypt", alexandria engineering journal, 55(2): pp. 1515-1539, 2016.
[64] Elsherbiny, s.a.m., s.a.-f. Gad, and a.m. abdel-alim, "critical success factors by applying total quality management in construction projects ", %j journal of al-azhar university engineering sector, 18(66): pp. 237-258, 2023.
[65] Hammam, a., o. El-anwar, and m. El-said, "a text classification approach for evaluation of delay claims ", journal of al-azhar university engineering sector, 13(48): pp. 894-907, 2018.
[66] Shibani, d.a., et al., "causes of time overruns in the construction industry in egypt", international research journal of engineering it & scientific research, 3: pp. 2582-5208, 2021.