ISSN: 2277-9655
Impact Factor: 4.116

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

# TIME DELAY DISPUTES IN CONSTRUCTION INDUSTRY AND PREDICTION MODEL

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**DOI**: 10.5281/zenodo.59951

## ABSTRACT

Construction disputes are one of main obstacles, which face the construction projects, most of construction projects are long period and complex, often finish out of planned period and budget. The main causes of construction dispute are accerlation, co-ordination, differing goals, delays, design, engineer, project complexity,quality and workmanship, site conditions, tender, variations and value engineering. It is essential to study and analyze causes of construction time delay disputes. This paper studied a list of time delay disputes causes gathered from literature having different types of construction, different countries and different periods .A questionnaire and personal interviews have formed the list 110 time delay disputes causes. The questionnaire survey was distributed to 100 construction participants who represent consultants, contractors and owners. The interviewers were stratifying a minimum of five years up to above 30 years' experience in construction projects in Egypt. So, practitioners were selected to be from seniors to Managers in large construction organizations, a number of 40 responds were Suitable for analysis. Relative Importance Index (RII) is calculated and according to the highest values, the top fifteen causes for time delay disputes of construction projects in Egypt are determined. It is necessary to provide a prediction model that can predict by construction time delay dispues as percentage and give recomedation to reduce the expected time delay disputes. The inputs of this system include project information, probability of occurring the most fifteen factors of time delays disputes and the proposed type for analysis (manual/equal weight/automatic). The outputs of the proposed Model will be the expected percentage for occurring time delay disputes, recommendations for reducing time delay disputes and summarized report consist from one paper including project information, expected percentage for time delay disputes and the recomendatios. Some guide lines will be systematically provided to show how can the suggested model be operated, finally it is applied case study related to arab contractors company on the model and there is completely matching between the case study and the model output, the model expected occurring dispute by percentage 83% (very high), The case study confirmed that occurring dispute between the owner and the contractor and compensation of the contractor.

**KEYWORDS**: Delay, Disputes, Prediction model, Consrtuction Disputes, Contract, Time Delay Dispute.

## INTRODUCTION

Construction disputes are one of the main factors that effect on construction project to be finally completed out of the specified planned time or the expected budget ceiling. Construction disputes may frequently arise during the different phases of the construction project.

Construction disputes have many causes according to the point of view of each participant within any construction project. These causes may include delays, additional work, and variation in contractual works, change in physical conditions, disasters and errors in contract clauses. Disputes between participants may consume long time from

project period and add costs to the project. The negotiation process between the participants aims at additional time or money or both in order to compensate the injured party losses.

The objective of this paper is creation a prediction model by time delay disputes that can effectively help decision makers (Client, Contractors and Consultants) in predicting by the expected ocurre percentage of construction disputes and giving recommendations to avoid or reduce the expected disputes.The suggested prediction model was built on the most important causes of time delay disputes in Egyptians environment based on applying questionnaire.The output of this model will be in summarized report including the expexted percentage for occurring of time delay dispute and recommendations for avoiding or reducing the expected dispute.

## LITERATURE REVIEW

Assaf and Al- khali (1995) found 56 causes of disputes over delays and identified and reported that the contract disagreement was one of their main delay causes in large building projects. Ayman (2000) conducted a survey on the causes of delay on public projects in Jordan. The results indicated that design, change orders, weather, site conditions, late deliveries, economic conditions, and increase in quantity where the causes of dispute and consequently delay the construction schedule, Similarly, Odeh and Battaineth (2002) reported that interference, inadequate contractor experience, financing and payment, labor productivity, slow decision making were the five most important causes of dispute and delay in construction project with traditional contract, Kululanga etal. (2001) identified four sources of dispute in construction, errors, defects and omission the contract documents, underestimating the real cost of the project in the beginning, and changed conditions and stakeholders involved in the project.

In Thailand, material procurement, waiting for information and poor contractor management have been identified as important factors responsible for disputes and main contractor delays (Long et al., 2004). Also, bad weather, labor shortages, and design delays generate disputes and further delays. The traditional design-bid-build is still the main public works contract in Thailand. A design-bid-build increases the likelihood of changing orders. These changed orders can end up lessening the initial value.

Quality may be compromised because public owners generally may not consider factors other than price except in specific, narrowly-drawn, circumstances. This may likely to continue over the next decade. Furthermore, the main key players in public construction sector are owners, main contractors, and consultants. There is no solid strategy solution responsible for coordinating the activities of the main key players during the construction period and hence repetition. On miscommunication can be seen. Similar problems have been reported in Nigeria (Aibinu and Odeyinka, 2006), Vietnam (Long et al., 2004), and Malaysia (Lim and Mohamed, 2000). Singapore has introduced a system for the selection of consultants for public sector projects. It is called the Quality-Fee-Selection Method (QFM). This system emphasizes on the experiences, Capabilities and costs of engaging the service of tender firms. Thus, high technically skilled and experienced consultant firms can then be procured (Israngkura Na Ayudhya, 2006).

In Hong Kong, the use of time limitations on claim notification (commonly referred to as ‘time- bars’) has been introduced in lump sum projects, especially where the client uses their design, partnering or target cost project. This amendment clause helps contractors to follow a strict regime of claim notification and re-notification in order to preserve their rights under a contract.

Walton and Dutton (1969) found that conflicts in inter-organizational level results and low respect, which in turn has an adverse impact on performance. It required an effort and support from legal, design, and construction team in order to minimize the dispute among construction teams. Therefore, construction practitioners including the owner, consultant, and main contractor should fully understand the dispute impact. Although both owners and main contractors need to take solid steps to ensure that dispute is kept at minimum level. They also need to be prepared and well-versed in how to identify, prepare, and mitigate a dispute. For this reason, the dispute should be cleared and understood by all parties, main contractors, so that they know how to avoid dispute risks in a way that the agreed completion of the project date can be met.

ISSN: 2277-9655
Impact Factor: 4.116

## CONSTRUCTION DISPUTES

Dispute is defined as a conflict of legal rights has been settled to reach a political and legal solution. It is also assumes the existence of two or more parties recognize the existence of differences and problems between them and by showing that one of these parties at least a willingness and desire to solve the problem. It seems logical starting point to suggest some steps that can be taken by the contractors to avoid access to dispute, Also dispute is defined as an assertion of opposing views or claims or disagreement as to rights (Merriam Webster's Dictionary of Law, 1996). The conflicts and dispute are co-related where the dispute occurs when the contracting parties failed to manage the problems and dissolve the conflict (Carmicheal 2002).

### The main areas causing disputes:

Construction is a unique process which can give rise to some unusual and unique disputes. According to College of Estate Management Academic Web site, they published an article by subject of construction dispute on 17 November 2015 they made research in Australia, Canada, Kuwait, the United Kingdom and the United States suggests that a number of common themes occur quite frequently:

**1. Acceleration**

It is not uncommon for commercial property owners to insist upon acceleration of a construction project. Such examples might include the completion of a major retail scheme, and the need to meet key opening dates or tenant occupation in an office development. The construction costs associated with acceleration are likely to be less than the commercial risk the developer may face if key dates are missed.

The circumstances surrounding acceleration are often not properly analyzed at the time the decision is made, and that inevitably leads to disputes once the contractor has carried out accelerative measures and incurred additional costs only to find that the developer refuses to pay. The construction of facilities in Athens for the Olympic Games 2004 were subject to acceleration, and a wealth of disputes were expected once the facilities were completed and the euphoria of the Games over.

**2. Co-ordination**

In complex projects involving many specialist trades, particularly mechanical and electrical installations, co-ordination is a key, yet conflict often arises because work is not properly co-ordinated. This inevitably leads to conflict during installation which is often costly and time-consuming to resolve, with each party blaming the other for the problems that have arisen.

Ineffective management control may result in a reactive defense to problems that arise, rather than a proactive approach to resolve the problems once they become apparent.

**3. Culture**

The personnel required to visualize, initiate, plan, design, supply materials and plant, construct, administer, manage, supervise, commission and correct defects throughout the span of a large construction contract is substantial. Such personnel may come from different social classes or ethnic backgrounds. In the United Kingdom skill shortages have led to an influx of personnel from central and Eastern Europe, a trend likely to continue with the growth of pre-accession states seeking access to the labor market in the European Union.

Major international construction projects may employ or engage people from different nationalities and cultures. For example, on a major pipeline contract in Kazakhstan the owner was a joint venture comprising Kazakh, Canadian and British companies, and the owner’s representatives on the project for day-to-day matters were of Canadian, French, Russian and British nationalities. The contractor was a Greek–Italian joint venture that employed labor from no fewer than 24 different countries throughout central and Eastern Europe, the Middle East and the Indian sub-continent. Forming a teamwork approach across cultures can be very difficult where each culture has its own values.

**4. Differing goals**

Personnel engaged on a large construction contract are likely to be employed by one of many subcontracted firms, including those engaged as suppliers and manufacturers. Each of these firms may have their own commitments and goals, which may not be compatible with each other and could result in disputes.

**5. Delays**

Disputes frequently arise in respect of delays and who should bear the responsibility for them. Most construction contracts make provision for extending the time for completion. The sole reason for this is that the owner can keep alive any rights to delay damages recoverable from the contractor. On international construction projects the question of any rights the contractor might have to extend the time for completion was a matter often addressed towards the end of the contract, when an overrun looked likely. From the owner's point of view, this made the examination of the true causes of delay problematical and inevitably led to disputes between the contractor and the owner as to the contractor's proper entitlement.

Under the FIDIC contracts the contractor is now required to give prompt notice of any circumstances that may cause a delay. If the contractor fails to do so, then any rights to extend the time for completion will be lost, both under the contract and at law. This may seem a harsh measure, but a better view is that this approach brings claims to the surface at a very early stage and gives the recipient an opportunity to examine the cause and effect of any delay properly as and when it arises, so that the owner has some say in what can be done to overcome the delay.

**6. Design**

Errors in design can lead to delays and additional costs that become the subject of disputes. Often no planning or sequencing is given to the release of design information, which then impacts on construction. Equally, the design team sometimes abrogate their responsibilities for the design, leaving the contractor to be drawn into solving any design deficiencies by carrying out that part of the work itself to try to avoid delays, and, in doing so, innocently assuming the risk for any subsequent design failures.

**7. Engineer and Employer's Representative**

The personality of the Engineer or the Employer's Representative and their approach to the proper and fair administration of the contract on behalf of the Employer is crucial to avoiding disputes, yet a substantial proportion of disputes have been driven by the Engineer or the Employer's Representative exercising an uneven hand in deciding differences in favor of the Employer. In domestic and international contracts, the Engineer traditionally had an independent and impartial role. This independence or impartiality was often not properly exercised, and in some cases there was clear evidence of bias by the Engineer towards the Employer. This practice was not limited to third world countries but also existed in developed countries. It is a complete fiction to say that the Engineer under government contracts in the United Kingdom could possibly act independently of the Employer on every issue. Some contracts are open as to the constraints imposed on the Engineer: in Hong Kong Engineers are subject to financial constraints in respect of variations and in the extensions of time that can be given. While this may be understandable from a public policy point of view, it is unacceptable for it to be done behind a veil so that the fiction of independence is preserved. Under the FIDIC contracts the Engineer no longer has an impartial role but expressly acts for the Employer. This does not prevent the Engineer from taking a professional view on the merits of any difference that may be at issue, but in the event of a dispute the mechanism to resolve such matters quickly by independent means has been achieved by the introduction of a dispute adjudication board.

**8. Project complexity**

In complex construction projects the need to carry out a proper risk assessment before a contract is entered into is paramount: yet this is often not done. There are numerous examples of projects taking much longer than planned and contracted for because there was insufficient appreciation of the risks associated with the project's complexity. Inevitably the delay and additional costs the contractor incurs, and the owner's right to claim damages for delay, often develop into bitter disputes.

**9. Quality and workmanship**

In traditional construction contracts, disputes often arise as to whether or not the completed work is in accordance with the specifications. The specification may be vague on the subject of the dispute in question, and each party to the contract may have a different view on whether the quality and workmanship is acceptable. This is even more so in international contracts. Although great care may have been taken to prescribe the quality of the materials and their compliance with European standards, these standards may contradict the local laws and regulations in the country where the project is being constructed, and any dispute will be governed by the law of that country. In design and build contracts, perhaps the greatest deficiency is in the contract documentation, particularly the Employer's

requirements. This inadequacy inevitably leads to claims by the contractor for additional costs, which, if not resolved, can lead in turn to costly disputes.

**10. Site conditions**

If the contract inadequately describes which party is to take the risk for the site conditions, disputes are inevitable when adverse site or ground conditions impede the progress of work or require more expensive engineering solutions. Even if the Employer, in good faith, provides detailed information on the site conditions to the contractor, if that information is discovered to be incorrect and the contractor has relied on it and acted upon it to their detriment, the Employer may be liable to the contractor for the consequences.

**11. Tender**

The time allowed to scrutinize the tender documents, prepare an outline program, methodology, carry out a risk assessment, calculate the price, and conclude the whole process with a commercial review is often impossibly short. Mistakes in this process may have an adverse effect on the successful commercial outcome of the project. A culture may be engendered in the contractor of pursuing every claim that has a prospect of redressing any ultimate financial shortfall. This approach does nothing to foster close and co-operative working relationships between the owner and the contractor during the progress of the work, and inevitably leads to disputes.

**12. Variations**

Variations are a prime cause of construction disputes, particularly where there are a substantial number, or the variations impact on partially completed work or are issued as work is nearing completion. The nature and number of variations can transform a relatively straightforward project into one of unmanageable complexity. The new Parliament building in Edinburgh is such an example. The building was planned to house 329 people, but through variations the building increased in size and complexity to house 1200 people. It was perhaps not surprising that the total cost of construction exceeded £500 million, almost ten times more than the original budget.

**13. Value engineering**

This term often lacks definition in construction contracts and can lead to disputes, particularly where the saving is to be shared between the contractor and the owner. Savings in respect of the supply and installation of the material or product in question might be relatively easy to determine and agree, but these are not the only benchmarks, and a proper value engineering approach needs to take full account of the life cycle costs of any proposed change.

ISSN: 2277-9655
Impact Factor: 4.116

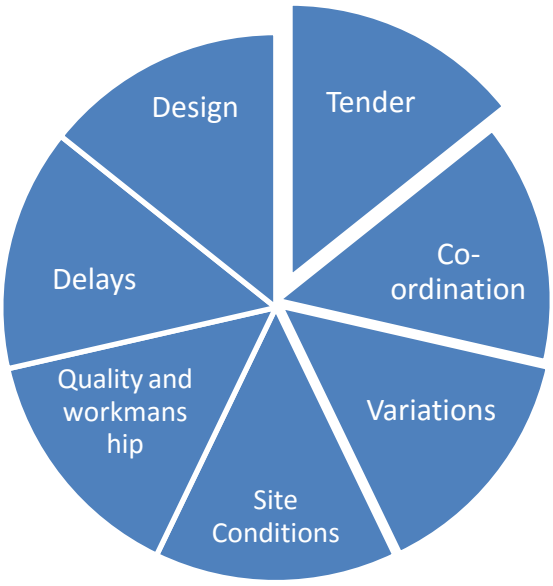


***Fig.1 the main areas causing disputes***

## THE QUESTIONNAIRE

It is essential to study and analyze causes of construction time delay disputes to make questionnaire, the interviewers were stratifying a minimum of five years up to above 30 years' experience in construction projects in Egypt. So, practitioners were selected to be from seniors to Managers in large construction organizations, and owner representatives, contractors firms, consultants' offices. The purpose from this step is to discuss the major problems of the Egyptian construction projects

It is prepared a questionnaire as follow: the first row is asking about the the respondent information, the type of party:Consultant, Owner or Contractor,the second row is asking about the respondent name and his experience.The third row is asking about the time delay disputes factors and consist from 6 columns: category id, category name factor id, factor description and number of respondent scoring from very little effect(1) to very high effect (5),The respondet put tick on this field for each time delay dispute factor according to his point of view.

the questionnaire form include on 110 causes for construction disputes, these causes are summaraized to fifteen groups as Financing, Owner, Contractor, Labor, Design, Site, Contractual Relationships, Contract, Project, External, Equipment, Rules & Regulations, Consultant, Scheduling and Controlling and Material Related Cause as table (1).
Rating of 1 to 5 was given to each factor, which 1 represent very little effective, 2 little effective, 3 average effective, 4 high effective, 5 very high effective. Ratings were given to each factor to evaluate the relative effectiveness of each factor in causing the time delay disputes as table (1).

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*Table 1. Questionnaire form*

| | | | | | Type of Party | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Respondent Name/ Experince years* | | | | |
| *Category ID* | *Category Name* | *Factor No.* | *Factor ID* | *Time Delay Disputes Factor Description* | *Number of respondents scoring* | | | | |
| | | | | | *Very Little effect (1)* | *Little effect (2)* | *Average effect (3)* | *High effect (4)* | *Very High effect (5)* |
| *1* | *Financing Related Cause* | 1 | FRC01 | Owner financial problems / client finance /economic ability for the project | | | | | |
| | | 2 | FRC03 | Delays in contractors progress payment by owner | | | | | |
| | | 3 | FRC07 | Financing by contractor during construction | | | | | |
| | | 4 | FRC08 | Exchange rate ( price ) fluctuation / economic | | | | | |
| | | 5 | FRC10 | Cash- flow problems during construction | | | | | |
| | | 6 | FRC11 | Global financial crisis | | | | | |
| | | 7 | FRC12 | Material and labor wage escalation ( inflation ) | | | | | |
| | | 8 | FRC15 | Late payment to subcontractor by the main contractor | | | | | |
| *2* | *Owner Related Cause* | 9 | ORC01 | Slowness of the owner decision making process | | | | | |
| | | 10 | ORC02 | Indication of suspension, postponement or delay of project by owner | | | | | |
| | | 11 | ORC03 | Design changes by owner or his agent during construction | | | | | |
| | | 12 | ORC04 | Change orders by owner during construction (variation ) | | | | | |
| | | 13 | ORC06 | Late issuing of approval of design documents by owner | | | | | |
| | | 14 | ORC08 | Waiting for sample material approval | | | | | |
| | | 15 | ORC09 | Delay in approval of completed work by client/CM | | | | | |
| | | 16 | ORC12 | Poor scope definition | | | | | |
| | | 17 | ORC13 | Improper selection of subsequent consultants | | | | | |
| | | 18 | ORC14 | Lack of experience of owner in construction projects | | | | | |
| | | 19 | ORC15 | Delay in material to be supplied by the owner | | | | | |
| | | 20 | ORC21 | Frequent change of client managers | | | | | |
| *3* | *Contractor Related* | 21 | CRC01 | Controlling subcontractors by general contractors in the execution of work | | | | | |
| | | 22 | CRC02 | Poor subcontractor performance / delays | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 23 | CRC03 | Often change of subcontractors | | | | | |
| | | 24 | CRC05 | Rework because of errors during construction | | | | | |
| | | 25 | CRC07 | Poor site management and supervision by contractor | | | | | |
| | | 26 | CRC08 | Delay in site mobilization by contractor | | | | | |
| | | 27 | CRC09 | Poor resource management | | | | | |
| | | 28 | CRC10 | Incompetent project team | | | | | |
| | | 29 | CRC11 | Inadequate contractor experience ( work ) causing error | | | | | |
| | | 30 | CRC14 | Delay in commencement | | | | | |
| | | 31 | CRC15 | Poor qualification of the contractors technical staff | | | | | |
| | | 32 | CRC17 | Unstable management structure and leadership style of contractor | | | | | |
| | | 33 | CRC20 | Time spent to find appropriate subcontractors for each task | | | | | |
| 4 | *Labor Related Cause* | 34 | LRC01 | Shortage of labor | | | | | |
| | | 35 | LRC05 | Labor disputes and strikes | | | | | |
| | | 36 | LRC08 | Slow mobilization of labor | | | | | |
| | | 37 | LRC09 | Staffing problems | | | | | |
| | | 38 | LRC13 | Low productivity level work | | | | | |
| 5 | *Design Related Cause* | 39 | DRC01 | Design errors made by designers ( due to unfamiliarity with local conditions) | | | | | |
| | | 40 | DRC03 | Variation order in extra quantities | | | | | |
| | | 41 | DRC06 | Slow response of designer | | | | | |
| | | 42 | DRC08 | Incomplete/conflicts of design drawings details and specifications | | | | | |
| | | 43 | DRC17 | Rework due to change of design or deviation order | | | | | |
| | | 44 | DRC18 | Late design work | | | | | |
| | | 45 | DRC20 | Slow information delivery between designers | | | | | |
| | | 46 | DRC22 | Mistakes and delays in producing design documents | | | | | |
| | | 47 | DRC26 | Change in drawings & specifications | | | | | |
| 6 | *Site Related Cause* | 48 | SRC02 | Mistakes in soil investigation | | | | | |
| | | 49 | SRC03 | Errors committed during field construction at job site | | | | | |
| | | 50 | SRC04 | Effects of subsurface conditions (e.g, soil . High water table , etc ) | | | | | |
| | | 51 | SRC05 | Geological problems on site | | | | | |
| | | 52 | SRC06 | Unexpected underground condition | | | | | |
| | | 53 | SRC18 | Delay in providing services from utilities ( water , electricity , etc) | | | | | |
| | | 54 | SRC22 | Site accidents due to lack of safety measures | | | | | |
| 7 | *al Relations hips Related* | 55 | RRC01 | The relationship between different subcontractors | | | | | |
| | | 56 | RRC02 | The conflict between contractor and other parties (consultant & owner ) | | | | | |
| | | 57 | RRC03 | Conflicts between consultant and design engineer | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 58 | RRC04 | Poor organization of the contractor or consultant / inappropriate to the project) | | | | | | |
| | | 59 | RRC05 | Difficulty of coordination between various working on the project | | | | | | |
| | | 60 | RRC08 | Poor communication by contractor with other parties | | | | | | |
| | | 61 | RRC10 | Legal disputes between various parties in the construction project ( claims) | | | | | | |
| | | 62 | RRC24 | Poor documentation | | | | | | |
| 8 | *Contract Related Cause* | 63 | COR01 | Poor contract management | | | | | | |
| | | 64 | COR02 | Mistakes and discrepancies in contract documents | | | | | | |
| | | 65 | COR04 | Contract modification / excessive contracts and subcontracts | | | | | | |
| | | 66 | COR05 | Change orders of contract | | | | | | |
| | | 67 | COR06 | Unrealistic contract price | | | | | | |
| | | 68 | COR07 | Unrealistic ( unreasonable ) contract time ( duration ) & requirements imposed | | | | | | |
| | | 69 | COR08 | Unclear contract conditions | | | | | | |
| | | 70 | COR09 | Use of standard form of contract | | | | | | |
| 9 | *Project Related Cause* | 71 | PRC08 | Ineffective delay penalties | | | | | | |
| | | 72 | PRC10 | Type of project bidding and award ( negotiation , lowest bidder ) | | | | | | |
| | | 73 | PRC11 | Delay in finalization of rates for extra items | | | | | | |
| 10 | *External Related Cause* | 74 | EXR11 | Weather conditions | | | | | | |
| | | 75 | EXR12 | Political situation | | | | | | |
| | | 76 | EXR14 | Conflict , war , revolution, riot, and public enemy | | | | | | |
| | | 77 | EXR17 | Monopoly | | | | | | |
| | | 78 | EXR19 | Unavoidable changes in construction/execution methods | | | | | | |
| | | 79 | EXR22 | Poor government judicial system for construction dispute settlement | | | | | | |
| 11 | *Equipment Related Cause* | 80 | EQR01 | Shortage in equipment / insufficient numbers | | | | | | |
| | | 81 | EQR02 | Lack of skilled operators for specialized equipment | | | | | | |
| | | 82 | EQR03 | Equipment productivity ( efficiency ) | | | | | | |
| | | 83 | EQR04 | Equipment failure ( breakdown ) | | | | | | |
| | | 84 | EQR05 | Slow delivery ( mobilization ) of equipment | | | | | | |
| | | 85 | EQR06 | Lack of high-technology mechanical equipment | | | | | | |
| | | 86 | EQR10 | Inadequate modern equipment | | | | | | |
| 12 | *Regulations & Relate* | 87 | RRR01 | Obtaining permits from municipality (government) | | | | | | |
| | | 88 | RRR04 | Changes in laws and regulations | | | | | | |
| 13 | *Consultant* | 89 | CSR01 | Waiting instructions from consultant | | | | | | |
| | | 90 | CSR02 | Delay of design submittal from consultant | | | | | | |
| | | 91 | CSR04 | Insufficient inspectors | | | | | | |
| | | 92 | CSR09 | Inspection delays ( delay in performing inspection and | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | testing by consultant ) | | | | | |
| | | 93 | CSR10 | Late in reviewing and approving design documents | | | | | |
| | | 94 | CSR11 | Delay in approving major changes in the scope of work by consultant | | | | | |
| 14 | *Scheduling and Controlling Related Cause* | 95 | SCR03 | Overestimation / underestimation of the productivity | | | | | |
| | | 96 | SCR04 | Inadequate early planning of the project | | | | | |
| | | 97 | SCR05 | Preparation of scheduling networks and revisions by consultant | | | | | |
| | | 98 | SCR07 | Unreasonable or unpractical initial plan | | | | | |
| | | 99 | SCR08 | Incompetence of planning and control from contractor staff | | | | | |
| | | 100 | SCR09 | Priority on construction time | | | | | |
| | | 101 | SCR10 | Ineffective planning and scheduling of project by contractor | | | | | |
| | | 102 | SCR12 | Damage to structure / liquated damage | | | | | |
| | | 103 | SCR14 | Inadequate progress review | | | | | |
| | | 104 | SCR23 | Ambiguity in specifications & conflicting interpretation by parties | | | | | |
| | | 105 | SCR25 | Inadequate geotechnical investigations | | | | | |
| | | 106 | SCR28 | Inappropriate owner's capable representative management style | | | | | |
| 15 | *Material Related Cause* | 107 | MRC01 | Shortage ( availability ) in construction materials | | | | | |
| | | 108 | MRC02 | Materials changes in types and specifications during construction | | | | | |
| | | 109 | MRC03 | Slow delivery of materials | | | | | |
| | | 110 | MRC08 | Reworks due to defects in construction materials | | | | | |

ISSN: 2277-9655
Impact Factor: 4.116

## THE QUESTIONNAIRE ANALYSIS

The questionnaire forms are distributed on 100 respondents, only 40 respondents replied. The respondents are classified to14 Contractors, 11 Owners and 15 Consultants.


***Fig 2. Respondents classification***

The collected data were analyzed through the following statistical techniques and indices:
Importance index: A formula is used to rank causes of time delay disputes based on importance of occurrence as identified by the participants.
Importance Index (IMP.I.) % = ∑ a* (n / N) / 100 *5 Equation (1)
Where (a) is the constant expressing weighting given to each response (ranges from 1 for very little effective up to 5 for very high effective), (n) is the frequency of the responses, and (N) is total number of responses.

## THE QUESTIONNAIRE RESULTS

By applying the questionnaire on the 40 respondents (Contractors, Owner and Consultants), and using equation (1) on all time delay disputes factors. The result as following table (2):

***Table 2. Ranking of time delay disputes causes***

| Factor Rank | Factors Description | Group | (IMP.I.) % |
|---|---|---|---|
| 1 | Mistakes and discrepancies in contract documents | Contract | 78.50 |
| 2 | Change orders by owner during construction (variation ) | Owner | 78.00 |
| 3 | Delays in contractors progress payment by owner | Financing | 77.00 |
| 4 | Labor disputes and strikes | Labor | 75.00 |
| 5 | Poor subcontractor performance / delays | Contractor | 74.50 |
| 6 | Variation order in extra quantities | Design | 73.00 |

| | | | |
|---|---|---|---|
| 7 | Financing by contractor during construction | Financing | 72.50 |
| 8 | Poor site management and supervision by contractor | Contractor | 72.00 |
| 9 | Poor documentation | Contractual Relationships | 71.50 |
| 10 | Change in drawings & specifications | Design | 71.00 |
| 11 | Unexpected underground condition | Site | 71.00 |
| 12 | Difficulty of coordination between various working on the project | Contractual Relationships | 70.00 |
| 13 | Materials changes in types and specifications during construction | Materials | 69.00 |
| 14 | Obtaining permits from municipality (government) | Rules and Regulations | 68.50 |
| 15 | Conflict , war , revolution, riot, and public enemy | External | 67.50 |

## THE TIME DELAY DISPUTES PREDICTION MODEL (TDDPM)

**Introduction**

After studying data analysis and getting the high fifteen ranked factors, it became necessary to make a simple model to predict by time delay disputes and help the users by recommendations to deal each cause of time delay disputes.

It is designed a simple model to predict by time delay disputes. this system will be referred as "Time Delay Disputes Prediction Model [TDDPM]"). The model was designed as Microsoft Excel Sheets contains from six sheets, the first one : welcome page, second one the project information, third one input data by entering the probability percentage for each cause of time delay disputes, fourth one data analysis by three optional weights (manual/equal/automatic), fifth one output (1) the expected dispute percentage. And last one output (2) recommendations for the five high probability causes.

The model was developed by C-sharp program by simple interfaces to be easy and familiar to users. The model includes seven slides as Previous Microsoft Excel Model, welcome page, projects, project information's, input data, data analysis, expected dispute percentage and recommendations.

**The model Architecture**

The overall architecture of TDDPM will be presented. The detailed structure of each construction disputes phase will be briefed including: Contract factors, financial factors, contractor factors, materials factors and external factors. Flexibility in choosing the type of weight of these factors: manual or equal weight or automatic.

The Architecture of C-sharp software production rule system is comprised of three primary components as Fig (1)

1.Input: The project information criteria, main fifteen time delay dispute factors, the probability of each factor and its weight.

2.Process: The IF Condition then Action representation and simple equation for calculation of expected dispute percentage.

3..Output by percentage, grade, recommendations and report.

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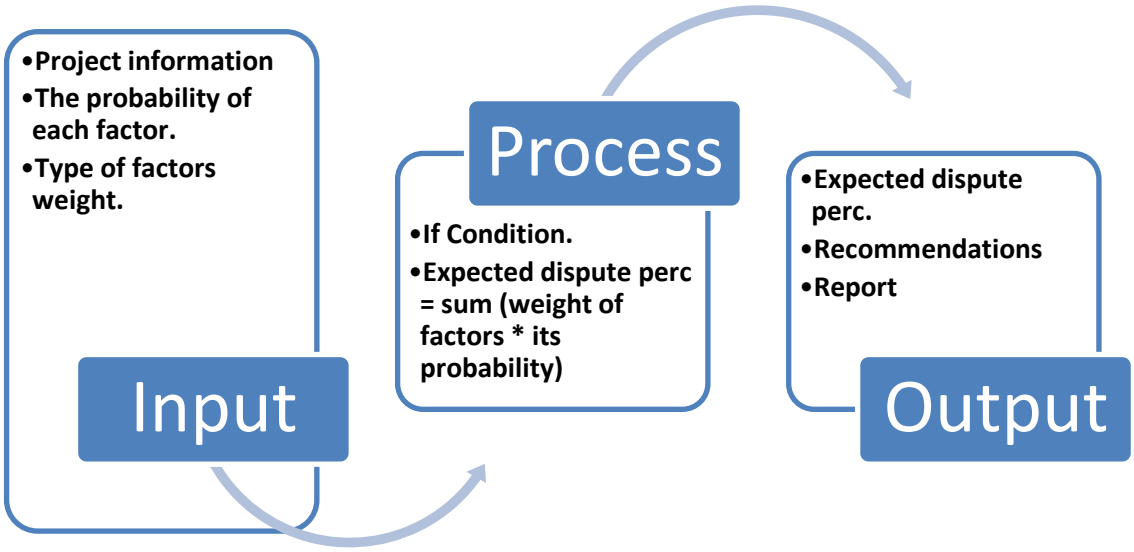


*Fig .3 The model Architecture*

**The User Manual**

The proposed system was carefully designed to be easily operated. In other words, it has a friendly operating environment. Such operating environment includes a number of menu screens that works easily in a serial order. To get the proposed system TDDPM, started the following steps should be followed:

1-Install the program.
2-Select T.D.D.P.M. from programs from start menu.
3 -The first screen will appear as shown in Fig (3) Welcome page.
4- The user can transfer between all processes through the left vertical list which is continuous from welcome page to last page the recommendations.
5- The model includes seven slides briefly as follow:


*Fig4. Welcome Page*

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This is welcome page, includes the name of model and who prepared and checked the model and the vertical list includes all process of the model to manage the user to transfer between all process (project information, input data, data analysis, expected dispute percentage and recommendations as Fig (3).


***Fig 5. Projects Details***

The second page is projects, includes lift vertical list and horizontal windows, the vertical list includes all process of the model to manage the user to transfer between all process (project information, input data, data analysis, expected dispute percentage and recommendations. The vertical list is repeated in all pages.

The horizontal windows includes the first window is list of projects which saved on the model, the second window for opening or close any stored projects, the third window for creating a new project. The graph presents the comparison between dispute and none dispute percentage for the latest three projects as Fig (4).

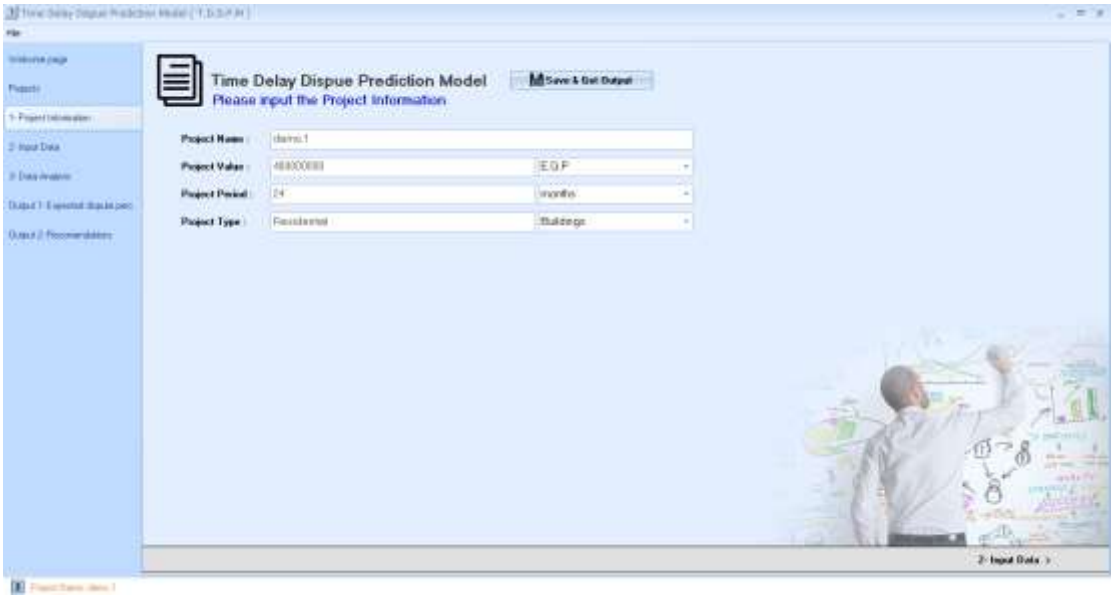


***Fig 6. Project Information***

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The third page is project information, includes project name, project value, project period and project type. The user can enter the project value either by Egyptian pound or American dollar, project period either by months or years and project type either buildings or industrial or roads & bridges or infrastructure or others as fig (5).

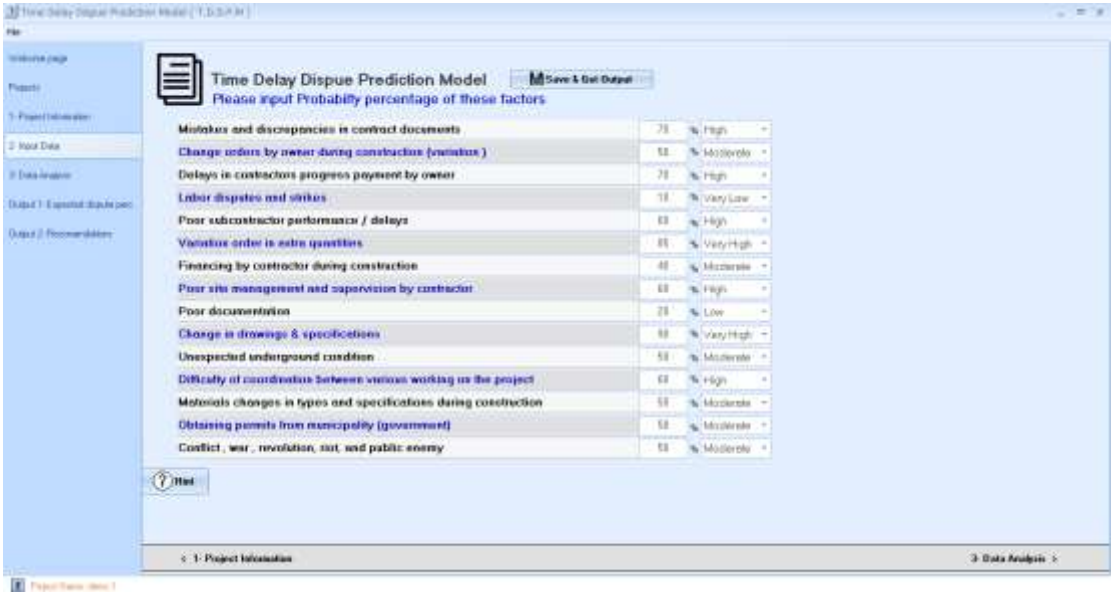


***Fig 7. Input Data***

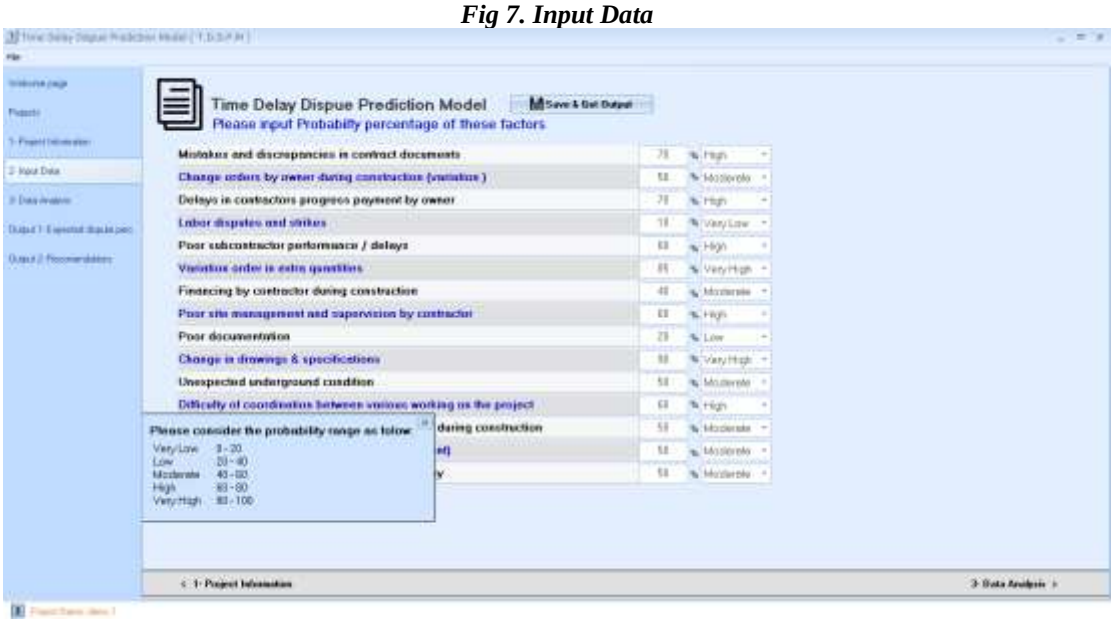


***Fig 8. Input Data Hint***

The fourth page is input data; the user can enter the probability percentage for the most important fifteen causes of time delay dispute from 0 to 100 % or by grade from very low to very high as Fig (6).There is hint below present the relation between the grade and the percentage as Fig (7).

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***Fig 9. Data Analysis***

The fifth page is data analysis, the user can choose the proposed type of analysis: manual by his self or equal weight for all factors or automatic weight stored in the model based on the questionnaire analysis as Fig (8).

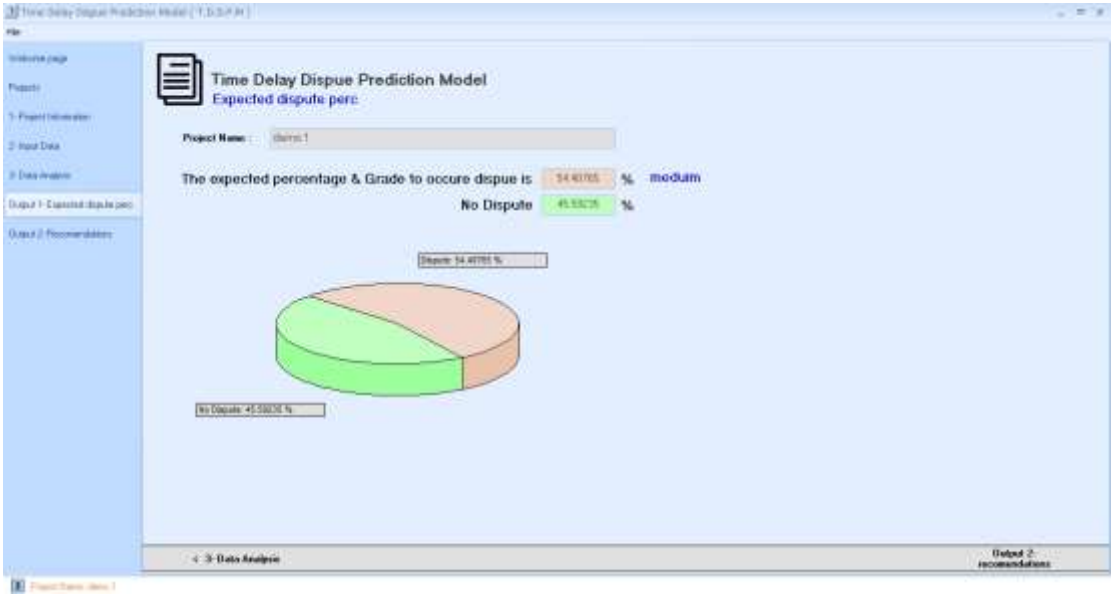


***Fig 10. Expected Dispute Percentage***

The sixth page is the first part from the model output, the model provide the user by the expected percentage and grade to occur dispute, also pie chart present comparison between occurring dispute and non-dispute as Fig (9).

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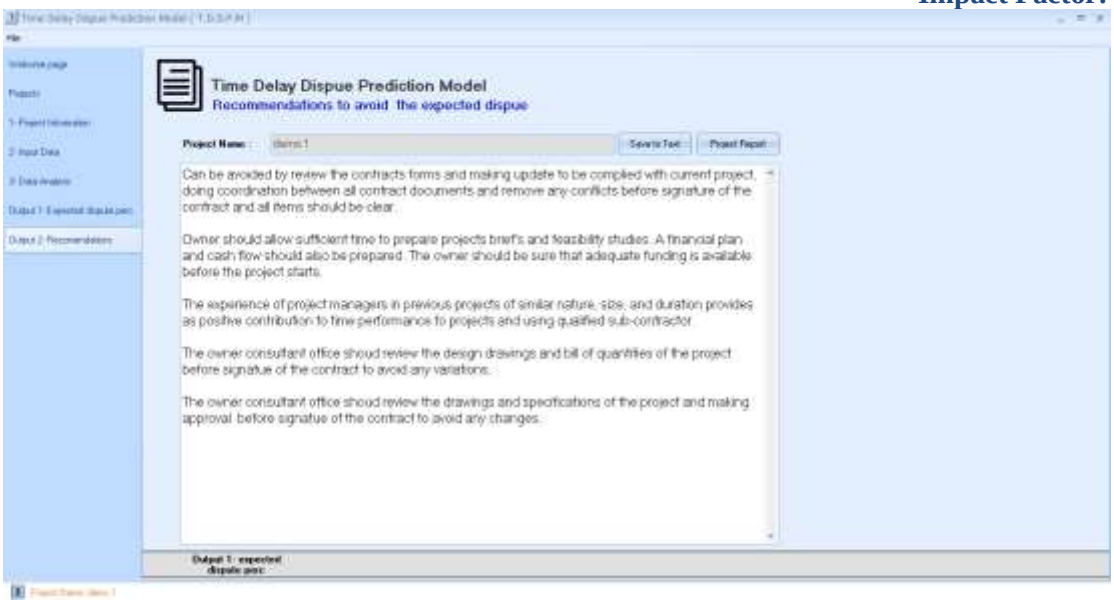


***Fig 11. Recommendations***

The seventh page is the second part from the model output, the model provide the user by the most important recommendations to minimize time delay dispute, as Fig (10).

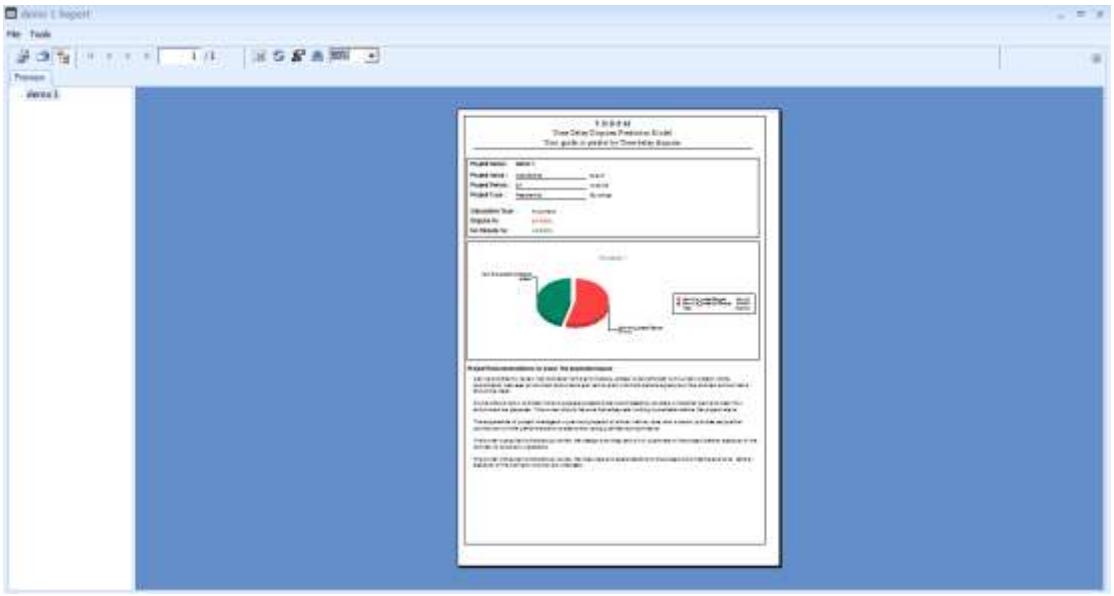

***Fig 12. Final Report***

The model can provide the user by brief report about the assign project; include the project information, type of data analysis, the dispute percentage, pie chart and the most important recommendations to avoid the dispute in this project as Fig (11).also the user can print or save this report.

**Application of case study on the model**

It is applied the model on the project related to arabe contrctors company as a case study, the causes of dispute, weight and probability as following table (3)

***Table 3. the factors weight of the dispute for case-study which matching the model***

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| Causes of dispute | weight | Rel. weight | Probability |
|---|---|---|---|
| Extra works. (More than 100%) | 1.0686 | 32 | 100 |
| Change Orders | 1.1418 | 34 | 100 |
| Late payment (more than one year) | 1.1271 | 34 | 50 |

Ii is entered the data of case study to the model and run the model

## RESULTS AND DISCUSSION

After entering the previous data to the model and clicking on button of save & Get output The model makes analysis and calculations to get the expected dispute percentage (89.9%) & grade (very high) to occur dispute and present this percentage on pie chart as Fig (12)

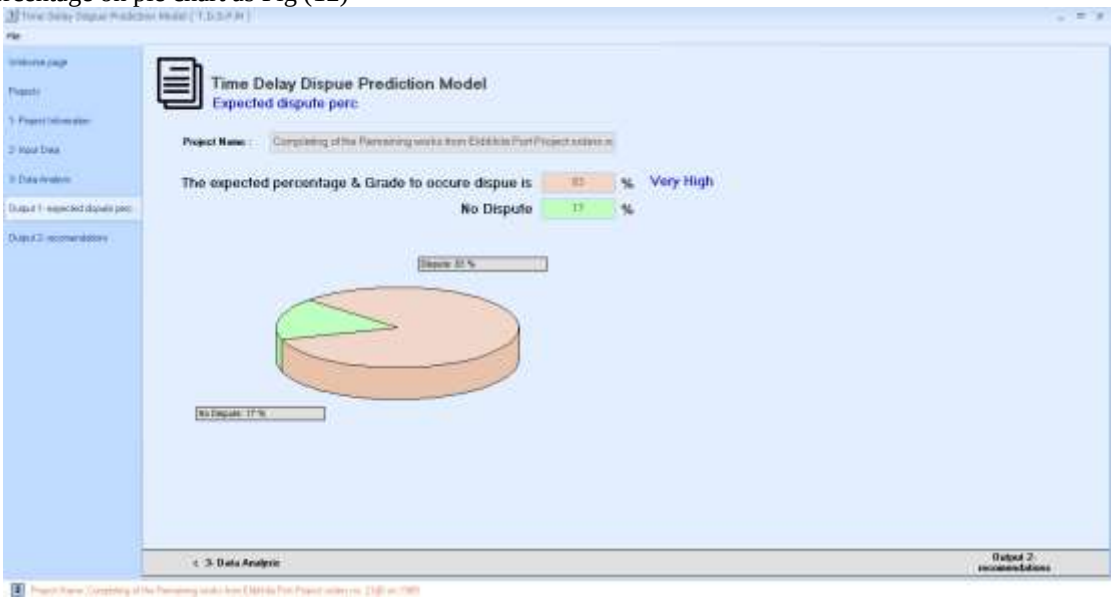


***Fig 13. Expected Dispute Percentage***

Also the model provide the user by the most important recommendations to avoid the disputes either in project study phase or project construction phase as Fig (13)

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***Fig 14. Recommendations.***

Finally, the model provides the user by report about the project include project information & expected percentage and the most important recommendations collected in one paper as Fig (14).

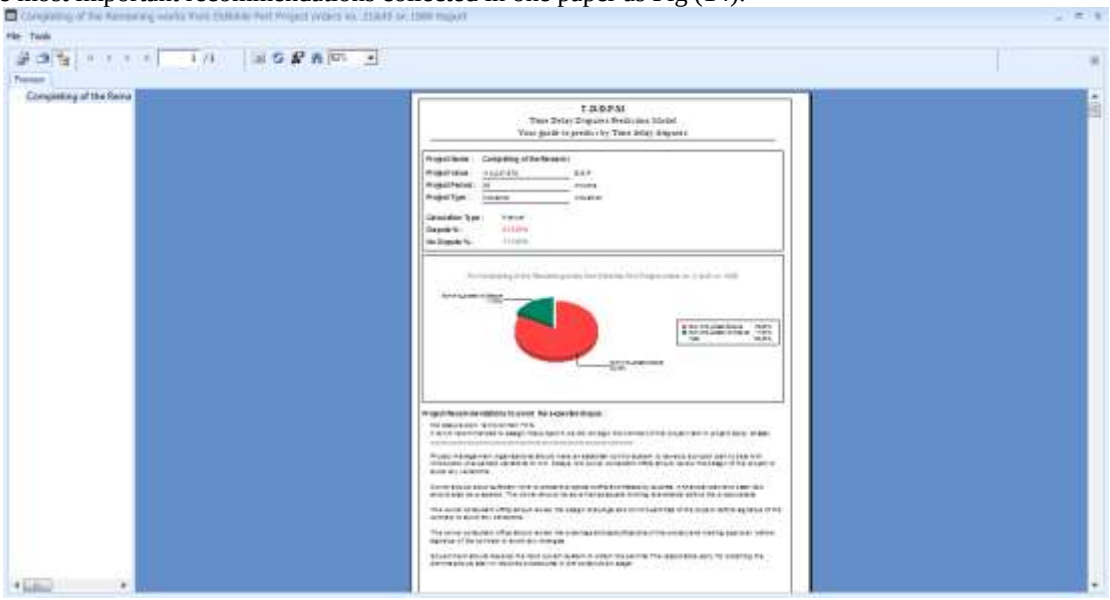

***Fig (15) Final Report***

## CONCLUSION

Construction disputes have many causes according to the point of view of each participant within any construction project. These causes may include delays, additional work, and variation in contractual works, change in physical conditions, disasters and errors in contract clauses. Disputes between participants may consume long time from project period and add costs to the project. The negotiation process between the participants aims at additional time or money or both in order to compensate the injured party losses.

It is made questionnaire form include 110 causes of time delay disputes are grouped to fifteen main groups as Financing, Owner, Contractor, Labor, Design, Site, Contractual Relationships, Contract, Project, External,

Equipment, Rules & Regulations, Consultant, Scheduling and Controlling and Material Related Cause. The questionnaire are distributed to 100 respondents, only fifty replied, ten forms are excluded, only 40 respondents forms are considered ; the respondent evaluated each factor according to its effective degree from very little (1) to high effective (5).The factors of time delay disputes are ranked by owner, contractor, and consultant point of view and combined (all parties).

Based on questionnaire results, It is designed a simple model to predict by time delay disputes (TDDPM). The model consist of seven slides, the first one welcome page by user, the second one is projects; includes the new and stored projects, the third one; includes the project information as name, value, period and type, the fourth one is input data; includes entering the probability percentage for the most important fifteen causes of time delay dispute from 0 to 100 % or by grade from very low to very high by user, The fifth page is data analysis, choosing the proposed type of analysis: manual by his self or equal weight for all factors or automatic weight stored in the model based on the questionnaire analysis, The sixth page is the first part from the model output, the model provide the user by the expected percentage and grade to occur dispute, also pie chart present comparison between occurring dispute and non-dispute and The seventh page is the second part from the model output, the model provide the user by the most important recommendations to minimize time delay dispute.

After applying the case study on the proposed model, it is very clear completely matching between the case study and the model output, the model expected occurring dispute by percentage 83% (very high),The case study confirmed that occurring dispute between the owner and the contractor and compensation of the contractor.

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