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Delay causes analysis in complex construction projects: a Semantic Network Analysis approach

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ABSTRACT
Delays are among the most crucial adversaries to the success and performance of construction projects, making delay analysis and management a critical task for project managers. This task will be highly complicated in large-scale projects such as construction, which usually consist of a complex network of heterogeneous entities in continuous interaction. Traditional approaches and methods for the analysis of delays and their causes have been criticised for their ability to handle complex projects, and for considering the interrelationships between delay causes. Addressing this gap, this research introduces an alternative approach for delay causes analysis by adopting Semantic Network Analysis (SNA) method. The paper reports the results from an investigation of delays in construction projects in the Oil-Gas-Petrochemical sector using SNA. The method's capacity to identify and rank delay causes, which can assist managers in selecting appropriate measures for eliminating them, are empirically examined and discussed. The paper argues that SNA leads to a more comprehensive understanding of the main causes of delay in large and complex projects, allowing a better identification and mapping of the interrelationships between these discrete factors.

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Delay analysis; semantic networks analysis; construction project delay; petrochemical industry

1. Introduction

Delays are identified as a major issue for successful project management. Delay is a common problem in most projects, the magnitude of which varies significantly from project to project and industry to industry (Wa'el et al. 2007). The literature contains extensive studies of the subject across various industries (see Wu [2016]; in Aviation Industry, Ruqaishi and Bashir [2015]; in construction industry ,Fallahnejad [2013]; Fouché and Rolstadas [2010] and Dey [2012]in Oil and Gas industry).

Delays not only affect the delivery of the project, but can lead to other sources of inefficiency such as cost overrun as well as managerial and relationship issues (Sambasivan and Soon 2007). The field of Project Management (PM) has attempted to discern delay causes, seeking to assist managers in tackling this key problem (see Arditi and Pattanakitchamroon [2006]; Assaf and Al-Hejji [2006]; Sambasivan and Soon [2007]; Braimah and Ndekugri [2008]; Gill [2008]; Sweis et al. [2008]; Dey [2012]; Doloi et al. [2012]; Yang and Kao [2012]; Yau and Yang [2012]; Fallahnejad [2013]; Amoatey et al. [2015]; Joslin and Müller [2016]). According to Gunasekaran and Ngai (2012) attending these aspects of project management are becoming increasingly important to the production planning and control function in operations management,

Construction projects are vital to many industries, including energy, water resources development, communication, architecture, public health, and Oil, Gas and Petrochemical (OGP) (Gardezi, Manarvi, and Gardezi 2014). Other sectors and industries are also indirectly affected by the performance of construction projects, which signify the prominent role of such projects in national economies. As such, delays in construction projects can pose a critical threat to the success of national infrastructural plans.

Studies have shown that even with today's advances in technology, management systems and techniques, project completion dates still get pushed back (Sweis et al. 2008). Sambasivan and Soon (2007) and Yang and Ou (2008) see delays in construction projects as a global problem, being one of the most commonly recurring issues in the industry (Tumi, Omran, and Pakir 2009; Doloi et al. 2012; Yang and Kao 2012). Yang and Ou (2008) used a structural equation modelling (SEM) approach to identify the reasons for delay in construction, and categorised the causes as: (1) contract related, (2) management related, (3) human related, (4) non-human related, (5) design related and (6) finance related. Yang and Kao (2012) find three main reasons for this: construction projects (1) generally have highly complicated situations during execution, (2) involve many project stakeholders and interfaces, and (3) are influenced by many external factors. Gardezi, Manarvi, and Gardezi (2014) argue that the level of risk and uncertainty in construction projects is higher than other sectors, which are largely because such projects have complex and time consuming

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designs, involving processes and methods, which are more likely to be affected by unprecedented circumstances.

One of the most important fields involving extensive construction projects is the OGP industry. Projects in this sector are usually of mega scale, with the potential to affect national economies. An understanding of delay causes and their dynamics is therefore particularly crucial for this sector. Recent events in the Middle East region coupled with reduced oil prices necessitate improved productivity and efficiency in OGP projects in which delay analysis plays a key role.

The methodology applied in most of the extant literature deals with the occurrence of delays and their tangible liabilities for the projects. However, such methods have been criticised for failing to support analysis of complex projects in complex environments (Yang and Kao 2012). Complex projects like large construction projects, particularly in the OGP sector, involve various stakeholders and actors, and multiple nodes and factors that interact and communicate within interwoven networks. Understanding causal factors of delay, and the prioritisation of these factors, requires a methodology that accommodates the interwoven nature of these factors and their potential liabilities. For this purpose, this study employs the Semantic Network Analysis (SNA) method, which is advocated for studies involving structure and behaviours in complex networks (Pereira et al. 2011).

The paper presents a novel approach to the study of project delays and analysis of their root causes. SNA, which presents a network view of the projects and their interrelationships, foregrounds the meaning of delay factors as understood by various entities and managers involved in industry projects. Applying the method results in a more accurate hierarchising of the identified causes. While the empirical results may be considered specific to the chosen sector, the results provide new insights into examining and dealing with delays more efficiently and effectively. The study offers two key contributions: (1) presenting a new method for analysing delays in projects, the SNA, and (2) suggesting an order of significance for factors that are critical to construction project delays in the OGP industry.

2. Literature review

2.1. Project delays

Cost, time and quality have been recognised as major determinants of project success. Project managers aim to achieve the best of the 'Golden Triangle'– budget, schedule and quality (Riazi, Riazi, and Lamari 2013). Time is reported to be the most important factor (Gill 2008; Chang and Li 2014). As noted by Gill (2008) time has effects on cost and quality aspects of projects. Efficient control of project delay is therefore needed for optimum project performance and success (Chang and Li 2014; Kariungi 2014).

Delay is a gap between the real project completion and its scheduled completion time (Zwikael, Cohen, and Sadeh 2006). In other words, delay is a state in which a time extension is required for executing all or part of a project, consequently postponing its completion (Manavazhi and Adhikari 2002; Fugar and Agyakwah-Baah 2010; Gardezi, Manarvi, and Gardezi 2014). Delays are known to be the most important events that cause inconvenience for project managers (Carden, Leach, and Smith 2008), creating major difficulties for projects (Aibinu and Jagboro 2002). Delays have consequences such as reduction in project productivity, increased costs, missed opportunities and elimination of projects' economic feasibility (Long et al. 2004). Aibinu and Jagboro (2002) and Amoatey et al. (2015) found six potential negative consequences for project delays, namely time overrun, cost overrun, dispute, arbitration, litigation and total abandonment. Manavazhi and Adhikari (2002) reported project delays' actual impact to be on project cost and budget.

Delays can occur in various forms and modes. Taher and Pandey (2013) suggest that different types of delay could have different effects on non-critical activities, for which additional elaborated analysis is needed to work out such impacts (Taher and Pandey 2013). Following is a summary of delay types demonstrated by Williams, Ackermann, and Eden (2003), Kikwasi (2012) and Taher and Pandey (2013):

(1) Excusable delay with compensation: delays caused by the client's actions or inactions.
(2) Excusable delay without compensation: delays in which neither the consumer nor the contractor is deemed accountable.
(3) Non-excusable delay: This delay is caused by contractor's avoidance of the contract agreement.

2.2. Delays in construction projects

Delays in the construction industry have been a subject of study in a wide array of works undertaken in several countries (Alavifar and Motamedi 2014; Ruqaishi and Bashir 2015). Studies have shown varied approaches to the examination of project delays, and have reported diverse results. Fallahnejad (2013) identified four categories of study for finding the main causes of project delays: studies in construction projects, studies in long-term and large-scale projects such as highways, studies in public/governmental project, and studies in OGP projects. Researchers have suggested and classified different types of delays in these industries. Elawi (2015) categorised the causes of delay in road and bridge construction projects in terms of owner causes, contractor causes, consultant causes and other stakeholder causes. Arditi and Pattanakitchamroon (2006) introduced four methods for delay analysis in construction projects as 'as planned vs. as-built schedule analysis method', 'impact as-planned schedule analysis method' 'collapsed as-built schedule analysis method', and 'time impact analysis method'. Assaf and Al-Hejji (2006) identified 56 reasons for delay in large construction projects. Alavifar and Motamedi (2014) summarised causes of delay from their review of the literature, finding a variety of factors which differ not only from one country to another, but based on the researchers' approach and applied methods. Table 1 shows a few of the summarised studies by Alavifar and Motamedi (2014). As shown in the table, planning and scheduling is one factor shared by most studies.

2.3. Delays in OGP industry construction projects

OGP construction has attracted the attention of researchers due to the importance of this industry. As Weijermars (2009) and

Table 1. Summary of previous studies of the causes of delay in construction projects in Middle East region (Alavifar and Motamedi 2014).

Country	Researchers	Major causes of delay
Saudi Arabia	Assaf and Al-Hejji (2006)	• Slow preparation and approval of shop drawings • Delays in payments to contractors • Changes in design/design error • Shortages of labour supply • Poor workmanship
Saudi Arabia	Al-Khalil and Al-Ghafly (1999)	• Cash flow problems/financial difficulties • Difficulties in obtaining permits • 'Lowest bid wins' system
United Arab Emirates (UAE)	Faridi and El-Sayegh (2006)	• Slow preparation and approval of drawings • Inadequate early planning of the project • Slowness of owner's decision-making • Shortage of manpower • Poor site management and supervision • Low productivity of manpower
Saudi Arabia	Assaf and Al-Hejji 2006	• Change in orders by the owner during construction • Delay in progress payment • Ineffective planning and scheduling • Shortage of labour • Difficulties in financing on the part of the contractor
Iran	Pourrostam and Ismail (2012)	• Delay in progress payments by client • Change orders by client during construction • Poor site management • Slowness in decision-making process by client • Financial difficulties by contractor • Late in reviewing and approving design documents by client • Problems with subcontractors • Ineffective planning and scheduling of project by contractor • Mistakes and discrepancies in design documents • Bad weather

Salazar-Aramayo et al. (2013) contended, the dependence of many economies on oil and gas, pushes the industry to operate at high intensity levels worldwide. Construction projects in this field are characterised by intensive investments (Castillo and Dorao 2013).

Salazar-Aramayo et al. (2013) assert that OGP construction projects are not only internally complex and high-risk, but also subject to pressure from different stakeholders, which exacerbates complexity. Jergeas (2008) assessed the time and cost overruns in three mega oil sands projects in Canada over a three-year research period. Their findings show that delay causes are rooted in 'feasibility study, risk management, primary cost and time estimation, and engineering'. Sepehri (2006) studied Iranian South Pars construction projects and reported that failure and time overrun happen more in planning phases than in construction or control phases. This author presented some failure factors including 'project planning, quality assurance, testing, configuration management, and development process'. Thuyet, Ogunlana, and Dey (2007) conducted a survey to identify the risk factors affecting OGP construction projects in Vietnam, identifying five factors as the major causes of project delay: (1) bureaucratic governmental systems and lingering project approval procedures, (2) poor design, (3) incompetence of project teams, (4) inadequate tendering practices and (5) delays in internal approval processes by the owners. In their study of OGP industry, Jergeas and Ruwanpura (2010) also classified the causes of cost and schedule overruns as: (1) misplaced optimism, (2) misguided objectives, (3) misaligned strategies, (4) misdirected execution and (5) missing links. Additionally, Dey (2012) found the delay factors in a refinery construction project in central India to be: (1) technical risks; (2) financial, economic and political risks; (3) organizational risks; (4) natural hazards; and (5) statutory clearance risks. Fallahnejad (2013) conducted a survey to identify and rank the causes of delay in gas-pipeline construction projects in Iran. This researcher identified the top ten important causes of project delays that are: imported materials, unrealistic project duration, client-related materials, land expropriation, change in orders, contractor selection methods, payments to contractors, obtaining permits, late delivery of ordered materials by suppliers, and contractors' cash flow.

In Addition, Ruqaishi and Bashir (2015) reviewed studies on the delay analysis of OGP construction projects, and summarised the main causes of these projects into eight groups: (1) Client-related causes, (2) Contractor-related causes, (3) Consultant-related causes, (4) Material-related causes, (5) Labour/equipment related causes, (6) Contract-related causes, (7) Contract relationship-related causes and (8) External causes.

While the studies reviewed above present some key factors of delays in the industry, they fail to prioritise the variety of causes that arise. Resource constraints limit project managers' ability to attend to every factor at once. Therefore, project managers need a way to prioritise delay causes and deal with them accordingly. Besides, in complex project environments like the OGP industry, cross impacts often emerge from the interplay between key factors. Understanding this interplay is therefore important for identifying and managing delay causes in complex projects. The absence of such an approach to the study of delay causes in the current research on the subject has motivated our study.

3. Research method

This research aims to extend our knowledge of project delay management, where the planning and control dimension of projects and their operations management play a key role. The research addresses a gap in the literature by identifying both the causal factors and their mutual effects on each other. This will be important for presenting a more accurate account of the factors and the way the factors may be prioritised. This will assist in developing methods for dealing with delays and their causes in a more effective way. By mapping the effects of each delay factor on the other, the main causes may be highlighted, and those which must be prioritised clarified.

This research adopted SNA to address this critical void, as the following section explains. To examine this approach, it was imperative to provide a suitable field of study. Suitability in this study entails economic importance, and a significant degree of complexity. The OGP industry, which as discussed is known for its global economic importance, was selected as a suitable context to work from. Results from the study of this sector can inform other sectors and types of construction projects.

3.1. Semantic Network Analysis as the method

Various analysis methods have been developed over the time for the analysis of delay in projects. Some main methods include global impact, as-planned, impacted as-planned, net impact, time impact, collapsing, isolated delay type, snapshot and window analysis, and SEM (Kao and Yang 2009). As reiterated by Yang and Ou (2008), finding the causes of delay, which affect project's critical paths and their completion, is a key aspect in such methods. While most known methods have paid attention to the causes of delay, the methods have been criticised for their ability to identify critical path changes and to deal with more complicated delay types (Yang and Kao 2012). Besides, existing methods have failed to illustrate the relationship between different delay causes, and how the identified causes affect each other and collectively influence schedule delays (Yang and Ou 2008). Such insight of delays and their causes, particularly in complex projects, can help the managers to identify priorities for attending and resolving the causes. There is a need therefore, for new approaches to identifying and analysing delay causes which can present a priority model of the causes based on the analysis of the relationship between different causes. The SNA is able to do this.

SNA as the alternative to existing methods is found to be a useful approach for addressing complicated circumstances as it is interested in extrapolating the relations between factors (Atteveldt 2008). SNA, which inherently is based on qualitative assessment of networks and their actors' perceptions and behaviour, provides a more in-depth view of the potential causes of delay beyond statistical-based approaches such as SEM. Yang and Ou (2008) who applied SEM in their study, refer to the limited information users may receive from the correlation coefficient-based analysis of relationship between two causes, which would be too simple to present a holistic perception of the key causes of delay.

Social network analysis and complex network theory have previously been applied to study the behaviour and structure of complex networks such as technological networks, biological networks, social networks, organisation networks, information networks and semantic networks among others (Pereira et al. 2011). The concept of semantic networks was first introduced by Quillian (1968). The method established a foundation for knowledge modelling and representation (Helbig 2006), which was supported by an adaptable formal framework in order to systematically analyse systems and develop applications (Drieger 2013).

SNA refers to a collection of research techniques that consider each concept/occurrence as a node in a network and a semantic relationship among the nodes (Jung and Park 2015). The method analyses the relationship between concepts by recording co-occurrence of concepts (Oh et al. 2013). SNA has been used by Zarei, Chaghouee, and Ghapanchi (2014) as a new methodology for the recognition, analysis and prioritisation of inefficiency factors in the organisational diagnosis process.

The methodology is defined in three steps: (1) the recognition of key factors; (2) the recognition of elements determining and defining each of the key factors; (3) analysis of factor effects. In the first step, the researcher scans the occurrence of the factors before attempting to identify the main factors of inefficiency according to the evidence. Primarily, qualitative methodologies are employed, such as focus groups or Delphi. Information and ideas are collected through interviews with informants, who are identified as key people in the organisation, selected for their direct knowledge and expertise of the matter at hand. The data is then analysed to extract and prioritise the key factors that are responsible for inefficiencies. In the second step, these key factors are broken down to the elements that comprise them. In the third step, the effects of each element on the other elements are determined and illustrated with SNA.

The process of SNA involves a network approach that includes the following key elements and symbols:

(1) Nodes: nodes encode concepts which are recognised as the key factors. As mentioned by (Drieger 2013), nodes can be quantitatively characterised by a measure which indicates the number of adjacent nodes, to denote a node's connectedness.
(2) Edges: Edges represent relations between two nodes, which are weighted according to statistical quantities of adjacent nodes, such as their centrality measures (Drieger 2013). In our model, relations are divided into the following categories:
   (a) Is-From: the factor which is constructed from other factors (R-I).
   (b) Can-affect: the factor that has direct effect on other factors (C-A).
(3) Hubs: Hubs represent important nodes in a network, often corresponding to highly connected nodes.

After finalising the network, the elements, which are identified as Hubs, are addressed and improved. Theoretically, improvement of these elements is expected to have significant effects on overall project efficiency as well as improving other factors. The application of this method in delay analysis provides the opportunity to resolve the limitations of previous methods. The strengths of this method include:

(1) It can handle analysis of complex environments where complicated relationships and processes exist.

(2) The network of causes of delay identified using the method can highlight critical path changes. It means that more impactful nodes will be given priority for improvement and change.
(3) It resolves the problem of method efficiency by removing dependence on the time of doing the analysis.
(4) The method identifies liability allocation clearly through recognition of factors and sub factors, as well as the relationships between them.

3.2. Research design and development

The empirical study was carried out through a case study approach, to demonstrate the suitability of the proposed approach (Arena et al. 2014). As a method, case study is ideal for studies such as this, where it enables the investigation of a contemporary phenomenon within its real-life context (Verschuren 2003; Palmberg 2010; Stewart 2012; Zach and Munkvold 2012). The main unit of analysis in research like this are organisational units, which are in continuous and evolving relationships. Their relationships are intrinsically complex in structure, and are therefore difficult to access conceptually (Easton 2010). The inherent flexibility of the case study method suits the study of such complex and evolving interactions in the industrial market (Beverland and Lindgreen 2010). Case studies provide the opportunity for more contextual assessment of social and behavioural aspects of the target industry (Kurkkio, Frishammar, and Lichtenthaler 2011). A multiple case study approach was preferred, as it suits collecting comparative data, hence being likely to yield an accurate and generalisable result (Kurkkio, Frishammar, and Lichtenthaler 2011; Stewart 2012).

This study focuses on Iranian OGP. The OGP industry has been reported by Kurkkio, Frishammar, and Lichtenthaler (2011) to be complex, consisted of multiple iterative activities. In the Middle East region, Iran has the largest gas and oil reserves. The OGP industry is the main industry in Iran, comprising up to 60% of gross national revenues and about 80% of foreign currency revenues. Large-scale investments have been directed to the Iranian Petrochemical Industry in recent years, in accordance with national development plans. Such capacity-development projects require extensive competencies, and project efficiency. The success of such projects has been hampered largely by excessive project delays, causing concerns for industry leaders as well as policy-makers (Fallahnejad 2013; Zarei, Chaghouee, and Ghapanchi 2015).

Prior studies have reported significant delays in Iranian petrochemical construction projects. According to IMO (2013), the average delays in the Iranian petrochemical construction projects were 500, 470 and 357 days in 2010, 2011 and 2012, respectively. Based on a review of the Iranian Industrial Management Organisation's reports on delays in petrochemical construction projects (IMO 2013), three petrochemical construction projects with the longest delays in 2012–2013 were selected for the case study in the research. The initial study of the cases included an analysis of the industry types and delays in various firms within the sector. 26 construction contractors in these projects were identified and selected for data collection. These firms provide a comprehensive representation of the industry considering the scope and size of the projects the firms were responsible for. Besides, our early investigations and examination of the documents, obtained from the firms and their projects, showed that delays in these firms' projects were more impactful to the success of the overall projects.

A focus group methodology was selected for collecting the data in the research. Focus groups are analytically challenging, as the team tends to deal with and combine three levels of data, including individual, group, and group interactions (Onwuegbuzie et al. 2009). According to Zarei et al. (2014) the optimal size of a focus group is between six and eight participants.

The aim of the focus group panels was primarily to seek agreements among the members of the discussion. This was achieved by focusing on and recording the disagreements between the members. For selecting the expert panel, the research team requested formally from CEOs of 26 firms in the Iranian Petrochemical industry to introduce one of their experts with ten or more years of job experience to represent them. As the result, the expert panel was a representation of 26 firms in the Iranian Petrochemical industry, who were recruited to the research process following their agreement to participate in the study. Most of the firms approached in the study were very keen to learn why their projects face delays so that the company can better handle them.

Following initial meetings to explain the objectives and approach to the study, focus group sessions were planned and conducted. Each session included at least eight experts to discuss causes of project delay and break down contributing factors in detail. In total, 21 sessions were held with the participants in the identification phase. The sessions took 2 to 3 h each, which were chaired and controlled by a moderator who was assisted by an observer (co-researcher). The primary role of the moderator was to initiate, observe, facilitate and conduct discussions, while the observer took field notes and observed the participants' non-verbal communication patterns. The sessions were voice recorded. Data from each session was analysed through the following steps as proposed by Zarei et al. (2014):

(1) Overview: reading the transcripts several times to get the gist.
(2) De-contextualisation: categorising data according to the themes in the research guide.
(3) Coding: organising the text according to emerging categories within each theme.
(4) Conceptualisation: identifying the main concepts in the emerging codes and sub-codes.
(5) Re-contextualisation: re-arranging the text according to the emerging logic.
(6) Documentation: documenting the outputs which was presented to participants to validate the process of analysis in the next session.

The validity and reliability of the data was verified following Beverland and Lindgreen (2010) as follows:

(1) Construct validity: Multiple documents were examined and multiple informants were asked to provide additional information in follow-ups.

(2) Internal validity: This was achieved through searching for indications of negative effects, which was used to rule out or account for alternative explanations.
(3) External validity: Achieved through selecting the target firms using expert opinion to make cases as unique as possible.
(4) Reliability: Achieved using a standardised interview/discussion protocol, and careful write-up of the data.

To examine and validate the results from this stage, follow up interviews were undertaken with 15 informants. The selection of informants was undertaken by first identifying the potential top executive managers of the selected petrochemical firms. From a list of 50 managers, 15 informants were selected randomly. All 15 informants were male managers who had more than fifteen years of job experience and had been involved with up to five different managerial positions at the Iranian petrochemical industry.

In these interviews, the participants were presented with the results from the focus group studies and SNA analyses, and asked to comment on how the outcome relates to their problems, and whether it would inform their future views and decisions. Figure 1 presents a flow diagram of the steps taken through the field study.

4. Findings

In the first step, the research team examined and evaluated the project's delays and their causes based on the projects' documents. Review of the documents and evidence showed that the causes of delay can be categorised in five standard processes of project management (i.e. PMBOK's categories) as follows:

(A) Delays related to initiating processes
(B) Delays related to planning processes
(C) Delays related to executing processes
(D) Delays related to controlling processes
(E) Delays related to closing processes

These categories were discussed in the first few sessions of focus group panels. The discussions led to a refined version of categories based on the following points:

(1) The delays in executing process are primarily due to the problems of contracting process, and therefore contractual problems are the root causes of process issues. In addition, it was expressed and agreed that delay causes are varied across different processes undertaken by different contractors. Consequently, it is not possible to generalise such causes, and therefore categorising them under generic themes is not helpful. The panel members therefore concluded that classification of 'delays related to executing processes' should change to 'delays related to contracting processes'.
(2) The processes related to project closing, in practice come in play after the project's executing processes and handing over to the project owners. Since the scope of this research covered processes up to the project delivery to owners, the panel concluded that 'delays related to closing processes' is outside the scope of this exercise and should be omitted.

Based on these points the delays of the projects were groups in four categories as shown in Table 2.

Investigating the relations between elements of each category was a key factor in the investigation, and one important contribution of this research. Figure 2 depicts the 'Is-From' (I-F) and 'Can-Affect' (C-A) relations between cause groups, and demonstrates how the emergence of a problem in one group leads to delay in others. This required identification of the elements of each category (as depicted in Table 3). For this purpose, the participants in focus groups were asked to list what they consider to be the main constituting elements of each category. These factors were then collated, analysed and finalised in a general session attended by members of all expert panels. The final consensus on the layout of the elements is depicted in Table 3.

In Figure 3, 'Result-In' (R-I) is applied to demonstrate the relationship between factors leading to delays in each group. Uncovering such relationships is of great value to the management of projects. Take, for instance, group A, which includes eleven elements. 'Absence of industrial feasibility study and capacity planning' (factor 1) can 'result in' problems such as 'lack

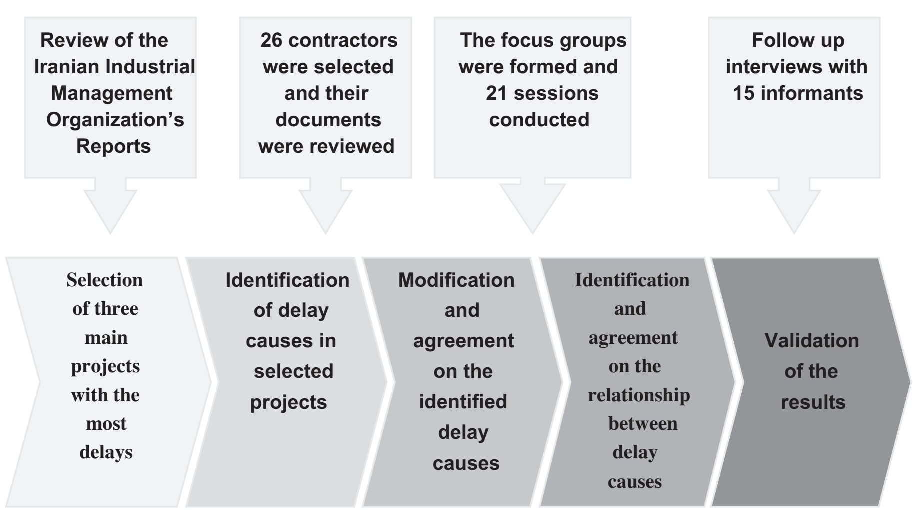

Figure 1. The research steps flow diagram.

Table 2. Different categories of the IPI project causes of delays.

Group	Definition
A	Delays related to the initial negotiations
B	Delays related to contracting processes
C	Delays related to planning process
D	Delays related to control process

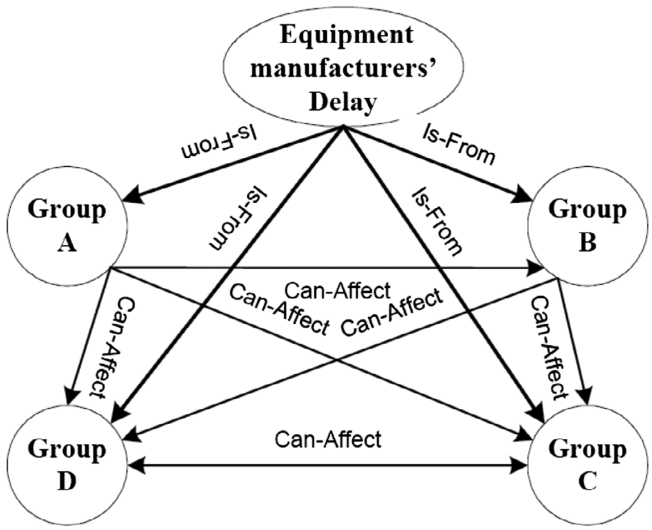

Figure 2. Semantic network of delay causes of IPI.

of the required Engineering Procurement (EP) documents or incomplete documents from EP' (factor 3) and 'Uncontrollable contextual factors such as monopolies or market fluctuations' (factor 5). 'Incomplete and ineffective Contracts' (factor 2) may cause 'Lack of reviews, feedbacks and corrective actions' (factor 6). This network also shows that a problem such as 'Unclear definition of responsibilities and duties of EP and equipment manufacturers' (factor 11) results from 'Time consuming process of reviewing and confirming suggestions and plans by EP' (factor 7), 'Frequent changes in information and documents presented by EP' (factor 8) and 'Long lags between the changes announced by EP' (factor 9). Figure 3, drawn using Edraw 7.9 software, illustrates an overall image of relationships using four categories of delay sources, and the detailed components of each. These connections were suggested by the focus groups participants, who were asked for their view on the relationships between factors and their elements. The summarised results were then presented, discussed and finalised in the final general session.

The main relationships in the semantic network are between categories, which may be referred to as external relationships. With 15 direct effects from A on B, 33 from A on C and 53 from A on D, category A can create 101 causal relationships. From all 167 direct delay relationships, nearly 61% of delays result from category A, 38% from category C and just 1% from category B. The relationships and their values are shown in Table 4.

A-6, A-11 and A-1 with 35, 28 and 23 relationships with delay sources, respectively, are the most effective factors of category A. These factors have considerable influence on other categories. C-6 and C-4 with 10 and 7 relationships within category D, respectively, have the greatest effects on this group. As a result, therefore, improving the performance of projects and reducing their delays can be achieved by considering and improving factors A-6, A-11, A-1, C-6 and C-4 as critical decisions for the managers.

Another important aspect of the data is the frequency of factors and their ranking, which are analysed and presented in Table 5. In this step, the significance of elements is ascertained through the opinions of the experts in the focus groups. According to the results, the most prominent causes of delay in the petrochemical industry are 'Inaccurate or wrong estimation of costs in initial negotiation (A-4)', 'Time consuming process of reviewing and confirming suggestions and plans by EP in the planning process (C-2)' and 'Time consuming process of reviewing and confirming suggestions and plans by EP in the control process (D-2)'.

5. Discussion

The most recurring issue in the construction industry is delay (Tumi, Omran, and Pakir 2009; Doloi et al. 2012; Alavifar and Motamedi 2014), which is associated with the level of uncertainty (Gardezi, Manarvi, and Gardezi 2014), and complexity of projects in this sector (Tumi, Omran, and Pakir 2009; Doloi et al. 2012; Yang and Kao 2012). The OGP industry plays a crucial economic role in many economies (Fallahnejad 2013; Farboudmanesh, Moradi, and Rad 2013; Salazar-Aramayo et al. 2013; Ruqaishi and Bashir 2015), and is shaped largely of construction projects with intensive investments (Castillo and Dorao 2013). With delay being the main factor affecting the production planning and control dimension of operations (Gunasekaran and Ngai 2012), its management is therefore critical to this sector and its success. This paper contributes to the field of study by presenting a new and comprehensive approach to the investigation of delay causes in complex environment such as OGP. The critical nature of the industry to the economy, which motivated this study, highlights the importance of identification of causes of delay.

The study uncovers some limitations of existing project delay analysis models, especially the models which are modified for OGP projects, such as those developed by Thuyet, Ogunlana, and Dey (2007), Jergeas (2008), Jergeas and Ruwanpura (2010), Dey (2012) and Fallahnejad (2013). As argued in the paper, these methods are not found to satisfy the requirements for managing complex projects in large business environments (Kao and Yang 2009; Yang and Kao 2012). Furthermore, a key gap identified in the extant studies is that researchers while have attempted to identify the causes of delay, but mostly have neglected the interplay and interaction between such causes. In the study of project management systems, the causal models are very important as the concept of 'time' is crucial for managers in this area. In project management, the dynamics of elements involved in the process of the projects are of great importance to managers. Interviews with the Iranian petrochemical managers showed how important it is for them to resolve the delay causes in a systematic and step by step approach due to resource limitations. The introduced method enables the managers to identify and remove key delay causes, which will be followed by further iterative reviews through the time as well as examination of the effects delays might have on other causes.

The results from the field study concluded that Iranian petrochemical construction projects suffer from a range of key issues including technical, financial, economic, political and organisational risks, alongside being sensitive and prone to natural

Table 3. Delay causes in Iran petrochemical projects.

Delay category	Components
(A) Initial negotiations	Absence of industrial feasibility study and capacity planning
	Incomplete and ineffective contracts
	Lack of required EP documents or incomplete documents from EP
	Inaccurate or wrong estimation of costs
	Uncontrollable factors such as monopolies or market fluctuations
	Lack of reviews, feedbacks and corrective actions
	Time consuming process of reviewing and confirming suggestions and plans by EP
	Frequent changes in technical design by EP
	Long time lags between the changes announced by EP
	Lack of standard and well-defined communication systems between EP and equipment manufactures
	Unclear definitions of responsibilities and duties of EP and equipment manufactures
(B) Contracting processes	Absence of industrial feasibility study and capacity planning
	Incomplete and ineffective contracts
	Lack of required EP documents or incomplete documents from EP
	Time consuming process of reviewing and confirming suggestions and plans by EP
	Frequent changes in technical design by EP
	Long time lags between the changes announced by EP
	Delayed payments by EP
	Deficiency of project management systems
	Unpunctual delivering of equipment and materials
(C) Planning process	Incomplete and ineffective contracts
	Time consuming process of reviewing and confirming suggestions and plans by EP
	Frequent changes in technical designs by EP
	Delayed delivery of equipment and materials by EP
	Lack of standards and well-defined communication systems between EP and equipment manufacturers
	Inefficient organizational structure and internal processes of equipment manufacturing companies
	Lack of use or access to new software for designing
	Deficiency of motivational systems in equipment manufacturing companies
	Deficiency of human resources management on equipment manufacturing companies
	Lack of powerful management in equipment manufacturing companies' resource planning and procurement
	Deficiency of production/project planning systems on equipment manufacturing companies
	Deficiency of quality planning systems
	Deficiency of financial planning system of equipment manufacturing companies
	Changes in the scope of the projects implementation by EP without involving the equipment manufacturing companies
	Lingering process of opening LC and providing materials and goods
	Inefficient management of subcontractors of equipment manufacturing companies
	Inefficient warehousing system in petrochemical factory sites
(D) Control process	Inaccurate or wrong estimation of costs by equipment manufacturing companies
	Time consuming process of reviewing and confirming suggestions and plans by EP
	Frequent changes in technical designs by EP
	Delayed delivery of equipment and materials by EP
	Delayed payments by EP
	Deficiency of motivational systems in equipment manufacturing companies
	Lack of powerful management over the resource planning and procurement of equipment manufacturing companies
	Changes in the scope of the projects implementations by EP without involving the equipment manufacturing companies
	Lingering process of opening LC and providing materials and goods
	Deficiency of project control systems of equipment manufacturing companies
	Absence of any analysis of the past events or periodical reports by equipment manufacturing companies
	Late requests for corrections or revisions of delay causes and proposition of strategies for compensating the delays by equipment manufacturing companies
	Lack of integrated controlling systems for production
	Lack of integrated quality controlling systems in equipment manufacturing companies
	Deficiency of human resources controlling systems in equipment manufacturing companies
	Deficiency of financial/budget controlling systems in equipment manufacturing companies

hazards. As suggested by Dey (2012), such risks will cause delay. The delay causes were identified in this study at two levels, which are generally consistent with the findings of Alavifar and Motamedi (2014) and Ruqaishi and Bashir (2015) in their studies of delays in construction projects in the Middle East.

The expert focus groups initially helped in the identification of the causes which were organised in four groups, namely initial negotiations, contracting, planning and control processes, along with several key constituting factors under each group. Application of SNA, as the adopted method for analysis of the data from focus group sessions, proved very effective resulting in a model representing delay causes and external relationships between them. The approach also included ranking of the sub-factors by the members of panel. This capacity for detecting interrelationships, and ranking them in order of priority, are two key advantages of SNA compared to the previous methods (Atteveldt 2008; Kao and Yang 2009; Pereira et al. 2011; Yang and Kao 2012; Oh et al. 2013).

The analysis of the relationship network using SNA assisted in a more accurate identification of the main factor causing delays in Iranian petrochemical construction projects. The outcome showed the 'initial negotiations deficiencies', a stage in which different stakeholders' conflicting views and expectations apply pressure to the process (Salazar-Aramayo et al. 2013) to constitute the main cause in this case. In addition, the analysis of the sub-factors showed 'Lack of reviews, feedbacks and corrective actions' to be the most significant factor. The results suggest that problem-solving in the initial stage of project negotiation should be

Figure 3. Semantic Network of delay causes in IPI projects and their relationships.

Table 4. External relationships of delay categories.

	No of relationship				Most effective			Most vulnerable		
Findings	Effect on		Effect from			Value			Value	
Delay category	D*	ID**	D	ID	Factor no.	D	ID	Factor no.	D	ID
A	101	172	0	0	6	15	35	–	–	–
B	2	11	15	0	–	–	–	–	–	–
C	64	0	35	3	6	10	0	10	6	6
D	0	0	117	172	–	–	–	13, 14	19	42

*Direct effect; **Indirect effect.

Table 5. Frequency of each factor.

Group A	Frequency	Group B	Frequency	Group C	Frequency	Group D	Frequency
A-1	12	B-1	12	C-1	13	D-1	12
A-2	13	B-2	13	C-2	15	D-2	15
A-3	11	B-3	11	C-3	10	D-3	10
A-4	15	B-4	14	C-4	9	D-4	9
A-5	10	B-5	10	C-5	12	D-5	7
A-6	11	B-6	9	C-6	13	D-6	14
A-7	14	B-7	8	C-7	11	D-7	10
A-8	10	B-8	14	C-8	14	D-8	11
A-9	9	B-9	13	C-9	13	D-9	12
A-10	12			C-10	12	D-10	11
A-11	12			C-11	12	D-11	11
				C-12	11	D-12	10
				C-13	13	D-13	12
				C-14	9	D-14	10
				C-15	8	D-15	14
				C-16	9	D-16	13
				C-17	9		

prioritised in the examined industry. The analyses imply that such an approach could reduce the delay of construction projects and improve their efficiency significantly. As Joslin and Müller (2016) suggest, the project success depends on: (1) Project efficiency, (2) Organisational benefits, (3) Project impact, (4) Stakeholder satisfaction and (5) Future potentials. It is therefore expected that resolving the 'initial negotiation deficiencies' in construction projects would make projects more successful. The empirical study and the information and insights produced during its course proved highly useful to the managers of the studied firm. The approach to delay analysis helped the executive managers to locate delay problems easier and with more confidence, allowing them to address them by appropriate measures in time. In this case, previous studies have suggested measures for improving this aspect of projects (Javed, Lam, and Chan 2014):

(1) Changing the negotiation strategies employed
(2) Changing the scenarios used in the negotiations
(3) Changing negotiation standards and laws
(4) Revising the negotiation processes and reinforcing their agility
(5) Negotiating through qualified individuals, and assigning appropriate incentives for them.

The validation follow up interviews provided strong support for the research exercise and the achieved outcome. Most of the managers found the results extremely supportive in shaping their attitude towards and understanding of the complex and dynamic nature of delays. A considerable number of the managers expressed intention to accept the outcome from the study and introduce and implement the identified corrective measures.

Application of visual methods such as SNA in examining a phenomenon, where various stakeholders with different views are involved, is an effective approach (Drieger 2013). Such methods assist in a faster and more accurate formation of a collective view from the varied and unique interpretations of different stakeholders. The research supported this effect further by showing that the use of visual mode led to a unified interpretation of project delays and their causes in focus group sessions. In other words, the introduction of visual methods can assist in originating transformation in the projects.

6. Conclusion

An important contribution of this paper is the adoption and application of SNA in the identification and analysis of construction project delays in OGP industry. The method's capacity to identify and rank delay causes can assist managers in selecting appropriate measures for eliminating them. Furthermore, this method is able to account for interrelationship between delay causes, which compensates for the weakness of previous methods. The application of analytical tools and methods in addressing industry and projects problems has been an established research exercise for many decades. The increasing complexity in firms and their projects has however called for advancing interdisciplinary approaches that can handle such complexities. This research attempted taking the existing project delay studies, which have generally approached project analysis using techniques such as Structural Equation Modelling (e.g. studies done by Atteveldt 2008; Yang and Ou 2008; Kao and Yang 2009; Yang and Kao 2012) further by applying an analysis method which is used in social and technological fields. The successful outcome of this method in analysing project delays and their causes showed that research in project management can be further enriched and extended through introducing interdisciplinary approaches.

In addition, the suggested method (SNA) can be a starting point for using Artificial Intelligence in project delay management and could lead to new tools for project management. Application of SNA in this study opens the way for the application of the method in the study of other aspects of project management, particularly in complex environments. The proposed methodology and the findings can be applied in similar project environments in order to explore delay dynamics, and develop tactics for improving the effectiveness and efficiency of construction projects. The paper successfully bridges the gap between theory and practice, which will benefit practitioners and managers who seek to more effectively manage their projects. These findings could be used as a useful roadmap for identifying and removing delay causes at different levels of construction projects in the petrochemical industry. Managers can apply the findings here in developing better strategies for handling construction project delays. In addition, the research method and results will help petrochemical construction project managers and policy-makers understand the effects of these delays on construction project outcomes, and improve the efficiency of their projects. The research provides both academia and practice sectors with a novel tool for delay causes analysis. This can be extremely useful in developing countries which typically suffer from efficiency and effectiveness problems in projects.

A limitation of this study is that the results are based on one field of OGP projects, however the applied method proves its efficiency as a generic methodology for complex project environments.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Aibinu, A., and G. Jagboro. 2002. "The Effects of Construction Delays on Project Delivery in Nigerian Construction Industry." *International Journal of Project Management* 20: 593–599.

Alavifar, A. H., and S. Motamedi. 2014. "Identification, Evaluation and Classification of Time Delay Risks of Construction Project in Iran". Paper presented at International Conference on Industrial Engineering and Operations Management, 919–929. Bali, Indonesia.

Al-Khalil, M., and M. Al-Ghafly. 1999. "Important Causes of Delay in Public Utility Projects in Saudi Arabia." *Construction Management Economics* 17 (5): 647–655.

Amoatey, C., Y. Ameyaw, E. Adaku, and S. Famiyeh. 2015. "Analysing Delay Causes and Effects in Ghanaian State Housing Construction Projects." *International Journal of Managing Projects in Business* 8 (1): 198–214.

Arditi, D., and T. Pattanakitchamroon. 2006. "Selecting a Delay Analysis Method in Resolving Construction Claims." *International Journal of Project Management* 24: 145–155.

Arena, M., G. Azzone, E. Cagno, A. Silvestri, and P. Trucco. 2014. "A Model for Operationalizing ERM in Project-based Operations through Dynamic Capabilities." *International Journal of Energy Sector Management* 8 (2): 178–197.

Assaf, S., and S. Al-Hejji. 2006. "Causes of Delay in Large Construction Projects." *International Journal of Project Management* 24: 349–357.

Atteveldt, W. V. 2008. *Semantic Network Analysis: Techniques for Extracting, Representing, and Querying Media Content*. Charleston, SC: BookSurge Publishers.

Beverland, M., and A. Lindgreen. 2010. "What Makes a Good Case Study? A Positivist Review of Qualitative Case Research Published in Industrial Marketing Management, 1971–2006." *Industrial Marketing Management* 39: 56–63.

Braimah, N., and I. Ndekugri. 2008. "Factors Influencing the Selection of Delay Analysis Methodologies." *International Journal of Project Management* 26: 789–799.

Carden, R., S. Leach, and J. Smith. 2008. "A Market Reaction to DOD Contract Delay – Does the Market Reward Poor Performance." *Review of Financial Economics* 17 (1): 33–45.

Castillo, L., and C. Dorao. 2013. "Decision-making in the Oil and Gas Projects Based on Game Theory: Conceptual Process Design." *Energy Conversion and Management* 66: 48–55.

Chang, J., and H. Li. 2014. "The Study on Key Factors Influencing Time Delay of Public Construction Project"." *Advanced Materials Research* 912–914: 1838–1841.

Dey, P. K. 2012. "Project Risk Management Using Multiple Criteria Decision-making Technique and Decision Tree Analysis: A Case Study of Indian Oil Refinery." *Production Planning and Control: The Management of Operations* 23 (12): 903–921.

Doloi, H., A. Sawhney, K. Iyer, and S. Rentala. 2012. "Analysing Factors Affecting Delays in Indian Construction Projects." *International Journal of Project Management* 30: 479–489.

Drieger, P. 2013. "Semantic Network Analysis as a Method for Visual Text Analytics". Presented at 9th Conference on Applications of Social Network Analysis, 4–17. Procedia – Social and Behavioral Sciences.

Easton, G. 2010. "Critical Realism in Case Study Research." *Industrial Marketing Management* 39: 118–128.

Elawi, G. S. 2015. "Owners' Perspective of Factors Contributing to Project Delay: Case Studies of Road and Bridge Projects in Saudi Arabia." PhD thesis. Arizona State University.

Fallahnejad, M. 2013. "Delay Causes in Iran Gas Pipeline Projects." *International Journal of Project Management* 31: 136–146.

Farboudmanesh, R., S. Moradi, and M. T. Rad. 2013. "Assessing and Identifying Entrepreneurial Opportunities in Petroleum Industry in Iran." *European Online Journal of Natural and Social Sciences* 2 (3): 2802–2816.

Faridi, A. S., and S. M. El-Sayegh. 2006. "Significant Factors Causing Delay in the UAE Construction Industry." *Construction Management Economics* 24 (11): 1167–1176.

Fouché, D. P., and A. Rolstadas. 2010. "The Use of Performance Measurement as a Basis for Project Control of Offshore Modification Oil and Gas Projects." *Production Planning and Control* 21 (8): 760–773.

Fugar, F. D., and A. B. Agyakwah-Baah. 2010. "Delays in Building Construction Projects in Ghana." *Australasian Journal of Construction Economics and Building* 10 (1/2): 103–116.

Gardezi, S. S., I. A. Manarvi, and S. J. Gardezi. 2014. "Time Extension Factors in Construction Industry of Pakistan." *Procedia Engineering* 77: 196–204.

Gill, A. 2008. "An Effect-cause-effect Analysis of Project Objectives and Trade-off Assumptions." *International Journal of Managing Projects in Business* 1 (4): 535–551.

Gunasekaran, A., and E. Ngai. 2012. "The Future of Operations Management: An Outlook and Analysis." *International Journal of Production Economics* 135: 687–701.

Helbig, H. 2006. *Knowledge Representation and the Semantics of Natural Language: With 23 Tables*. Berlin: Springer.

IMO. 2013. *Report for Methodology and Problems Recognition of Delays in Product Production in Iran and Solution Recommendation*. Tehran: Industrial Management Organization.

Javed, A. A., P. T. Lam, and A. P. Chan. 2014. "Change Negotiation in Public–Private Partnership Projects through Output Specifications: An Experimental Approach Based on Game Theory." *Construction Management and Economics* 32 (4): 323–348.

Jergeas, G. 2008. "Analysis of the Front–End Loading of Alberta Mega Oil Sands Projects." *Project Management Journal* 39: 95–104.

Jergeas, G., and J. Ruwanpura. 2010. "Why Cost and Schedule Overruns on Mega Oil Sands Projects?" *Practice Periodical on Structural Design and Construction* 15 (1): 40–43.

Joslin, R., and R. Müller. 2016. "The Relationship between Project Governance and Project Success." *International Journal of Project Management* 34: 613–626.

Jung, K., and H. Park. 2015. "A Semantic (TRIZ) Network Analysis of South Korea's 'Open Public Data' Policy." *Government Information Quarterly* 32: 353–358.

Kao, C.-K., and J.-B. Yang. 2009. "Comparison of Windows-based Delay Analysis Methods." *International Journal of Project Management* 27: 408–418.

Kariungi, S. M. 2014. "Determinants of Timely Completion of Projects in Kenya: A Case of Kenya Power and Lighting Company, Thika." *ABC Journal of Advanced Research* 3 (2): 9–20.

Kikwasi, G. J. 2012. "Causes and Effects of Delays and Disruptions in Construction Projects in Tanzania." *Australasian Journal of Construction Economics and Building, Conference Series* 1 (2): 52–59.

Kurkkio, M., J. Frishammar, and U. Lichtenthaler. 2011. "Where Process Development Begins: A Multiple Case Study of Front End Activities in Process Firms." *Technovation* 31: 490–504.

Long, N., S. Ogunlana, T. Quang, and K. Lam. 2004. "Large Construction Projects in Developing Countries: A Case Study from Vietnam." *International Journal of Project Management* 22: 553–561.

Manavazhi, M., and D. Adhikari. 2002. "Material and Equipment Procurement Delays in Highway Projects in Nepal." *International Journal of Project Management* 20: 627–632.

Oh, J., T. Kim, S. Park, H. Yu, and Y. H. Lee. 2013. "Efficient Semantic Network Construction with Application to PubMed Search." *Knowledge-Based Systems* 39: 185–193.

Onwuegbuzie, A. J., W. B. Dickinson, N. L. Leech, and A. G. Zoran. 2009. "A Qualitative Framework for Collecting and Analyzing Data in Focus Group Research." *International Journal of Qualitative Methods* 8 (3): 1–21.

Palmberg, K. 2010. "Experiences of Implementing Process Management: A Multiple-case Study." *Business Process Management Journal* 16 (1): 93–113.

Pereira, H., I. Fadigas, V. Senna, and M. Moret. 2011. "Semantic Networks Based on Titles of Scientific Papers." *Physica a: Statistical Mechanics and Its Applications* 390: 1192–1197.

Pourrostam, T., and A. Ismail. 2012. "Causes and Effects of Delay in Iranian Construction Projects." *International Journal of Engineering and Technology* 4 (5): 598.

Quillian, M. R. 1968. "Semantic Memory." In *Semantic Information Processing*, edited by M. Minsky, 227–270. Cambridge, MA: MIT Press.

Riazi, M., S. Riazi, and F. Lamari. 2013. "Public Sector Project Delay: The Malaysian Perspective and the Way Forward". Presented at the 19th CIB World Building Congress. Brisbane: Queensland University of Technology.

Ruqaishi, M., and H. Bashir. 2015. "Causes of Delay in Construction Projects in the Oil and Gas Industry in the Gulf Cooperation Council Countries: A Case Study." *Journal of Management in Engineering* 31 (3): 501–517.

Salazar-Aramayo, J. L., R. Rodrigues-da-Silveira, M. Rodrigues-de-Almeida, and T. N. de Castro-Dantas. 2013. "A Conceptual Model for Project Management of Exploration and Production in the Oil and Gas Industry: The Case of a Brazilian Company." *International Journal of Project Management* 31: 589–601.

Sambasivan, M., and Y. Soon. 2007. "Causes and Effects of Delays in Malaysian Construction Industry." *International Journal of Project Management* 25: 517–526.

Sepehri, M. 2006. "Analysis of Time Delays in Projects – Application to Iran and Emerging Countries". Presented at the International Conference on Management of Innovation and Technology, 681–684. IEEE Xplore.

Stewart, J. 2012. "Multiple-case Study Methods in Governance-related Research." *Public Management Review* 14 (1): 67–82.

Sweis, G., R. Sweis, A. A. Hammad, and A. Shboul. 2008. "Delays in Construction Projects: The Case of Jordan." *International Journal of Project Management* 26: 665–674.

Taher, E. F., and R. Pandey. 2013. "Study of Delay in Project Planning and Design Stage of Civil Engineering Projects." *International Journal of Engineering and Advanced Technology* 2 (3): 456–461.

Tumi, S., A. Omran, and A. Pakir. 2009. "Causes of Delays in Construction Industry in Libya." Presented at the International Conference on Administration and Business, 264–271. Romania: University of Bucharest.

Thuyet, N. V., S. O. Ogunlana, and P. K. Dey. 2007. "Risk Management in Oil and Gas Construction Projects in Vietnam." *International Journal of Energy Sector Management* 1 (2): 175–194.

Verschuren, P. 2003. "Case Study as a Research Strategy: Some Ambiguities and Opportunities." *International Journal of Social Research Methodology* 6 (2): 121–139.

Wa'el, A., R. Mohd, A. Kadir, and D. Ernawati. 2007. "The Significant Factors Causing Delay of Building Construction Projects in Malaysia." *Engineering, Construction and Architectural Management* 14 (2): 192–206.

Weijermars, R. 2009. "Accelerating the Three Dimensions of E&P Clockspeed – A Novel Strategy for Optimizing Utility in the Oil & Gas Industry." *Applied Energy* 86: 2222–2243.

Williams, T., F. Ackermann, and C. Eden. 2003. "Structuring a Delay and Disruption Claim: An Application of Cause-Mapping and System Dynamics." *European Journal of Operational Research* 148: 192–204.

Wu, C. L. 2016. *Airline Operations and Delay: Insights from Airline Economics, Networks and Strategic*. London: Routledge.

Yang, J. B., and C. K. Kao. 2012. "Critical Path Effect Based Delay Analysis Method for Construction Projects." *International Journal of Project Management* 30: 385–397.

Yang, J.-B., and S.-F. Ou. 2008. "Using Structural Equation Modeling to Analyze Relationships among Key Causes of Delay in Construction." *Canadian Journal of Civil Engineering* 35 (4): 321–332.

Yau, N. J., and J. B. Yang. 2012. "Factors Causing Design Schedule Delays in Turnkey Projects in Taiwan: An Empirical Study of Power Distribution Substation Projects." *Project Management Journal* 43:50–61.

Zach, O., and B. E. Munkvold. 2012. "Identifying Reasons for ERP System Customization in SMEs: A Multiple Case Study." *Journal of Enterprise Information Management* 25 (5): 462–478.

Zarei, B., Y. Chaghouee, and A. Ghapanchi. 2014. "Investigating the Relationship between Business Process Orientation and Social Capital." *Knowledge and Process Management* 21 (1): 67–77.

Zarei, B., Y. Chaghouee, and F. Ghapanchi. 2015. "Stakeholder Analysis: A Vital Step in Restructuring Projects in Project-based Companies." *International Journal of Business Innovation and Research* 9 (6): 731–749.

Zwikael, O., Y. Cohen, and A. Sadeh. 2006. "Non-delay Scheduling as a Managerial Approach for Managing Projects." *International Journal of Project Management* 24: 330–336.