TESE DE DOUTORADO

DILEMMA OF PROJECT MANAGEMENT IN OMAN

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ESCOLA DE DOUTORAMENTO INTERNACIONAL

PROGRAMA DE DOUTORAMENTO EN ENXEÑERÍA PARA O DESENVOLVEMENTO RURAL E CIVIL

SANTIAGO DE COMPOSTELA / LUGO

2020

DOCTORAL THESIS

USC
UNIVERSIDADE
DE SANTIAGO
DE COMPOSTELA

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Dilemma of project management in Oman

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To my mother, who passed away eleven years ago, my father, who passed away five years ago, and my elder brother without you, I could not achieve it!

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Appendix

This thesis is based on the follow scientific articles listed below in Roman numerals:

I. Al Amri, T., & Marey-Pérez, M. (2019). Causes of construction project delays and cost overruns in Oman: A literature review. 23rd International Congress on Project Management and Engineering, 1-10.

II. Al Amri, T., & Marey-Pérez, M. (2020). Towards a sustainable construction industry: Delays and cost overrun causes in construction projects of Oman. *Journal of Project Management*, *5*(2), 87-102. DOI: 10.5267/j.jpm.2020.1.001

III. Al Amri, T., & Marey-Pérez, M. (2020). Value Engineering as a Tool for Sustainability in the Construction Industry of Oman. *International Journal of Advanced Science and Technology*, *29*(3), 7433 - 7444. DOI: 10.6084/m9.figshare.12093426

IV. Al Amri, T., & Marey-Pérez, M.. (2020). Key Quality Issues Affecting the Sustainability of Construction Projects in Oman. *International Journal of Advanced Science and Technology*, *29*(3), 4330 - 4338. Retrieved from http://sersc.org/journals/index.php/IJAST/article/view/5258

V. Al Amri, T., & Marey-Pérez, M. (2020). Impact of Covid-19 on Oman's Construction Industry. *Technium Social Sciences Journal*, *9*(1), 661-670. https://doi.org/10.47577/tssj.v9i1.1021. DOI: 10.47577/tssj.v9i1.102

VI. Al Amri, T., & Marey-Perez, M.(2020). Project delays and cost overruns between public and private sectors in Oman. *Journal of Public Affairs*, e2262. DOI: 10.1002/pa.2262

Executive Summary

The state of Oman is mainly dependent on oil and petroleum products. However, construction is the second largest industry in Oman based on economic contribution. Due to high dependability in the construction industry, it is significant to highlight its problems and issues and measure its success. The study has introduced the construction industry and its basis in Oman. The study is mainly focused on the dilemma of the construction industry of Oman. Therefore, to analyze the conditions of the construction industry of Oman, a thorough literature review was conducted.

Moreover, the project delays and cost overruns are analyzed based on the empirical data and literature analysis. This analysis is further extended to evaluate the private and public sectors of Oman in terms of project delays. Furthermore, Oman's sustainable development and green construction are also analyzed based on a thorough literature review and secondary data. Lastly, the impact of COVID-19 on the construction industry of Oman is evaluated based on the current conditions. The construction industry has catastrophically been affected by the lockdown situation due to the COVID-19. The study results are summed up in the discussion section.

Abstract

Oman's economy largely depends on oil and oil-based products. It has been argued that oil and petroleum products contributed immensely to the prosperity experienced by many Arab Gulf countries, including Oman. In fact, Oman's entry into the world market and its renaissance are attributed to oil discovery. Currently, oil is the main contributor to Oman's gross domestic product. Notwithstanding, the construction industry also has a strong contribution to the Omani economy. Available data shows that it is the second biggest contributor to the economy. Over the years, this industry has experienced phenomenal growth. Government interventions such as the Eighth Five-Year Development Plan and private investments in this industry have played a major role in this growth. Based on this premise, it is important to highlight some of the many dilemmas that pervade this industry. Project delays and cost overruns, for example, are a major issue in the Omani construction industry. Sustainable development and green construction are the other areas in the Omani construction industry that is pervaded by problems. Lastly, the Coronavirus pandemic has had a preponderant effect on not only the Omani construction industry, but also the entire economy. A thorough analysis and literature review of these areas as they apply to Oman, warrants interest and are the basis of the following research work.

In **Chapter 2**, problems of project delays and cost overrun issues will be reviewed in general. Gulf Cooperation countries have seen massive infrastructure growth over the last twenty years or so. Project delays and cost overrun issues continue to pervade a majority of construction projects, many of which amount to billions of dollars in losses. Analysis of the literature review indicates that the causes of project delays and cost overrun may be categorised into four factors, including client/owner based factors, contractor based factors, consultant based factors, and external factors. These four factors may roughly fall under poor contractor management, design delay, low productivity level, unqualified labor, poor coordination, an

inadequate workforce, and financial difficulties. In Oman, poor communication, poor estimations, and frequent changes in the project plan, have been indicated in the literature review as the main causes of project delay and cost overrun issues. Review of literature shows that the Performance Information Procurement System (PIPS) could help solve the dilemma of project delay and cost overrun.

Chapter 3 of the thesis looks at the project delay and cost overrun dilemma in the context of Oman. Oman has one of the most active construction industries amongst the Gulf Cooperation Countries. Currently, there are over 2000 government construction projects estimated to cost more than $190 billion. There are also as many private projects in the country which cost tens of billions of dollars. A number of approaches on how to solve issues such as shortage of material, ineffective scheduling and planning, design changes, poor site management, slow process of permits, weather conditions, deliberate owner's decisions, and poor coordination, which often lead to delays and cost overrun are discussed. An analysis of various literature demonstrates that the schedule management plan is a viable tool for solving the aforementioned issues. Procedural delays, which are often caused by the government, were depicted as contributors to construction delays and cost overruns. Furthermore, analysis indicates that delays and cost overruns may be beyond any of the stakeholders at times. Specifically, issues such as unpredictable weather and catastrophes that include earthquakes and tsunamis may lead to delays and cost overruns.

In **chapter 4,** project delays and cost overruns in public and private construction projects in Oman are reviewed. The chi-square test of independence is used here to determine the significance of the different factors that cause delays and cost overruns between private and public projects. The chi-square test of independence is essentially a mathematical tool that can check the presence or absence of association between several variables. In this chapter, the tool will be used to test the association between the causes of delays and cost overruns in a public

and private construction project. This will be based on their relation to seven factors including client-related delay causes, contractor related delay causes, consultant related delay cause, client cost-overrun causes, contractor cost-overrun causes, consultant cost-overrun causes and external factors. A survey consisting of 35 respondents is also conducted in this chapter. Results obtained in the survey show that project delays and cost overruns in public and private construction projects are either caused by the client, the contractor, the consultant, or external factors. Results of the chi-square test of independence show that there is no significant difference between client related delays between private and public owned projects. Furthermore, the results show that contractor related delays and cost overruns as well as consultant related delays and cost overruns in both private and public projects are similar. The chi-square test of independence also shows that there is a significant difference between client associated cost overruns in public and private projects. Lastly, the chi-square test of independence shows that there is no significant difference in external factors that cause public and private project delays and cost overruns.

Chapter 5 discusses the issues affecting the sustainability of construction projects in Oman. Science and technology play a major role in improving the efficiency of construction projects which make said projects green and more sustainable. Analysis of literature shows that there is a monopolization of the housing construction market in Oman. This monopolization makes it difficult for small and medium-sized entities to enter the market. The analysis also shows that regulatory organizations are not coordinated, and this affects the control of quality in construction products. Furthermore, the concept of green construction has been found to be initiated in Oman. However, further understanding of the concept of green construction in Oman is still required. Lastly, a review of the literature has revealed that there is an absence of independent expert institutions in Oman. Most customers rely on state orders in quality

management issues. There are also contractual problems as real estate in the country can only be bought by an Omani citizen.

Chapter 6 reviews value engineering as a tool for sustainable construction in Oman. Currently, the construction industry in Oman is pervaded with sustainability issues, including high energy consumptions, being low quality, possessing technological backwardness, and so on. Additionally, the recent influx of migrant workers into the Omani construction industry presents a policy issue. Through value engineering, the construction industry in Oman can use the least resources and forge its way towards the path of green construction.

Chapter 7 of the thesis analyses the impact of the coronavirus pandemic on the Omani construction industry. The pandemic has had far-reaching effects on the macroeconomic factors of all countries. Billions of dollars have been lost due to the disruption of the global supply chain. With the lockdown measures in place, business is down, and the demand for labor in the construction industry has seen a massive decrease. The lockdown measures have also disrupted the supply of construction materials. In places such as Muscat and the surrounding regions, there were restricted construction works in order to curb the spread of the virus. Overall, the analysis shows that most of the construction work has continued despite the pandemic. However, with the global shutdown, sourcing of construction supplies has become a major issue. Moreover, there is an increase in efforts to keep construction sites safe for workers. These aspects, no doubt, have led to a slowdown in business, an increase in costs, and low demand for labor, among other issues. Overall, the COVID-19 pandemic has had a tremendous impact on the Omani construction industry.

Resumen

La economía de Omán depende en gran medida del petróleo y de los productos derivados del petróleo. Se ha afirmado que el petróleo y los productos derivados del petróleo contribuyeron enormemente a la prosperidad que experimentaron muchos países árabes del Golfo, entre ellos Omán. De hecho, la entrada de Omán en el mercado mundial y su renacimiento se atribuyen al descubrimiento de petróleo. En la actualidad, el petróleo es el principal contribuyente al producto interno bruto de Omán. No obstante, la industria de la construcción también contribuye en gran medida a la economía de Omán. Los datos disponibles muestran que es el segundo mayor contribuyente a la economía. A lo largo de los años, esta industria ha experimentado un crecimiento fenomenal. Las intervenciones del gobierno como el Octavo Plan Quinquenal de Desarrollo y la inversión privada en esta industria han desempeñado un papel importante en este crecimiento. Basándose en esta premisa, es importante destacar algunos de los muchos dilemas que impregnan esta industria. Los retrasos y los costos excesivos de los proyectos, por ejemplo, son un problema importante en la industria de la construcción de Omán. El desarrollo sostenible y la construcción ecológica es la otra área de la industria de la construcción omaní que está impregnada de problemas. Por último, la pandemia del virus covid ha tenido un efecto preponderante no sólo en la industria de la construcción de Omán sino en toda la economía. Un análisis exhaustivo y un examen de la bibliografía sobre estas esferas en lo que respecta a Omán merecen interés y constituyen la base de la siguiente labor de investigación.

En el **capítulo 2**, el trabajo examina los problemas de los retrasos de los proyectos y los problemas de sobrecostos en general. Los países de la cooperación del Golfo han experimentado un crecimiento masivo de la infraestructura en los últimos veinte años aproximadamente. Los problemas de retrasos en los proyectos y de sobrecostos siguen

impregnando la mayoría de los proyectos de construcción, muchos de los cuales suponen pérdidas de miles de millones de dólares. El análisis del examen de la bibliografía indica que las causas de la demora de los proyectos y el exceso de costos pueden agruparse en cuatro factores, incluidos los factores basados en el cliente/propietario, los factores basados en el contratista, los factores basados en el consultor y los factores externos. Esos cuatro factores pueden ser, a grandes rasgos, la mala gestión de los contratistas, la demora en el diseño, el bajo nivel de productividad, la mano de obra no calificada, la mala coordinación, una fuerza de trabajo inadecuada y las dificultades financieras. En Omán, la mala comunicación, las estimaciones deficientes y los cambios frecuentes en el plan del proyecto, el examen de la bibliografía los indicó como las principales causas de la demora del proyecto y los problemas de sobrecostos. Sistema de obtención de información sobre el rendimiento (PIPS) el examen de la bibliografía muestra que podría ayudar a resolver el dilema de la demora del proyecto y el exceso de costos.

En el **capítulo 3** del trabajo de investigación se examina el dilema de la demora del proyecto y el exceso de costos en el contexto de Omán. Omán tiene una de las industrias de la construcción más activas de los países de la cooperación del Golfo. Actualmente, hay más de 2000 proyectos de construcción del gobierno que se calcula que cuestan más de 190.000 millones de dólares. Los proyectos privados en el país son también tan numerosos y cuestan decenas de miles de millones de dólares. Se discuten varios enfoques sobre cómo resolver cuestiones como la escasez de material, la programación y planificación ineficaces, los cambios de diseño, la mala gestión del sitio, la lentitud del proceso de permisos, las condiciones meteorológicas, las decisiones deliberadas de los propietarios y la mala coordinación, que a menudo provocan retrasos y sobrecostes. El plan de gestión de la programación que muestra el examen de la bibliografía es un instrumento viable para resolver las cuestiones mencionadas. Las demoras en los procedimientos, que a menudo son causadas por el gobierno, el examen de la literatura

las describe como contribuyentes a las demoras en la construcción y a los sobrecostes. Además, el análisis indica que a veces las demoras y los sobrecostes pueden ir más allá de cualquiera de los interesados. Concretamente, cuestiones como la imprevisibilidad del clima y catástrofes como terremotos y tsunamis pueden provocar retrasos y sobrecostes.

En el **capítulo 4** se examinan las demoras y los sobrecostes de los proyectos de construcción públicos y privados en Omán. Aquí se utiliza la prueba de chi-cuadrado para determinar la importancia de los diferentes factores que causan retrasos y sobrecostes entre los proyectos privados y públicos. La prueba chi-cuadrado es esencialmente una herramienta matemática que puede comprobar la presencia o ausencia de asociación entre varias variables. En este capítulo, la herramienta pondrá a prueba la asociación entre las causas de las demoras y los sobrecostes en un proyecto de construcción público y privado, ya que se relacionan con siete factores, entre ellos las causas de las demoras relacionadas con el cliente, las causas de las demoras relacionadas con el contratista, las causas de las demoras relacionadas con el consultor, las causas de los sobrecostes del cliente, las causas de los sobrecostes del contratista, las causas de los sobrecostes del consultor y los factores externos. En este capítulo también se realiza una encuesta con 35 encuestados. Los resultados obtenidos en la encuesta muestran que las demoras y los sobrecostes de los proyectos de construcción públicos y privados son causados por el cliente, el contratista, el consultor o por factores externos. Los resultados de la prueba de chi-cuadrado muestran que no hay una diferencia significativa entre las demoras relacionadas con el cliente y las demoras relacionadas con el sector privado.

El **capítulo 5** analiza los problemas que afectan la sostenibilidad de los proyectos de construcción en Omán. La ciencia y la tecnología juegan un papel importante en la mejora de la eficiencia de los proyectos de construcción y, por lo tanto, hacen que dichos proyectos sean verdes y más sostenibles. El análisis de la literatura muestra que existe una monopolización del mercado de la construcción de viviendas en Omán. Dicha monopolización dificulta el ingreso

de pequeñas y medianas entidades a este mercado. El análisis también muestra que los organismos reguladores no están coordinados, y esto afecta al control de calidad en los productos de construcción. Además, se inició en Omán el concepto de construcción ecológica de análisis de la literatura. Sin embargo, falta comprensión del concepto de construcción ecológica en Omán. Por último, una revisión de la literatura señala que hay una ausencia de instituciones de expertos independientes en Omán. La mayoría de los clientes confían en las órdenes estatales en cuestiones de gestión de la calidad. También existen problemas contractuales, ya que los bienes raíces en el país solo pueden ser comprados por un ciudadano omaní.

El **capítulo 6** analiza la ingeniería de valor como herramienta para la construcción sostenible en Omán. Actualmente, la industria de la construcción en Omán está plagada de problemas de sostenibilidad, que incluyen altos consumos de energía, baja calidad, atraso tecnológico, etc. Además, la reciente afluencia de trabajadores migrantes a la industria de la construcción de Omán presenta un problema social. Mediante la ingeniería de valor, la industria de la construcción en Omán puede utilizar una menor cantidad de recursos y abrirse camino hacia la construcción ecológica.

El **capítulo 7** del proyecto de investigación analiza el impacto que tiene la pandemia de coronavirus en la industria de la construcción de Omán. La pandemia ha tenido efectos de gran alcance en los factores macroeconómicos de cualquier país. Se han perdido miles de millones de dólares debido a la interrupción de la cadena de suministro global. Con las medidas de bloqueo en vigor, el negocio ha caído y la demanda de mano de obra en la industria de la construcción ha experimentado una disminución masiva. Las medidas de cierre también han interrumpido el suministro de materiales de construcción. En lugares como Mascate y las regiones circundantes, se restringieron las obras de construcción para frenar la propagación del virus. En general, el análisis muestra que la mayor parte del trabajo de construcción ha

continuado a pesar de la pandemia. Sin embargo, con el cierre mundial, el abastecimiento de suministros de construcción se ha convertido en un problema importante. Además, existe un creciente llamamiento a mantener las obras de construcción seguras para los trabajadores. Estos aspectos, sin duda, han provocado una desaceleración del negocio, un aumento de los costes y una baja demanda de mano de obra, entre otros problemas. En general, la pandemia de Covid -19 ha tenido un impacto tremendo en la industria de la construcción de Omán.

Resumo

A economía de Omán depende en gran parte do petróleo e dos produtos a base de petróleo. Argumentouse que o petróleo e os produtos petrolíferos contribuíron enormemente á prosperidade experimentada por moitos países do Golfo Árabe, incluído Omán. De feito, a entrada de Omán no mercado mundial e o seu renacemento atribúense ao descubrimento do petróleo. Actualmente, o petróleo é o principal contribuínte ao produto interior bruto de Omán. Non obstante, a industria da construción tamén contribúe moito á economía omaní. Os datos dispoñibles mostran que é o segundo maior contribuínte á economía. Co paso dos anos, esta industria experimentou un crecemento fenomenal. As intervencións gobernamentais como o oitavo plan quinquenal de desenvolvemento e o investimento privado nesta industria xogaron un papel importante neste crecemento. Partindo desta premisa, é importante resaltar algúns dos moitos dilemas que impregnan esta industria. Os atrasos do proxecto e os gastos excesivos, por exemplo, son un problema importante na industria da construción de Omán. O desenvolvemento sostible e a construción ecolóxica son a outra área da industria da construción de Omán que está impregnada de problemas. Por último, a pandemia de coronavirus tivo un efecto preponderante non só na industria da construción omaní senón tamén en toda a economía. Unha análise exhaustiva e unha revisión bibliográfica destas áreas que se aplican a Omán garante o interese e son a base do seguinte traballo de investigación.

No **capítulo 2**, o traballo revisa os problemas de demora do proxecto e os problemas de superación de custos en xeral. Os países de cooperación do Golfo experimentaron un enorme crecemento da infraestrutura nos últimos vinte anos. A maioría dos proxectos de construción continúan impregnando o atraso do proxecto e os problemas de superación de custos, moitos dos cales ascenden a miles de millóns de dólares en perdas. A análise da revisión bibliográfica indica que as causas do atraso do proxecto e o exceso de custos poden agruparse en catro

factores, incluíndo factores baseados no cliente / propietario, factores baseados en contratistas, factores baseados en consultores e factores externos. Estes catro factores poden caer aproximadamente nunha mala xestión dos contratistas, un atraso no deseño, un baixo nivel de produtividade, unha man de obra sen cualificación, unha mala coordinación, unha man de obra inadecuada e dificultades económicas. En Omán, a mala comunicación, as malas estimacións e os cambios frecuentes no plan do proxecto, a revisión da literatura indicounos como as principais causas do atraso do proxecto e os problemas de superación de custos. Sistema de adquisición de información de rendemento (PIPS), a revisión da literatura pode axudar a solucionar o atraso do proxecto e o dilema de superación de custos.

O **capítulo 3** do traballo de investigación analiza o atraso do proxecto e o dilema de superación de custos no contexto de Omán. Omán ten unha das industrias de construción máis activas dos países de cooperación do Golfo. Actualmente, hai máis de 2000 proxectos de construción gobernamentais que custan máis de 190.000 millóns de dólares. Os proxectos privados no país tamén son tan numerosos e custan decenas de miles de millóns de dólares. Unha serie de enfoques sobre como resolver problemas como escaseza de material, planificación e planificación ineficaces, cambios de deseño, mala xestión do sitio, proceso lento de permisos, condicións meteorolóxicas, decisións deliberadas do propietario e mala coordinación, que a miúdo levan a atrasos e custos. discútese sobre o exceso. O plan de xestión de horarios que a revisión da literatura mostra é unha ferramenta viable para resolver os problemas mencionados. Os atrasos procedimentais, que a miúdo son causado polo goberno, a revisión da literatura describiunos como contribuíntes aos atrasos na construción e ao exceso de custos. Además, a análise indica que ás veces os atrasos e os excesos de custos poden superar calquera dos grupos de interese. En concreto, cuestións como o tempo imprevisible e as catástrofes como terremotos e tsunamis poden provocar atrasos e excesos de custos.

No **capítulo 4** revísanse os atrasos do proxecto e os excesos de custos en proxectos de construción públicos e privados en Omán. A proba de independencia chi cadrado úsase aquí para determinar a importancia dos diferentes factores que provocan atrasos e sobrecostos entre proxectos privados e públicos. A proba de independencia chi-cadrado é esencialmente unha ferramenta matemática que pode comprobar a presenza ou ausencia de asociación entre varias variables. Neste capítulo, a ferramenta comprobará a asociación entre as causas dos atrasos e os excesos de custos nun proxecto de construción público e privado xa que se relacionan con sete factores, incluíndo as causas de demora relacionadas co cliente, as causas de demora relacionadas co contratista, as causas de demora relacionadas co consultor, os custos do cliente causas de exceso, causas de exceso de custos do contratista, causas de exceso de custo do consultor e factores externos. Neste capítulo tamén se realiza unha enquisa composta por 35 enquisados. Os resultados obtidos na enquisa mostran que os atrasos do proxecto e os excesos de custos en proxectos de construción públicos e privados son causados polo cliente, o contratista, o consultor ou factores externos. Os resultados da proba de independencia chi-cadrado mostran que non hai diferenza significativa entre os atrasos relacionados cos clientes entre os privados.

O **capítulo 5** analiza os problemas que afectan á sostibilidade dos proxectos de construción en Omán. A ciencia e a tecnoloxía xogan un papel importante na mellora da eficiencia dos proxectos de construción e fan que estes proxectos sexan máis ecolóxicos e máis sostibles. A análise da literatura mostra que existe unha monopolización do mercado da construción de vivendas en Omán. Esta monopolización dificulta a entrada a este mercado de pequenas e medianas entidades. A análise tamén mostra que os organismos reguladores non están coordinados e isto afecta o control de calidade nos produtos de construción. Ademais, analizouse na literatura o concepto de construción ecolóxica que se está iniciando en Omán. Non obstante, hai unha falta de comprensión do concepto de construción ecolóxica en Omán.

Finalmente, unha revisión da literatura indica que hai ausencia de institucións expertas independentes en Omán. A maioría dos clientes confían en pedidos estatais para problemas de xestión da calidade. Tamén hai problemas contractuais, xa que os inmobles do país só os pode mercar un cidadán omaní.

O **capítulo 6** analiza a enxeñería de valor como ferramenta para a construción sostible en Omán. Actualmente, a industria da construción en Omán está plagada de problemas de sostenibilidade, que inclúen altos consumos de enerxía, baixa calidade, atraso tecnolóxico, etc. Ademáis, a recente afluencia de traballadores migrantes a industria da construción de Omán presenta un problema social. Mediante a enxeñería de valor, a industria da construción en Omán pode utilizar unha menor cantidade de recursos e abrirse camiño hacia a construción ecolóxica.

O **capítulo 7** do proxecto de investigación analiza o impacto que ten a pandemia de coronavirus na industria da construción de Omán. A pandemia tivo efectos de gran alcance nos factores macroeconómicos de calquera país. Perderonse miles de millóns de dólares debido a interrupción da cadena de suministro global. Coas medidas de bloqueo en vigor, o negocio caeo e a demanda de man de obra na industria da construción experimentou unha disminución masiva. As medidas de cerre tamén interrumpiron o suministro de materiais de construción. En lugares como Mascate e as rexións circundantes, restrinxironse as obras de construción para frear a propagación do virus. En xeral, a análise amosa que a maior parte do traballo de construción continuou a pesar da pandemia. Sen embargo, co cerre mundial, o abastecimento de suministros de construción convertiuse nun problema importante. Ademáis, existe un crecente chamamento a manter as obras de construción seguras para os traballadores. Estos aspectos, sen dúbida, provocaron unha desaceleración do negocio, un aumento dos costes e unha baixa demanda de man de obra, entre outros problemas. En xeral, a pandemia de Covid - 19 tivo un impacto tremendo na industria da construcción de Omán.

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Chapter 1. Introduction

Background

The term construction industry is used worldwide to refer to many different industries temporarily assembled at construction or industrial sites where construction work or civil engineering projects are underway. The scale of the work performed is impressive based on its scope. Extensive construction work and large-scale civil engineering projects have been going on for many years, bringing together hundreds of different contractors, each with their expertise, plant, and equipment. However, despite the huge differences in the scale and complexity of the work performed, the construction industry's main sectors have much in common. While small-scale household and agricultural construction is permitted based on informal agreements between the purchaser and the contractor of the construction works, the vast majority of construction and civil engineering projects are carried out after formal contracts between the customer and the contractor according to the recommended scheme. Construction projects are crucial for the development and economic growth of the country. It provides jobs, enhances trade, and generates newer opportunities for development.

Construction Industry of Oman

Analysis of the structure of the economy of the Gulf States allows us to distinguish four groups of countries according to these indicators:

1. Countries with a sharp predominance in their structure of the economy of the primary sector (primarily oil production): the Arab countries of the Arab Gulf (except for Iraq);
2. Countries with a relatively high share of agriculture and manufacturing. Agriculture, due to the climatic characteristics of this region, is low-productive; manufacturing industry is largely based on handicraft industries: (Iran, Yemen);

3. States with a predominance of the tertiary sector and manufacturing industry (Jordan, Lebanon);
4. Countries in which industry, services, and agriculture are represented in approximately equal proportions (UAE, Egypt).

Oman belongs to the first group of countries, which are commonly known as "oil-producing states." Since being discovered in the late 1960s, commodity oil reserves contributed to Oman's entry into the world market. It contributed to the renaissance of the country in all aspects. Moreover, today's generally prosperous domestic political and economic situation in the country is largely based on the national oil sector's activities, which makes up 40% of the annual national product and 75% of exports (up to 40 million tons of oil annually).

Oman is one of the Gulf countries with a larger oil-dependent economy. However, the construction industry is the second largest contributor to economic growth. Saleh and Alalouch (2015) regard Oman as the country with one of the fastest growths in the building and construction industry. Growth is one among other factors that contributed to booming economic expansion, making the country a major destination for global business, commerce, and leisure (Silaparasetti, Rao & Khan, 2017; Yafai et al., 2014). Official information from government sources indicated that between 2012 and 2016, the Omani construction industry experienced an impressive 9.4% annual growth rate (Sulaiman, 2016). Of particular significance was the governmental intervention known as the Eighth Five-Year Development Plan 2010-2015. It became the anchor for government-led growth and expansion in the construction industry. Experts have forecasted that even though this government intervention ended in 2015, the industry is expected to experience continued growth from 2017 to 2021 (Alzebdeh et al., 2015). With the end of the plan, many have started to worry about the private sector's readiness to fully lead the growth agenda. There are several issues in project management, which negatively impact the growth of the industry (Al Nasseri&Aulin, 2016;

Baey&Yeoh, 2015). These are in the areas of time, cost, and quality (Darko et al., 2017; Al-Jebouri et al., 2017). Umar and Egbu (2018) stressed that it would be difficult to experience continuous growth without conscious efforts to address these issues.

Construction projects involve several factors that can vary based on regional circumstances. The successful growth and expansion of every construction industry is highly dependent on the three issues of time, cost, and quality. Projects are constructed to have financial value. Therefore, the earlier the projects can be completed, the earlier they would serve their intended financial values (Jarkas et al., 2015; Hosseini et al., 2016). At the same time, the project will help identify major delay factors, where key players in the construction industry can be aware of and strategize to deal with projects. Projects are also implemented to offer value for money. Therefore, being value for money, cost evaluation factors, and dilemmas must be identified as part of the project management process (Lee & Han, 2017). Secondly, it is necessary to equip project managers and other stakeholders with some of the key cost evaluation factors affecting projects' value. Once project managers are aware of these factors, they can strategize to ensure that these factors do not negatively affect their projects.

Similarly, quality is crucial if projects can be sustainable, used over longer periods, and continue to serve the purposes for which they were constructed (Kareem, Asa&Lawal, 2015; Jarkas, 2015). Emphasis on quality will thus, help project managers to put up more sustainable projects. Overall, this study will be very useful and significant in contributing to the growth and expansion of the construction industry in Oman to achieve the industry's forecasted growth. When the construction industry in Oman grows, it would directly impact its economy as a whole.

Research Aims and Objectives

The research study is particularly focused on the construction industry of Oman. The research investigates Oman's project management dilemmas in time, cost, and quality within six published articles. Therefore, to fulfill the objective, a literature analysis is conducted on the key factors of the project management and quality parameters of the construction industry of Oman. Furthermore, quantitative analysis of the Omani construction industry, growth, factors concerns in project delays, and considered quality parameters is conducted. Thorough research has highlighted the key factors of project success and failure in the State of Oman, leading to the construction industry's sustainable development. Given the current pandemic situation, the study is further extended to include the impact of COVID-19 on the construction industry of Oman.

Chapter 2. Project Delays and Cost Overruns in Oman: A Literature Review

Based in: *Al Amri, T., & Marey-Pérez, M. (2019). Causes of construction project delays and cost overruns in Oman: A literature review. 23rd International Congress on Project Management and Engineering, 1-10.*

Introduction

The construction industry is one of the leading causes of economic growth. In recent years, the number of construction companies in Oman has been growing. Construction companies have been switching from the extensive path of development due to the growth of additional production factors, entering the intensive path by attracting and investing funds in the implementation of large construction projects based on scientific and technological progress and innovations. This path presupposes a completely different approach not only in planning all the investment project's further activities separately, but also the entire company. At the planning stage, the project's main parameters (timing, cost, and other resources) are determined. It is at this stage where a decision is made to start construction of the facility or to abandon it. The project's future fate will largely depend on the quality of the analysis of the information collected.

Construction projects are critical to the economic growth and development of a country, whether it is a developing or developed country. The government and private investors spent a lot of resources in various construction projects, most of which create jobs and enhance trade – both local and international. Therefore, it is imperative that construction projects of whichever kind are completed within the scheduled time using the planned resources. Unfortunately, many construction projects around the world are rarely finished in time. Failure to complete a project in time has several social, economic, and political consequences. Other than project delays, cost overrun is also typical in almost the same measure with project delays. Therefore, to mitigate these challenges, it is vital that a proper understanding of the underlying factors is achieved. Therefore, this chapter seeks to determine the dilemma of project

management in Oman, concerning the causes of project delays and cost overrun. The chapter provides a critical review of studies that have since been done about the proposed study. Specifically, it examines the causes of project delays and cost overrun in Oman, and in general. The critical determinants of project delays were: financial problems by both clients and contractors, change of initial design by the client, poor planning and scheduling, and incompetent contractors. Regarding cost overruns, the critical factors included: change of initial design, financial constraints by the client and contractor, inaccurate cost estimation, inexperienced contractors, and poor tendering process. In this chapter, the use of Performance Information Procurement system instead of the lowest bidder system is recommended. Also, it argues that the corporation among contractors, clients and financial lending institutions should be responsible for mitigating the financial challenges.

Construction project delay is a common phenomenon that is experienced in almost every part of the world. Past researches have documented some reasons for project delays – both universal and regional or project specific (Ramanathan, Narayanan, and Idrus, 2012). Different projects may have varied reasons that cause delays. However, the widespread nature of delays in the completion of construction projects paints a picture that suggests a higher similarity among the causes. Nevertheless, it is certain that the magnitude of delays experienced in various projects and countries around the world is highly varied. In some countries, the rate of project delays are significantly higher as compared to others (Ika, Diallo, and Thuillier, 2012). For example, in the United Arabs Emirates, Gebrehiwet and Luo (2017 p.366) reported that at least 50% of construction projects were completed later than the scheduled time. Similarly, Albogamy, Scott, and Dawood (2012 p.148) reported that 70% of the public projects in the Kingdom of Saudi Arabia had been delayed in the past decade. Perhaps the prevalence of project delays in the United States, Malaysia, India, or any other country could be different.

The consequences of project delays are numerous, including economic, social, political, and environmental. However, most importantly, delayed projects often result in financial inconveniences to various parties involved in the construction project – the owner, constructor, and consultant. According to Sunjka and Jacob (2013 p.647), the common consequences of delays in the completion of construction projects include budget overruns, poor project quality, litigations, disputes and claims, and sometimes even total abandonment of the project. These consequences are related to one another. For example, delayed building construction is likely to cost the owner additional finances. Sunjka and Jacob (2013 p.647) argued that delayed projects may have low quality, which is a threat to the occupants of the buildings. If the building collapses, for example, the owner is likely to face some litigations which are also directly related to financial costs. Delayed completion of public projects has far-reaching implications. For example, a delay in completion of a high way has a direct economic impact as a result of delayed trade between regions that are connected by the highway.

Given the prevalence, causes, and consequences of project delays, it is important to explore the dilemma of project completion in Oman. The causes of project delays and cost overrun in construction projects in Oman will be analysed and critically reviewed in this literature review.

Methodology

This literature review is written based on consulting the databases of scientific journals focusing on the field of project management, giving priority to most recent literatures regarding the subject. The literature will also be classified according to their objectives, methods and the relevance of their results to meeting the objectives of this thesis.

Results and Discussion

Causes of Project Delays

Albogamy et al. (2012) examined the causes of project delays in the KSA, and the relative importance of the different causes of delay. The authors proposed 63 factors that could potentially cause project delays in the country. However, four main categories were developed under which the 63 factors were re-grouped. The categories were: Owner/Client, Contractor, Consultant, and External Factors. The results indicated that the contractors and owner related factors were the most critical determinants of project delays. From the owner/clients' perspective, the study reported that poor performance by the contractors was the most important determinant of project delays. Owner/client-related factors included delayed progressive payment by the client, inadequate planning, slow decision-making by owners, alteration of the initial plan by the owner, and delayed approvals of submittals. With regards to the contractors-related factors, the results indicated that delays by the sub-contractors was the most critical factor. Other factors include poor skills and experience, insufficient scheduling and planning, delayed drawings, lack of qualified engineers, and financial problems.

Al-Emad et al. (2017) conducted a study similar to that of Albogamy et al. (2012) by ranking the factors that caused delays in construction projects in Makkah. Through a quantitative survey approach, the authors administered 100 questionnaires to respondents who were mainly contractors, project management, and consultants. These respondents were experts in the construction industry. However, it should be noted that the project owner/client is excluded from this study. Also, note that unlike in the study by Albogamy et al. (2012), Al-Emad et al. (2017) used a total of 37 factors that were derived from the literature review. Also, the authors did not categorize the factors in a similar manner to previous studies. Using the

average score index, Al-Emad et al. (2017) ranked the following factors in order of their importance.

i. Financial difficulty by the contractor
ii. Poor coordination among the project stakeholders
iii. Inadequate workforce
iv. Delayed design documents
v. Insufficient scheduling and planning
vi. Delayed progressive payment
vii. Low labor productivity
viii. Inadequate communication among stakeholders
ix. A workforce that is unqualified
x. Poor contractor management

Alnuaimi and Mohsin (2013) explored the causes of delay in project completion in Muscat, which is the capital and the largest city in Oman. The authors used a quantitative research approach. The data was collected from clients and consultants. Therefore, the contractors' perspective was not captured in the study. In this study, the causes of project delay were reviewed for two periods – 2007/2008 and 2008/2009. Similar to the study by (Albogamy et al., 2012; Al- Emad et al., 2017), the study ranked the causes in terms of their importance towards project delays. In the current review, the top five causes reported for the two periods are presented below.

Table 1. Causes of Delay in Project Completion

	Period 2007-2008		Period 2008-2009
i.	Weather	i.	Scheduling and planning
ii.	Claims and variations	ii.	Inadequate experience by contractors
iii.	Initial design change	iii.	Material shortage
iv.	Inadequate funds	iv.	Inability to follow the design practically
v.	New rules and regulations	v.	Initial design change

Source: Alnuaimi and Mohsin, 2013

The results indicate a significant change in the causes of project delays within a short period of one year. Furthermore, weather is only a seasonal problem and should not count as a significant cause of the delay. However, between the two periods, change in the initial project design is common, which was also reported by (Albogamy et al., 2012; Al- Emad et al., 2017). The three studies also concur on project funding as a source of delay.

Alamri, Amoudi, and Njie (2017) analyzed the causes of dam constructions in Oman. Based on the analysis of previous literature, the authors developed 60 factors that could potentially influence project delays. Out of the 60 factors, the author performed statistical analysis to rank them in terms of significant influence. The results reported that adverse weather condition, change of design, uncertainty about the ground condition, poor management of the site, and bureaucratic process in clients' organization were significantly related to project delays. Although the study was project-specific, the weather was also listed as a cause of delay,

which is similar to the findings by Alnuaimi and Mohsin (2013). Again, all the four studies concur on the change of initial project design.

Emam, Farrell, and Abdelaal (2014) explored the causes of project delays in countries in the Gulf Corporation Council (GCC). In Oman, Emam et al. (2014) reported the results of another study conducted by Ruqaishi and Bashir (2013), which explored the causes of project delays. Data in the study was collected from 59 project managers. The authors reported a high consensus among project managers on the following causes of project delays – poor site management, sub-contractor issues, scheduling and planning, delay in material deliveries, inadequate communication, and poor coordination with vendors.

However, the above listed factors except communication and problems with the sub-contractors, were also mentioned by Kog (2018). The study by Kog (2018) is critical in this review since it is a meta-analytic study that has explored the majority of the studies that have been done concerning the cost of project delays in Saudi Arabia. The authors reviewed several studies in terms of the effectiveness of their methodologies. Studies based on underdeveloped methodologies were not included in the analysis. Although none of the studies that have been mentioned herein were dismissed, the author indicated the overrepresentation of contractors' perspective by some studies. Therefore, it can be concluded that Kog (2018) pursued a less biased approach. The following factors were identified according to their degree of influence on project delays:

i. Owners financial problems regarding payment of completed work
ii. Change of the initial order design by the client
iii. Inadequate planning and scheduling
iv. Shortage of construction materials, or late delivery of the same
v. Incompetent contractors

vi. Poor site supervision and management

vii. Labor shortage

viii. Inspection and approval delays

The majority of factors mentioned above have also been reported in other studies. This implies that despite the criticism by Kog (2018) about some studies' methodology, the studies' findings are still in tandem with the larger picture. Kog (2018), however, offers a significant insight in designing future research on which the current review is based.

On the other hand, Alzara et al. (2016) reported that consultant-related issues were critical determinants of project delays. The author examined the causes of project delays in a state university of Saudi Arabia which had up to 150% of its construction projects being delayed. The researchers used an exploratory research design. Furthermore, the study compared the university-specific problems, to the general causes of project delays reported in KSA. The results reported that the causes of project delays in the university projects were similar to the general causes of project delays in the KSA. Also, the results indicated the significant consultant-related causes of project delays in the order of importance as indicated in the table in the next page:

Table 2. Causes of project delays

Factor number in order of importance	Consultant-related cause of project delay
1	Failure by the consultants to product the design document
2	Failure of the approval of the design documents
3	Discrepancies and mistakes in the design document
4	Rigidity
5	Poor performance by the consultant
6	Inadequate employees of the consultancy companies

Source: Alzara et al., 2016

Atout (2016) also confirms the first three consultant-related causes of project design as listed by Alzara et al. (2016) as main causes of project delays in Saudi Arabia and the Gulf region in general. The two studies provide crucial information regarding the role of consultants in construction projects. Another factor that is mentioned by both studies even though it is not listed as a priority cause is the failure by the consultants to notice mistakes and discrepancies from the initial design during progressive work. This is a mistake that happens occasionally. Often when such mistakes are discovered later, the resulting consequences may sometimes involve reconstruction which not only causes a delay in completion but is costly as well.

Causes of project cost overruns in Oman

Alghonamy (2015) researched the causes of cost overrun in Saudi Arabia's construction projects from the contractors' perspective. Data was collected from 43 respondents using survey questionnaires. Based on the findings, a total of 34 potential factors were examined. These factors were ranked according to their importance in influencing cost overrun. The results indicated that the awarding of project tenders to the lowest bidders was the most significant factor. Note, however, that this is from the contractors' perspective, which makes the finding even more appropriate. Other factors include the change of the initial design, poor

planning, the prolonged duration between design and project implementation, and lastly, delayed payments.

Mahamid (2014) conducted research similar to Alghonamy (2015). In this study, 41 factors were identified based on analysis of various literature and consultation with experts. Data was collected from 51 contractors. The results of the study reported that wrong cost estimation was the most significant cause of project cost overrun. In fact, this issue is very common, though not reported by Alghonamy (2015). The two studies however concurred on one factor - the prolonged period between design and implementation. Other factors reported include absence of construction cost data, cost of labor, and machinery costs.

Johnson and Babu (2018) explored the causes of time and cost overrun in construction projects in the United Arabs Emirates. The authors used both qualitative and quantitative methods to analyze the data which were collected from professionals in the construction industry. Similar to other studies that have been mentioned in this paper, the authors ranked the various factors according to their importance regarding cost overrun. The results indicated that the top five causes of cost overrun for construction problems in the UAE were:

i. Variation in project design
ii. Poor cost estimation
iii. Poor decision making by the client
iv. Client's financial constraints
v. Procurement procedures that are inappropriate

The results by Johnson and Babu (2018) concur with Mahamid (2015) that poor cost estimation is an essential cause of cost overrun. In addtion, the researchers concurred with Alghonamy (2015) on the change of project design as a cause of project cost overrun. It is

important to note that the change in initial cost design is also mentioned as a significant factor regarding causes of project delays. The client's financial constraint, although only mentioned in one study, is a potential cause of project cost overrun, especially considering its broad documentation as a factor of project delay. For example, when a client delays with progressive payment, the contractors are likely to hold their services until the payments are completed which causes project delays. While the projects are on hold due to financial delays by the client, the prices of construction materials are vulnerable to inflation. As such, should inflation occur during the delay period, the prices are likely to increase and cause cost overruns.

However, Senouci, Ismail, and Eldin (2016) reported that contract cost was directly related to cost overrun. This differs from the findings of Alghonamy (2015) who reported that low bids were associated with cost overruns. This highlights the impacts of relying on the perspective of a specific respondent group like Alghonamy (2015), who focused on the contractors' perspective. However, the findings by Senouci et al. (2016) does not obscure the significant role of poor project cost estimation which is typical among many contractors – low, moderate, and high bidders. Aljohani, Ahiaga-Dagbui, and Moore(2017) comprehensively reviewed the literature to determine the major causes of cost overrun as documented by studies in different countries. The study examined 17 countries and reported the following as the most commonly reported causes, in order of significance:

i. Change of design frequently
ii. Financial constraints by the contractor
iii. Payment delays by the client
iv. Inadequate experience by the contractors
v. Poor estimation of project cost
vi. Inappropriate tendering

vii. Improper tendering and documentation

Again, these findings were concurred largely by those reported in the study by Johnson and Babu (2018). However, these findings were not reflected by Sharma and Goyal (2014). Sharma and Goyal (2014) ranked the causes of project cost overrun as slow decision making, unrealistic durations for completing projects, owner's interference, slow payment of completed work, mode of payment, poor planning and scheduling, inadequate experience by the contractors, and contractors' financial constraints among others.

Causes of Project Delays: External Factors

Other than the contractor, client, and consultant-related issues, other causes of project delays are numerous and may include general project management and weather among other factors. In a study which examined the use of indicators in project management, project information from different countries around the world was explored in non-probabilistic research design. The results indicated that successful project management was dependent on systematic planning and use of indicators, which could either be a project, or project management-specific. The results indicated that almost 80% of the projects around the world use general project management indicators which include customer satisfaction, project progress, earned value, and risk indicators (Montero et al., 2017). Responding to the general issues of project management, Amaral and Dias (2017) proposed the use of the project management office PMO governance. It is believed that this office will encourage information sharing and learning among top management. This will be effective in harmonizing the significant problems of project management and in helping to develop appropriate solutions for the same issues.

Weather is yet another critical external factor that can potentially cause project delays. Specifically, extreme weather conditions (EWC) such as flooding and hailstones are a

significant cause of project delays since they stop the project construction workers from accessing the sites. According to Alshebani and Wedawatta (2014), the Middle East construction workers have generally adapted to some of the weather conditions such as heat waves. However, EWC remains a major cause of project delays. Aziz and Abdel Hakam (2017) conducted systematic review research to investigate the top causes of project delays in Egypt. The studies sampled were drawn from different countries to enhance the sample representation. The results of the study indicated that weather as an external factor was mentioned with the highest frequency. It is therefore important to include weather as a potential significant determinant of delays in project completion.

Conclusion

From the studies reviewed in this section, the most salient factors that cause the delay in the completion of projects are financial problems by the client and contractors, change of the initial project design, poor planning and scheduling, problems with the sub-contractors, communication, as well as inadequate skills and expertise in construction. Delay of materials and the shortage of labor are also important causes of the delay. To this extent, it is logical to argue that financial issues rank more importantly because of its relation to other factors such as the purchase of materials. Furthermore, it is a problem that affects both clients and contractors. It is also worth noting that few studies have had consultants' issues ranked among the top ten significant causes of project delays, yet, they play a significant role in construction project management.

Regarding the causes of cost overrun in projects, the salient factors identified include the change of the initial project design by the client, financial constraints by both the client and contractors, inadequate experience by the contractors, poor cost estimation, poor tender bidding

processes, and slow decision making by the clients. From this perspective, it is evident that the change in initial project design significantly influences the overall financial cost.

Recommendation for Future Action

To deal with the problem of project delays, Alzara et al. (2016) recommended the use of the Performance Information Procurement System (PIPS). As revealed in the article, other than the clients' financial constraints and change of initial project design, the contractors seem to bear most of the responsibility for both project delays and cost overruns, which some studies argue to be a result of the lowest bidding tendering procedure. It is indeed apparent that many contractors are likely to present unrealistically low contract bids to win tenders, which consequently causes the abovementioned problems. Therefore, procurement procedures should henceforth be based on the performance track record of the contractors. Through this method, the risks of project delays and cost overrun will be significantly minimized as already demonstrated in places where the PIPS are utilized.

As exhibited, financial constraint is another major cause of project delays and cost overruns. It is a complex problem and requires a collaborative approach between clients, contractors, and financial institutions. Public projects may not be affected by this problem significantly since the sponsoring institution can always seek funding from a relevant government authority. Private clients and contractors are however, very vulnerable to this problem. The financial institutions in Oman should explore legal ways by which justified financial support can be offered to projects experiencing unnecessary delays and cost overruns. The legal provision should provide the modalities on which credit support can be offered and repaid. For this arrangement to work, it is important to emphasize the need for a rigorous tendering process to eliminate unscrupulous contractors.

Chapter 3. Project Delays and Cost Overruns in Construction Projects of Oman

Based in*: Al Amri, T., & Marey-Pérez, M. (2020). Towards a sustainable construction industry : Delays and cost overrum causes in construction projects of Oman. Journal of Project Management, 5(2), 87-102.*

Introduction

Al Amri & Marey-Pérez (2020) explain the major issues of cost overruns and project delays in Oman's construction industry. The study presents the contribution of the construction industry to the development of developing countries. The cost overruns are a result of the delays made by the construction companies, consultants, and clients. Saleh and Alalouch (2015) explained the causes of delays in construction projects; unlike traditional construction projects, modern constructions are based on environmental, social, and economic factors. Oman is a small GCC country with low oil and gas reserves, so the Omani government started developing infrastructure to attract tourism in the state. The TRC council of Oman started innovating construction ideas, and several projects are completed to focus on technology and innovation. GCC countries faced several project delays similar to other parts of the world. Project delays are a common issue for the construction industry. Therefore, Emam, Farrell, and Abdelaal (2014) examined the causes of project delays in GCC countries. Some of these causes include slow payments, ineffective scheduling and planning, design changes, poor site management, shortage of material, slow process of permits, weather conditions, deliberate owner's decisions, and poor coordination.

Review of Empirical Studies

Causes of Delay in Project Completion in Oman

Saleh and Alalouch (2015) explored the challenges facing the Oman construction industry from a different perspective. The authors considered the sustainability of the construction industry

and the problems related to it. Unlike the traditional focus on building and construction, which mainly emphasizes on durability, utility, and economic costs, sustainable construction in modern society is supposed to focus on environmental, social, and economic factors. This is indeed an important consideration which the authors argued that it requires considerable time for stakeholders to internalise and embrace the concept. It takes more than the contractors and perhaps, government policies to implement the sustainable construction approach. As a result, Saleh and Alalouch (2015) argued that it is one of the reasons that contribute to delays in project construction in Oman. Among the GCC countries, Oman has the lowest oil and gas reserves. Therefore, the infrastructural development is targeted to improve the country's economy through the attraction of tourism. As such, the construction industry must be in line with global sustainable construction standards.

In 2005, The Research Council (TRC) in Oman was established to facilitate innovation and innovative initiatives such as green building initiatives in Oman (Saleh & Alalouch, 2015). The TRC has supported the use of renewable energies, especially in terms of using sustainable methods in cooling and air-conditioning. The TRC also focuses on identifying crucial areas where renewable energy can be used and can impact the economy of Oman. The council also lends support to experimental pilot projects in specific areas by applying solutions based on updated information and various techniques. The same council also relies on scientific facts to help promote evidence-based solutions, which also assists in the planning of policies and regulations. Overall, the TRC indicates the importance of renewable energy in capacity building in order to establish a sustainable environment. Through the provisions of the TRC, the country has had its infrastructural growth following the policy guidelines. This begins from feasibility, through the planning stage to construction, which is reported to significantly decrease the construction time as compared to ordinary projects that do not follow the policy guidelines.

Delays in construction projects have been reported to affect many countries in the GCC. As mentioned in the previous chapter, the study by Emam, Farrell, and Abdelaal (2014) examined construction projects in Gulf countries to identify common significant factors that cause delays in project completion. Some of these factors include: finance and slow payments, ineffective planning and scheduling, shortage of materials, poor site management, design change by owners, deliberate decision by owners, delays by subcontractors, slow process of permits, weather conditions, and poor communication and coordination. According to Emam et al. (2014), a review of studies that have taken place in Gulf countries differed in some of the delayed factors. The authors proposed a procedure to re-rank and re-categorise the findings presented by previous researchers. In this study, the ANOVA technique was employed to analyse the previous results and verify the commonality of delay factors. The findings indicated that management inefficiency, shortage of resources, and personnel issues are the majority motives of delay factors in GCC. This study may find similar issues as well, especially concerning management inefficiency and the shortage of resources which are common issues in the construction industry.

Alnuaimi and Mohsin (2013) researched to explore the causes of project delays within the Muscat area, the largest city in Oman. The sampled projects for the research were classified into two temporary groups – those that were started in the period 2007-2008, and those in the year 2009-2010. The authors obtained data from clients and consultants. The results indicated that for both groups, over 40% of the projects were completed later than the initially scheduled completion time. Additionally, the study reported that the causes for delays changed over time. Nevertheless, the results indicated that the majority of the delayed projects were as a result of the client's constant change in orders as well as the non-availability of construction manuals and procedures. For the projects in the first group (2007-2008), the reasons for delays ranked in priority included lousy weather, claims and variations, change in the initial design, lack of

enough funds, new legal rules or instructions, and nature of the ground. For the second group (2009-2010), the reasons ranked according to their importance were programming and planning construction work, lack of experience of contractors, material shortage, failure in translating the design into the actual construction, change in the initial design, and poor site management. In 2007, Cyclone Gonu struck Oman which caused catastrophic damage in the infrastructure, explaining the presence of weather in the first group as a principal reason. It is possible for causes of delay to change dramatically within a short period because some of the causes are still related to the initial causes of delay. The causes of this change largely stem from the contractor benefiting from the constant changes suggested by the client. Therefore, considering the reasons provided for the two groups, it appears that causes of project delays in Oman are shared both by the owner of the project, and contractors. Change of initial design and the lack of materials are reasons mentioned for both groups although their importance is ranked differently.

Albogamy, Scott, and Dawood (2012) conducted one of the most comprehensive studies that explored the causes of project delays in the MENA region. The research was specifically conducted in the Kingdom of Saudi Arabia (KSA). The impact of the delayed projects included a compromise of the project quality and loss of financial resources. As mentioned in the previous chapter, Albogamy et al. (2012) reported that poor performance of the lowest bidder for the government projects was a significant determinant as expressed by most of the respondents (63%). In fact, many governments use the lowest bidder tendering system as a way to minimize the costs incurred on construction projects. The government advertises its tenders to the public and invites different contractors to compete for the award of the tenders. The companies competing for the tender are then required to provide their costs and time estimates for the proposed project.

In most cases, the competition, especially in developing countries, as well as Spain and other parts of Europe, is based on the cost-effectiveness of the different tendering companies; with the lowest bidder often winning such tenders. In the cause of the project's life, such contractors are likely to face financial constraints, which consequently causes project delays and loss of finances. The realisation of the lowest bidder problem is indeed critical. In the studies that have been reviewed in the previous section, none of the researchers mentioned it. However as reported by Albogamy et al. (2012), it remain as a critical cause of project delay. It is important to note here that the findings were based on the owners' point of view, and not the contractor. According to the perspective of other respondents apart from the owners, the results also indicated that the owners' delay in progressive payments, delays in contract approval by the owner, slow decision making, and changes in design by the owner were also important causes of project delays. The findings of inadequate planning, change of initial design and financial constraints have also been reported by other researchers already mentioned in this chapter.

A total of 23 different items were used to measure the construct of contractors' related factors. The results indicated that most of the project delays in this regard were as a result of delays caused by the sub-contractors, as expressed by the majority (47%) of the participants. The results also reported that poor planning and scheduling, shortage of qualified professionals such as engineers, low skills, training and experience, problems with cash flows, and poor drawings were also important determinants of project delays. The most predominant consultant-related causes of project delays included delays in approval of project drawings. Other issues reported also included the changes in design, low qualification and training of staff, issues with documentation, and limited workforce. Lastly, two factors were reported to be the most important external factors, which were the lack of utilization of professional contractual management, and the increase in prices of construction materials. Indeed, the study

by Albogamy et al. (2012) provides a crucial perspective on the causes of delays in construction projects. Since many projects globally usually experience delays, it is logical to assume that the causes of project delays in KSA could be more or less similar to those in Oman. It is therefore prudent that in the current study, the questionnaire explores and measures the causes of project delays in the four constructs – owner/client, contractor, consultant, and external factors.

Al-Emad et al. (2017) recently conducted a research study in which the delay factors in the Makkah's construction industry were ranked according to their significance. Therefore, using the information derived from the literature review, the researchers developed structured questionnaires that were used to collect data from construction experts in Makkah. A sample total of 100 respondents were included in the study. The average index approach was used to rank the factors, and a total of 10 factors were ranked according to their importance. The most significant factor was financial difficulties faced by the contractor, which corroborates with the results of Albogamy et al. (2012) on the lowest bidder problem. Al-Emad et al. (2017) reported that the financial problems of the contractors caused delays in various ways including a delay in the payment of sub-contractors, and delayed commencement of the project right after it has been awarded. Most of such contractors who bid with low project costs estimates often have less financial reserves to start projects once they have been awarded. As a result, after they have been awarded the tenders, it takes them some time to gather financial resources to start the project. The second factor that was reported to be a significant determinant of project delays was poor coordination between parties, which in most cases include the owners, contractors, and the consultants. The other mentioned factors were workforce shortage, delay in design document productions, poor scheduling and planning, delays in progressive payment, low labour productivity, inadequate communication among the parties to the project, poorly trained and inexperienced workforce, and lastly, inadequate management of the project. Most of the

issues mentioned by Al-Emad et al. (2017) were also mentioned by Albogamy et al. (2012), including poor contract management.

Mpofu at al. (2017) explored the causes of delayed project completion in the United Arabs Emirates. From the outset, the researcher reported that overwhelming researches have since been done to explore the cause of project delays. In a country like the United Arabs Emirates, the pressure for infrastructural development is very high, given its development record in the past decade concerning infrastructural development. Despite many studies that have been done on the same issue, the problem of project delays persists. Hence, there is a need for persistent effort through more studies and to improve solutions that deal with the same problem. Similar to the study by Albogamy et al. (2012), the study explored the causes of project delays in three main categories – the consultants, contractors, and the clients. A quantitative research approach was used, with survey questionnaires distributed to the potential respondents to obtain data. The qualitative research approach was also used to obtain qualitative data through focus group discussions with selected key participants. The results reported several factors that were associated with project delays. Most importantly, unrealistic duration of the project contract, reduced productivity of labour, and financial delays by both the client and contractor were the most significant determinants of project delays. Generally, the author concluded that client, contractors, and consultants mainly caused project delays. Again, these findings were more or less similar to those reported by Albogamy et al. (2012) and Al-Emad et al. (2017).

Elawi Algahtany and Kashiwagi (2016) explored the factors that significantly contributed to project delays in Mecca, KSA. The findings of the study were compared with the causes of delays in other projects and other countries in the Gulf Corporation Countries (GCC). Data for the study were collected from a total of 49 different projects within Mecca

through quantitative research survey. This study, however, did not clearly indicate how these 49 projects were chosen. The results of the study reported that 39% of the projects in Mecca experienced delays. Unlike the other studies that have been mentioned herein, Elawi et al. (2016) reported that the most severe cause of project delays in Mecca was land acquisition problems. However, it can be argued that the perspective of the other researchers was based on the assumption that land for construction had already been acquired and tenders were already awarded to the selected contractors. Nevertheless, other results indicated that contractors' inadequate expertise, re-designing of the original project by the owner/client, and inadequate underground utilities were the leading causes of project delay. The study also reported that the majority of the findings matched those in other regions of KSA and the GCC.

From the review of the studies in this section, it is indeed evident that adequate researches on causes of project delays have been done in Oman, as well as its neighbouring countries such as the KSA, and United Arabs Emirates. It can also be argued that the causes of project delays can be grouped into three main categories – the owners, contractors, and consultants-related factors. External factors may also be considered. These findings are essential in determining how the questionnaire is to be structured.

Causes of Cost Overrun in Construction Projects

Gobana and Thakur (2017) explored the common causes of order variation in construction projects. Order variation is the change in the initial amount of order cost after the first agreement had been made. Sometimes the order change can be negative, however in most cases, order changes often occur concerning increased order cost. The results indicated that the most common causes of order change include schedule alteration, scope differences, financial challenges by the employer, delayed decision-making process, employers, the stubborn nature of parties, and specification changes by the employer. Other causes include the alteration of

the design by the consultant, variation of the consultant's documents, design complexity, poor drawings of the work, change in specification by the consultant, unavailability of equipment, lack of professional workforce, and financial difficulties by the contractor.

Ismail et al. (2012) explored the causes of order variation in the railway construction projects in Iran. The study used a structured survey questionnaire to obtain data from key players, including employers, consultants, and contractors. Out of the suggested 26 potential causes of variation order, the study confirmed 10. Among the ten factors, the ones reported as most critical include employers' change of plan/scope, omissions, errors in the design, variations in site conditions, and financial difficulties of the contractor. Consequently, variation order increases the period it takes to complete the order, and the total cost of completing the project. The authors, however, do not indicate or discuss results associated with other authors. Also, Alnuaimi et al. (2009) explored the causes of inflated costs in public construction projects in Oman. The author posits that many contractors rarely inflate project costs. Instead, they provide a certain overhead percentage that is meant to take care of the unforeseen changes that require additional costs. Evidence indicates that in most cases, many projects often end up costing relatively more than their original estimate. Alnuaimi et al. (2009) reported fourteen issues that were potentially the cause of order variation in Oman. These included the need for additional work because of emerging issues, modification of the original plan by the owner, unclear scope during the design stage, problem of decision making, poor representation of the owners by site engineers, and many more. Sohu et al. (2017) explored the causes of cost overrun in Pakistani's highway projects. Cost overrun for such projects is a common phenomenon worldwide. In the study, the researchers developed 64-item survey questionnaires that were used to collect data from a total of 30 respondents working in different construction projects in the province of Sindh, Pakistan. The results indicated that delayed payments by the client, poor planning, interference of the project by the client, delay in decision making, change

of scope, and poor management of contractors were some of the most important determinant of cost overrun.

Alghonamy (2015) researched on the causes of cost overrun in construction projects in Saudi Arabia. Similar to the majority of studies that have been analysed in this section, the researcher used a quantitative survey questionnaire based on 34 different items as informed by the literature review. A total of 43 respondents that were surveyed were a combination of participants in various construction projects, clients, contractors, and consultants. Findings indicated that out of the 34 different items used to measure causes of cost overrun, the most important factors included the awarding of tender or bids to the lowest bidder, change in design of the project by the owner or consultant, inadequate project planning, lengthy periods between project design and actual implementation, and delay in payments.

Alzara, Kashiwagi, and Al-Tassan (2016) expounded on the relationship between change order and cost overrun among the lowest bidding contractors. Firstly, the author explains the problem with the tendering system of KSA, where many bids are awarded to the contractors who present the lowest cost estimate for completing the project. Once they have won the tender, they change the project cost to compensate for the financial aspects that they had either understated or ignored in the original estimate. In such cases, the client has to pay for the additional cost of the project. In most cases, this often results in disputes and causes apparent delays in the commencement of the project. Depending on the financial capacity of the client, the project can be financed based on the new cost estimates, or completely abandoned as the client looks for a different contractor. If the client remains with the original contractor, mistrust is likely to develop, leading to poor communication among the parties involved. This would become, yet another source of dispute and quality compromise.

The review of the studies in the section on causes of cost inflation or variation indicated that three factors were critical as the potential causes of cost inflation. These factors are the change of the original plan as requested by the employer, change of the design as per the consultant, and a poorly outlined plan which prompts inevitable changes. Other important factors include the financial difficulties of both the employer and contractor, lack of clear communication among the stakeholders, and problems in decision making. The literature review also indicates that the consequences of order variation affect the cost and time of completing the project. These findings are essential in designing the questionnaires that were used to collect data for the present study.

In summary, for both the time and cost, the literature indicates that the key determinants of delays and cost overrun are similar. These key determinants are the client, contractors, and consultants. In most literature, clients and contractors as factors are indicated to be more critical determinants than consultants. Almost all of the studies that have been reported in the literature review were conducted using survey questionnaires, with the majority of the results being reported as descriptive statistics. None of the studies were designed using the correlations study design, which seems to be a significant knowledge gap. It would be more informative if studies could, for example, determine the correlation between the different causes. Also, a number of techniques could be used. For example, variance inflated factors could be used to eliminate variables and multivariate regression analysis could be used to determine the significance or lack of it thereof, for project delays and cost overrun. If more studies could be designed this way with more similar findings being reported, better solutions can be derived. This is so as simply relying on descriptive statistics makes it difficult to determine which causative factor is more important than the other.

Methodology

Study Design

This study design employs the technique used by the researcher to answer the research questions using the given data (Wahyuni, 2012). The quantitative and qualitative approaches determine the type of study design the researcher should use. Both the quantitative and qualitative research designs are based on two main philosophies – the positivism, and interpretivism philosophies. The positivism results refers to the philosophy on which quantitative research is based. According to this philosophy, knowledge is not subjective and can only be acquired through a systematic and scientific procedure (Scheurich, 2014). The philosophy further assumes that in undertaking the study, the researcher does not have prior knowledge of the phenomenon under study. However, even if the researcher has such knowledge, the results of the research process are independent of such prior knowledge (Schweber, 2015). Conclusions are made strictly out of observation. Therefore, the researcher in this process is an independent and passive participator. Based on the hypotheses set at the start of the study, results of the observation determine whether the hypothesis is accepted or rejected.

On the other hand, the qualitative research design is based on the interpretivism philosophy. According to interpretivism, knowledge and truth are subjective and can be perceived differently by anyone (Haddadi et al. 2017; Scotland, 2012). As such, a qualitative researcher actively participates in interpreting the results of the study, which makes the process vulnerable to bias. The methodology of the research is a significant determinant of study validity. This is often determined by the degree by which a given study can be done by a different researcher using the same procedure, in a different setting while arriving at the same conclusion. This is only possible in the case of quantitative research or the positivism approach

where there is a scientific and systematic procedure, with the results and interpretation being independent of the researchers' subjective knowledge. In the interpretivism research approach, it is difficult to replicate a given study and obtain similar results (Chowdhury, 2014). This is because even if the procedures were similar, the fact that interpretation is subjective to the researcher's rationale and perception of knowledge implies that even when the outcome means the same thing to the researchers, their communication can differ significantly. This can inevitably affect the quality of the outcome. Furthermore, since the primary purpose of the research is to solve societal problems, this means communicating research results is important.

Indeed, many proponents of the positivism research philosophy have criticized the interpretivism philosophy for the lack of credibility and adequate validity. Nevertheless, several cases exist where the quantitative approach cannot effectively generate the appropriate research knowledge. Therefore, qualitative approach is necessary. As such, many researchers today, regardless of whether they are proponents of positivism or interpretivism approach, are finding common ground for mixed research approach. The quantitative design uses numerical data to answer research questions. Often, the research design is based on pre-determined hypothesis or research questions which are explained using statistical results. Conversely, the qualitative approach relies on data collected from the respondents to develop a theory or hypothesis that answers a given research question (Marshall & Rossman, 2014). It does not require numerical data to develop the answers to the study questions (Bowling, 2014; Punch & Oancea, 2014). Mostly, researchers prefer to use quantitative design since it reduces study bias. In this case, the researcher independently interprets the study results based on the underlying theories and principles. However, the qualitative design allows the researcher to interpret the results based on his or her knowledge, intuition, experience, as well as existing knowledge (Bowling, 2014). This active participation of the researcher in interpreting the data makes the

process more vulnerable to bias. Therefore, the present study will use the quantitative research design. Specifically, the survey research design will be used to collect data from respondents.

Quantitative studies are also justified for this study because they provide quantitative and reliable measures of data (Johnson & Turner, 2003). For this study on delays in project management in Oman, the quantitative design can work best as it has better control in terms of sampling and design, as compared to qualitative research (Wahyuni, 2012). It is crucial to control sampling and design because this can provide a more accurate representation of results on project management. Quantitative research also ensures a proper control of causality statements via the application of controlled experiments (Johnson & Turner, 2003). In understanding delays in projects, it is vital to have reasonable control of experiments in order to accurately establish causes for such delays (Wahyuni, 2012). A numerical understanding can also be established using a quantitative research design. Ultimately, the use of statistics provides a measurable result for the research question which is necessary in this research where the delays in project management in Oman are being established (Marshall & Rossman, 2014). Moreover, the research process for quantitative research design can be replicable. It is important to ensure that research methods are replicable in order to allow for a repeat of procedures to check the results and processes involved in the research (Marshall & Rossman, 2014).

Quantitative research is also justified for this study as it can be used to identify information by accumulating numerically supported data (Marshall & Rossman, 2014). This ensures that the opinions, beliefs, as well as attitudes of individuals are weeded out of the information. It is essential to eliminate mere opinions from the data on project management delays because opinions would not provide an accurate portrayal of the causes of delays in projects (Scheurich, 2012). Quantitative research also usually relies on closed-ended research

questions which do not allow for in-depth answers from respondents (Scheurich, 2012). However, the choices indicated in the questionnaire for this study are based on data gathered from previous studies on a similar topic (Scotland, 2012). Quantitative research methods are also justified for this study because they allow for the gathering of data from a larger number of respondents (Scotland, 2012). While the target population was significant for this study, the final number of respondents was limited (Scheurich, 2012). Still, this research method is justified as it starts off from a large population of prospective respondents. The chosen close-ended method for this study is appropriate because it helps to direct the answers of the respondents to the choices. The choices have been screened thoroughly based on previous studies (Scheurich, 2012).

This study also includes a qualitative component, specifically in relation to the "other" option indicated in the questionnaire. This is an open-ended option which is more common in qualitative studies, but not uncommon in quantitative studies (Scotland, 2012). It is justified as a solution which helps respondents make personal choices apart from indicated choices (Scheurich, 2012). This is so as forcing the respondents to choose from the options indicated in the question can cause bias in results (Scheurich, 2012).

Sample Size and Sampling Procedure

The project managers are involved with the daily practices and management of the projects, more so than employees and consultants. Therefore, the study sample is focused on project managers. This is based on the assumption that the total active projects in Oman, which are estimated at approximately 2400, is the target population. A sample size of 100 participants was chosen to represent the target population. Projects from which to obtain respondents, as well as the respondents for the survey, were selected randomly.

Data Collection Tools and Technique

Questionnaires were used as the main data collection tool. Questionnaires can either be closed or open-ended (Johnson & Turner, 2003; Tharenou, 2007). Close-ended questionnaires are used to collect data for quantitative data, while open-ended questionnaires are usually used for qualitative data. The use of a close-ended questionnaire for quantitative data is to enable ease of coding, entering, and analyzing data in respective statistical software. The response levels in the close-ended questionnaires are often limited based on the underlying theory. The findings of the literature review mainly informed the questionnaires developed for the current study. The questionnaires were sent to the selected respondents via their Linkedin page. The respondents were given 60 working days to fill and return the questionnaire to the researcher. Before the actual data collection, ten questionnaires were mailed to respondents for the pilot study to determine how effective they were. Adjustments depending on the feedback of the pilot study were made. A total of 100 questionnaires were mailed to different respondents, with 35 questionnaires returned. The questionnaire gathered information about their demographic profile (gender, age, educational level), participation in the construction industry of Oman, as well as project affiliation. For the more specific content of the questionnaire related to the research topic, the respondents were asked about the causes of delay of projects in Oman, with these causes of delay classified based on typology of delays.

Data Analysis and Presentation

Regarding data analysis, the S Statistical Package for Social Scientist (SPSS 20) software was used to compute statistical results. Frequency distributions in the form of percentages formed part of the main results of the study. The data was presented using charts and tables. Themes were also generated from the results, as noted from the responses of the participants. These themes helped in developing more organized answers to the research questions.

Results and Discussion

A total of a hundred questionnaires were sent to respondents via LinkedIn. However, only thirty-five respondents were able to complete and send back the questionnaires. Results were visualized and analysed using the Statistical Package for Social Scientist (SPSS 20). Descriptive statistics were the primary data targeted. The following section presents the Excel output.

Demographic Information

According to the chart below, (85.71%) of the respondents were male, while only (14.29%) were females. In terms of age, Figure 1 below indicates that most participants were within the age bracket of 35- 44 years old(51.43%). Another majority (37.14%) were aged between 18 and 34, while the rest (11.43%) were between the ages of 45-55 years. All the respondents possessed either a bachelor or master degree, as depicted in Figure 1 below. The majority of the respondents (54.29%) had a bachelor's degree while the rest (45.71%) had a master degree.

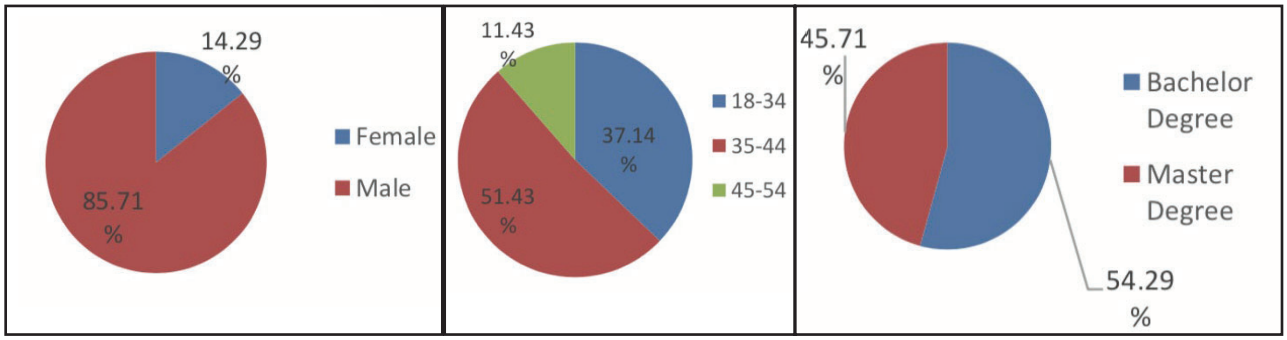

Figure 1. Personal characteristics of the participants (Gender, Age and Educational background)

Also, findings showed that most of the participants were affiliated more with public projects (54.29%) and the rest (45.71%) were associated with private companies. Furthermore, it was revealed that a majority of the respondents were clients (54.29%). Another (25.71%)

were consultants, and only (17.14%) were contractors. These findings are presented Fig. 2 as follows.

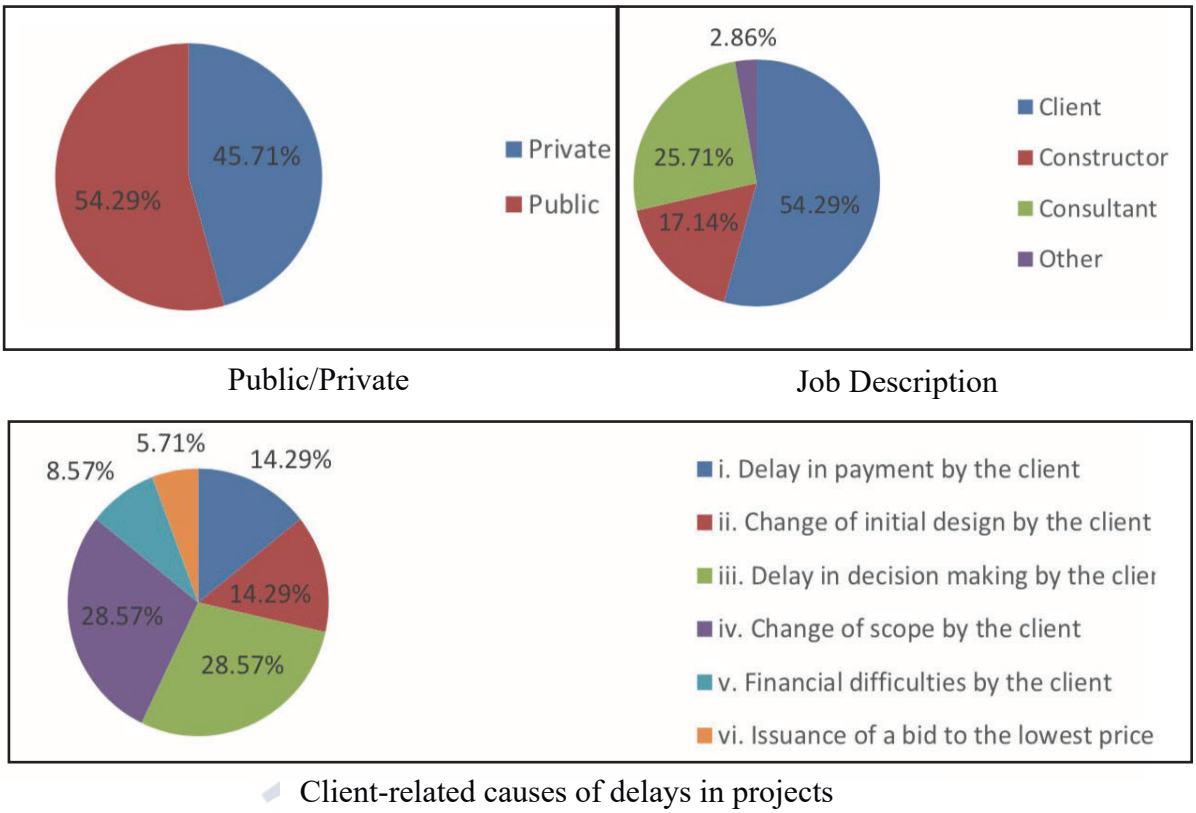

Figure 2. Characteristics of the project managers, their job description, and client-related cases of delay in the accomplishment of projects

Causes of Project Delays in Oman

1. Client-related Causes

As shown in Fig.2 above, the issues that were majorly cited as the client related cause of project delays in Oman include change of scope (28.57%), and delays in decision making by the client (28.57%). Change of initial design was also revealed to be an important determinant of project delays (17.14%), including the delay in payment (14.29%). The issue of the low bid was mentioned in the literature review, but the results above indicate that only (5.7%) of the clients considered it to be an important factor in determining project delays and cost overrun. As the results indicate, the major client-related causes of project delays include the change of scope

and delays in decision making. Delays in payment are also reported as a major cause of project delay. Similar findings are also reported by Elawi et al. (2016), including the problem with decision making by the client. The issue of bureaucracy in clients' organization has been stated by Alamri et al. (2017). At many stages of a project's life cycle, the client is expected to provide instructions on how the project should be completed continuously. Some of these instructions require significant time, especially when there were unforeseen events that required additional finances.

2. Contractor-related Causes

As shown in Fig. 3 below, the major contractor-related causes of project delays include the lack of experienced workers (37.14%), which had a similar response rate as poor contract management (37.14%). Late delivery of materials was also found to be an important cause, although it was only reported by (11.43%) of the respondents.

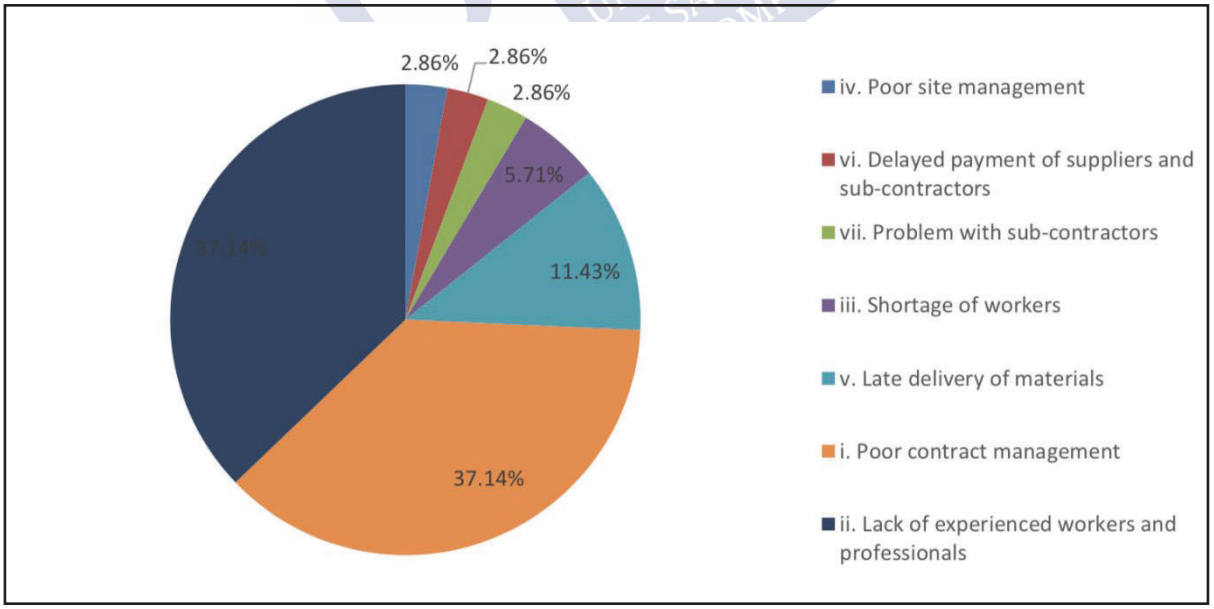

Figure 3. Contractor-related causes of project delays

The current study found that the main contractor-related causes of project delays include poor contract management and the lack of experienced workers. These findings were

also reported by Albogamy et al. (2012) as reported in the literature review. Lack of experienced workers can indeed be a major cause of problem delay in the Gulf region. Generally, the majority number of workers in Oman are expatriates according to National Centre for Statistics and Information, where there are 526,895 workers in the construction field (2019). They come mainly from Bangladesh, India, Pakistan, Philippines, Egypt, Uganda, Sri Lanka, Nepal and Tanzania. The figure is high compared to the total number of the expatriate population in the country due to the huge demand in the construction industry. This urges the accepting of workers from unexperienced backgrounds, especially from low-income countries, to overcome the high wages criteria for the local workforce. As a result of this, the quality of contract management deteriorates.

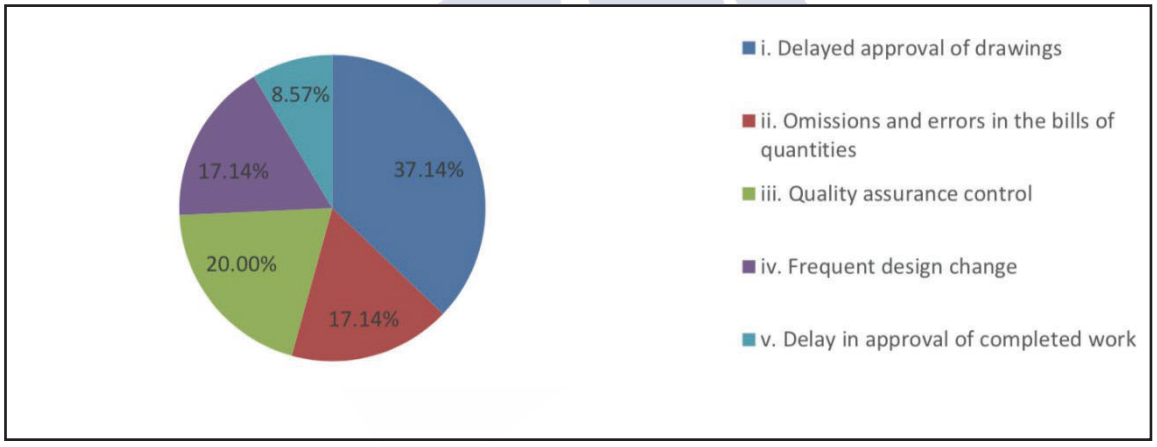

Figure 4. Consultant related issues

According to Fig. 4 above, majority of the respondents (37.14%) reported that delayed approval of drawings was the major cause of project delays in Oman. Issues with quality assurance control consisted 20% of consultant related issues. Frequent design change and errors in the bills of quantities were also reported as important causes of project delays of 17.14% each. The results also show that the delayed approval of project drawings is an important cause of project delays from consultant-related factors. Again, the findings are confirmed by Albogamy et al. (2012). Delays of approvals could be a result of several reasons, including the

lack of efficiency by the relevant approving departments. Other reasons could include huge case backlogs that may take unnecessarily long to clear.

Causes of Cost Overrun

1. Client-Related Causes

As shown in Fig. 5 below, most of the respondents (65.71%) believed that a change of project scope by the client is a significant cause of project cost overrun in Oman. Also, 17.14% of the clients cited poor communication with other parties, while 14.29% cited the change of the project's initial plan. Only 2.86% of respondents mentioned the delay in progressive payments. Results of the study revealed that the major client-related cause of project cost overrun is a change of scope of the initial project. This was also reported in the literature review by Gobana & Thakur, 2017. Changing a project scope, especially to increase its size, often involve additional financial resources.

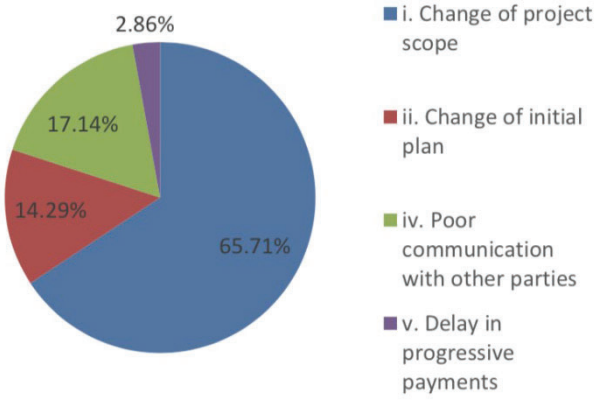

Figure 5. Client related causes

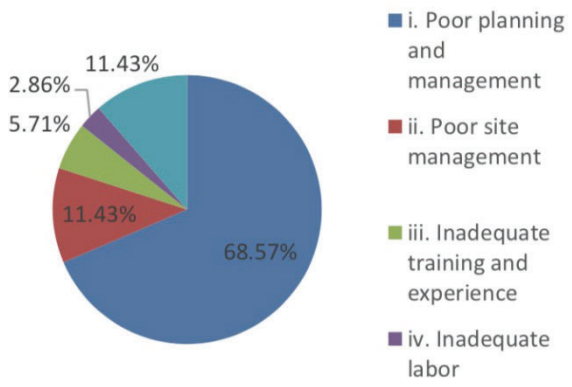

Figure 6. Contractor related causes

Contractor Related Causes

As for contractor-related causes of cost overrun, Fig. 6 above indicates that a large majority (68.57%) of the respondents thought that poor planning and management of the projects is the major cause of cost overrun in Oman. Also, 14.29% cited problems with sub-contractors, while 11.43% reported poor site management. Inadequate labour and inadequate training and experience were both reported at 2.86% each. Regarding contractor-related causes, the study indicated that poor planning and management was an important factor. Workers' backgrounds, in terms of language and culture, contribute to the hardship of planning and managing projects which leads to the inefficiency of site management. Poor planning can potentially result in significant loss of time and resources, which causes cost overrun eventually.

Consultant Related Causes

According to Fig. 7 below, the major part of respondents (40%) reported that poor drawing was an important factor that causes project cost overrun. Another 37.14% reported that delayed approvals of submittal were also an important problem. Lastly, 22.88% of the respondents cited poor quality control. There is no one reason shows a clear dominance over the others.

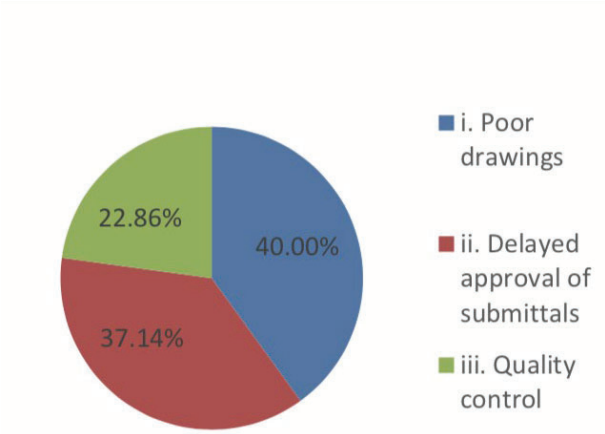

Figure 7. Consultant related causes of project delays

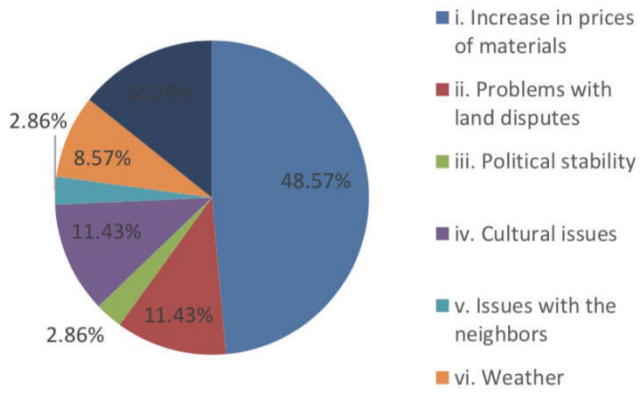

Figure 8. External factors causing project delays

External factors

As shown in Fig. 8 above, the majority of the respondents at 48.57% reported that the increase in prices of materials was the most common external factor that caused both project delays and cost overruns. Also, 14.29% cited a combination of other factors which were classified into the following factors – approval by the government of various activities including water, electricity, municipalities, and other relevant stakeholders. Other external factors include the lack of access to the appropriate information from relevant external stakeholders, stakeholders' requirements that may not have been captured in the original design, as well as requirements by the third party such as gender or persons with disabilities and permit and NOCs. Another 11.43% reported land dispute problems, 11.43% mentioned cultural issues, and 8.57% reported weather as a significant cause of project delays and cost overruns. Lastly, 2.86% reported political stability as a crucial external determinant of project delays. Commodity prices in most economies are always rising, which explains why the country's economic condition often determines the general price levels.

The current study revealed that the increase in the prices of materials is the most common external cause of project delay and cost overrun. Similar findings are also reported in Aziz and Abdel- Hakam, 2016. Depending on the length of the project, some projects may experience more detrimental effects of price increase, especially if the event occurs abruptly. It is safe to argue that the Qatar boycott may have had a significant effect on the cost of materials due to the restricted movements of goods and services within the Gulf region. Land disputes and cultural issues could also be attributed to regulations. This would indicate an issue that should be solved by the government. The presence of weather as a critical external factor is normal due to the location of the sultanate, which is struck yearly by a storm or cyclone. External factors influencing project delays and cost overruns could be enormous. Therefore, a qualitative approach to gather other factors not proposed bt previous studies was done by

adding an open "Other" option for respondents. Different factors have been indicated, but no repetition of one input was recorded.

Conclusion

Project delays and cost overrun are costly to the clients, contractors, consultants, and every other stakeholder who has interest in the project. Economic growth, for example, is significantly affected when national projects such as roads and railroad constructions are delayed. Likewise, poor quality of projects exposes the expected users to risks of injuries and sometimes death. It is therefore important that project management minimizes costs and completes the project in time. This study was designed to examine the causes of project delays and cost overrun in Oman. The study used a quantitative and qualitative approach. The major findings indicate that a change of scope and a delay in making decisions are the most important client-related causes of project delays. Regarding contractor-related factors, this study found that poor contract management and a lack of experienced workers were the most common causes of project delays. Delayed approval of drawings was also found to be an important consultant-related cause of project delay.

With regards to cost overrun, the main client-related factors include change of the project's scope. Poor planning and management were also established as important contractor-related determinants of project cost overrun. Lastly, poor drawings was a top cause for consultant-related cost overrun reasons. From the results of the study, all the results were confirmed by the literature review. Therefore, this implies that the research community has significantly established the causes of project delays and cost overrun. However, few studies have been conducted in Oman. Therefore, the present study recommends that future study should be focused in Oman, with a specific focus on individual factors such as cost overrun

and clients' relationship. This would contribute significantly to the already existing body of knowledge, helping to enhance rational policy formulations.

Chapter 4. Project Delays and Cost Overruns Between Public and Private Sectors in Oman

Based in: *Al Amri, T., & Marey-Pérez, M. (2020). Project delays and cost overruns between public and private sectors in Oman. Journal of Public Affairs, e2262.*

Introduction

Contractors can be part of the public sector, such as being part of the public works department of a city and district council. They could also belong to the economy's private sector. In past years, municipal public works departments have done much of the renovation works, primarily focusing on housing, schools, and roads. Recently, there has been a tendency towards executing such works based on bids. This can be explained by the increase in the movement associated with a more reasonable allocation of capital and getting more returns from them. The first step is to reduce the imbalance of staff allocation, where there is a concentration of staff in public works departments, while some places are severely understaffed. Additionally, there are mandatory open tenders for construction contracts. Work that was previously classified by the Department of Public Works is now being outsourced to private sector contractors on a "lowest contract price" basis. To reduce production costs, contractors can even cut down on overhead costs such as safety and training.

Overruns of cost and time in the majority of construction projects are obvious, however, the magnitude of such cost overruns and delays differ significantly from project to project. Hence, it is essential to discover the real causes behind cost and time overruns, and to counter these in construction projects. These overruns of cost and time significantly add to overall construction costs globally for several years (Abdul-Rahman, Yahya, Berawi, & Wah, 2008; Alinaitwe, Apolot, & Tindiwensi, 2013; Amandin & Kule, 2016; Charles & Andrew, 1990; Enshassi, Al-Najjar, & Kumaraswamy, 2009; Okpala & Aniekwu, 1988; Zaki & James, 1987). In the countries' development, the construction industry plays an important role. Delays in projects would lead to negative economic growth and financial loss at the macro-level

(Enshassi et al., 2009; Enshassi, Mohammed, & Abu Mosa, 2008; Lo et al., 2006). It would also lead to cost and time overruns, adjudication, disputes, and even abandonment of total project at micro-level (Abdul-Rahman et al., 2008; Enshassi et al., 2008). Here, it is necessary to define time overrun as the delay beyond projected accomplishment dates agreed by the contractors (Amandin & Kule, 2016). Next, delays refer to activities that affect the progress of a project and adjourn project actions.

Numerous factors may cause delays in projects such as bad weather, resource unavailability, and project design delays. Overall, most of the project delays are caused by factors that have both internal and external causality interactions (Vidalis & Najafi, 2002). The "cost overrun" refers to the addition of real cost over allocated project budget. "Cost escalation," "cost overrun," "cost increase," and "budget overrun" are also used as inter-changeable terms in the literature of project management (Zhu & Lin, 2004). The amount for cost overruns can be obtained by dividing the changed contract cost with the original awarded amount. However, for easier comparison, this calculation can be changed to a percentage (Jackson, 1999).

In the last two decades, the Middle East has experienced massive development. Countries like Saudi Arabia have recorded unprecedented growth within this period (El Mallakh, 2015). The discovery of oil in the region has also been identified as one of the core causes that spurred massive development in many industries in the region (Hesse & Poghosyan, 2016). The restructuring of many economies in the region, joining the global free trade organization, and the massive foreign investment that has flooded Middle Eastern countries has led to unprecedented growth in the construction industry (Kubursi, 2015). Currently, the Middle East has some of the largest construction projects in the world (Seymour, 2019). While industries such as manufacturing and fossil fuel easily overwhelm the construction industry

concerning GDB, the construction industry is a major influencer of the economy (Basheer, Ahmad, & Hassan, 2019; Hesse & Poghosyan, 2016). A project is considered successful if it is completed on time, within budget, and to the specified quality standards (Frimpong, Oluwoye, & Crawford, 2003). However, if it gets delayed, there is significant repercussions on both the time taken to complete the project and its costs.

The term “delay” in construction contracts has no precise technical meaning. It can be used in a different manner to mean different conditions in project execution (Pickavance 2005). However, in most cases, delay refers to a situation where a construction project is not completed within the defined period (Daniel and Mohan 1997). In the context of construction, contract time has great importance. A time period of the construction is quantified as the contract duration. The legal obligations related to the concept of delay, arising from every contractual obligations, specifies that one party will not stop, impede, delay, postpone, or interfere with the performance of the other party. Delays in construction can cause several changes in a project such as late completion, lost productivity, acceleration, increased costs, and contract termination. The party experiencing damages from the delay needs to be able to recognize the delays. Similarly, the parties responsible for them would need to recover time and cost. However, in general, delay situations are complex (Jafar & Mohammed, 2011). In international development, factors contributing to the delay of projects are in material procurement, slow financial process, land acquisition, resettlement issue, environmental issues, natural catastrophes, riots and commotion, and scope changes, were the leading factors contributing to time overrun (Ahsan and Gunawan 2010).

In general, delay analysis should be made possible by directly analyzing delay events and their impacts. The construction industry can stimulate economic growth, and influence many other industries that are acutely dependent on it to thrive. These industries include

important infrastructures, including a country's road network, rail system, dams, buildings that house factories, hotels, and many other vital infrastructures support the economy (Ahmed, 2019; Andersson & Andersson, 2017; Ofori, 2015). Notwithstanding the importance of this industry, many construction projects experience a myriad of problems. One of the most aching problems in many of these projects is delays. In Oman, many projects often experience huge delays; the results of which usually leads to an increase in cost estimates (Saleh & Alalouch, 2015, p. 177). Apart from affecting the economic practicality of the construction project, project delays often provide fertile grounds for claims and lawsuits which is not an ideal situation (Equbal, Banerjee, Khan, & Dixit, 2017; Jarkas, Al Balushi, & Raveendranath, 2015; Umar, 2018). To avoid delays in construction projects and ensure that they remain within the estimated cost, sound engineering judgment is required. This chapter aims to investigate the reasons for project delays according to project managers working in public and private sectors in Oman.

Literature Review

Time is generally an essential factor in project specifications. A well-fashioned project will stipulate when the project is supposed to end (Mahamid, Al-Ghonamy, & Aichouni, 2015). Numerous past studies have investigated the influencing factors of delays and cost overruns.

Kaming, Olomolaiye, Holt, and Harris (1997) have investigated the factors that can influence construction time and cost overruns in Indonesian high-rise projects. Frimpong and Oluwoye (2003) examined the important casual factors of delays and cost overruns in groundwater construction projects in Ghana Republic. Abdul Rahman, Memon, and Abdul Karim (2013) explored substantial factors that cause delays and cost overruns in Malaysian construction projects. On the other hand, Al- Najjar (2008) investigated the cost and time overruns factors in the construction projects of Gaza. Le-Hoai, Dai Lee, and Lee (2008)

explored factors of delay and cost overruns in large construction projects of Vietnam by comparing these factors with some other countries. Shanmugapriya and Subramanian (2013) examined the key influencing factors of cost and time overrun in large construction projects in India. Next, Alinaitwe et al. (2013) investigated the major causes of cost and time overruns in construction projects in the public sector of Uganda. Alinaitwe et al. (2013) have found the five most essential factors of time and cost overruns including "changes in the work scope, delayed payments to contractors, poor monitoring and control and high infla- tion and interest rates." Larsen, Shen, Lindhard, and Brunoe (2015) have also investigated the significant factors of quality level, delays, and cost overruns in public construction projects. In addition, several other studies strived to specify the reasons for construction project deferrals. These studies generally ascribe the reasons for delay in the factors introduced by clients, constructors, consultants, and external factors such as severe weather (Alamri, Amoudi, & Njie, 2017; Hossen, Kang, & Kim, 2015; Kendrick & Torreira, 2015; Larsen, Shen, Lindhard, & Brunoe, 2015; Mahamid et al., 2015; Senouci, Ismail, & Eldin, 2016). By having a better understanding of the reasons for project delays, contractors, clients, and consultants can better mitigate them (McCord, McCord, Davis, Haran, & Rodgers, 2015). In addition, new measures that help avert project delays may be identified and utilized in the project to prevent project delays (Jarkas et al., 2015; Sepasgozar, Razkenari, & Barati, 2015).

One of Oman's biggest and core infrastructure is the construction of dams. Unfortunately, these projects have been marred with delay problems in recent years. Alamri et al. (2017) performed a study designed to determine the cause of construction delay in dams in the country. According to these writers, there were many reasons for dam construction delays. Based on an intensive literature review, Alamri et al. (2017) spotted several sources of dam project lags in Oman. Therefore, a questionnaire survey was utilized to gather data from several

professionals involved in the industry. Through this, Alamri et al. (2017) found 60 causes of delay which were used to formulate a survey questionnaire.

The reasons for delays were grouped under four main categories – external based factors, client-based factors, consultant-based factors, and contractor- based factors. Data from the survey questionnaire were collected and analyzed statistically. The results underlined that the major causes of dam construction delays in Oman included severe weather changes in the project orders, and uncertainty in the condition of the ground. Other causes that ranked highly in causes of construction delays included poor management of the site, too much bureaucracy in the client's organizations, poor conducting of feasibility studies, and issues regarding land acquisition among other problems. Overall, Alamri et al. (2017) indicated that there was a need to mitigate client and constructor-based reasons for deferral in the construction industry. Similarly, Mahamid et al. (2015) endeavored to specify the sources of construction delays in Saudi Arabia. The work aimed to identify the risk matrix for delay causes from the perspective of consultants. The research work used a survey questionnaire in which 51 consultants working in Saudi Arabia were engaged, through which 35 causes of delays were identified. These were then used in the formulation of the survey questionnaires. The results underlined that the most significant cause of project delay from the consultants' viewpoint, was awarding projects to contractors with the lowest bids, as well as changing the type of material and specifications of the project midways through the venture and contract management. Other causes identified included fluctuations in prices, frequent design changes, poor planning, and poor labor productivity.

The work of Senouci et al. (2016) sought to uncover the sources of construction deferrals in Qatari public construction projects. Data was obtained from the Qatari Public Works Authority ASHGHAL. A total of 122 projects were identified. Senouci et al. (2016)

used the ANOVA method for data analysis. Regression models were drawn to help understand the relationship between cost overruns and project contract prices. These regression models were aimed at predicting cost overruns. These authors found that in constructing projects, as cost overruns rose, contract prices also rose. In contrast, these authors found that in drainage projects, as contract prices increased, cost overruns decreased.

A study by Al-Hazim, Salem, and Ahmad (2017) was undertaken to reveal the reasons for the lags and cost overspent in construction projects in Jordan. The work mainly reviewed infrastructure projects. The basis of the study was 40 public projects performed in the country between 2000 and 2008. The analysis by these authors showed that the delay and cost overruns in infrastructural projects in Jordan were caused by approximately 20 factors. Of these 20 factors, terrain and weather conditions were shown as primary reasons for cost overruns and delays in infrastructural projects in Jordan.

Larsen et al. (2015) strived to determine factors that affected schedule delay, quality, and costs in public sectors' projects. The study analyzed the factors that project managers deem as having the greatest effect on quality, cost, and time. The study also aimed to determine whether these factors were significantly disparate from each other. The methodology used in the research work by Larsen et al. (2017) was survey question- naires, in which 26 factors were identified from interviews and were used to obtain data from project managers. Friedman's test and Wilcoxon's test were also deployed in the research study. Based on the analysis, these authors found that the lack of project funding or unsettled funding was the highest contributor to delays. Errors and omissions were the main causes of cost and quality quandaries. These researchers also found that project quality, budget, and schedule were affected differently. Additionally, Al Saadi and Rahman (2019) identified the various factors in the management of construction projects in Sohar, Musanah, Bidbid, Khabourah, and Muscat cities of Oman that

cause delays and time overrun. These authors found 48 factors as the main triggers of in the project based on the literature which they reviewed. These factors were then organized into a survey questionnaire that was used to collect data from respondents. Respondents included contractors, consultants, and clients. The delay factors were categorized into five groups, including finishing, construction, design, planning, and miscellaneous. Some of the most significant causes of delay included changing the project scope, poor communication between parties, shortage in skill, mistakes in the project, and insufficient collection of data and analysis.

Arditi, Nayak, and Damci (2017) determined how organizational culture impacted construction delay. The study reviewed particular organizations in terms of their culture and how these impacted construction project delays. Using survey questionnaires, these authors collected data from construction companies in the United States and India. The questionnaires queried the study respondents on organization culture and the amount of delay each company experienced in their projects. According to these authors, the U.S. organizational culture among the companies researched was mainly based on "clan" culture. In contrast, in India, the organizational culture of the companies researched was based on "market" culture. Furthermore, these researchers found that companies that experienced delays in India were relatively higher compared to companies that experienced time overruns in the United States. However, although time overrun in most projects was a result of a multitude of reasons, statistical analysis by these authors showed that there was a significant correlation between the magnitude of delay and organizational culture. It was determined that the above inference could be attributed to cultivating organizational cultures that help to prevent time overruns in construction projects.

Aziz and Abdel-Hakam (2016) determined the construction delay reasons based on the literature gathered from different countries. The work also analysed the causes for construction

delay from different periods. Personal interviews and questionnaires were utilized by these authors to achieve their objectives. Overall, 293 causes of construction delays were listed by Aziz and Abdel-Hakam (2016). The survey questionnaires were distributed to 500 research subjects. Of these, 389 were site/design engineers, contractors, and consultants. These authors used the Relative Importance Index to determine the most and least significant delay causes. The study further analyzed a case study in Egypt, and compared the results to the most important reasons for deferral in construction projects. Moreover, the results of the test were relatively credible, as they showed a correlation in the causes. The study further developed a model for predicting the duration of road construction. The predictive model was tested in a case study to determine its efficacy. In conclusion, the analysis of the case study highlighted the primary contributors to construction delays to reduce construction delays in projects. The recommendations outlined by these authors can be helpful in aiding project managers to mitigate delays in road construction in Egypt. Some of the recommendations outlined by Aziz and Abdel- Hakam (2016) included reforms in procurement systems and the proper management of stakeholders within the construction project.

Mpofu, Ochieng, Moobela, and Pretorius (2017), indicated that construction delays were often coupled with other problems, including cash flow problems, arbitration, litigation, mistrust, and an adversarial relationship between stakeholders. Construction delays also led to a general feeling of consternation towards stakeholders in the industry. Moreover, Mpofu et al. (2017) sought to detect the most critical triggers of delays in construction in the United Arab Emirates. The study performed a survey in which three categories of stakeholders were identified, including consultants, contractors, and customers. Based on their analysis, there were many reasons for construction delays in the construction industry in the UAE. Specifically, these authors found that the most prominent cause of construction delay in the

UAE ranged from unrealistic contract duration, to poor labor productivity. In most cases, consultants and contractors had to shoulder the blame for the construction delay.

Mohammed and Jasim (2017) reviewed the causes of construction delays in Iraq. According to these authors, construction delays were a particularly huge problem in Iraq, with very few projects being completed on time. The purpose of this research was to recognize the main triggers that caused construction delays. The research reviewed six construction projects in Iraq and conducted interviews with engineers working in Iraq. Additionally, these researchers administered survey questionnaires to a group of engineers. The results obtained demonstrated that 48 key factors caused construction delays in Iraq. Lack of financial capacity on the contractor's part was identified as the main cause of construction delay.

Methodology

Different research methodology approaches have been utilized by studies reviewing construction projects' reasons for delay. The studies generally had a disparate scope and different conclusions. For this chapter, survey methodology was selected as the most appropriate research method. Surveys have several inherent advantages (Brace, 2018; Patten, 2016), where they are effective in allowing researchers to measure several variables. Surveys also encourages research for many variables, without increasing the time or cost associated with the research or analysis. Furthermore, they can include a relatively large number of study respondents within a relatively short duration of time. At the same time, surveys aid in survey generalization and are useful in cross-population generalizability (Mpofu et al., 2017, p. 356). In this way, a range of persons from different subgroups can be easily sampled and analyzed against each other without huge cost overlays.

For this chapter, primary and secondary data were collected in three distinct phases. In the first phase, causative factors that contributed to construction project delays were identified

from the literature. In the second phase, the causative factors were used to form the basis of the survey. Based on the literature review, causative factors based on client-related delay causes, contractor-related delay causes, and consultant-related delay causes were identified. The survey also reviewed the causes of cost overruns, as these tended to accompany project delays. Causative factors that lead to construction cost overruns were classified into client's cost-overrun causes, contractor's cost overrun causes, and consultant's cost overruns causes. External factors that led to delays and cost overruns were also included in the survey. In the third phase, the specific client, consultant, or contractor-related delay and cost overrun causes were used for data collection purposes. The above were further classified into either public or private sectors.

Also, the chi-square test of independence will be used to ascertain a significant difference in the factors that cause delay and cost overruns between private and public projects. All tests are done at a 95% confidence level ($\alpha = 0.05$).

Chi-Square Test of Independence

The chi-square test of independence is a non-parametric test used for checking the presence or absence of association between two or more categorical variables (Singhal & Rana, 2015). In this study, the presence of association for causes of overruns and delays will be tested for all seven factors using the chi-square test of independence. The factors are: Client Related Delay Causes, Contractor Related Delay Causes, Consultant Related Delay Cause, Client Cost-overrun Causes, Contractor Cost-overrun Causes, Consultant Cost-overrun Causes and External Factors. All statistical tests were done using SPSS.

The test statistic for chi-square is;

$$\chi^2 = \sum_{i=1}^{R} \sum_{j=1}^{C} \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$$

Where;

o_{ij} = is the observed cell count in the ith row and jth column of the table

e_{ij} = is the expected cell count in the ith row and jth column of the table

e_{ij} is ascertained using $\frac{row\ i\ total * column\ j\ total}{grand\ total}$

It is worthy to note that this calculation process is made seamless using SPSS.

Results

Client-related delay causes

The research identified five client-related delay causes for public projects and six client-related delay causes for private project (See Tables 3 and 4).

Contractor-related delay causes

The literature review identified four contractor-related delay causes for private projects and seven contractor-related delay causes for public projects (See Tables 5 and 6).

Consultant-related delay causes

The literature review identified five consultant related delay causes for private projects and five consultant related delay causes for public projects (See Table 7).

Table 3. Client-related delays causes for private projects

No.	Client-related delay causes
1	Customer's late payouts
2	Change of the original layout by the customer
3	Customer's late decision making
4	Adjustment of work's scope by customer
5	Customer's financial struggles
6	Awarding of the bid to the least bidder

Table 4. Client-related delay causes for public projects

No.	Client-related delay causes
1	Weak contract handling
2	Shortage of experienced laborers and specialists
3	Scarcity of laborers
4	Unsatisfactory site management
5	Delayed supply of materials

Table 5. Contractor-related delay causes for public projects

No.	Contractor related delay causes
1	Weak contract administration
2	Shortage of experienced laborers and specialists
3	Scarcity of laborers
4	Unsatisfactory site management
5	Delayed supply of materials
6	Postponed payment of suppliers and sub-contractors
7	Problems with subcontractors

Table 6. Contractor-related delay causes for private projects

No.	Contractor-related delay causes
1	Weak contract handling
2	Shortage of experienced laborers and specialists
3	Scarcity of laborers
4	Unsatisfactory site management

Table 7. Consultant-related delay causes for both private and public projects

No.	Consultant-related delay causes
1	Delayed approval of drawing
2	Omission and errors in the invoice of qualities
3	Quality control handling
4	Repeated layout alteration
5	Lag in accepting completed job

Client cost-overrun causes

A total of six causes for cost-overruns caused by clients were identified for both private and public projects (See Tables 8 and 9).

Contractor cost-overrun causes

The literature review identified four contractor cost-overrun causes for both private and public projects (See Table 10).

Consultant cost-overrun causes

The literature review identified three consultant cost-overrun causes for both private and public projects (See Table 11).

External factors

The literature review identified a number of external factors that caused project delays and cost overruns (See Tables 12 and 13).

Table 8. Client cost-overrun causes for private projects

No.	Client cost-overrun causes
1	Adjustment of work scope
2	Change in original layout
3	Weak communication with other parties
4	Postponement in progressive payments

Table 9. Client cost-overrun causes for public projects

No.	Client cost-overrun causes
1	Adjustment of work scope
2	Poor communication with other parties

Table 10. Contractor cost-overrun causes for public and private projects

No.	Contractor cost-overrun causes
1	Inadequate planning and management
2	Unsatisfactory site management
3	Insufficient training and experience
4	Problems with sub-contractors

Table 11. Consultant cost-overrun causes for both private and public projects

No.	Consultant cost-overrun causes
1	Poor drawings
2	Delayed approval of submittals
3	Quality controls

Table 12. External causes of delay and cost-overrun causes for private projects

No.	External causes of delay and cost-overrun causes
1	Increase in costs of supplies
2	Land disputes
3	Instable political concerns
4	Cultural issues
5	Disagreements with neighbours
6	Other

Table 13. External causes of delay and cost-overrun causes for public projects

No.	External causes of delay and cost-overrun causes
1	Increase in costs of supplies
2	Land disputes
3	Cultural issues
4	Disagreement with neighbours
5	Conditions of the weather
6	Other

The above data was highlighted as the specific causes for project delay and cost overrun. These factors also formed the basis of the survey. Out of the 35 study respondents who participated in the research, 5 were female and the rest were male. Also, 19 participants presented themselves as public-sector employees, whereas 16 introduced themselves as private sector

professionals. Furthermore, there were 19 clients, 9 consultants, and 6 contractors. One of the respondents specified their designation as others.

Chi-Square Results

1. Client Related Delay Causes

H_1: There is a significant difference between client related delay factors for public and private owned projects.

Rejection rule: The hypothesis would be rejected if the p. value is greater than 0.05.

	Value	df	P. value
Pearson Chi-Square	4.509	5	0.479

Since the p-value is greater than α = 0.05, the hypothesis is rejected; thus, there is no significant difference in the client-related delay between private and public owned projects. Thus, the p-value score means the delay caused by clients in projects remain the same irrespective of whether the project is public or private owned.

2. Contractor Related Delay Causes

H_1: There is a significant difference in contractor related delay factors between public and private-owned projects.

	Value	df	P. value
Pearson Chi-Square	5.553	6	0.475

Since the p-value is greater than α = 0.05, the hypothesis is rejected; thus, the delay caused to the project by contractors is not in any way dependent on the project owner. Contractor related delays are similar irrespective of whether a public or private enterprise owns the project.

3. Consultant Related Delay Causes

H_1: There is a significant difference in the consultant related delay factors between public and private-owned projects.

	Value	df	P. value
Pearson Chi-Square	5.996	4	0.199

Since the p-value is greater than α = 0.05, the hypothesis is rejected; thus, there is no significant difference in the consultant-related delay between private and public owned projects. The p-value score means the delay caused by consultants in projects remain the same irrespective of whether the project is public or private owned.

4. Client Cost Overrun Causes

H_1: There is a significant difference in the client cost overrun causes between public and private-owned projects.

	Value	df	P. value
Pearson Chi-Square	9.567	3	0.023

The p. value is 0.023; this is less than the significance value of 0.05; therefore, the hypothesis is accepted. The p-value score indicates that the difference in client-related cost overrun based on whether the project is publicly owned or privately owned is statistically significant.

5. Contractor Cost Overrun Causes

H_1: There is a significant difference in the contractor cost overrun causes between public and private-owned projects.

	Value	df	P. value
Pearson Chi-Square	5.450	4	0.244

The p. value is 0.244. This is greater than the significance value of 0.05; therefore, the hypothesis is rejected. The p-value score indicates no significant difference in the contractor related cost overrun causes between public and private-owned projects.

6. Consultant Cost Overrun Causes

H_1: There is a significant difference in the consultant cost overrun causes between public and private-owned projects.

	Value	df	P. value
Pearson Chi-Square	2.121	2	0.346

The p. value is 0.346. This is greater than the significance value of 0.05. Therefore, the hypothesis is rejected. Moreover, it indicates that there is no significant difference in the consultant related cost overrun causes between public and private-owned projects.

7. External Factors

H_1: There is a significant difference in the external factors that causes project delays between public and private-owned projects.

	Value	df	P. value
Pearson Chi-Square	8.132	6	0.229

The p. value is 0.229; this is greater than the significance value of 0.05; therefore, the hypothesis is rejected. Further, it indicates that the external factors inhibiting any project's completion are the same irrespective of whether the project is privately or publicly owned.

Discussion

The results indicate that the predominant cause of client-related delays in the private sector was due to the delay in decision making by the client at 15%. In the public sector, almost 17% of respondents indicated that the main cause of client-related delays was the postponement of compensation by the customer or client. The most insignificant cause of client-related delays in the private sector was the change in initial design by the client and the lowest bidder awarding.

In public projects, the least significant causes of client-related delays were the delay in payment by clients and financial hassles by the client. The study of Alinaitwe et al. (2013) found that the delay in payments was a significant influencing factor of delays and cost overruns in public sector projects. In the private sector, more than 20% identified that the most significant cause of contractor-related project delays was the lack of experienced workers and professionals. The shortage of laborers was the least significant cause of contractor-related delay causes in the private sector, at around 6%.

Odeh and Battaineh (2002) investigated the delay and cost over-runs factors in the construction project of Jordan and found labor productivity as a key. On the other hand, poor contract management was the most significant cause of contractor-related delays, chosen by one-fifth of respondents. The lack of experienced workers and professionals was also a major cause of contractor-related delays. The least detrimental causes of contractor-related delay were problems with subcontractors, delayed payments of suppliers and subcontractors, and poor site management. The study of Frimpong et al. (2003) also found poor contact management as the most important time-delay and cost increase factor. Additionally, the major cause of consultant related delays in the private sector was the delayed approval of drawings, as indicated by over 25% of participants. Chimwaso (2001) determined that drawing issues, lack of planning, and inflation of raw material were major cost-overrun factors. In the public sector, omissions and errors in bills of quantities and quality control issues were the most prominent cause of consultant related project delays. Both were selected by around 30% of participants. Incidentally, the results indicated that omissions and errors in bills of quantities were the least significant cause of consultant related delays in the private sector, besides the delay in approval of work. Koushki, Al-Rashid, and Kartam (2005) explored the lack of financial resources and time allocation in the design stage of the projects are the major contributors of cost increase and time delays.

Furthermore, 40% of the results obtained show that the leading cause of client-related cost overruns in the public sector was a result of a change in the project scope. This was also the most consequential reason for client-related cost overruns in the private sector at 25%. Poor planning was the leading cause of contractor-related cost overruns in both the private and public sectors. The results further show that the least significant contractor-related cost overruns cause in the private sector was due to inexperienced workers and unsatisfactory site

management. In the public sector, the least significant factor for contractor-related cost overruns was due to problems with sub-contractor.

According to the results obtained, most respondents highlighted that the most significant cause of consultant-related cost overruns in the private sector was poor drawings. In the public sector, the most significant cause of consultant related cost overruns was the delayed approval of submittals at 20%. The least significant cause of consultant-related cost overruns in both the public and private sectors was quality control. In both the public sector and the private sector, the increase in the price of materials was the most prominent external factor. Furthermore, Endut, Akintoye, and Kelly (2009) has determined, while comparing costs and time overruns of public and private projects, that only 8% public sector projects are completed without any delay and cost overruns. In addition, they found that 10% of private-sector projects have cost deviations as compared to the public sector, where the cost overruns percentage is more than 84%. Results from the study also reveal that the cost and time efficiency of private sector projects is higher than that of public sector projects.

The figures indicated a detailed review of the results (See Figures 9, 10, 11, 12, 13, 14, and 15).

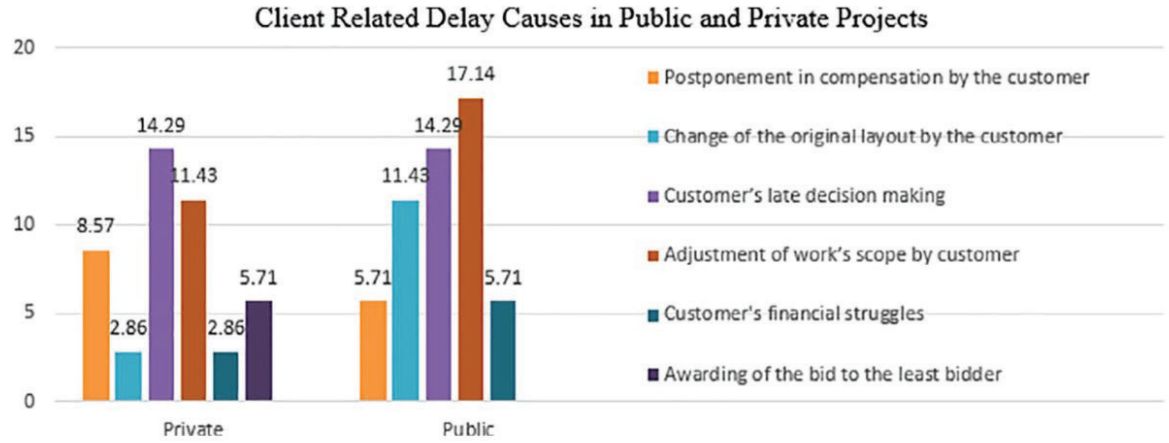

Figure 9. Client-related delay causes in the public and private sectors

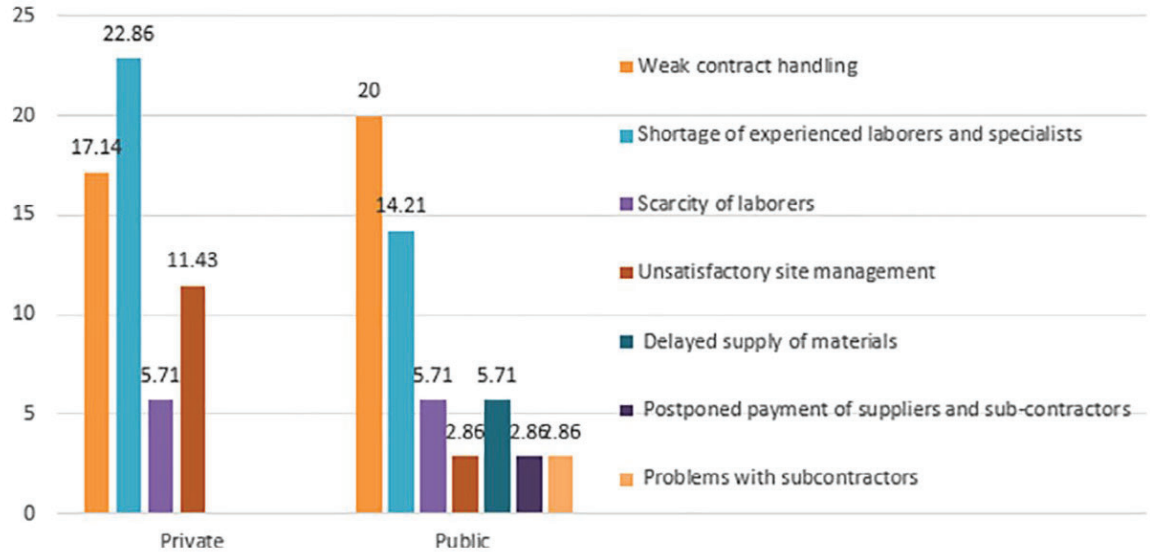

Figure 10. Contractor-related delay causes in the public and private sectors

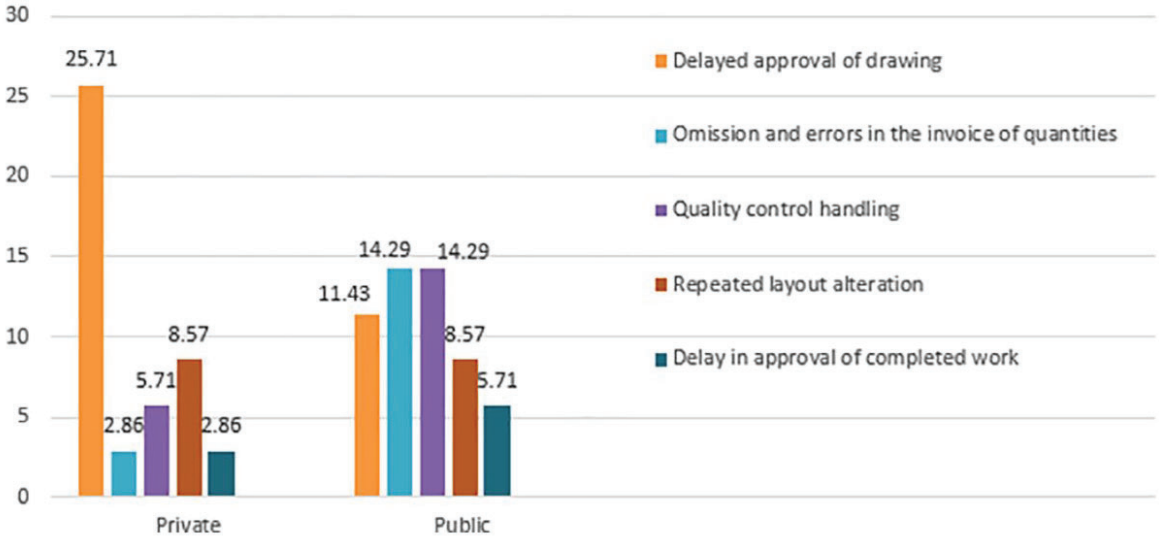

Figure 11. Consultant-related delay causes in the public and private sectors

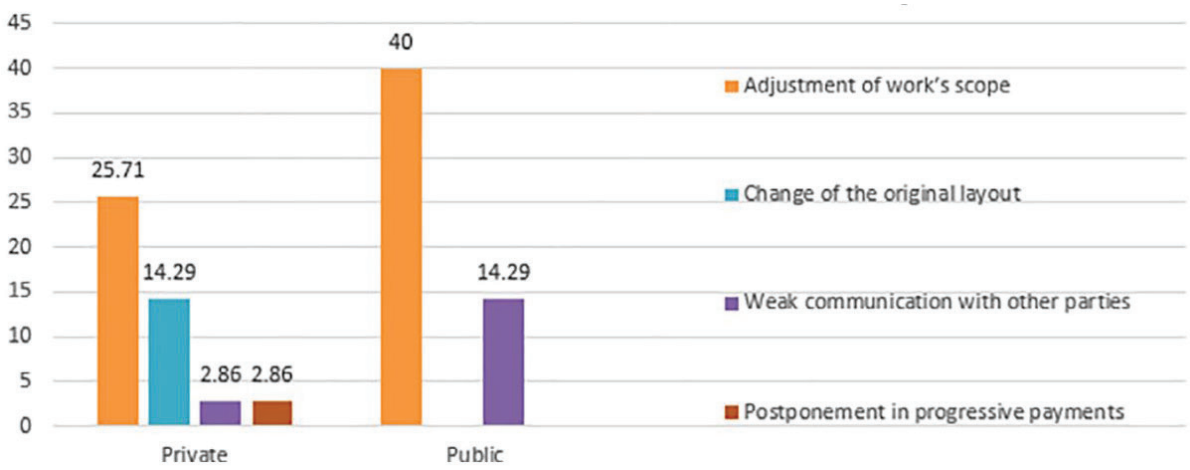

Figure 12. Client cost-overrun causes in the public and private sectors

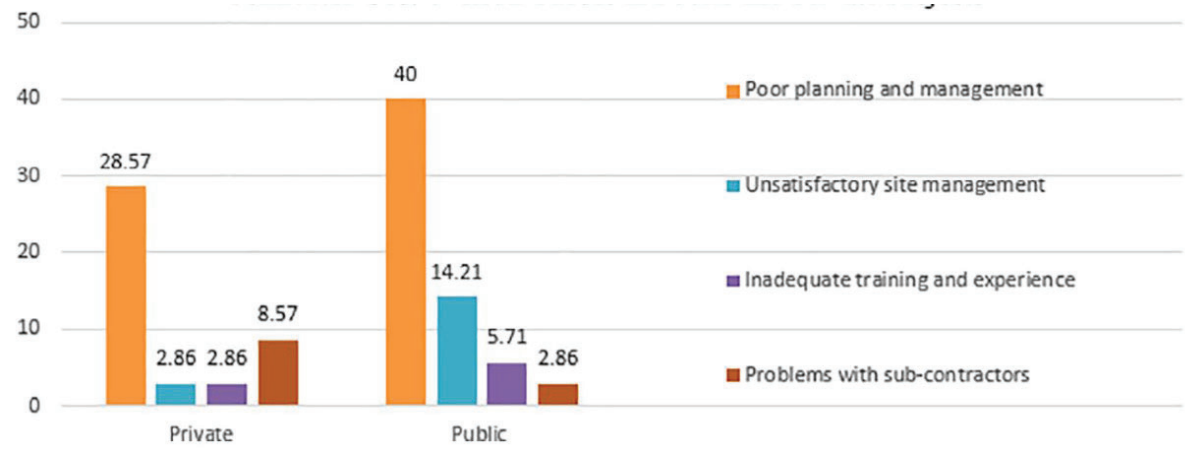

Figure 13. Contractor cost-overrun causes in the public and private sectors

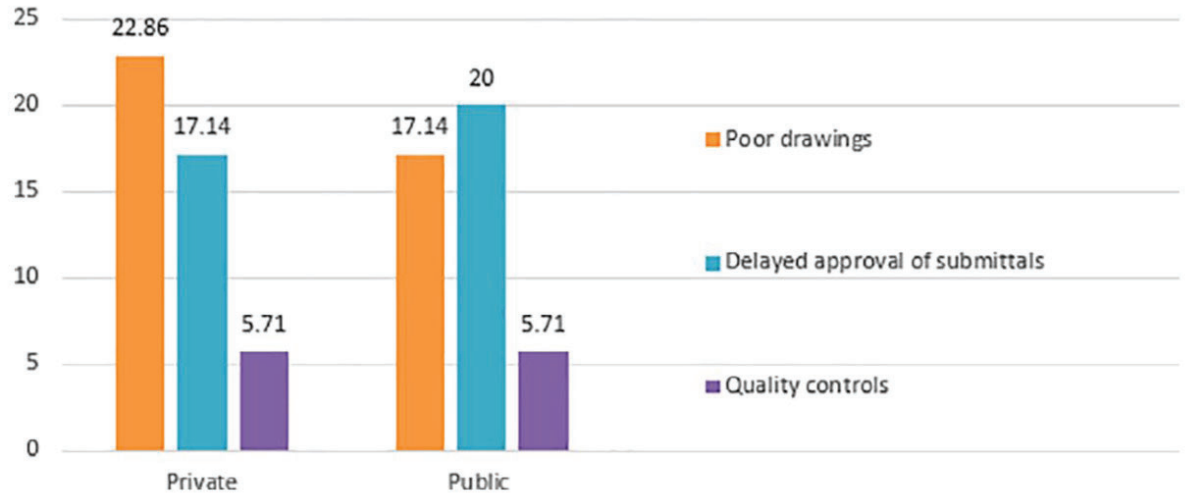

Figure 14. Consultant cost-overrun causes in the public and private sectors

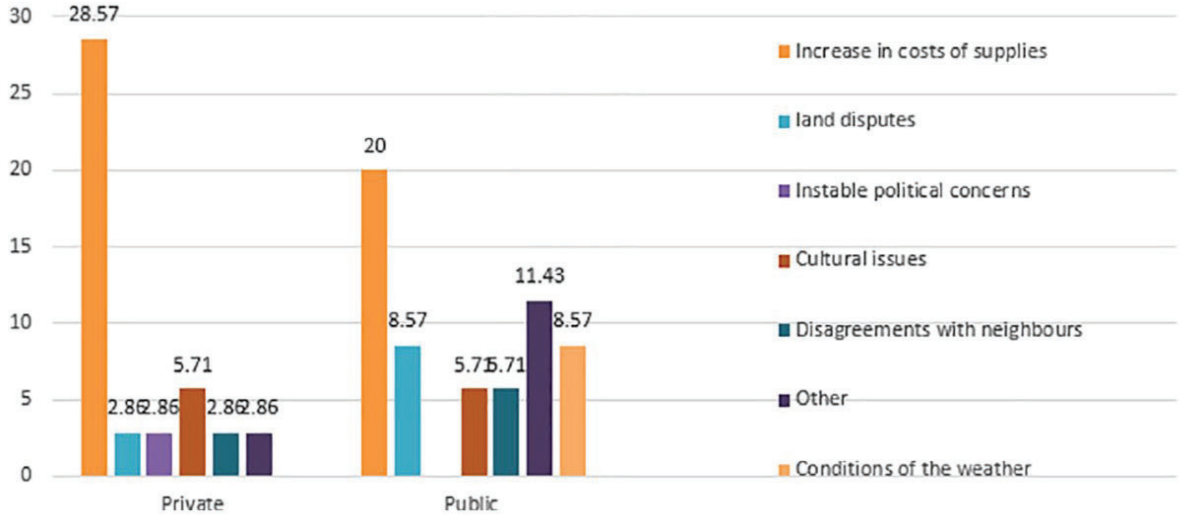

Figure 15. External factors in the public and private sectors

Conclusion

Oman and most Middle Eastern countries have seen massive growth over the last 20 years. With this growth, the building and construction industry has seen a massive upturn. Project delays, however, are a core problem in the industry. Literature has shown that construction delays are a common phenomenon in Oman and in many other GCC countries. Generally, these delays may be classified in terms of consultants, contractors, clients, and external contributing factors. These causative factors have been identified as the reasons for construction delays. While clients play a role in delays, the blame for construction delays is usually ascribed to contractors and consultants. A number of approaches have been identified based on an analysis that could aid in mitigating construction delays. Specifically, new technologies, improvement of labor productivity, and change in organizational culture are just some of the solutions that may help avert construction project delays.

Theoretical and Practical Implications

The results of this research have several theoretical implications. The first implication is that the limited understanding of delays in construction projects was extended. Attention was drawn

to the possible reasons and issues of delays in construction projects. This study departs from earlier studies because they merely focused on the reasons and causes of delays. Furthermore, this chapter compared the public and private sector to explore the causes of delay and to determine how these causes can vary depending upon the ownership nature.

The results of this chapter can help managers direct their attention towards understanding the reasons behind delays in projects. The results revealed that causes of delays in projects are different for the private and public sectors. Therefore, project managers should focus on the nature of the project ownership before starting or continuing the existing project. This research would provide an overview of the causes of construction delays to stakeholders in the Omani construction industry. Moreover, this study would help industry practitioners and decision-makers update their policies and regulations to avoid and mitigate the occurrence of undesired causes or delays in the future.

Limitations and Future Recommendations

However, it should be noted that the results from this chapter has several limitations which can be tackled by future researchers. Firstly, the primary data for the study was collected from Oman. This limitation could be addressed in future studies by collecting data from other countries with a larger sample size. Secondly, the study is broader as it compared the causes of delays in public and private sector. Hence, future studies can be sector specific and focus on one sector.

Chapter 5. Key Quality Issues Affecting the Sustainability of Construction Projects in Oman

Based in: *Al Amri, T., & Marey-Pérez, M. (2020). Key Quality Issues Affecting the Sustainability of Construction Projects in Oman. International Journal of Advanced Science and Technology, 29(3), 4330-4338.*

Introduction

Sustainability is a concern of all development processes and human activities. Construction projects are closely connected to the social, economic, and environmental aspects of human lives. One of the main goals of construction projects is to achieve sustainability and to attain favorable results. In modern the economic situation, construction organizations pay increasing attention to improving the efficiency of production activities by introducing scientific and technological progress in production. As a result, this increases the competitiveness of products. With the development of the country's economy and the construction industry, the problem of quality becomes especially urgent. The number of defects affecting the structural safety of constructed buildings and structures has increased, resulting in a tendency to increase the proportion of violations per object.

Literature Review

Jones, Michelfelder, and Nair (2014) stated that engineering managers are held responsible for achieving sustainability under operational activities. The primary duty of an engineer is to cement sustainability as one of the main objectives, which is to be achieved by the organizations where they work. Ensuring this can further encourage the engineers to perform sustainable practices while maintaining ethics during the conduct of operational activities. Even for the selection of operating sites, system designs and materials that are used in the construction projects tend to determine whether sustainability will be achieved. However, engineers face difficulties due to continuous global challenges associated with the availability of energy resources required to conduct operational activities of a project. These challenges are bound to emerge due to the growing level of globalization, liberalization, and continuously

changing market conditions. It was stated that “the possibilities of project events, activities and their outcomes cannot be predicted. The uncertainty and risk in projects can have a huge impact on the overall accomplishment of project objectives. The uncertainty and risk in project management events can be judged through prior assessment of opportunities, threats in combination and their possible impact on the overall achievement of objectives" (Chawla, Chanda, Angra, & Chawla, 2018, 160).

Key Quality Issues in Oman

According to Abidin and Powmya (2014), construction projects in Oman often lack quality standards. One of the principal reasons behind this is the lack of water availability, as well as the higher temperature especially during the warmer seasons. This is so as warmer seasons require a more consistent effort to water the plants and trees, resulting in water shortage in Oman. Another reason that was cited was the increasing rate of energy usage by companies that operate in the construction industry of this nation. At the same time, these companies also emit carbon dioxide (CO2) at a higher volume, which further affects environmental quality. Hence, these issues largely affect the sustainability of construction projects in Oman.

Robinson, Anumba, Carrillo, and Al-Ghassani (2006) further argued that construction companies are held liable in restricting the sustainable development of projects under construction. This may be due to the reasons of inadequacy in benchmarking and failing to perform innovative sustainable practices within the construction projects by the companies (Robinsonet al., 2006).

Furthermore, Issa and Al Abbar (2015) asserted that natural constraints, such as the lack of resource supply and operational challenges that includes retro fitting the existing buildings, could be cited as two barriers against achieving sustainability by the construction

projects in Oman. Evidence suggests that "green building codes" have been introduced in GCC countries as a legal framework for ensuring the completion of sustainable quality construction projects. In this context, Safinia, Al-Hinai, Yahia, and Abushammala (2017) argued that in Oman, priorities for sustainable development had been set in the urban areas. This is mainly due to the rapidly growing population in these areas. Construction of buildings in the urban regions have been enforced to use sustainable materials so that performing relevant project activities can be made more comfortable for project managers. Moreover, sustainable materials tend to ensure that the quality of the operating environment is unharmed. In addition, the use of sustainable resources will ensure the project is completed more efficiently, while achieving cost effectiveness. Therefore, these factors have been established under the "green buildings" sustainable framework so that the projects conducted in Oman can meet quality standards and achieve sustainability at the same time (Safinia et al., 2017).

Table 14. Registered and Certified Projects with LEED in GCC in 2010

Countries	Registered	Certified
Kuwait	3	0
Bahrain	7	0
Saudi Arabia	39	1
U.A.E	517	25
Oman	15	0
Qatar	42	0

Source: (Powmya &Abidin, 2013)

Table 14 demonstrates the status of registered and certified projects to achieve LEED by the year 2010. It shows that construction projects in Oman were not able to attain LEED certifications, whereas 25 construction projects in the UAE and one green construction project in Saudi Arabia was already certified. This paltry figure was justified according to Powmya and Abidin (2013), who investigated reasons that obstruct green construction in Oman (see Table 15).

Table 15. Key Factors Affecting Green Construction Projects of Oman

Barriers	Average Mean	Rank
Lack of understanding of this concept	3.81	6
Lack of demand for green construction	4.10	1
No local green certification available	3.78	8
Lack of locally produced green products	3.64	9
Lack of promotion for sustainable projects	3.79	7
Resistance to change in current practice	3.63	10
Believe that green construction is not important	3.31	12
Believe that cost of construction will be more	3.85	4
Lack of initiative by government/professional bodies	3.82	5
Lack of pressure by the government	3.96	2
Lack of incentives from the government	3.91	3
No culture for green construction	3.46	11

Source: (Powmya & Abidin, 2013)

Table 15 highlights some crucial factors serving as barriers for green construction projects in Oman (Powmya & Abidin, 2013). Application of LEED standards under the operations of construction projects in Oman could have further assisted the engineers of Oman to achieve sustainability (Times of Oman, 2018). According to data from 2010, the performance of construction projects towards sustainability was poor. Table 16 below, shows certified projects with LEED by February 2020. Saudi Arabia and UAE have seen a massive increase, with an increase of 928 projects for Saudi Arabia since 2010. As for the UAE, it has seen an increase in 43 more certified projects as compared to its 2010 results. However, Oman only has 13 certified projects whereas Qatar, Kuwait and Bahrain have 98, 13, and 3 respectively (GBIG, 2020).

Table 16. Certified Projects with LEED in GCC by 2020

Countries	Certified
Saudi Arabia	929
UAE	1067
Qatar	98
Oman	13
Kuwait	10
Bahrain	3

Source: (GBIG 2020)

Chowdhury, Rahman, and Srabon (2018) pointed out the primary reasons that affect the sustainability of small and/or medium-sized construction projects being carried out in Oman. These reasons are the lack of qualifications amongst the engineers and project managers, as well as the deficiency in the sustainable practices being carried out by these professionals. Apart from these, other factors include poor sustainability planning, the increasing expense of the projects, inadequate knowledge on the correct methods, and the lack of familiarity with the technological equipment to be used in construction projects. These factors have further inhibited the ability of the construction projects in Oman to achieve sustainability (Chowdhury, Rahman, &Srabon, 2018).

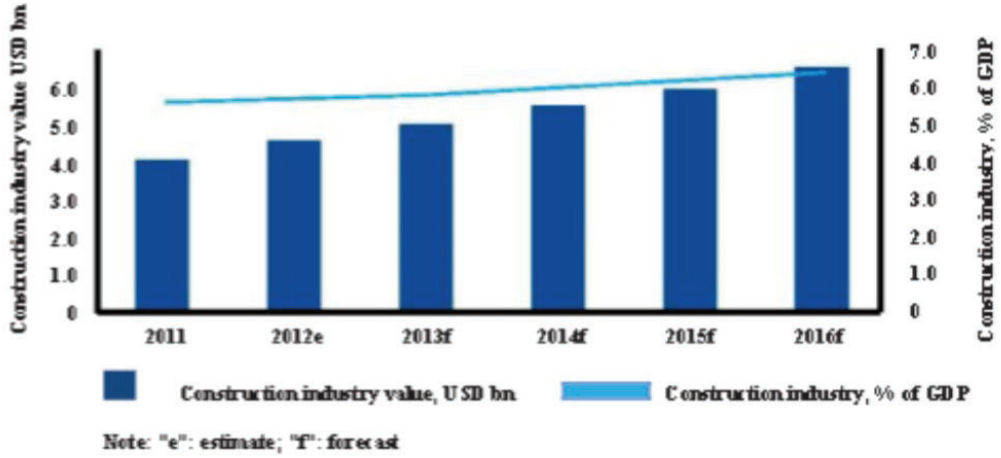

Figure 16. Construction Projects and its Value Growth in Oman

Source: (Saleh & Alalouch 2015)

Saleh and Alalouch (2015) have observed in recent years that the overall population rate in Oman increased substantially. This affected the sustainability of the nation's construction projects. Figure 16 above demonstrates how the GDP value of Oman is presently at threat. As a result of this factor, the emerging need for sustainable development has erupted at the moment. Initiatives towards stabilizing the GDP of Oman, which is a national issue, and increasing sustainability among the construction projects are being undertaken. Engineers and project owners have also involved themselves in achieving the sustainable development of the construction projects. Under this circumstance, Abidin and Powmya (2013) argued that the major reasons besides Oman's limited GDP includes, the poor knowledge about the concept of sustainability among the engineers, lack of engagement of the nation's government and other legal authorities of Oman, as well as the lack of incorporating environmental standards (green construction) into operations. Additional quality issues affecting the sustainability of construction projects in Oman can be identified as a lack of certification for sustainable measures, such as green construction and increasing operational expenses (Abidin&Powmya, 2013).

Mahadik and Mahadik (2015) highlighted key issues such as the low usage of the Value Engineering (VE) tool application by the construction industry in Oman. The integration of this tool has proven to increase sustainability among the construction projects. Furthermore, the VE tool ensures reliability, quality, durability, and efficiency when it is used in different construction projects. From a theoretical perspective, "value engineering is a creative, systematic effort directed at analyzing functional requirements of a project for the purpose of achieving essential functions at the lowest total cost over the life span of the project. Sustainable development is the balance between economic progress and environmental conservation needed for future survival" (Mahadik & Mahadik, 2015, 381). The benefits of the VE tool includes helping construction organizations to determine the best alternative design

for carrying out project-related operations, decreasing operational expenses, improving project qualities, and saving time. Furthermore, Zuofa and Ochieng (2016) argued that the engagement of different stakeholders for a construction project could generate problems due to differences in ideas and perspectives. Thus, the incorporation of ideas from engineers, contractors, project managers, workers, and the owners of the respective construction organizations is crucial to ensure that every stakeholder is focused on one objective (Zuofa&Ochieng, 2016).

Okeil (2014) stated that "based on responses from 59 project managers, it was found that there is a high degree of agreement among stakeholders on causes of delays. The top identified causes of delay were related to poor site management and supervision by contractors, problems with subcontractors, inadequate planning and scheduling, poor management of contractors' schedules, delay in delivery of materials, lack of effective communication among project stakeholders, and poor interaction with vendors in engineering and procurement stages" (612). This brings forth the various issues that cause delays in the operations of construction projects in Oman, which further results in the failure of achieving sustainability. Saleh and Alalouch (2015) also argued that “another aspect related to economics; apart from the cost; is the construction time which is considered as a critical performance criterion of construction projects. Construction delays will often increase the cost of the project and affect the reputation of all stakeholders. Since sustainable construction requires the integration of green technologies with other building components, therefore, dramatic delays will result if this is not considered throughout all project stages" (Saleh & Alalouch, 2015, 180). This highlights the fact that the delay of project operations and sustainable practices occurs and affects the probability of attaining sustainability in the construction projects based in Oman (Saleh & Alalouch, 2015).

Key Quality Issues in Other Gulf-countries

Based on the observation made by Ghaffour, Missimer, and Amy (2012), other GCC countries such as Saudi Arabia and Bahrain, also face quality-related issues concerning construction projects being conducted within the national boundaries. A critical factor presented is the poor water quality which is a result of an increased rate of salination across different regions of these countries. It must be mentioned in this context that "the cost of desalinated seawater has fallen below US$0.50/m3 for a large scale seawater reverse osmosis plant at a specific location and conditions while in other locations the cost is 50% higher (US$1.00/m3) for a similar facility. In addition to capital and operating costs, other parameters such as local incentives or subsidies may also contribute to the large difference in desalted water cost between regions and facilities" (Ghaffour, Missimer, & Amy, 2012, 1). Thus, due to the salination of water, the interest on indirect capital, project management costs, fees of architectural & engineering (A&E), along with the lack of contingency plans and operational practices, make it difficult for construction projects to maintain their quality and attain sustainability simultaneously. Issa and Al Abbar (2015) further elaborated that natural as well as operational constraints in the Middle Eastern countries affect the quality of the construction projects and prevents organisations from achieving sustainability at the same time.

Furthermore, Al Amri and Marey Perez (2019) stated that Oman is one of the GCC countries, wherein sustainable development is hardly achieved, especially in the operational practices of construction projects. Even though economic development has benefitted the nation's construction sector, the existence of certain influential factors such as social, political, economic, and environmental factors, tend to create financial inconveniency for companies. Thus, due to the lack of financial resources, operations of the construction projects are further delayed. Even if there is a possibility to accomplish sustainability through the addition of

financial resources, it becomes impossible due to the persistence of certain critical factors such as the lack of financial resources and political instability in Oman. Moreover, Abdellatif and Othman (2006) have also argued that the mentioned factors have created quality problems in construction projects in Gulf countries such as the UAE. These factors can be perceived as the culmination of an increasing rate of low-income building projects in the GCC countries. The respective governments can be held responsible for supporting the construction processes of these buildings such that they are completed within the specifically allocated time. In return, this would assure high-quality completion, cost-effectiveness, and the maintenance of a good surrounding environment wherein operations are held. Thus, sustainability issues tend to arise when the faults of low-income buildings are not detected well during the construction of projects not only in Oman, but also in other Gulf countries (Abdellatif & Othman, 2006).

Sweis, Hammad, and Shboul (2008) asserted that a lack of financial support has generated more severe concerns for the government of the GCC countries to maintain sustainability in construction projects. In addition, the contribution from project owners, along with the legal authorities, are barely witnessed. Thus, due to the negative impacts of these issues, sustainability is yet to be achieved by the construction sector in the GCC countries. Thus, in order to maintain quality, sustainability, and ensure completion of construction projects within a specific time frame, the governments of such countries have emphasized reforming resource-based policies for the development of the construction sector (Sweis et al., 2008). Furthermore, the reliance on measures alongside the integration of a sustainable practice framework to create positive results is required to drive the construction sector of Oman and other GCC nations. Doing so will certainly help to create a higher possibility of achieving sustainable development by every construction project across the Middle Eastern countries (Hammad & Shboul, 2008).

In these countries, the most common issues being faced by the construction industry are the delays in operations due to the lack of resources, poor supervision, contractual problems. and disrupted climatic conditions, among others. However, the introduction of a ranking system based on the level of impact upon delay and sustainability of the projects can help in prioritizing the main ones that have higher chances to create operational delays and barriers towards achieving sustainability. Thus, the practical legal approach can be undertaken by project owners and contractors to ensure that the operations are conducted in the most effective way, while tracking the issues to avoid them at any cost (Sweis et al., 2008). The principal approaches for dealing with these sorts of issues might entail developing and then, introducing the legal standard contracts and regulations. Some examples include the Construction Contract Act and engaging the Board of Members in the decision-making procedure (Thompson, 2019).

Methodology

A qualitative research method has been employed in this chapter to collect relevant data and reach into valid conclusions. Since the research is qualitative in nature, the case study method has also been used to assess the collected data related to the study topic. This research approach helped in conducting the study in an in-depth basis to derive clear findings on crucial quality issues being faced by the construction projects, especially in Oman. It also assisted in acquiring topic-related information from the other GCC countries through case studies associated with construction projects. “Qualitative research allows for a more in-depth examination of situations in which complex and potentially unclear issues are considered” (Al-Saleh &Taleb, 2010, 52). In the study, the literature review on the research topic mainly highlighted the core ideas about critical quality issues that created a barrier for the construction projects in Oman and other neighbouring countries such as Qatar, Saudi Arabia, and Bahrain in achieving sustainable development. These ideas and core elements associated with the research topic have

been explained by relevant peer-reviewed journal articles that were published between 2000 to 2019 (Al-Saleh & Taleb, 2010).

The findings acquired through the secondary sources, including the journals, mainly reflect the construction sector of Oman as compared to the other neighbouring countries. The journal article titles such as "Perceptions on motivating factors and future prospects of green construction in Oman", "Causes of construction project delays and cost overruns in Oman" and "Sustainability in the Middle East: Achievements and challenges" have been selected for review in this chapter. In addition, relevant journals or peer-reviewed articles have also been selected to justify the findings associated with the main topic. Overall findings portrayed by the journal articles highlighted the main essential ideas and concepts associated with the given research topic. Some of the more important concepts were "water desalination", "engineering managers and sustainable systems", "transformative leadership", "maturity roadmap", "Sultanate of Oman", "cost overruns", and "low-income housing projects".

The systematic literature review (SLR) approach has been used in the study to portray relevant literature findings from different journal articles. Overall, nine different peer- reviewed journal articles have been selected for review in this chapter (Mariano, Leite, Santos, Rocha,& de Melo-Minardi, 2017).

Table 17. Case Study Contribution throughout the Study

Article No.	Authors	Paper Name	Year	Journal
1	Abdellatif M. A & Othman A. A. E	Improving sustainability of low-income housing projects: The case of residential buildings in Musaffah commercial city in Abu Dhabi	2006	Emirates Journal for Engineering Research

2	Abidin N. Z.&Powmya A.	Perceptions on motivating factors and future prospects of green construction in Oman	2014	Journal of Sustainable Development
3	Al Amri T.&MareyPére M. F.	Causes of construction project delays and cost overruns in Oman: A literature review	2019	23rd International Congress on Project Management and Engineering
4	Chawla V.,Chanda A.Angra S., &Chawla G.	The sustainable project management: A review and future possibilities	2018	Journal of Project Management
5	Ghaffour N.Missimer T. M.Amy G. L.	Technical review and evaluation of the economics of water desalination: Current and future challenges for better water supply sustainability	2013	Desalination
6	Issa N. S. C.& Al Abbar S. D.	Sustainability in the Middle East: Achievements and challenges	2015	International Journal of Sustainable Building Technology and Urban Development
7	Jones S. A.& Michelfelder D.	Engineering managers and sustainable systems: The need for and challenges of using an ethical framework for transformative leadership	2017	Journal of Cleaner Production
8	Robinson H. S.Anumba C. J.Carrillo P. M., &Al- Ghassani A. M.	STEPS: A knowledge management maturity roadmap for corporate sustainability	2006	Business Process Management Journal
9	Safinia S.Al-Hinai Z.Yahia H. A., &Abushammala M. F.	Sustainable construction in sultanate of Oman: Factors effecting materials utilization	2017	Procedia Engineering
10	Al-Saleh M. Y.&Taleb H. M.	The integration of sustainability within value management practices: A study of	2010	Project Management Journal

		experienced value managers in the GCC countries		
11	Powmya A.&Abidin N. Z.	Green Construction in Oman: Progress and Implementation Barriers	2013	Proceedings of the 2013 Sustainable Building Conference. 2013
12	Chowdhury M. R. I.Rahman M., &Srabon T.A.	Sustainable construction performances: Challenge and limitation to successful adoption in construction industry	2018	Journal of System and Management Sciences
13	Mahadik U. A.&Mahadik A. B.	Value engineering tool for sustainability in construction projects	2015	Civil Engineering Systems and Sustainable Innovations
14	Zuofa T.Ochieng E.	Sustainability in construction project delivery: A study of experienced project managers in Nigeria	2016	Project Management Journal

Based on the above-illustrated Table 17, it can be seen that most of the peer-reviewed journal articles emphasized the delivery of sustainable development under the operations held in the construction projects of Oman and other GCC countries such as, Saudi Arabia, Qatar and Bahrain. A majority of the case study findings highlighted some crucial quality issues that affect the sustainability of construction projects in Oman and its neighbouring countries. Based on most of the case study findings, it can be seen that the construction sector of Oman failed to incorporate sustainable standards, such as green construction in the past years. Thus, the absence of sustainable standards among the construction projects could be cited as one of the vital quality issues being observed in the construction sector of Oman. Green construction, as an environmental standard, has started showing improvements under the projects whereas the application of the VE tool was the most effective tool in delivering sustainability in construction projects. In addition, the introduction of legal regulations and policies associated

with the environmental, managerial, and operational standards must be regulated by these countries in order to attain a significant sustainability achievement in different construction projects.

In addition, the government and other legal authorities must engage in conducting regular surveys to monitor the performance of the construction companies in Oman and other GCC countries. Integrating market research can also help in determining the opportunities for delivering effectiveness on sustainable measures. A qualitative observational method can be implemented at the time of conducting market research on an "eco-house construction project", which will further help in acquiring accurate data associated with the sustainability of construction projects in Oman (Smit & Onwuegbuzie, 2018).

Conclusion

In accordance with the secondary findings, it is apparent that GCC countries, including Oman, Saudi Arabia, Qatar, and Bahrain, are still on the route of pursuing sustainable development in construction projects. Improvements have started mainly in the GCC countries as compared to Oman. In this context, Oman should attempt to improve the development of sustainability within construction projects through the incorporation of environmental standards. Oman's poor performance is mainly due to the slower progress in terms of using effective and sustainable measures under project operations. In this occasion, the application of the VE tool can be an effective solution towards delivering sustainability within construction projects. Moreover, incorporating the VE tool could display its effectiveness in mitigating the impact of sustainability issues in construction projects. Resource, operational, managerial, political, social, and environmental aspects can be enhanced through the usage of the VE tool. In addition, a lack of quality in the completion of construction projects could be avoided through this tool.

Realizing the importance of achieving sustainability under the construction sector of Oman and other GCC countries, the national governments have introduced a sustainable “green building code”. After the recent introduction of these codes into the construction sector, positive improvements in terms of sustainability have been observed within the construction projects. Since the issues are linked to the managerial proceedings along with the decisions of different construction companies operating in Oman, the application of the VE tool could be the ultimate solution to ensure sustainability in the construction projects. Furthermore, the new Sultan, who sworn in recently, was leading the Oman Vision 2040 committee which increases the hope for the construction industry.

Chapter 6. Value Engineering as a Tool for Sustainability in the Construction Industry of Oman

Based in: *Al Amri, T., & Marey-Pérez, M. (2020). Value Engineering as Tool for Sustainability in the Construction Industry. International Journal of Advanced Science and Technology, 29(3), 7433-7444*

Introduction

Development of the infrastructure of forms of settlements, the state of the urban economy, the safety of structures, and the quality of life are determined by the quality of the construction industry. This is so as the construction industry serves as the basis for the innovative development of a large number of related industries. It is also one of the most important points of growth for the national economy in the socio-economic development of the State of Oman. In the construction industry, there are a large number of organizations participating in the process of creating new facilities and forming an architectural and construction complex (Chowdhury, Rahman & Srabon, 2018). Moreover, achievements in architecture and urban planning are visible indicators of the country's engineering and technical development. Currently, the construction industry as well as the housing and utilities complex are the basic sectors in the economy. Together, they account for about 27 percent of the gross domestic product of the state of Oman. The construction industry of Oman traditionally employs more than 19 percent of the country's able-bodied population and is responsible for significantly affecting the country's economy, power, and defenses as a whole.

In the last few decades, the construction industry in Oman has seen tremendous growth owing to the presence of oil, which has helped finance the developments in different industries and aspects. As a member of the GCC, value engineering has been a familiar concept in Oman due to the substantial interest shown by GCC professionals in value management practice, which was first introduced by defense projects in KSA (Al- Saleh & Taleb, 2010). However, there has increasing calls to include value engineering features in their activities to steer sustainability and

increasing the function while limiting cost will be the most sensible idea to achieve sustainability. Incorporating value engineering in Oman will ensure that the cost of construction remains low while the output increases significantly. VE would increase the value, and the application should take place in the early planning stages of the development, where all parameters required are considered before implementing the targeted design. Figure 17 shows the process flow diagram according to SAVE International, whereas Figure 18 shows the high cost of implementation and the low net loss for VE.

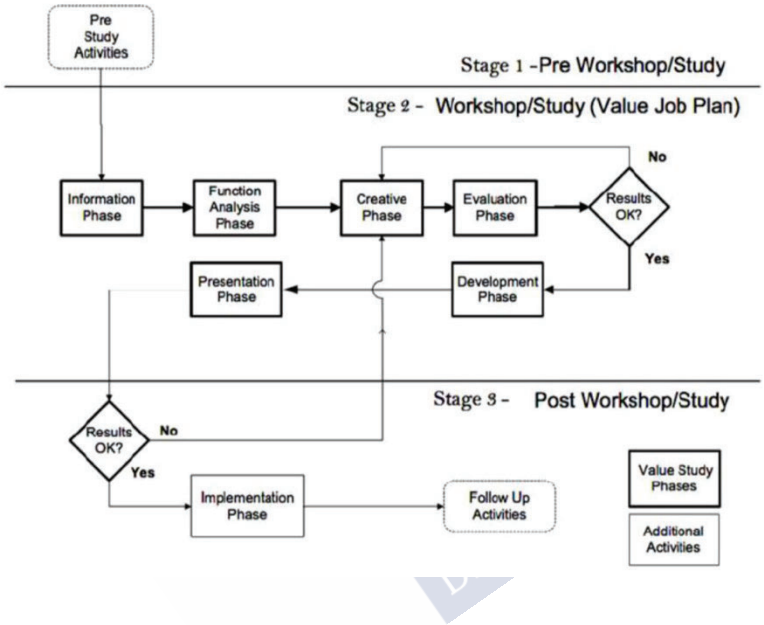

Figure 17. Value study process flow diagram (SAVE International, 2006)

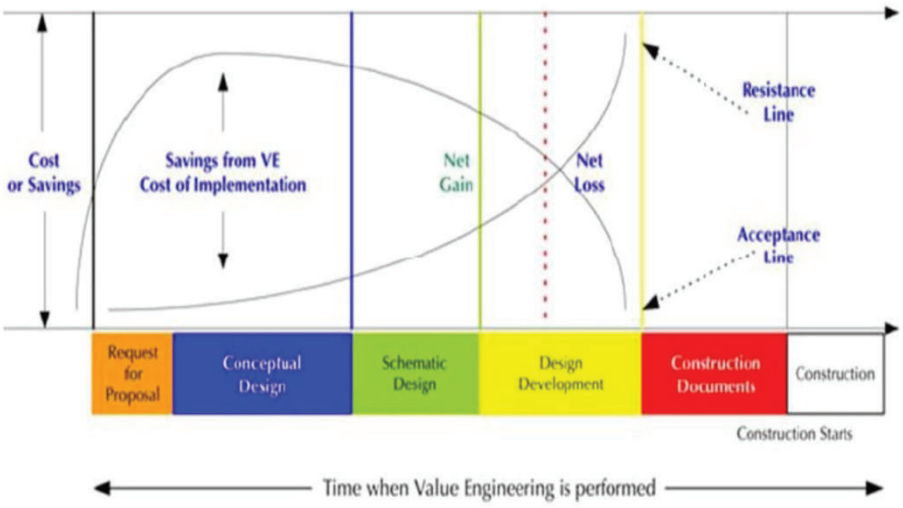

Figure 18. Stages of the project and their relation to anticipated savings using VE (SAVE International, 2006)

Value engineering in Oman's construction practices would not only be a cost-cutting initiative, but an assurance that an engineering intervention is completed efficiently. This attempt would revolve around maintaining quality while reducing the cost, especially when proper utilization of materials exists. GCC countries, along with Oman, indulge in the excessive use of fossil fuels, with a limited emphasis on sustainable construction modes (Al-Saleh & Taleb, 2010). In this regard, Oman's engineering sector is not conscious of the efficient consumption of water, energy, construction material, and health and safety conditions. It is justified to speculate that at this stage, it may cause Oman's construction industry to be less sustainable for future generations.

Value engineering has been present in the GCC countries, but with a different terminology known as "value management". The need for sustainability in the development of GCC has prompted most scholars to consider value management as a critical factor in undertaking systems. As an aspect of value management, value engineering aims to maximize benefits while minimizing costs to spearhead resource savings. However, care is taken so that when the cost is cut, the function or quality of an intervention remains unaffected (Cooper, 2017). Therefore, value engineering involves saving on construction and maintenance durations, as well as reducing possible cost increments due to changes in design. Consequently, this chapter focuses on value engineering and exploring the Oman construction industry to determine how sustainability can be enhanced if value engineering becomes a primary parameter.

Methodology

The primary source of information for this chapter was based on various articles, books, and websites highlighting the nature of the Oman construction industry and sustainability requirements. The items selected ranged from the year 2010 to 2019 to help gain a

contemporary view of the country's construction industry since the last ten years. Google Scholar was the central database for conducting this search, and it provided numerous sources to facilitate the study. During research, some of the keywords that directed our research included "value engineering for sustainability", "Oman construction industry", and "Value engineering parameters" amongst other keywords related to value engineering. Articles addressing sustainability issues for the Oman construction industry were also selected on the premise that value management, which is closer to value engineering, has been incorporated in the GCC countries to enhance productivity. All articles selected were authored in English, and they were to contain keywords that have been mentioned above. Sources used for this chapter were limited to those focused on the central theme of the chapter. In this regard, 24 articles were selected for this research. A comprehensive study was carried out to ensure that they were comparable and relevant to the objectives of this research.

The articles majorly focused on few topics independently, meaning that some focused on the Oman construction industry while others were centred on value management and sustainability. However, some articles that were concentrated on Omani systems were able to provide an analysis of the relationship between the Omani construction industry and value management.

The literature was further organized into five different steps. These include formulation of the research question, location of study, selection and evaluation of the study, analysis and synthesis, and the provision of a report from the study. This study will provide relevant information in showing how value engineering can contribute to sustainability. Table 18 shows the articles that contributed to the current study.

Table 18. Articles selected for research contribution

No.	Author's Name	Title	Year	Source
1	Abidin, N.Z Powmya, A	Drivers for green construction in Oman and its future prospects	2014	Middle East Journal of Scientific Research
2	Abidin, N.Z Powmya, A	Perceptions on motivating factors and future prospects of green construction in Oman	2014	Journal of Sustainable Development
3	Albalushi, I.A Usman, F Alnuaimi, A.S	Appraisal of value engineering in construction industry in Oman	2013	Successful completion of value practice studies
4	Al-Saleh,Y .M Taleb, H.M	The integration of sustainability within value management practices	2010	Project Management Journal
5	Anastas, P.T	Green engineering and sustainability	2003	Environmental Science and Technology
6	Buckley, M Zendel, A Biggar, J Frederiksen, L Wells, J	Migrant work & employment in the construction sector	2016	International Labor Organization
7	Evans, S Vladimirova, D Holgado, M Van Fossen, K Young, M Silva, E.A Barlow, C.Y	Business model innovation for sustainability: Towards a unified perspective for the creation of sustainable business models	2017	Business strategy and the environment
8	Grober, U Cunningham, R.	Sustainability: A cultural history	2012	Cambridge Green Books
9	Haase, S	Engineering students' sustainability approaches	2014	European Journal of Engineering Education
10	Islam, M.A Khadem, M.M.R.K.	Productivity determinants in Oman construction industry	2013	International Journal of Productivity and Quality Management
11	Janani, R Chakravarthy, P.K Raj,D.R.R	A study on value engineering & green building in residential construction	2018	International Journal of Civil Engineering and Technology

12	Mordor Intelligence	Oman Construction Market | Growth, Trends, and Forecast (2019 – 2024)	2020	Mordor's website
13	Powmya, A Abidin, N.Z.	The challenges of green construction in Oman	2014	International Journal of Sustainable Construction, Engineering and Technology
14	Purvis, B Mao, Y Robinson, D	Three pillars of sustainability: in search of conceptual origins	2019	Sustainability Science
15	Rachman, R Abotaleb, I Elgazouli, M	The influence of value engineering and sustainability considerations on the project value	2016	Procedia Environmental Sciences
16	Safinia, S Al Hinai, Z Yahia, H Abushamala, M	Sustainable Construction in Sultanate of Oman: Factors Effecting Materials Utilization	2017	Procedia Engineering
17	Saleh, M.S Alalouch, C	Sustainable Construction in Sultanate of Oman: Factors Effecting Materials Utilization	2015	Procedia Engineering
18	Spetnagel, H	Value Engineering for sustainability	2020	Society for Experiential Graphic Design
19	T.J. Sin G.K Chesen Wee, G H. Hwang	Perceptions of motivating factors and prospects of green construction in Oman. Journal of Sustainable Development	2013	International of engineering and technology
20	Usman, F Jalaluddin, N.A Hamim, S.A	International Conference on Sustainable Building Asia		Journal of Sustainable Development
21	Zumelzu, A Doevendans	Modularity and sustainability: Eindhoven as an example of pragmatic, sustainable design	2016	Urban Design International

22	Albalushi, I. A Usman, F Alnuaimi, A.S.	Value Engineering Advisory System in Construction	2014	Value World
23	Cooper, R	Target costing and value engineering	2017	Routledge
24	Karunasena, G Rathnayake, R.M Senarathne, D	Integrating sustainability concepts and value planning for sustainable construction	2016	Built environment project and value planning for sustainable construction

Based on the literature review conducted, several research questions were identified as critical parameters for this study. Therefore, this chapter will work to offer answers to the following questions:

i. What makes value engineering important for the Omani construction industry?
ii. How can value engineering bring about sustainability for Oman's engineering frameworks?
iii. What is the relationship that exists between sustainability and value engineering?
iv. What factors impede the incorporation of value engineering in the Omani construction sector?
v. What are the factors that will initiate a faster integration of value engineering?

Results and Discussion

Importance of value engineering in the Omani construction industry

The Mordor intelligence website gives an insight into the Omani construction industry, exploring the available opportunities that will warrant value engineering. It states that the construction industry in Oman is on a growing trajectory in supporting the diversification of the economy to spearhead economic growth. Therefore, the government is increasing its

expenditure in the promotion of developments and the stimulation of private investment opportunities.

Additionally, there is also a need by Oman to limit its reliance on gas and oil through the initiation of cuts on GDP dependence on hydrocarbons and substitution with a diversified economic base. In this regard, a significant amount of money has been put aside, amounting to nearly 106 billion USD, for the manufacturing and construction industry (Albalushi et al., 2013). This explains why value engineering is vital for the country to realize its potential in limiting its oil dependency.

In this respect, value engineering will ensure that Omani construction systems allocates its resources wisely. This would require increasing their total output while utilizing appropriate means. Oman's construction potential should also graze across all the different facets of life that are essential for the populace. These will include the commercial sector, industrial and infrastructural systems, residential construction, and energy utility systems. This shows that value engineering will be working to guarantee that such vital services are completed within the shortest time possible with the most appropriate resources necessary.

A diversification process is a form of enhancing sustainability. This is so as at some point, there is a possibility that the oil wells will dry up or that non-polluting energy sources such as solar energy will be in favor. Therefore, the country will work to provide a viable alternative on which the country's economy will benefit from other industries within the country. Recently, several holding corporations in aviation, such as the Oman Aviation Group, and logistics like the ASAAS, were launched to consolidate and achieve this sustainability. These reformations will ensure that the Oman government can collect enough resources to finance the country's needs. In this regard, value engineering safeguards structural components that are in line with the appropriate design criterion so that the usage of such structures are not

compromised by value reductions (Karunasena et al., 2016). This aspect ensures that the finances allocated for developments are within limits and commensurate with the development values recognized worldwide. This will ensure that some alternative systems or materials are cost-effective or environmentally viable for the development at hand. Henceforth, although removing redundant expenses is commonly a result of the VM process, this must not affect function or quality. If this occurs, the value is reduced (Al-Saleh & Taleb, 2010).

Furthermore, value engineering would be useful in value addition by ensuring that higher-quality products are utilized in the construction of the Oman infrastructure. This will enable the structures to last without frequent maintenance costs that might put pressure on the country's resources. Also, value engineering ensures that life cycle analysis is conducted. This certifies that there are options for creating a balance between the initial construction costs and long-term maintenance requirements (Karunasena et al., 2016). Consequently, this confirms that the Omani engineering sector is aware of the lifespan of structures, thus initiating the requisite budget for sustainable future performance of the developments undertaken. Finally, value engineering ensures that the durability of the structures is considered during structural development. Therefore, engineering options or alternatives will provide for systems that make maintenance costs as low as possible. This guarantees that the lifespan of buildings in Oman is evaluated to a great extent, so future costs incurred can be accounted for or kept to the lowest level. Value engineering ensures that projects are implemented consciously to ensure that future need for resources is reduced (Al-Saleh & Taleb, 2010).

How value engineering can bring about sustainability in Oman

Sustainability revolves around the maintenance of environmental balance so that resources are not exhausted when used for various developmental techniques. Value engineering, on the other hand, revolves around the systematic methods employed in engineering to improve the

value of products, materials, or services provided in a construction project through a critical examination of the functions (Islam & Khadem, 2016). Therefore, focusing on value is a recipe for sustainability, as most building projects tend to be harmful to the environment which would be detrimental to sustainability. On a global scale, the building industry is responsible for the emission of greenhouse gases. Besides, engineering is the number one contributor to the exploitation of the world's resources. Islam and Khadem (2013) stated that a significant amount of the country's resources was directed towards construction as a way of diversifying the economy. Saleh and Alalalouch (2015) also affirmed that the construction industry in Oman was mostly unregulated (Saleh & Alalalouch, 2015). The result of the unregulated construction industry contributes to the production of greenhouse gases which might cause disastrous effects in the future.

Janani and Raj (2018), in their study of value engineering, proposed that there are multiple benefits that sustainability can bring about to a construction industry, including in Oman. Firstly, it stresses the responsibility and efficiency in the use of resources for such engineering interventions (Janani & Raj, 2018). As such, the resources allocated to the construction of Oman systems should be optimized to avoid wastage. Moreover, value engineering is driving towards creating responsible and environmentally knowledgeable design concepts aimed at saving energy costs, water, and consumption of other essential resources (Spetnagel, 2010). In this regard, the designs of structures are created in a way to optimize natural resources. For example, designs will allow natural light to brighten a room rather than depending on electrical energy sources.

Zumelzu and Doevendans (2016) also focus on modularity as a component of value design that can bring about sustainability. Modularity emphasizes how replaceable parts of a given construction element are to initiate easy removal or addition (Zumelzu & Doevendans,

2016). This is usually pervasive in apartment design, where different components are to interact with each other to ensure efficient resource utilization. For example, apartments adjacent to or closer to each other are designed to use a similar plumbing network to reduce the cost of installation.

Finally, value engineering is useful in the development of preferred systems as a premise for the development of sustainable building outcomes. Wao et al. (2016), focusing on value engineering for sustainable construction, explain that value engineering encourages the use of tools in create realistic and purposeful changes to limit the possibility of unforeseen accidental changes that can happen in a project (Wao et al., 2016). This certifies that Oman's engineering frameworks engage in a prior planning technique to be initiated for sustainable facilities so that the various stages of design from conceptual to construction stages are in line with the requirements of sustainability. In the Omani construction industry, it would be prudent if value-engineering job plans serve as the guiding agenda towards achieving sustainable business systems.

Therefore, it is imperative that value engineering incorporation in building systems focuses significantly on sustainability measures. Green building construction has become an integral part of contemporary construction as it not only ensures absolute environmental safety, but also encourages the use of appropriate technology in the systems of design to direct sustainable development (Anastas, 2003). Through integrating such systems, Oman's construction industry will work to launch sustainability. Evans et al. (2017), in their calls toward sustainable engineering practices, consider value engineering concepts and precepts as crucial factors in the formulation of appropriate systems to achieve a sustainable development system for any engineering intervention (Evans et al., 2017). The booming construction industry in Oman means that there will be a need for efficient engineering designs to spearhead

faster growth through the employment of valuable resources. Furthermore, value engineering ensures that Oman construction industry activities do not result in widespread environmental pollution. Thus, a guarantee toward an improved health quality for its population should arise, contributing to the development of a sustainable system.

Relationship between value engineering and sustainability

Sustainability requirements may be due to various systems, but value engineering concepts are generally a reflection sustainable methods (Grober & Cunningham, 2012). In the European Journal of Engineering Education, Haase (2014) highlights some of the viable approaches that an engineer ought to consider for any intervention. Value engineering is important as it prioritises the sensible utilization of resources for any aspect of constructional work. Rachwan et al. (2016) reflects upon functional analysis as a vital component in value engineering. Therefore, this involves an increase in the value of projects through the analysis of functions that it intends to achieve. As such, there have been proposals on the practical alternatives to be explored for engineering interventions such that the value grows while possible compromises in the design are limited.

Sustainability measures, on the other hand, focuses on the programs, initiatives, and actions that are geared towards improving the preservation of a given resource. The primary resource in Oman is oil, and its continuous exploitation provides the means necessary for financing major constructional facilities (Mordor Intelligence, 2020). Sustainability revolves around four primary pillars, which consist of social, environmental, economic, and human aspects. In the context of Oman, sustainability measures ensure that the four pillars are accorded due attention during the planning stages of any constructional facility. Value engineering, therefore, has a relationship to sustainability based on the four pillars stated.

For human sustainability, the objective is to maintain human capital in a society and to include investments in health systems, access to services, skills, and nutrition. It stresses the need to maintain individual well-being while sustaining economic growth. In this setting, value engineering guarantees that humans have the requisite skills and capacity in engineering frameworks to support the sustainability functions of structures. Regarding social sustainability, the objective is to incorporate ethics in the exploration of societal systems (Saleh & Alalalouch 2015). The achievement of this is through the provision of information for equality towards societal issues. Value engineering, in this regard, ensures that the resources for a given society are used wisely for the betterment of their systems.

In the economic sustainability aspect, the presence of materials is crucial for executing projects to create products and services on time. Value engineering supports this aspect significantly in that it focuses on the effective utilization of limited resources in achieving the desired outcomes (Abidin & Powmya, 2014). Additionally, it will corroborate the economic interventions that are completed within the stipulated time to save on costs and essential resources. Finally, regarding environmental sustainability, the use of fossil fuels in powering engineering systems in Oman is extensive. Therefore, this appraises the need to address greenhouse gas emissions to the atmosphere.

Additionally, construction and engineering utilizes most of the Earth's resources, which increases the possibilities of environmental degradation. Therefore, environmental capital aims to protect natural capital, including air, water, minerals, and land (Purvis et al., 2019). In this situation, value engineering focuses on the utilization of alternative construction methods and materials that are environmentally viable. It stresses the use of green energy systems, such as the use of solar power and design parameters, that bring about the effective use of water and energy sources.

Factors that impede the incorporation of value engineering in the Oman construction sector

Safinia et al. (2017) focused on the factors that hinder the utilization of value engineering precepts in the Oman construction industry. The results will provide us with relevant information on how value-engineering concepts can be implemented in the engineering sector (Safinia et al. 2017). Oman's oil production capacity is significantly lower than that in neighboring GCC countries. Hence, the implementation of value engineering would be the most viable alternative to lead sustainable development. The journal lists some of the factors that tend to make the incorporation of sustainable technologies a difficult task in the Oman construction industry, with materials given the due priority.

With regards to materials, an obstacles are the high costs related to the materials (Safinia et al., 2017). Costs are also related to maintenance measures to ensure that the installations are congruent with the design aspects. Procurement for sustainable materials comes with upfront costs and acts as a significant impediment by discouraging the developers from considering the same. Most sustainable materials have a higher cost in comparison to traditional materials, and most Oman stakeholders tend to assume that it cuts across all sustainable related materials (Safinia et al., 2017).

Secondly, there is a lack of demand for sustainable materials. Decision-makers in Oman find it hard to implement green energy interventions because clients show no interest in using environmentally friendly materials. Additionally, they tend to prefer older design practices, making it difficult for effective practices to be put in place.

The third aspect is the shortage in the publicization of sustainable materials and strategies. In cases where the promotion of sustainable alternatives increases in the Oman industry, potential clients will have sufficient information on the choices for the selection of

viable alternatives (Powmya & Abidin, 2014). The media and advertisements do not centre on these promotions, resulting in the absence of people's knowledge of the availability of such systems.

Fourth, there are limitations in the enforcement of green regulations. The Oman government is doing little to ensure that laws relating to green policy are implemented in construction realms. Sin et al. (2013) argued that the insufficiency in implementation is due to the fear of the government that it might scare investors who may not be ready to put up with the new regulations. However, the Omani construction industry requires such regulations so that sustainability is given priority in any development.

The fifth factor is the lack of knowledge regarding sustainable materials among the Omani population. Sin et al. (2013) further asserted that awareness is the most significant impediment to the successful application of sustainable tools such as value engineering. The absence of awareness results in the population having a poor concept of the sustainable alternatives required in the construction industry. Therefore, the insufficient understanding has been proven to be among the factors limiting the shift to value engineering. Other factors that limit the implementation of sustainable measures include limitations on recycling plans available in the country, shortage in the initiatives and interests of the Omani government to encourage the use of such materials, unavailability of sustainable materials, and inadequate expertise in designers and builders to employ the novel technologies (Safinia et al., 2017). Therefore, the employment of adequate systems will require the consciousness of such policies so that useful systems are implemented in the country to provide adequate ground for the utilization of value engineering concepts.

Factors that will initiate a faster integration of value engineering

Oman is currently diversifying its economy as a means of limiting their economic dependency on oil. Diversifying the economy will require opening the construction industry to other global players, which could convey value design principles to the Omani construction sector. The first factor enhancing Omani's incorporation of value engineering tenets is the presence of international players in their constructional industry. Recently, Oman has entered an economic collaboration with China, and they are building the Sino Oman industrial park at a cost of 10.7 billion USD (Mordor Intelligence, 2020). This scheme aims to convert its seaport, which is often underutilized, to a hub for global trade. In this manner, Oman will open its gates to the rest of the world, making it easy for value engineering precepts to be incorporated into their internal systems.

Furthermore, the construction sector remains the largest employer in Oman, forming a critical component of the Omani economy. Data from the National Centre for Statistics and Information 2016 stated that the sector provides an opportunity for 25% of Omani workers and 39% of expatriates (Buckley et al., 2016). This sector, therefore, works to imbue nationals with the requisite skills and experience to help in meeting their obligations (Abidin & Powmya, 2014).

Additionally, there has been a significant change in the perception of people awareness of the benefits of sustainable alternatives. An interview conducted by the Journal of Management on Value Management Studies found that some managers hold the view that sustainable concepts should be incorporated into the curriculum. This system will ensure that people in the construction industry have the requisite value engineering precepts to inform their choice for techniques and materials (Abidin & Powmya, 2014). Others also argue that sustainable techniques are viable alternatives that can be employed to make people adhere to

other approaches to meeting objectives and performing tasks with resource value as a basis for their activities.

Albalushi et al. (2014) affirmed why value engineering would be essential in the engineering sector. The study analysis showed that there was a general need for projects to be completed within 20 months after initiation. The study found that when a project is completed within a short period, there are higher returns from the engineering intervention. This could potentially help provide a platform where the Omani populace undertakes activities that are sensitive to value increase. Usman et al. (2018) also explored Omani construction firms. The study records significant cost reduction patterns through such utilization, resulting in a broader application and gain acceptability in the entire Omani construction framework.

Conclusion

The literature review provides us with the requisite information to answer the research questions formulated for this study. The analysis section, therefore, provides us with a comprehensive review and delivering ideal information for the questions at hand. From the review, the importance of value engineering in Oman was highlighted. Factors that promote and obstruct successful application were explored. Additionally, the literature review revealed the various ways in which the incorporation of value engineering will most likely include the sustainability issue in the construction industry. From the text, it is evident that Oman is currently recording significant growth in the construction industry, mainly due to the need by the government to diversify the economy and reduce its dependence on oil. In this regard, they need to have appropriate engineering systems that would provide sustainable alternatives for the economy's development.

Moreover, some of the important aspects of value engineering for Oman's construction industry range between cost decrease, waste reduction, and incorporation of appropriate

expertise for the people so that they have the skills to propel the use of sustainable patterns in a similar construction setup. Finally, value engineering is the most significant factor in tackling the sustainability issue in Oman. Value engineering can provide promising results since it provides the requisite guidelines that companies can adhere to when the prudent utilization of resources comes into question. It also provides a baseline to guide how resources can be effectively utilised for different developmental purposes.

Chapter 7. Impact of Covid-19 on Oman's Construction Industry

Based in: *Al Amri, T., & Marey-Pérez, M. (2020). Impact of Covid-19 on Oman's Construction Industry. Technium Social Sciences Journal, 9(1), 661-670.*

Introduction

The construction industry remains one of the most important sectors of the economy in the world. The construction industry is huge, sustainable, and consumes up to 10% of finances spent globally. It is already clear that the epidemic will have serious consequences for the economies of the world. According to the forecast, the annual growth of world GDP until 2020 will fall to 2.4%, as compared to the projected 2.9% in 2019. Furthermore, growth might possibly be negative in the first quarter of 2020.

The Coronavirus pandemic (COVID-19) has had a significant impact on almost all areas of economic life in Oman and the world. Global efforts are aimed at trying to minimize the spread of the virus and to mitigate its effects (Confronting the COVID-19 pandemic in the Middle East and Central Asia, 2020). Companies in almost all sectors of the economy found themselves in a difficult situation because they are responsible for the major contracts and employees. In an ever-changing situation, the business is faced with a wide range of commercial and legal difficulties (Woertz, 2020).

With the spread of the COVID-19 pandemic, the business world will not be the same, including the construction industry. The shortage in the local workforce massively increased the demand for laborers from low-income countries (Al Amri & Marey Perez, 2020; Albogamy et al., 2012). Therefore, there has been a massive inflow of such laborers into the country, which is the same for other high-income GCC countries. According to a study by Price Waterhouse Coopers (2020), there are three main concerns caused by COVID-19 for engineering and construction. The concerns are the financial, international recession, and

influence on the workforce. The study has surveyed the current literature to analyze the impact of the COVID-19 pandemic on the construction industry of Oman (Woertz, 2020).

COVID-19, A Pandemic

An outbreak of pneumonia caused by a new type of coronavirus, according to the WHO classification, was recorded in December 2019 in the Chinese city of Wuhan (Woertz, 2020). To date, the number of cases in the PRC has reached approximately 80.5 thousand people; almost 54 thousand patients have been cured. Cases of infection have been recorded in more than 85 countries, including Oman (Woertz, 2020). The World Health Organization, in connection with the rapid expansion of the virus, has raised its global risk assessment to "very high" (WHO, 2020). On February 27, UN Secretary-General António Guterres stated that there was a clear risk of a coronavirus pandemic and called on governments to do everything possible to stop the spread of the virus. According to the UN Secretary-General, the coronavirus pandemic can have a devastating effect on the global economy (Woertz, 2020). The most massive outbreaks are occurring in the United States (> 932 thousand people) and European countries: Spain (> 219 thousand people), Italy (> 195 thousand people), and Germany (> 154 thousand people). In China (> 84 thousand people), the effects of the pandemic declined in March, but by the end of April, the number of new cases started to pick up again (Woertz, 2020).

In order to prevent the mass spread of infection which would overload the health care system, many countries have taken unprecedented measures. These measures include the introduction of full or partial quarantine (self-isolation of the population and stopping all non-vital enterprises), and the cessation of transportation (Choudhury, Ghosh & Sindhi, 2020). Such measures will inevitably lead to a slowdown in production, rising unemployment, and a drop-in consumption (Choudhury, Ghosh & Sindhi, 2020).

Unprecedented measures to curb the spread of the COVID-19 will have a negative effect on countries' economies regardless of their integration into global value chains (Choudhury, Ghosh & Sindhi, 2020). Experts from The International Monetary Fund (IMF) believes that the world GDP will decrease by 3% by the end of 2020, which is a much higher indicator than the financial crisis of 2008–2009. A similar fall will make the current crisis the worst since the Great Depression (Choudhury, Ghosh & Sindhi, 2020). It is noted that a recession in the second half of 2020 is anticipated, with an expected 5.8% global growth in 2021 as economic activities are more normalized. Economically developed countries will be hit hardest by the crisis (Cheshire & Hilber, 2020). On average, the GDP of developed countries will decrease by 6.1% in 2020 – the USA will experience a 5.9% decrease, countries in the Eurozone of 7.5%, and 5.2% for Japan. Conversely, developing countries will be less affected by the current crisis where their economies will shrink by 1% on average. In China, an increase of 1.2% is expected, as compared to a growth of 6.1% in 2019. Brazil's economy is expected to shrink by 5.3%, Mexico's by 6.6%, South Africa's by 5.8%, and Russia's economy by 5.5% (Cheshire & Hilber, 2020). The drop in industrial production is one of the reasons for the slowdown in economic growth. The shock dealt by solvent demand and supply chains, supply chain gaps, reduction investments are all factors that negatively affect several sectors of industrial production (Cheshire & Hilber, 2020).

Methodology

COVID 19 has impacted every aspect of life and has resulted in the disruption of all major businesses around the globe. This chapter is focused on analyzing the impact of the COVID-19 pandemic on the construction industry of Oman. Oman is an oil-rich country, and the economy majorly is dependent on oil and oil extracts. However, the construction industry is the second major contributor to the economy. Nonetheless, there has been a lack of recent research articles analyzing the impact of COVID-19 on oil and the economy of Oman.

Moreover, there is a lack of literature based on the impact of the pandemic on the construction industry encourages further research.

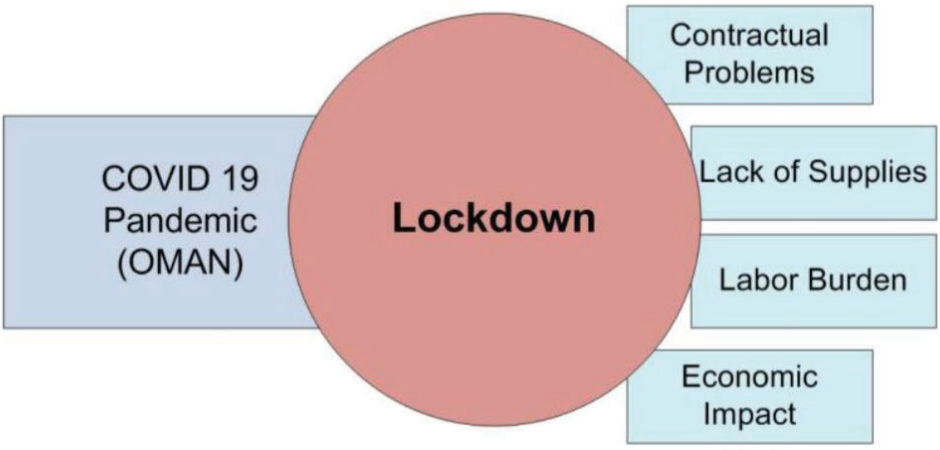

Figure 19. Impact of the COVID-19 on Construction Industry of Oman

Therefore, secondary research based on the news, governmental statistics, and current literature have been done to analyze the current situation of the construction industry of Oman. Figure 19 depicts the main elements of the construction industry in Oman that are affected by the COVID-19. The study has analyzed the vulnerabilities, risks, and losses due to the impact of COVID-19 on the construction industry of Oman. Furthermore, the labor burden and contractual issues due to the pandemic that are based on the laws of the state of Oman will also be discussed. Therefore, this chapter focuses on both the economic issues, and the major problems faced by the labor and construction-based companies in Oman.

Discussion

Oman is known as the pearl of Arabia, and it is attractive for its events. The country boasts a fascinating history, geographical diversity, and cultural heritage, which makes it a distinctive and authentic place. Oman's economy continues to grow due to rising oil prices and serious efforts to increase the contribution of non-oil sectors to the GDP (Ahmad & Masan, 2015). As

Oman diversifies its economy to meet the goals of economic growth, the construction industry is becoming an increasingly important factor in attracting domestic investment (Alkalbani et al., 2013).

The COVID-19 outbreak continues to actively intervene not only in people's lives, but also in the global economy (Maliszewska Mattoo & Van Der Mensbrugghe, 2020). It is already known that the virus affects oil prices, exchange rates, airline routes, and large-scale events (Khan et al., 2020). The shock of solvent demand is one of the key factors resulting in the decline in industrial production. IMF experts note that consumers reduce their spending amid falling incomes, fear virus infection, or increased uncertainty (IMF, 2020). This leads to the reduction of demand for products and services in many sectors of the economy and industries. This trend has more impact on medium and small businesses, where 77% of companies with annual revenues of less than £ 50 million ($ 62 million) reported a drop-in demand. For large companies, this rate is 64%. However, the big construction business is facing great difficulties related to supply chains as compared to medium and small businesses. This is seen where 44% of big construction businesses have reported issues as compared to 32% of medium and small construction businesses (EIC, 2020).

Impact of COVID-19 on Construction Industry

Due to the operation requirements, the construction industry cannot be transferred to a remote mode of operation. Therefore, this industry is one of the most vulnerable sectors to the coronavirus infection. At the same time, decisions on a complete ban on construction were not made (Alandijany, Faizo & Azhar, 2020). However, due to strict quarantine, construction works were almost completely suspended in the USA, Italy, and Spain (KHL, 2020). In other virus distribution centers, only non-critical construction sites were stopped.

The COVID-19 situation poses two major threats to the Omani construction industry. The first threat is a decline in consumer activity; in an epidemic, citizens will simply not have time to buy a home. Also, developers may be forced to close quarantine sales offices. Experts have pointed out that the spread of coronavirus can hypothetically affect the ability to start and finish construction projects on time. In April, the UK analytical agency Global Data adjusted its forecast for growth in global volumes of the construction sector in 2020 from 3.1% to 0.5% (Williams & Kayaoglu, 2020). This trend of revising forecasts can be seen in many countries, where in China, the planned growth in construction volumes decreased from 5.1% to 3.6% and in Italy, from 1% to 0.7% (Williams & Kayaoglu, 2020). The main reasons for the decline in construction volumes were attributed to:

i. The suspension of constructing individual projects by the decision of developers or government agencies.
ii. Interruptions in the supply of materials and equipment.
iii. The displacement of workers due to the closure of borders between countries
iv. The suspension of transport links, where the materials were mainly sourced from China, and the labor force mainly came from Eastern Europe
v. Reduced laborers' productivity due to increased security measures.
vi. Increased financial problems for contractors and suppliers of materials, as most companies are small businesses that do not have stocks and or access to liquidity (Kahn Lange & Wiczer, 2020).

According to estimates by exports, 30% of European manufacturers of engineering and construction equipment are now on the verge of bankruptcy. Another 30% of manufacturers are also reported to be cutting production. The contracts in the Middle East are estimated to decline by 75% in March 2020 (Kahn Lange & Wiczer, 2020).

Impact of Pandemic on Construction Industry of Oman

1. Construction Industry of Oman

Oman is an oil-rich country, and most of its GDP depends on oil and oil products. However, the construction industry is also a major part of its economy (Crosthwaite, 2000). Unfortunately, the Omani real estate market and construction industry are in crisis due to the departure of foreign workers. However, according to an estimate, about 670 commercial property owners in Oman are facing the problem of bankruptcy. The main pressure has appeared after several foreign workers left the country because of the repeated government initiative of replacing them with locals (Said, 2016).

Officials implemented the Omanization in 1988. It aimed to increase job opportunities for the locals by reducing the number of foreign workers in Oman (KC & Nilambari, 2018). The government has shifted or removed most of the privileges and benefits, including free commercial land, preferential business loans, and free training for private sector companies who do not nationalize a certain amount of their employees (Said, 2016). The country is perhaps experiencing the most serious labor crisis since the last four decades. According to the World Bank, Oman's unemployment rate is around 17% (The World Bank, 2018). Therefore, the Ministry stepped up the onslaught of nationalization, instructing private companies to generate about 25000 jobs for locals by the mid of 2018 (Times News Service, 2018). Furthermore, according to the Ministry of Manpower, up to 60,000 individuals of Oman, mostly graduates, are currently searching for work (Al Shaibany, 2015). The government's goal was to create between 40,000 and 50,000 jobs every year for the next five years, with half of them in the private sector by 2018 (Times News Service, 2018).

Moreover, the adviser to the Ministry noted that if any company does not support innovations, the Ministry will not provide it with the necessary services, including the issuance of work cards, permits, and renewals (Alandijany, Faizo & Azhar, 2020). In April 2018, similar measures were already applied for 199 companies, where 16,544 foreigners worked. However, many landlords may not reciprocate this initiative, as many of them face bankruptcy and the inability to repay the loans they took to build the property (Alandijany, Faizo & Azhar, 2020). In such cases, the property is confiscated by the state and will be sold at auctions. According to an estimation, about 115,000 workers left Oman between March 2016 to March 2018 (Alandijany, Faizo & Azhar, 2020). Construction industry experts fear that a market crash is inevitable. However, according to ratings, Oman is among the top countries for expats (Alandijany, Faizo & Azhar, 2020).

As for the real estate industry, Oman's real estate sales have fallen by 78% in 2017 as compared to 2016. The total value of all real estate transactions in April 2017 amounted to $ 2.5 billion (NCSI, 2020a). According to the National Center for Statistics and Information of the Sultanate (NCSI), in April 2017, the total fees collected from the purchase of real estates amounted to $ 78.7 million, which is 20.8% higher than 2019(NCSI, 2020a). In total, in April 2017, buyers entered into 21,675 sales contracts (NCSI, 2020a). This is 19.4% less compared to 2016 (26,883 transactions) (Bhatia, 2017). For the indicated period, 83,307 documents confirming the right of ownership were registered (Bhatia, 2017). In the same month in 2019, there were 4.8% more of such documents (87,489). A report on the real estate market prospects of Cluttons' Muscat Spring 2017, reported that rental rates in the capital of Oman decreased by 10.1% in 2016. "The difficult times on the market have prompted homeowners to take a more flexible, innovative approach to attract potential tenants" (Bhatia, 2017).

The National Centre for Statistics and Information in Oman indicated that the construction workforce was at 490,206 by the end of December 2019. (Mordor Intelligence, 2020). Likewise, in their last bulletin of May 2020, the NCSI revealed that the number was 454,027 in April. Thus, there is an approximate 7.38% decrease in the total expatriate workforce (NCSI, 2020a). Moreover, the number of Omani workers in the Construction Industry has fallen by 2,288. This is around a 3.89% drop from December 2019 (NCSI, 2020a). Table 19 shows the numbers from January to April 2020, and the numbers of 2019. The decrease in numbers is expected to grow if more countries announce lockdown plans in the future. In an industry that already suffers from project delays, the impact of this pandemic on the construction industry would be severe. In his recent study, Umar (2020) investigated the impact of accidents in some GCC countries. The study indicated that accidents annual expenses in Oman are approximated at USD$ 415,00, and the economic burden exceeded USD$ 2.5 million per annum (Mordor Intelligence, 2020).

Table 19. Number of Workers in the Construction Sector of Oman

2019		**2020**			
		Jan	**Feb**	**March**	**April**
Omanis	58793	57841	57901	57026	56505
Expatriates	490206	480108	479022	457483	454027

Source: NCSI, 2020a & b

While the government is trying to diversify the economy, the expectations of more growth in the construction industry were high. According to Mordor Intelligence (2020), the construction industry is anticipated to have a growth of 6% from 2019 to 2024. However, the industry endured a drop of 5.8% (NCSI, 2020). Therefore, the construction industry indeed is going through the toughest times since WWII.

Lockdown Situation

Authorities of the Sultanate of Oman decided to close the capital province of Muscat as part of the fight against the spread of the coronavirus. Roadblocks were set up between the provinces to control the movement of people (Gulfnews, 2020). The lockdown situation resulted in the reduced commercial activity and newer contracts. The Construction industry of Oman is largely damaged because of restrictions and the loss of business focus on the construction industry. Due to the pandemic, market focus has been shifted towards the necessities of life, such as food and medical facilities. Therefore, the construction industry of Oman has been negatively impacted. This is seen in the decrease in the construction volume in Oman where the contract rate in March 2020 was reduced to 75% in the Middle East (Mordor Intelligence, 2020).

Contractual Problems and Lack of Supplies

COVID-19 has impacted the construction industry in a variety of ways, including the loss of labor, lack of supplies, increased cost of construction material, and the change in demand (Mordor Intelligence, 2020). Due to the pandemic, it is hard to complete most of the construction projects in time. In such cases, force majeure can be used. However, force majeure is not recognised by the legislation of the state of Oman. According to the Article 172 of Oman's Civil Transactions Law (RD 29/2013), "in bilateral contracts, if force majeure occurs rendering the performance of the obligation impossible to complete, the corresponding obligation shall be extinguished, and the contract shall automatically be revoked." Force majeure is used to excuse the company from delays or failure of its responsibilities because of some inevitable event that is not under the control of the company (Thomas, 2017). Therefore, it is necessary to include the clause of force majeure in the contract terms. Moreover, in case of the "impossibility" to fulfil contracts in Oman, the company can follow Article 647 of The Civil Transactions Law which states that "if an excuse hinders the execution of the contract or

the completion of such execution, it may be rescinded or terminated by either of the parties, as the case may be." These clauses are needed for the adjustment of contracts in a crisis such as pandemic being faced by the world.

Labor Burden

According to estimates by the International Labor Organization, COVID-19 has affected nearly 2.7 billion workers worldwide, which corresponds to about 81% of the global workforce. The crisis has led to an unprecedented decline in economic activity and working time. During the second quarter of 2020, working hours are expected to decrease by 6.7%, which is equivalent to 195 million full-time workers (at 48-hour work week). According to the classification of the International Labor Organization, the construction industry is included in the number of industries where employees are most affected by the effects of the crisis (ILO, 2020). Quarantine measures, closing stores, cancellation of orders, and lower wages reduce consumer demand, which directly affects the situation of workers in the industrial sector.

Furthermore, the negative effects of the COVID-19 has lead to a shock in the proposal. Experts believe that, in terms of labor, there has been a decrease in labor supply due to an increase in mortality, malaise, and absenteeism that can be caused by the need to deal with children due to school closures. Lower supply and demand lead to lower revenues enterprises that are forced to take tough measures such as the reduction of wages and the dismissal of workers (Trowers & Hamlins, 2020). According to some forecasts, unemployment as a result of quarantine measures smay reach up to millions of people. In Oman, most of the labor is utilized in the construction industry that shares the major burden of labor and unemployment (Al Maskary, 2018). Due to the rapid spread of the COVID-19, Oman has added checkpoints and limited the major industrial supplies. Some of the construction projects are suspended, and the others are delayed, which resulted in heavy financial losses. Due to reduced construction,

the rate of unemployment in Oman will increase in the future. At the same time, the construction industry is suffering from a lack number of skilled laborers (Al Amri & Marey-Perez, 2020). Overall, the continuation of the pandemic would certainly reduce the numbers of both Omani and expatriate construction workers'.

Economic Impact

Unlike the 2008 situation, the consequences of the COVID-19 pandemic could be significantly worse for several reasons. Firstly, a crisis may have greater reach, influencing the company's FDI and capital expenditures for developed and developing countries (Pachura, 2011) Secondly, the effect of projects delays on the FDI may be less significant due to the significant decrease in consumer demand, accompanied by the forced completion and postponement of investment projects. Thirdly, in the event of a crisis in the financial sector, enterprises will not be able to fulfil their financial obligations, which will result in a fall in global investment flows as a result of the "domino effect." Closure of commercial and manufacturing enterprises, as well as construction sites, would immediately cause a delay in the implementation of investment projects (PricewaterhouseCoopers, 2020). Enterprises will continue to bear some investment cost, such as fixed running costs, while costs on other aspects will be forgone. New investment projects will most likely be delayed, and the processes of mergers and acquisitions will slow down in Oman.

Conclusion

The COVID-19 global pandemic has had a drastic impact on the construction industry, resulting in slowing economies. Oman's construction industry is the backbone of the country's economy during the global lockdown that severely impacts the global oil prices. The construction industry has slowed down due to the lockdown in Oman that restricts tourism and demand for new facilities. Furthermore, the pandemic has changed the global demand for development, and countries are more focused on giving relief to the shrinking economic sectors. Construction contracts are now delayed, with closed borders serving as the major issue in critical material supply chains. Construction companies are also reducing their staff, and the workforce is mostly unemployed. Contractual delays are also restricting the operations of the construction industry. In addition, critical labor and field specialists based abroad are not available because of the global travel ban. Overall, the declining economic condition of the construction industry has posed great challenges for employees and managers to manage the operating cost. The COVID-19 global pandemic has affected the future economic prospects of the construction industry in Oman, limiting the opportunities and creating new obstacles for future economic development.

Chapter 8. General Discussion

The thorough review of various literature and secondary data has underlined several issues affecting the Omani construction industry. Overall, the most pressing issues are the dilemmas in delay and cost overrun, sustainability and green construction, and the impact of the COVID-19 pandemic on the Omani construction industry. This chapter will provide a critical analysis of these topics that have been discussed in earlier chapters. Firstly, project delays and cost overruns and their impact on Oman's construction industry will be discussed. Next, dilemmas in sustainability and green construction as they relate to the Omani construction industry will be analyzed. Lastly, the problems that have been evoked as a consequence of the COVID-19 pandemic and their impact on Oman's construction industry will be discussed. Overall, this chapter aims to delve into the meaning, relevance, and the importance of the results obtained.

Project Delays and Cost Overruns

Findings from the earlier chapter has demonstrated that project delay and cost overrun problems can be categorized into client/owner based factors, contractor based factors, consultant based factors, and external factors. These factors broadly include poor contractor management, design delay, low productivity level, unqualified labor, poor coordination, an inadequate workforce, and financial difficulties, among others. Findings further show that the Performance Information Procurement System (PIPS) and the schedule management plan are suitable solutions that can be used to tackle these problems.

In addition, it has been found that factors that contribute to construction delays and cost overruns in private and public projects are not always similar. These research findings have a number of implications. Firstly, they show that project delays and cost overruns are a pervasive problem in the Omani construction industry. Secondly, it is evident that whenever delays and

cost overrun occur, its cause can always be attributed to the project owner, the contractor, the consultant, or external factors. Client/owner based reasons may include aspects such as financing, poor communication, persistently changing the project plan, and so on. The contractor may cause delays and cost overruns by deploying unqualified labor or having an inadequate workforce. The consultant, on the other hand, could contribute to delays by submitting the project designs late. External factors such as natural weather occurrences could cause delays and cost overruns in construction projects. Overall, the Performance Information Procurement System (PIPS), the schedule management plan, and good communication between the different stakeholders within a project are essential to tackle the problem of delays and cost overrun in the Omani construction industry.

Sustainability and Green construction

Findings show that green construction and sustainability are still pervaded by a number of issues in Oman. Specifically, the Omani housing market is largely monopolized by big construction companies, which makes it difficult for small and medium-sized businesses to make a footing in the market. Furthermore, small and medium-sized entities are often deemed as inexperienced and unskilled in the areas of sustainability and green construction and thus, often cannot secure construction contracts.

Furthermore, this thesis has proved that Omani regulatory bodies lack coordination. The fact that these organizations are not well-coordinated means that their policies are largely fragmented. This has affected Oman's sustainability and green construction because there are no unified policies to underline how sustainable and green construction ought to be conducted. Adopting unified green building codes may help to solve this dilemma. The review of literature also shows that while the concept of green construction was introduced in Oman several years ago, it is not well understood by the different stakeholders in the construction industry. What this implies is that the implementation of green construction will not be effective since

stakeholders in the industry lack sufficient understandings. As for this problem, schooling and training may help solve this problem.

This thesis has also demonstrated that there are no independent organizations in Oman that specialize in sustainability and green buildings, resulting in a lack of a centralized body in tackling the issue. Furthermore, findings show that value engineering could help solve a number of sustainability and green construction issues that pervade the country, including high energy consumptions, low quality, and technological backwardness, among other issues. Therefore, value engineering should be actively pursued so that the Omani construction industry can effectively allocate its resources to forge its way towards the path of sustainability and green construction.

COVID-19 Pandemic

The COVID-19 pandemic has had a devastating impact on the global economy. The construction industry has also been impacted drastically. This thesis has shown that the demand for infrastructural projects in Oman has decreased due to the pandemic. Because of this, business in the construction industry has been extremely slow which has greatly affected the profitability of the industry. Furthermore, the sourcing of supplies and labor from overseas has been hugely impacted as international travel has been largely restricted. Construction companies that are still operational have also had to put measures in place to help protect their workforce. These issues have been shown to be expensive, time-consuming, and disheartening for construction companies. As the world begins to open up, the Omani construction industry may have to address issues illuminated by the pandemic, such as the overreliance on migrant workforce and suppliers from overseas.

Chapter 9. Conclusion and Limitations

Conclusion

In conclusion, while the Oman economy is still mainly reliant on the oil industry, the construction industry plays an extremely important role by being the second biggest contributor to the country's GDP. Furthermore, this is highlighted by the fact that the industry currently employs a sizable portion of the country's labor force. Available data shows that up to 27 percent of the country's workforce work in the construction industry. As a result of the significance of the Omani construction industry, this thesis has endeavored to underline dilemmas that pervade the Omani construction industry. Three dilemmas have been brought forth – the problem of project delays and cost overrun, sustainability and green construction, and lastly, the impact of the COVID-19 pandemic on the country's construction industry.

The paper conducted a thorough review of various literature and used secondary data to obtain a comprehensive view of these aspects as they relate to the Omani construction industry. According to the findings, the main factors that contributed to the problem of project delays and cost overrun tend to be caused by client/owner, contractors, consultants, or by external factors. Specific examples of these include poor contractor management, design delay, low productivity level, unqualified labor, poor coordination, an inadequate workforce, and financial difficulties, among others. Amongst these reasons, poor communication, poor estimations, and frequent changes on the project plan have been proven to be main causes of the project delay and cost overrun issues in Oman. In addition, it is found that project delays in public and private projects are, more often than not, caused by relatively similar factors.

Next, science and technology plays a key role in ensuring that the Omani construction industry is sustainable and green. Notwithstanding, this area is also rife with dilemmas. For example, the monopolization of the housing market makes it hard for small and medium-sized

entities to venture into sustainable and green construction as these entities are often deemed as inexperienced and unqualified. Aside from these, many of Oman's regulatory bodies lack coordination which negatively impact green constructions. Furthermore, the concept of green construction is not well understood in Oman, notwithstanding the fact that the concept was only introduced in the country several years ago. Oman's construction industry also lacks independent expert organizations that can coordinate with government agencies to ensure a sustainable construction industry. The above are just some of the many issues that pervade sustainability and green construction in Oman.

In addition, the coronavirus pandemic has decimated economies around the world. Billions of dollars have been lost as countries scramble to contain the virus. The Omani construction industry has been dealt a resounding blow by the pandemic. Specifically, with lockdown measures in place, businesses in the construction industry continue to be slow as demand for infrastructural development wane. Apart from these, sourcing materials has been difficult and expensive as borders have remained closed and global travel banned. However, while a number of construction sites in Oman have remained open, construction companies have had to protect their employees. This has proved to be quite expensive, time-consuming, and overall, daunting.

Limitations

One of the biggest limitations of this study is that it relies mainly on secondary data. As such, various issues that lie with secondary data would also be implicated in this study. Also, the reliance on mostly one type of data narrows the scope of this study. Therefore, future research ought to be a mix of primary and secondary data so as to solve this quandary. Furthermore, while surveys were also used in analysis, the data attained could have sample bias. The survey might also have been impacted by the researcher's preconceived notions.

Overall, the dilemmas that pervade the Omani construction industry in the areas of delays and cost overrun, suitability and green construction, and the COVID-19 pandemic are far-reaching. A thorough understanding of these problems that has been outlined in this paper would assure that stakeholders in the industry are cognizant of the solutions to arrest these issues.

Chapter 10. Recommendations

The research puts forth a number of recommendations to help Oman deal with project delay and cost overrun issues, sustainability and green construction issues, and the effects of the COVID-19 pandemic. Delay and cost overrun issues can be solved through the Performance Information Procurement System (PIPS) and through a schedule management plan. Good communication between project stakeholders is also recommended. The PIPS and schedule management plan essentially force all project stakeholders to be accountable and helps to manage risk. These tools also ensure that performance is measured. In addition, good communication ensures that all stakeholders are on the same page, which would minimize problems such as reworks of projects.

One of the biggest issues that pervade the Omani construction industry in the areas of suitable and green construction is a lack of coordination between regulatory bodies. Thus, to help resolve this dilemma, this research work recommends effective communication and the constant building of trust between different bodies. To do so, regular rotation of personnel from different bodies can be done. Also, the development of Green Building Codes is recommended to raise the bar for energy efficiency since they go beyond the minimum requirement. Codes such as the International Green Construction Code (IgCC) and others are also recommended as they can help Oman raise its level of efficiency in a multitude of areas in construction.

Unfortunately, the coronavirus pandemic has meant that Oman cannot source supplies from overseas since many countries have restricted travel and closed their borders in an effort to contain the virus. One approach to help the country circumvent this dilemma is to develop the local supply chain industry. Many of the construction supplies that Oman imports can actually be developed in the country. Therefore, the government should strive to encourage this

as it will lead to many positive impacts for Oman. Not only will Oman be able to become more self- reliant, costs incurred from the import of supplies can also be reduced. Hopefully, with the steering of future efforts in the directions recommended, the Omani construction industry can increase its efficiency and productivity in the years to come.

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