

Impact of Supply Chain Disruptions and Inflation on the Construction Industry in the Arab States of the Gulf Cooperation Council

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During the years of 2022-2023, the world economy encountered the significant challenge of supply chain disruptions due to COVID 19, Russia's invasion of Ukraine, and government subsidies during 2020 and 2021. In addition, COVID 19 disturbed the balance of the labor market; many workers retired, changed professions, moved, etc. creating a shortage of workforce. The supply chain disturbance and labor shortage lead to inflation rates that have not been seen for 40 years. The construction industry is a significant part of the any country's economy including the Gulf Cooperation Council (GCC) countries which is composed of: United Arab Emirates, Bahrain, Kingdom of Saudi Arabia, Sultanate of Oman, Qatar, and Kuwait. It is hypothesized that the GCC States are immune to such supply chain and inflation drivers due to the oversupply of imported work force and the economic prosperity that these countries enjoy. Is the construction sector, which is one of the leading economic sectors in the GCC region also immune as well? This paper attempts to examine this hypothesis through a survey designed to capture the opinions of construction professional operating in these states. This survey attempts to

- *Examine the impact of supply chain disturbance, labor shortage, and inflation on the construction industry in the GCC countries.*
- *Figure out how the construction industry reacted to and dealt with these challenges.*

The findings of this research would give us a snapshot of the state of the construction industry and help the industry deal with the above-cited challenges.

Keywords: *Inflation, supply chain, construction industry, and Gulf Cooperation Council (GCC)*

Introduction

This section provides the reader with a generic overview of the geographic, historical, and economical nature of the Gulf Cooperation Council (GCC) region. The GCC is the natural progression of the shared history, religion, and culture along with the prevailing kin relations among the citizens of its countries. GCC is a practical answer to the shared challenges of security and economic development in the region (Encyclopaedia Britannica 2023). In May 1981, the leaders of Bahrain,

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Kuwait, Oman, Qatar, Kingdom of Saudi Arabia (KSA), and the United Arab Emirates (UAE) established a cooperative framework to enhance coordination, integration, and inter-connection among these states to unify, deepen and strengthen the relations and cooperation among their citizens (Gulf Cooperation Council 2023). In addition, being one geographical entity have facilitated contacts and interaction among its citizens and have created homogeneous values and characteristics (Encyclopaedia Britannica 2023).

GCC aims to formulate similar regulations in economic/financial affairs, commerce, customs, communications, education, culture, health care, information, tourism, and legislative/administrative affairs. It also seeks to stimulate scientific and technological progress in the fields of industry, water, mining, agriculture, and animal resources. The council also encourages cooperation in scientific research and joint ventures for the good of their peoples (Gulf Cooperation Council 2023).

The Arabian Peninsula is a desert environment surrounded by saltwater bodies: Persian Gulf, Arabian Sea, and Red Sea as shown in Figure 1. KSA, which is the largest member of the GCC, receives only four inches of precipitation per year on average. The southern portions of the peninsula are some of the hottest places on Earth. Summer temperatures can reach more than 120° F. There are no natural lakes or significant rivers on the peninsula. Historically, the region is extremely dry with low population density, though oil discoveries increase the population density in the region (Dastrup 2019). The GCC states are small open economies with high dependence on international trade; they export oil and natural gas and import almost all the material and supplies needed to sustain a high standard of living for 58.86 million capita (WorldData.info 2024). The high dependence on international trade makes them vulnerable to global and domestic shocks (Rezghi et al. 2023).

Figure 1. Map of the Gulf Cooperation Council (GCC) Countries (Encyclopaedia Britannica 2023)



The GCC states supported Egypt and Syria in the war of October 6, 1973, against Israil through forcing oil embargo on the countries that supported Israil. The oil embargo tripled the oil prices within a span of a few years as shown in Figure 2 providing these states with a significant increase of GDP. The GCC rulers invested the cash surplus in improving the standard of living for their citizens through massive infrastructure projects and subsidizing education, health care, and other services. After achieving some level of prosperity, the GCC steered their resources towards diversifying their economy to sustain continuous prosperity when the oil era ends. Consequently, trillions of dollars were invested in this region over the last half a century miraculously transforming these countries from empty deserts to developed states with some high standard of living. This accomplishment is highly commendable and admirable.

Figure 2. Oil Prices during from 1970 to 2015 (Decressin 2012)



The rest of this paper is structured according to the following headings:

1. Literature review of the
 - a. Labor and material procurement in the GCC countries.
 - b. potential reasons for global inflation and supply chain disruptions.
 - c. nature of the construction sector in these countries and its magnitude.
 - d. inflation and supply chain in challenges in the GCC countries.
2. Research questions
3. Research methodology
4. Survey results and finding
5. Research conclusion and recommendation
6. Acknowledgement
7. References

Literature Review

The above-mentioned investments created a huge demand for workforce of all kinds and for material, equipment, and services. The huge demand combined with the extreme heat forced the GCC firms to pay premium salaries and wages to their workers, making the GCC an extremely attractive place for people to work. The creative business leaders of GCC countries created a business model with which they imported workforce from all over the world and synchronized their efforts to change these countries from empty desert to what it is today.

Labor and Material Procurement in the GCC Countries

Due to the desert nature of the GCC region, low-density population, and oil-revenue surplus; these countries relied on imported labor workforce from all over the world. The governments and citizens of these countries created an entrepreneurial model through which they attracted and managed highly-skilled professionals from the developed countries (such as UK and USA), middle-level professionals from the Middle East (such as Egypt, Jordan, Turkey, Syria, and Lebanon) and other developing countries, and low-skill workforce from neighboring developing countries such as India, Pakistan, Afghanistan, Bangladesh, Philippines, Egypt, Sudan, Syria, Lebanon, etc. They also attracted, recruited, and managed high talents and skills from all over the world, but the above-cited model represents the main skeleton of the economic development and transformation during the last half century.

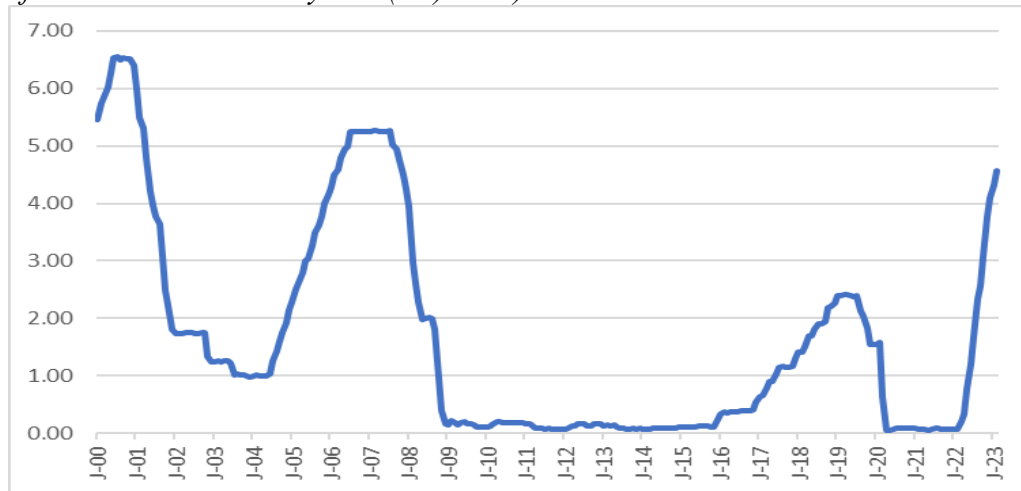
They used the kafala (sponsorship) system which gives private citizens and companies in GCC almost total control over the employment and immigration status of their migrant workers. The system arose from the above-cited growing demand for cheap labor in GCC and the desperation of many migrants (seeking work) to send money home to their families back home. Some employers abused the kafala system leading to human rights abuses, racism, and gender discrimination. The preparation for the 2022 FIFA World Cup in Qatar combined with the global anti-racism protests and the COVID-19 pandemic exposed the flaws of the kafala system and fueled calls for reforms (Robinson 2022).

Potential Reasons for the Global Inflation and Supply Chain Disruptions

During the period from 2000 to 2023, most productive countries around the world went through several events that changed the economic landscape and introduced significant economic challenges that drove the economic policy makers to take certain actions. Chief among these actions is the adjustment in the central bank interest rates. The 9/11 attack (on the World Trade Center in New York and the pentagon in Washington, DC) along with the bursting of the internet bubble of the late 1990s significantly slowed down the US economy. Consequently, the federal reserve lowered its interest rate (which governs the banking lending rates) as shown in Figure 3. While the recession of 2008 was caused by creative financial engineering orchestrated by financial investments banks, it created mortgage crises that paralyzed many global banks. This fiscal crisis significantly slowed down the world economy

and kept inflation at historic low levels. The major central banks pumped trillions of dollars into their economy and kept their basic interest rates slightly above zero to avert severe recession for most of the years from 2009 to 2020.

Figure 3. *The Monthly Federal Reserve Rates from 2000 to 2023 (Board of Governors of the Federal Reserve System (US) 2023)*



After the collapse of the Soviet Union, the world economy slowly changed from a bipolar trade to global trade. Businesses and governments built supply chains for the needed goods and services that exploited intellectual resources in the developing countries, cheap labor in developing countries, and global raw material. The admission of China into the World Trade Organization in December 2001 accelerated the perfection of the manufacturing supply chain creating an environment of low inflation. The lower cost of shipping goods from a manufacturing facility to the next facility assisted in creating very specialized manufacturing facilities all over the world with China gaining the lion share of this manufacturing. Over time, the supply chain (for goods and services in a globalized economy) has been gradually finetuned and almost reached perfection. Producers outsourced manufacturing functions and invested in facilities in areas with low-cost labor; they also outsourced some design, management, and customer services overseas further reducing production cost. The digital technological revolution that enabled cheap audio, video, and data transfer accelerated the outsourcing process. In addition, competition among producers and sellers kept prices at bay. Consequently, inflation was contained in the range of 2-3% during this period. The combination of historic low interest rates and low inflation created a goldy lock environment which created sustainable economic growth in most of the world. The perfection of the supply chain enabled China to maintain economic growth rates exceeding 7% per year and partially kept inflation at bay in the US and European Union during this period. China, consequently, lifted more than 300 million capita from poverty to middle class and created a class of millionaires and billionaires.

A supply chain disruption is any event that causes a disruption in the production, transportation, or distribution of products due to natural disasters, regional conflicts, and pandemics (Arena, a PTC Business 2023). The above-mentioned supply-chain

perfection made the world economy more vulnerable to supply chain shocks. The COVID-19 epidemic forces many countries (all over the world) to shut down their economy during the first half of 2020 due to lack of knowledge about virus and high death rate. During the rest of 2020 and a good part of 2021, manufacturing all over the world kept on sputtering as many workers worked from home and only essential workers were working in the factories. China kept combating the virus by using the zero Covid policy that led to complete shutdown of large provinces, counties, and townships in 2020 and 2021. In addition, China prioritized Chinese industrial needs over international needs; this was evident in the medical supplies. The shutdown created many supply chain bottle necks that the manufacturing sector had to deal with. In the addition to the supply chain disruption by COVID-19, Russia's invasion of Ukraine and the sanctions imposed on Russia along with the blockage of the Black Sea worsened the supply chain disruption and increased inflation throughout the entire world.

In early 2022, the US and the industrialized world, started to gain confidence about dealing with COVID-19. More than half the population has been vaccinated (and postered) and a good part of the other half has developed some immunity because they have been infected with the virus. The whole US and the industrialized nations simultaneously tried to operate at full capacity as much as it can. However, the supply chain shocks due to COVID-19 and Russia's invasion of Ukraine hampered the world's ability to operate at full capacity. The authors hypothesize two more driving forces for inflation:

- (1) The rich countries pumped trillions of borrowed-governmental dollars into their economy to prevent great depression. These funds created excessive capacity to purchase goods and services once the fear of COVID-19 subsided.
- (2) Misjudgment of the central banks, world wise, about the sticky nature of inflation in late 2021 and early 2022 as they diagnosed this inflation as transitory. The delayed response of the central banks, due to the fear of recession, exacerbated the inflation to a level that has never been seen since the late seventies.

Despite the efforts of global governments to reduce laying off workers, businesses laid off a good percentage of their workers to offset reduced sales. Many of the laid off workers changed their career and/or relocated to lower cost areas. In addition, the workers, who were close to retirement, retired. Consequently, when the businesses attempted to reach full production capacity, they did not find the needed workforce in terms of quantity and quality. Consequently, businesses were forced to offer higher wages and salaries to attract workers, increasing the production cost.

Nature of the Construction Sectors in the GCC Countries

The governments of the GCC countries use construction projects to increase employment and foreign investments and to meet the transformational and developmental aspirations of their citizens. Consequently, the construction sector is

one of the top three sources of employment in the GCC countries employing many local, foreign, and expatriate workforces. KSA is one of the leading cement producers worldwide, and much of the produced cement is mainly supplied for domestic use. Qatar is another considerable producer of cement in the region (Statista Research Department 2023).

Statista Research Department (2023) states that most of the construction investments in the GCC region were in residential and commercial buildings, followed by energy and infrastructure projects. The first phase of KSA's mega project Neom, is expected to be completed by 2025, worth 500 billion U.S. dollars. Among the recent major construction investments were the Etihad Rail projects and the Gasoline and Aromatics projects in the UAE, which made the UAE an important player in the global construction industry. The stadiums and the infrastructure projects needed for Qatar to host the soccer FIFA 2022 World Cup were among the major construction projects in the region (Statista Research Department 2023).

Figure 4. *The World's Mega Projects (Arabian Business 2023)*



Katharina Buchholz, Data Journalist with Statista, stated that many of the recent global megaprojects have centered on the Arab Gulf Region (Buchholz 2023). Figure 4 lists these top ten global megaprojects; five of these projects are in the GCC. Madinat al-Hareer (Silk City) in Kuwait: \$132 Billion is one of the top 5 most expensive construction projects in the world (1build staff 2021). The value of the current projects in GCC exceeds \$100 billion (Statista Research Department 2023). The Arab Monetary Fund (AMF) said that the Arab construction sector has recovered from the impacts of the Covid-19 pandemic, with its contribution to GDP in 2021 amounting to around \$186.8 billion, up from \$178.3 billion in 2020, or a 4.7%

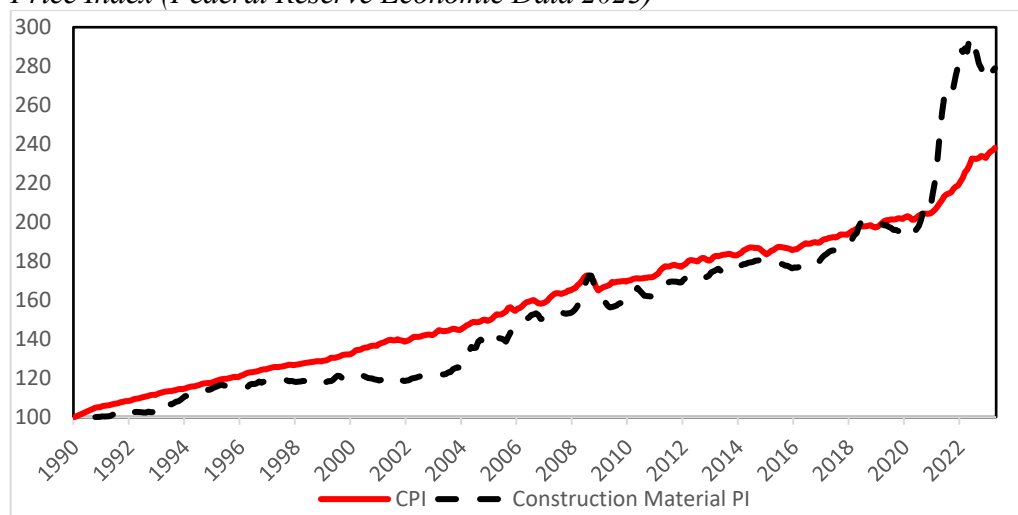
increase. The KSA and UAE construction sectors contributed the most to their countries' GDPs, with around \$45.5 billion and \$36.8 billion, respectively. In Qatar and Oman, the construction industry contributed \$24.1 and \$6.4 billion respectively (Mohamed 2022). The NEOM city-being built in Northwestern Saudi Arabia- is expected to be the first construction megaproject with a cost exceeding \$1 trillion. NEOM in Saudi Arabia and Silk City in Kuwait are two of the biggest planned construction projects globally (Arabian Business 2023).

Paul Griffiths, CEO of Dubai Airports announced that the start of phase 2 of Dubai World Central - Al Maktoum International Airport's (DWC) expansion, representing a substantial investment of 128 billion UAE Dirham (\$34.85 B). After the completion of phase 2, DWC will be a state-of-the-art airport that will provide a quick, convenient, and high quality 21st century experience for its customers. This further solidifies Dubai's strategic goal of becoming a leading aviation hub on the world stage (Griffiths 2024).

Construction Material Prices over the Last Five Years

Because the construction industry is one of the largest single industries in most countries, it is natural to theorize that the above-cited inflation and supply chain disruptions affect the construction industry. Figure 5 illustrates the consumer price index along with the construction material price index using the year 1990 as 100. The graph (whose raw data was obtained from the Federal Reserve Economic Data) illustrates that inflation of the construction material (during the period from 2021 to 2023) was higher than consumer price index, which is the highest for the last 50 years. While the data in Figure 5 is obtained from the US, these prices mirror the global prices due to the open nature of the US economy.

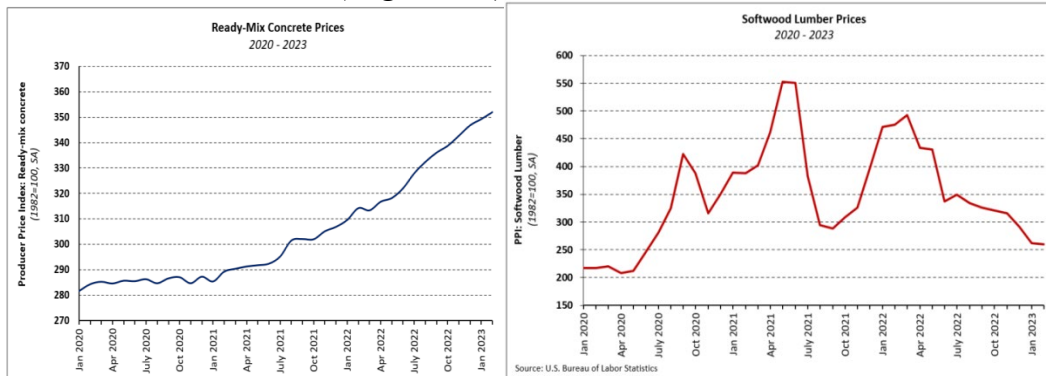
Figure 5. *Consumer Price Index (Federal Reserve Economic Data 2023) & Construction Price Index (Federal Reserve Economic Data 2023)*



Lumber, concrete, and rebar are major construction material world wide. Figure 6 presents the softwood lumber prices and ready-mix concrete prices during the

period of 2020 to 2023 in the US (Logan 2023). The figure shows that the lumber prices increased significantly during the second half of 2020, then they went down towards the end of 2020 and beginning to 2021. The prices climbed up and down again later in 2021 and they had a similar cycle again in 2022. In part, these ups and downs in lumber and many other material gave credit to the conclusion that inflation is transitory not sticky during the second half of 2021. This ups and downs in essential construction material like lumber provided a challenge to construction project managers. On the other hand, the ready-mix concrete prices were in steady increase during the same period.

Figure 6. Softwood Lumber Prices (left) and Ready-mix Concrete Prices (right) 2020-2023 in the US (Logan 2023)



Gilbane Building Company (in its Construction Market Conditions Report-Q2 2022) reported the amount of delay of several construction materials as shown in Figure 7. The electrical and HVAC material and equipment experienced the highest level of delays because much of these materials and equipment are unique to the specific projects and are manufactured to order due to their cost and manufacturing complexity (Gilbane Building Company 2022).

Figure 7. Building Material and the Amount of Delay (Gilbane Building Company 2022)

Material	Lead Time
Generators	72-95 weeks
Switchboards	45-80+ weeks
Chillers	42-52+ weeks
AHUs	40-75 weeks
Panelboards	30-52+ weeks
Switchgear	30-80+ weeks
International Fabricated Millwork	24-28 weeks
Elevators	20-48 weeks
RTUs	20-30 weeks
Curtainwall	14-28 weeks
Steel	12-30 weeks
Roofing (Select Materials)	4-20 weeks

The supply chain disturbance unbalanced the supply and demand forces leading to an increase in the prices of building material and equipment. Figures 8 and 9 present the changes in material prices of the essential construction material during the period from Q4 2020 to Q4 2022 based on the Cost Index - Chicago Q4 2022 (McGreal & Van Anne 2023).

Figure 8. Material Pricing Change Q4-20 to Q4 22 (McGreal & Van Anne 2023)

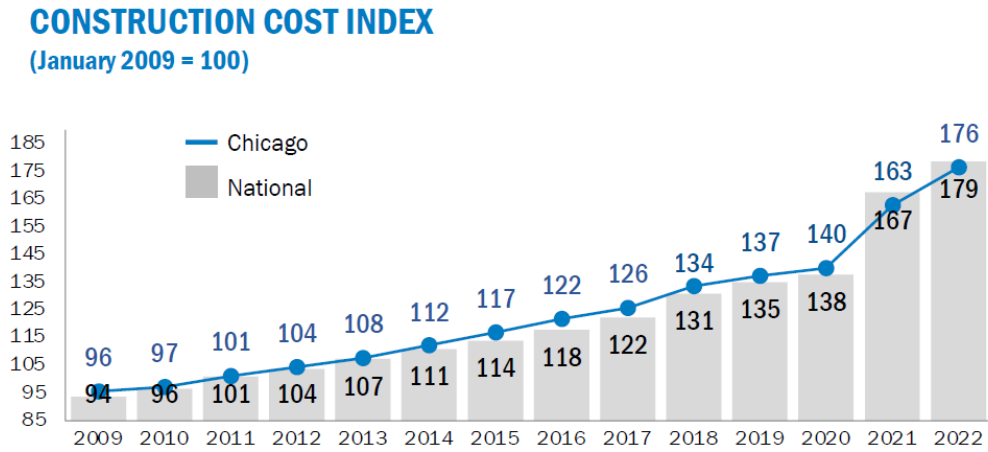
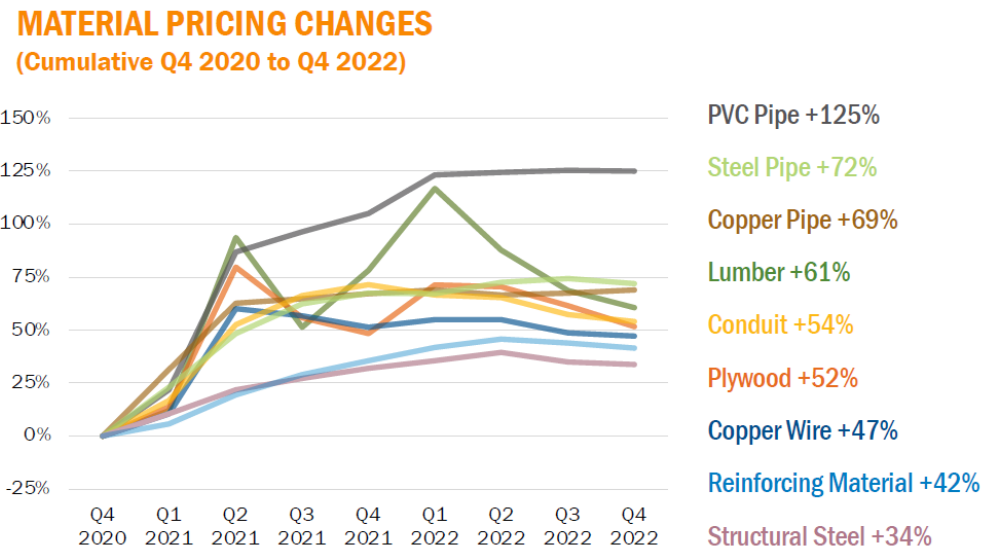


Figure 9. Material Pricing Change Q4-20 to Q4 22 (McGreal & Van Anne 2023)



Inflation and Supply Chain Challenges in the GCC Countries

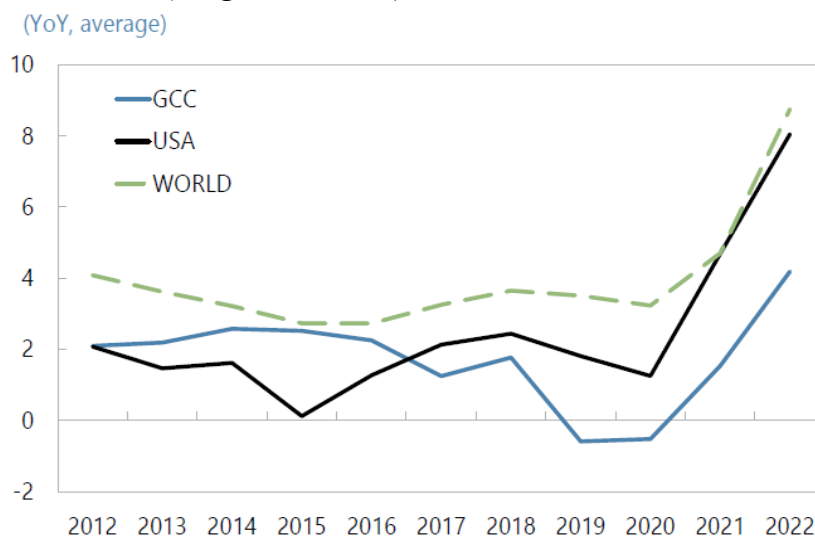
Because of the desert and climatic nature of the GCC countries, these countries heavily rely on imported goods and international trade. Theoretically, this heavy reliance makes these countries more susceptible to inflation and supply chain disruptions. Inflationary pressures have intensified in the GCC countries in 2021-2022, mainly driven by the global tradeable goods inflation described earlier in this

paper. Despite this increase, inflation remained relatively contained as compared to rest of the world (Fareed et al. 2023).

Fareed et al. (2023) found that the imported inflation from main trading partners, mainly driven by China, is the main drivers of inflation in the GCC region. They also concluded that the direct pass-through of international commodity price shocks was somewhat limited, after controlling for trading partners' inflation due to the prevalence of subsidies and administered prices in the region and the adoption of the nominal effective exchange rate (NEER) monetary policy by the GCC states (Fareed et al. 2023). NEER is an unadjusted weighted average rate at which one country's currency exchanges for a basket of multiple foreign currencies. NEER is an indicator of a country's international competitiveness in terms of the foreign exchange (BYJU'S 2024). The GCC monetary policy frameworks targeting a stable exchange rate seem to have contributed to stabilizing inflation (Rezghi et al. 2023).

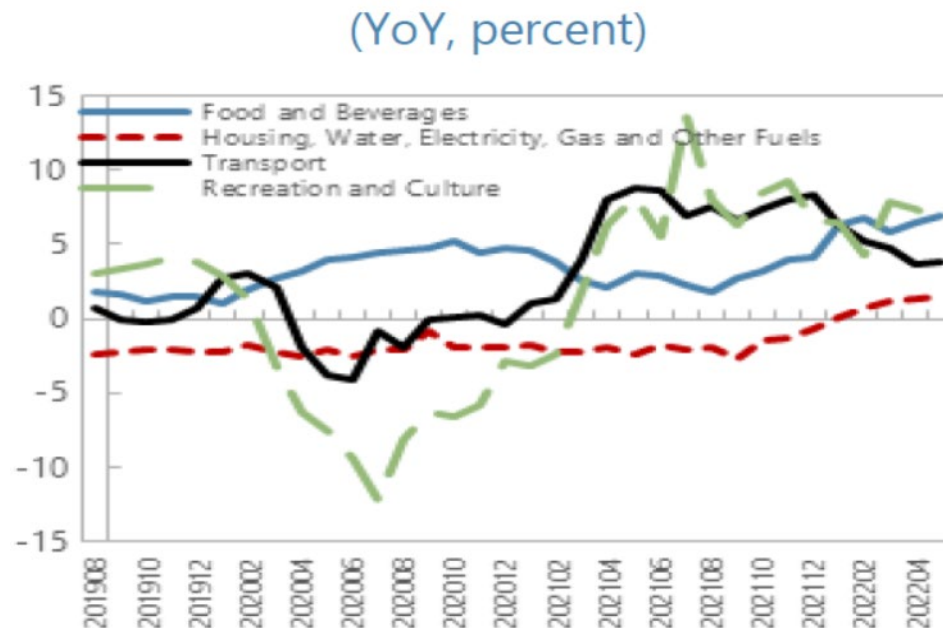
Inflation in the GCC countries has remained relatively stable (below 3% on average) over the past decade. However, inflation picked up some steam in several GCC countries since the end 2021, mainly due to an increase in food and transport prices as shown in Figure 10 (Rezghi et al. 2023).

Figure 10. Consumer Price Index in the GCC Countries, USA, and the World from 2012 to 2022 (Rezghi et al. 2023)



Furthermore, food and transport are major drivers for inflation increases in 2021 and 2022. Food inflation has increased from 2.2 percent (y/y) in April 2021 to 6 percent (y/y) in June 2022. While inflation has been on an upward trend, it remained below neighboring countries in the Middle East and North Africa. The prevalence of administered prices and subsidies may explain these inflation differences. Figure 11 depicts the inflation by category in the GCC countries from August 2019 to April 2022.

Figure 11. Inflation by Category in the GCC Countries from August 2019 to April 2022 (Rezghi et al. 2023)



Considering the magnitude of the economy of these countries and size of the construction sector in these countries, capturing a snapshot of the industry after COVID-19 and its disturbance to the supply chain and inflation along with investigating how the industry reacted to this challenging environment is beneficial to the construction industry. The rest of the paper presents the research design criteria, implementation, findings, and results.

Research Questions and Methodology

The anecdotal conversations with many construction professionals about supply chain disturbance (combined with high inflation) motivated the authors to research their impact on the construction industry in the GCC and how the industry reacted to these forces. The literature review confirmed these forces along with their macroeconomic magnitude, but the impact of these forces on the different parties of construction projects was not documented. How the different sectors of construction industry experienced these disturbances. How much the material/systems components of the construction projects have been impacted? Did the size of the construction firms make a difference in the magnitude of impact? It is also interesting to learn how construction firms reacted to these forces and operated in this environment.

Research Methodology

In addition to reviewing literature about inflation and supply chain disruptions, asking the construction professional who dealt with these disturbances to inform us about their impact gives us another insight. The authors developed a survey to

collect the answers to these research questions. The survey, which is included in Exhibit 1, is composed of the following sections:

- Demographic questions to see if the impact differs among the subjects based on the different types of construction work, the subject's role in the project, and the sales volume of the subject's firm.
- The magnitude of the impact of the different construction material and equipment.
- The extent of wage increases to the firms' labor workforce along with the type of workforce that got bigger increases.
- The amount of the impact on the construction schedule, budget, profitability, and quality.
- The severity of the impact of labor shortage, losing loyal skilled workers, and project termination
- The implementation of the escalation clauses to adjust the contract's prices and durations.
- The adjustments by the estimating department to raise the cost of material and labor in their estimating data basis.
- The adjustments made by the prices by competing firms.

It was important to ensure that the duration of answering the survey was less than 10 minutes to facilitate responding to the voluntary survey. The authors eliminated time consuming questions and fill-in questions and combined questions to reduce the survey duration. Then the authors piloted the survey to assess its duration and to ensure that the subject interpreted the questions according to the intended meaning. Based on the provided feedback, the authors modified the survey instrument; the final survey instrument is Appendix I. Because this research involves human subjects, the Institutional Review Board (IRB) at Bowling Green State University reviewed and approved the survey prior to its distribution. The researcher used Qualtrics XM platform to create, distribute, and analyze the survey.

At least 400 construction professionals living and operating in the GCC countries were invited to respond to the survey in both English and Arabic. These construction professionals were personal contacts to the authors and their personal contacts. The authors sought the assistance of several associations such as Me3margi, Lean Construction Institute – Qatar (LCI Qatar); LinkedIn posts got over 3200 impressions that helped spread the word. We ended up with 54 valid responses despite all the efforts to increase the response rate constituting a response rate of 13.5%.

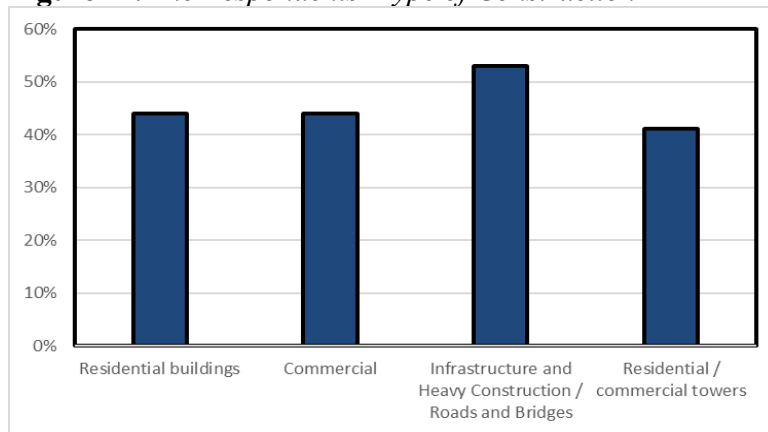
Survey Results and Finding

Demographics of the Survey Subjects

68% of the respondents worked for Engineering/Architectural firms, 29% worked for General Contracting firms, and 3% of the respondents worked for subcontracting

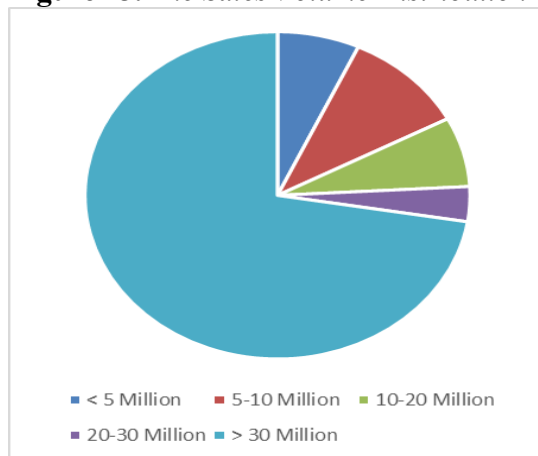
firms. This may have skewed the subjects towards the Engineering/ Architectural firms, which may not have intimate relationships with material supply shortage. The firms (for which the subjects were working) were involved in variety of types of construction; their distributions (which is shown in Figure 12) were as follow: 44% of the respondents engaged in residential construction, 44% were involved in commercial construction, 53% engaged in heavy construction (such as infrastructure and roads and bridges), and 41% were involved in residential/ commercial towers. Please note that the summation of all the percentage is more than 100% because some firms participated in more than one type of construction.

Figure 12. *The Respondents' Type of Construction*



The sales volume distribution of the respondents is shown in Figure 13. 72% of respondents have a sales volume that exceeds 30M Riyal, which is equivalent to around \$8M. This may have skewed the subjects towards the larger side of firms. The currencies of the GCC states are relatively close to each other except the Kuwaiti Dinar, which is around 12-13 time the Riyal. Consequently, we created a separate version of the survey for the Kuwaiti construction professionals. The numbers and percentages shown in the Figure are adjusted to the Kuwaiti equivalent in Saudi Riyal.

Figure 13. *The Sales Volume Distribution of the Respondents in Saudi Riyal*



The Impact of Materials /Systems Shortage on the Business Operations

The survey subjects rated the impact of the shortage of the materials /systems (listed in Table 1) on their business on a scale of 1 (almost no impact) -5 (very severe impact) (in case the material not applicable to company work keep blank). The authors used the Likert scale, or rating system, which is a measurement method used in research to evaluate attitudes, opinions, and perceptions (Qualtrics XM 2024). In this analysis, the authors used a weight of one for minimum impact and five for maximum impact.

Table 1 presents the impact of materials /systems shortage on the business operations of the subjects on a scale of 1 to 5. Most of the impacts were between 2.6 to 3.5, which means that the subjects did not significant encounter shortage in these items because the encounter was short in duration/magnitude, and/or the encounter was easily managed. A few material items had slightly higher impact; their impact was less than 4.0. These items were electrical fixtures and equipment, plumbing fixtures and equipment, cement, and rebar. Because of the prevalent use of cement and rebar in the construction sector in these countries, any small disturbance has felt impact.

Table 1. *Weight Value for the Impact of Shortage of Construction Material/Systems on their Operations*

Material	Weighted Value	Material	Weighted Value
Timber formwork	3.23	Backfill material	3.3
Electrical wires	3.48	Asphalt	3.47
Electrical fixtures and equipment	3.6	Gabbro	3.13
Pipes	4	Polymer	2.69
Plumbing fixtures and equipment	3.93	Bitumen	3.4
Firefighting fixtures & equipment	3.32	Curb stone	3.31
HVAC system	3.2	Rebar	3.67
Glass	2.83	Interlock tiles	2.93
Moister protection material	3.21	Others:	2.54
Kitchen finishing items (ex. Cabinets and countertop)	2.59	Energy (electrical, gasoline, diesel)	3.57
Cement	3.81	Masonry	3.33
Woodwork	2.66	Flooring finishing materials	3.39
Aluminum works	2.9	Paint	3.07
Wrought iron works	2.93	False ceiling materials	2.74
Washed sand	3.07	Insulation material	3.13

The Impact Labor Shortage on the Business Operations

In their answer to question # 5, how much did your firm increase the wages of its workers during the last 18 months; 64% indicated that raised the wages of their workers by less than 5%. 18% of the subjects increased their wages between 5 to 10%, and 9% increased their wages by 10 to 20%, and 9% increased the wages of their workers by more than 20%. A potential explanation for such a slight increase

in labor wages is that most of these workers were imported workers from countries whose economies were hit hard by COVID-19 and global inflationary forces explained earlier in the paper. In other words, the premium difference between their income in their own countries and their income working in the GCC countries increased significantly (even if these workers got a very slight increase).

In their response to Question 6 - Did your firm faced any shortage in manpower? 14% indicated that they did not face shortage, and 86% indicated that they faced labor shortage with most of the shortage was for skilled workers. The answers to the follow up Question # 7 indicated that 27% of the shortage was for average-skilled workers and 55% of the shortage was for the highly skilled workers.

The Impact of Supply Chain Disruptions on Their Construction Projects

In their response to Question 8-Using the table below, please indicate, where applicable, the percentage impact of supply chain disruptions on your construction projects, where 0 – 20% indicates the least impact with 81-100% the highest impact; the analysis results (using the Likert scale) are shown in Table 2. The figures in the table indicate that the impacts of supply chain disturbances were mostly slightly above average.

Table 2. *Impact of Supply Chain Disruptions on Their Construction Project*

Area of Impact	Average Score
Schedule and ability to finish the project on time	3.09
Price Inflation	3.18
Profitability/ business growth	2.81
Labor shortage	3.13
Losing loyal skilled workers	3.06
Procurement substitution	2.9
Project termination	2.52

Employment of Escalation Clauses to Adjust the Contract Price and Duration

In their response to Question 9-If your firm suffered from inflated prices and supply chain problems, did the project owner consider it as part of the contracting business risks that the contractor must absorb? 57% of the respondents indicated that the owner did not modify the contract time and/or price because of this disturbance. On the other hand, 43% indicated that the owners of their projects adjusted the contract process and saw the disturbance as a legitimate reason for a change order to modify the contract time and price.

Adjustment of the prices in the estimating databases

The responses to Question 10 - Did the estimating department in your firm update its cost to reflect the increased prices and material shortage? 75% stated that their estimating department updated its cost databases to reflect the increased prices and material shortage, 25% did not.

Question 11 - Did the competing firms to your firm update their prices to reflect the increased prices and material shortage? 72% of the respondents indicated that their competition increased their prices as well, and 28% did not see the competition raising their prices.

Future Forecast

Question 12 asked the respondents when they foresaw that supply chain disruptions would subside? 22% foresaw that it will end towards the end of 2024, 19% foresaw the subsidence by the end of 2026, 59% foresaw that it will never end; this is the new normal.

Question 13 asked the respondents how they foresaw the effects of the supply chain disruptions on the growth projections of their firms over the next three years. 42% expected a decline in the company's growth over the next 3 years, 19% expected that their company would maintain the same growth rate, and 39% expected that their firms would expand in the next three years due to the increased demand for their services.

Research Conclusion and Recommendation

The political and economic events during the last thirty years drove the global central banks to keep interest rates low for a long time to avoid economic recession. During the second half of 2022, inflation started to rise due to economic recovery from COVID-19, but global central banks underestimated the sticky nature of inflation. Ukraine war at the beginning of 2023 added fuel to the inflationary forces. Both COVID-19 and Ukraine war presented a significant challenge to the global supply chain including the construction material, equipment, and systems.

The GCC nations were able to absorb the inflationary pressure better than many other regions in the world. The GCC monetary policy framework targeting a stable exchange rate (such as NEER) and subsidies seems to have stabilized inflation. The construction sector, which is a sizable portion of the GDP of these countries, dealt with/managed the global supply chain distributions and inflation as hypothesized. The impacts of materials /systems shortages on the business operations of the subjects were between 2.6 to 3.5; which means that the subjects encounter mostly minor shortage in these items, or the shortage lasted for a short manageable period. Critical items such as cement and rebar scored an impact higher than 3.5, but less than 4.

The wages of workers in the GCC countries did not increase significantly because many of the workers in GCC were imported workers from countries whose economy were hit hard by COVID-19 and global inflationary forces. The authors hypothesize that the wages/salaries premium for working the GCC states (compared to those of working in the home countries) increased because the impact of inflation was harder in their home countries. The construction firms in GCC suffered a slight shortage of labor (mostly on the skilled labor level).

The supply chain disturbance and inflation had minimum impact on the construction operations such as schedule, business profitability, and growth. 43% of the subjects indicated that the owners of their projects adjusted the contract process and saw the disturbance as a legitimate reason for a change order to modify the contract time and price. 75% of the subjects stated that their estimating department updated their cost databases to reflect the increased prices and material shortage. Their competitors also raised their prices as well. 59% of the respondents foresaw that current prices and inflation will never end; this is the new normal. 57% of the respondents expected that their firms would expand in the next three years (or stay as they are) due to the increased demand for our services.

In the authors' opinions, the shortcomings of this study include the low response rate and skewed subject pool of larger firms who were mostly work for Engineering and architectural firms. Ideally, the subject pools would have more general contractors and subcontractors. Also, larger firms might have better capacity to manage supply chain disruptions than small firms did.

Research Recommendations

The authors recommend pursuing studying the effect of supply chain disruptions and inflation with respondents who mostly work for contracting and subcontracting firms. These subjects procure/manage construction material, equipment, and systems more directly than those who work for Engineering/ Architectural firms. It is also recommended to study the effect of supply chain disruptions and inflation on the construction industry in less economically fortunate countries because they may not have the capacity to deal with these issues. It is also recommended to study these effects on the construction industry in various locations across the world such as the USA and European Union.

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Appendix 1. *Impact of Supply chain disruptions and Inflation on the Construction Industry in gulf region EN/AR*

This is an informed consent for the “Effect of supply chain disruptions and inflation on the construction industry in Qatar, UAE and KSA.”

My name is Alan Atalah, and I am a professor at Bowling Green State University in the Construction Management Department. We are trying to study the impact of supply chain disruptions and inflation on the construction industry. We are approaching you because you are a construction professional whose experience and views are relevant to this study.

This research can help the construction industry by (1) evaluating the impact of supply chain disruptions and inflation (that the entire world experienced in 2022 and 2023) on the construction industry and (2) learning how the industry adjusted to the material shortage and inflation challenges. This is a voluntary survey without direct benefits.

We understand how busy construction professionals like you are; we deeply appreciate giving us an estimated to be less than 10 minutes of your time. After the completion of the survey, the collected data will be stored on a BGSU server. The collected data will be analyzed under my supervision to draw the appropriate databased conclusion. The risks involved in participation are no greater than those experienced in daily life.

Your participation is completely voluntary. You are free to withdraw at any time. You may decide to skip questions (or not do a particular task) or discontinue participation at any time without explanation or penalty. Your decision whether to participate will not affect your relationship with Bowling Green State University or with me. Please be advised that taking the survey indicates consent.

The survey data will be kept confidential and stored on a secured university server accessible only by me (and my graduate assistant Walid Al Azanki) with the appropriate password. The data will be kept for a year after the publication of the paper/report. This survey does not collect sensitive data; however, if you are concerned, please be aware that (1) some employers may use tracking software so you may want to complete the survey on a personal computer, (2) do not leave the survey open if using a public computer or a computer that others may have access to, and (3) clear your browser cache and page history after completing the survey.

If you have any questions, please do not hesitate to contact Professor Alan Atalah at aatalah@bgsu.edu or phone number: +(1) 419372 8354. If you have any questions about your rights as a participant in this research, please contact the Chair of the Institutional Review Board at Bowling Green State University, at +(1) 419-372-7716 or irb@bgsu.edu. Thank you for your time.

Impact of Supply chain disruptions and Inflation on the Construction Industry in gulf region EN/AR

1. What is the role of your firm in the construction industry?
 - Engineer
 - General Contractor
 - Subcontractor
2. What is the major type of construction work that your firm is involved in
 - Residential Commercial Infrastructure and Heavy Construction
3. What is the annual sales volume for your firm?
 - < 5 M Riyal \$5-\$10 M Riyal \$10-20 M Riyal \$20-30 M Riyal
 - >\$30 M Riyal
4. Please rate the impact of the shortage of these materials /systems on your business on a scale of 1 (almost no impact) -5 (very severe impact)

Material	1 (min. impact)	2	3	4	5 (very severe impact)
Lumber					
Concrete					
Rebar					
Energy (electrical, gasoline, diesel)					
Masonry					
Flooring					
Ceiling					
Roofing material					
Insulation material					
Electrical wires					
Electrical fixtures					
Electrical equipment					
Pipes					
Plumbing and firefighting fixtures					
Plumbing and firefighting equipment					
HVAC Conduits					
HVAC finish fixtures					
HVAC equipment					
Doors and windows					
Moister protection material					
Kitchen finishing items (ex. Cabinets and counters)					

Other (please state in the line below)

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5. By roughly how much did your firm increase the wages of its workers during the last 18 months?
- < 5%
 - 5-10%
 - 10-20%
 - >20%
6. Did your firm faced any shortage in manpower? multiple answers selection is allowed.
- NO,
 - Yes, in skilled labor.
 - Yes, in unskilled labor.
7. What category of workers got higher wage raises?
- Low skilled workers Middle level skilled workers Highly skilled workers
8. Using the table below, please indicate, where applicable, the percentage impact of supply chain disruptions on your construction projects, where 0 – 20% indicates the least impact with 81-100% the highest impact.

RANGE OF IMPACT (%)	0-20%	21-40%	41-60%	61-80%	81-100%
Schedule and ability to finish the project on time		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Price Inflation		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Profitability/ business growth		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Labor shortage		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Losing loyal skilled workers		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Procurement substitution		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Project termination		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

9. If your firm suffered from inflated prices and supply chain problems, did the project owner consider it as
- Part of the contracting business risks that the contractor must absorb.
 - Legitimate reason for a change order to modify the contract time and price.
10. Did your estimating department update its cost to reflect the increased prices and material shortage?
- Yes No
11. Did the competing firms to your firm update their prices to reflect the increased prices and material shortage?
- Yes No
12. Do you foresee that supply chain disruptions will subside by?
- The end of 2023 The end of 2024 The end of 2025
- It will never end; this is the new normal.

13. Did the supply chain disruptions affect your firm's growth projections for the next three years?
- Yes, our growth declined slightly No, our growth stayed the same.
- No, our growth projection increased because this is high demand for our services.