

# Impacts of the COVID-19 Pandemic on construction industry: a comparison between Hong Kong and Singapore

Jinying Xu<sup>1</sup>, Zhongze Yang<sup>2\*</sup>, Weisheng Lu<sup>3</sup>, Fan Xue

This is the authors' version of the paper:

Xu, J., Yang, Z., Lu, W., & Xue, F. (2021). Impacts of the COVID-19 Pandemic on construction industry: a comparison between Hong Kong and Singapore. *Proceedings of the 26th International Symposium on Advancement of Construction Management and Real Estate (CRIOCM2021)*, Springer, in press. [Merit Paper Award](#).

This file is shared for personal and academic use only, under the license [CC BY-NC-ND 4.0](#)

(Non-Commercial, No Derivatives, and with an Attributed citation when you use). The final published version of this paper can be found at: [\[LINK\\_TO\\_SPRINGERLINK\]](#). Any uses other than personal and academic purposes must obtain appropriate [permissions from Springer](#) first.



**Abstract:** The COVID-19 pandemic has great impacts on the whole world. Construction industry is no exemption. However, to what extent has the pandemic influenced the construction industry has not been fully investigated. This paper aims to quantitatively analyze such impacts in Hong Kong and Singapore, which are two international cities high dependent on the global logistics and supply chain that is greatly affected due to the pandemic. Macro statistical reports relating to the construction industry performance and institutional arrangement to contain the impacts of the pandemic in general or industry-specific manner were collected and analyzed. Indicators including construction industry GDP, construction site number or contract award number, construction worker engagement, and job vacancy rate in the two cities were compared on a year-on-year change basis. The analyses show that the Hong Kong construction industry shows higher resilience during the pandemic as evidenced by milder changes and quicker recovery while Singapore construction industry, due to the shutdown from April to June 2020, experienced sharp decrease and slower recovery. The paper thus discussed the effects of different pandemic development situation and institutional arrangements on the construction industry performance in the two similar cities and gave some suggestions for the post-pandemic industry development.

**Keywords:** COVID-19; Construction industry; Performance; Hong Kong; Singapore.

---

<sup>1</sup> Jinying Xu

Department of Real Estate and Construction, The University of Hong Kong, Hong Kong, China

<sup>2\*</sup> Zhongze Yang

Corresponding author, Department of Real Estate and Construction, The University of Hong Kong, Hong Kong, China

E-mail: [zhongze@hku.hk](mailto:zhongze@hku.hk)

<sup>3</sup> Weisheng Lu

Department of Real Estate and Construction, The University of Hong Kong, Hong Kong, China

<sup>4</sup> Fan Xue

Department of Real Estate and Construction, The University of Hong Kong, Hong Kong, China

# 1 Introduction

The COVID-19 was declared a pandemic on March 11, 2020 and hit all the nations around the globe within four months <sup>[1]</sup>. Never before has nearly half of the world population experienced lockdown situations, and never before have so many people and businesses been asked to change their ways of working, producing, and consuming in sudden and dramatic manners <sup>[2]</sup>. The whole world is affected in an unprecedented way by this long-lasting and wide-ranging pandemic. The real GDP growth of world was estimated as -4.3% in 2020 <sup>[3]</sup>. The Financial Times Stock Exchange 100 Index has dropped 14.3% in 2020 <sup>[4]</sup>. The unemployment rate of Brazil, Italy, Canada, and the U.S. has increased to 13.4%, 11%, 9.7%, and 8.9%, respectively <sup>[4]</sup>. Many industries, such as civil aviation, hotel, tourism, and logistic and supply chain, have been heavily damaged. The construction industry has not been exempted <sup>[5,6]</sup>. For example, the total construction output of the UK decreased by 12.5% in 2020 compared with 2019 <sup>[7]</sup>. For the US construction industry, the real GDP in the second quarter of 2020 dropped 26.5% <sup>[8]</sup>. In Hong Kong, construction workers infected by the COVID-19 are higher than other groups. By 4 February 2021, there were total 268 registered construction workers infected and 3,162 quarantined <sup>[9]</sup>.

Nevertheless, as Ogunnusi et al. <sup>[1]</sup> put it, despite the negative impacts, this pandemic also posed some positive effects on the construction sector. Its effect has brought about innovative and diverse use of technology in an exemplary manner which may change the course of construction even after the extinction of COVID-19. In the UK, because of the government's arrangements, the public construction sector is one of the few industries that have been maintained (to some extent) in this pandemic <sup>[10]</sup>. Similarly, observations imply that the Hong Kong construction industry has soon recovered from the impacts by the social distancing measures, and resumed to normal. This is endorsed by the recent information release of the Hong Kong Construction Industry Council (HKCIC). There were 103,000 workers working on construction sites in December 2020 on a daily basis, a 5.2% increase than 2019 <sup>[9]</sup>. The industry's quick resilience is not easy, given the fact that Hong Kong's construction is highly reliant on international suppliers, which all have been much impacted by the pandemic. There must be something that we can learn from construction industry to instigate a resilience in it or even other industries.

The fallout in the global economy caused by the pandemic is compelling governments to derive policies for invigorating the economy <sup>[1]</sup>. One year after the COVID-19 epidemic, although it is still not over, we have known better the institutional arrangements. These arrangements may include various social distancing measures (e.g., work-from-home, gathering restrictions, and shutting down entertainment venues), transportation lockdown, deployment of temperature testing devices, delivering free masks and disinfectant, launching testing services, injecting relief fund, dispatching vaccines, and adopting state-of-the-art technologies. The digital technologies implementation in the service industries, which are heavily hit by the pandemic, help to reduce the chances of the contagion of the COVID-19 <sup>[11]</sup>. The construction industry has also gathered some positive experiences such as deployment of technological tools, re-organization of work plans, planning ahead for unforeseen circumstances and inclusion of contingency, storing bulk materials on-site, encouraging collaboration and risk assessment; workspace management and design consideration; and increase off-site construction (i.e. prefabrication or modular construction) <sup>[1]</sup>.

This research tries to figure out how the construction industry was actually doing during the COVID-19 pandemic. It will collect the statistical data to evaluate the performance of the construction industry. Then it will comb the construction related institutional arrangements implemented in Hong Kong and Singapore in a longitudinal way. Further, it will try to analyze the possible relation between these institutional arrangements and the performance of the construction industry to generate some suggestions for the new normal at the post-pandemic era. The rest of the paper is organized as follows: the next section will review the existing research on the COVID-19 pandemic and its impacts on the construction industry. Afterward, the data collection will be reported in Section 3. Data analyses, results, and findings of the construction industry performance and the impacts of institutional arrangements will be reported in Section 4. Discussion and conclusion will be drawn in the last section.

## 2 COVID-19 pandemic and its impact on the construction industry

The long-lasting, wide-ranging, and still on-going COVID-19 pandemic has changed the world dramatically <sup>[1]</sup>. By March 4, 2021, the global confirmed cases are 114,853,685 and the total caused death is 2,554,694. In Hong Kong, with a population of less than eight million, there are a total of 11056 confirmed cases and 201 deaths cause by COVID-19 by the same date. Behind these numbers, the life routine of every individual is changed, so are the activities of every organization and the operations of

every industry. Among them, the civil aviation, hotel, tourism, logistic and supply chain industries are the most heavily impacted. For example, according to the International Civil Aviation Organization (ICAO), COVID-19 has caused reduction of around 60% passengers (i.e. 2,699 million) and approximate loss of 371 billion dollars <sup>[12]</sup>. The monthly year-on-year change rates of passengers of Hong Kong International Airport have maintained at around -98% since March 2020 <sup>[13]</sup>.

The interconnectedness, complexity and global nature of the construction industry's supply chains and workforce affect the cost and schedule of construction projects during the COVID-19 pandemic <sup>[14]</sup>. Specifically, the UK construction sector GDP fell by a record 40.7% in April 2020 and all work fell by 12.5% in 2020 compared with 2019 <sup>[7]</sup>. It was estimated that about 6.7% of apprentices are possibly lose jobs and construction industry projects a 26.7% decrease in agency workers and self-employed <sup>[1]</sup>. Similarly, in the U.S., the unemployment rate rocketed to a record 14.8% in April 2020 <sup>[6]</sup> and the annual real GDP of 2020 decreased 3.5%, compared to an increase of 2.2% in 2019 <sup>[8]</sup>. Mainland China is the only major economy that reported positive GDP growth in 2020, with a growth rate of 2.3% because the COVID-19 was well-contained <sup>[15]</sup>. China's construction sector GDP growth rate of 2020 is also positive with 3.5% <sup>[16]</sup>. The situation in Hong Kong is not that optimistic with the annual real GDP of 2020 decreased 6.1% from 2019 while the gross domestic fixed capital formation of building and construction decreased 7.3% in 2020 compared with 2019 <sup>[17]</sup>.

Specifically, the impacts of COVID-19 pandemic on construction industry are evidenced by various aspects along the whole supply chain. The lockdown of factories, social distancing measures, and border control arrangements lead to material delivery delays and shortage, delays in inspection and securing permits, reduction in efficiency and productivity rates, suspension or slowing of ongoing projects and delay in the starting date for new projects, price escalations, additional costs, loss of revenue, and payment delays <sup>[6]</sup>. The expected impacts may also include safety concerns regarding virus spread in workplace, increase in demand from local suppliers and manufacturers, and increase in disputes, litigation, and claims <sup>[6]</sup>. All these fundamental impacts challenge the traditional supply chain and working practices of the construction industry and push it to change.

It is agreed that the whole world and the construction industry will not be the same when the COVID-19 pandemic is over <sup>[1]</sup>. The 'new normal' where virtual environment, digital tools, artificial intelligence, and robotics are being more and more integrated in construction works is an irreversible trend catalyzed by the pandemic. For example, the social distancing measures facilitate the wide adoption of virtual communication tools such as Zoom, Microsoft Teams, and Tencent Conference. Building information modelling (BIM) and digital work supervision system (DWSS) also encountered their chance of widely promotion and adoption. Meanwhile, the government bodies in different countries or regions release various institutional arrangements by trails to mitigate the negative effects and remedy the downturn. However, whether these arrangements will generate positive effects is unsure even for policy-makers and economists. This research will try to roughly evaluate the effectiveness of the institutional arrangements by mapping them with the construction industry performance during the COVID-19 pandemic.

### 3 Data Collection

Hong Kong and Singapore are selected for the investigation because both are highly international cities with high density in Asia. They share many similarities. Both cities are highly dependent on the global supply and logistics which is heavily impacted by the COVID-19 pandemic. However, The COVID-19 pandemic development and contain measurements in the two cities are also quite different. For the construction industry, they are both mature city with similar proportion of construction activities while they are different that the Hong Kong construction industry is dependent on local manpower while Singapore largely relies on migrant workers mostly from Bangladesh and India. Therefore, it would be interesting to compare the construction industry performance of the cities to see how COVID-19 impact them differently.

To investigate the performance of construction industry, data that indicate its performance from different dimensions, such as industry output and industry scale are desired. After browsing the data released by government, it is found that the GDP data, construction site number or amount of construction awarded contracts, number of construction manual workers, and industry job vacancy can be assessed. For Hong Kong, total Gross Domestic Product (GDP), GDP of construction works, the number of construction sites, the number of construction manual workers, and industrial job vacancy rate can be collected from the Census and Statistics Department, the Building Department, and the Human Resources Planning and Poverty Co-ordination Unit. The data are released on a quarterly basis. For Singapore, total Gross

Domestic Product (GDP), GDP of construction works, the amount of construction awarded contracts, the number of construction manual workers, and industrial job vacancy rate can be gathered from the Building and Construction Authority (BCA), Department of Statistics, and Ministry of Manpower. The construction awarded contract number is released on month basis while other indicators are on quarterly basis. For the data range, the data records from 2018 to 2020 are collected for comparison before and during the pandemic. To ensure the comparison among different statistical calibers, the year-on-year change rate will be calculated ensure comparisons between Hong Kong and Singapore. The construction industry policies, regulations, measures in Hong Kong and Singapore are sourced from the HKCIC and the BCA, respectively. By screening the news release and regulations on their official website, the policies and regulations related to COVID-19 institutional arrangements are selected, recorded, and organized in a chronological manner. All the above mentioned data are collected and reorganized to revert the whole picture of the construction industry performance under COVID-19 pandemic. Microsoft Excel 2016 was used to process and analyze the data.

## 4 Data analyses and findings

To analyze how the construction industry is doing during the pandemic, this section will firstly investigate the institutional arrangements construction industry taken along with the COVID-19 pandemic development in Hong Kong and Singapore. Then, it will analyze the construction industry performance of Hong Kong and Singapore from four dimensions, i.e. GDP, construction site number/awarded contracts, construction worker engagement, and job vacancy rate.

### 4.1 Anti-pandemic institutional arrangements

Figure 1 presented the COVID-19 pandemic development in Hong Kong and Singapore. The pandemic has been going on for more than a year in Hong Kong with three spikes showing up. Hong Kong experienced the first spike in March 2020, the worse second for nearly two months from July 5, 2020, and an even worse third spike sustaining for four months from November 23, 2020. Singapore's performance in containing the pandemic is extraordinary with the data curve remaining flat for months since October 2020. The pandemic imposed great impacts on the construction industry of both Hong Kong and Singapore since they are both highly dependent on the global logistics and supply chain which is severely hit during the combat with the pandemic.

Both regions took measures in face of the pandemic. The anti-pandemic institutional arrangements to combat the pandemic in both regions are also summarized according the timeline, see Figure 1. For the construction industry, Singapore suspended construction works during the severe period from April 20 to June 1, 2020 and gradually resume them until the outbreak was basically controlled. Afterward, different types of measures, including fiscal support, rostered routine testing, innovation and digitalization technique applications, were jointly taken until the pandemic was controlled and the construction works were recovered to normal. The responses in Hong Kong construction industry were different. Most of the construction works in Hong Kong kept going under permitted conditions if no outbreak took place at the construction site. There was no construction site shutting down at large scale. The major measures were offering anti-epidemic fund and delivering free masks for workers. At the later stage, regular testing service and vaccination injection priority were also included. Rough statistics shows that the direct government support fund in Singapore was about 14000 million Singapore dollars (SD) while the figure for Hong Kong was approximate 6800 million Hong Kong dollars (HKD).

In Hong Kong, there were two rounds of governmental anti-epidemic fund (AEF). The construction industry is also beneficial from them. At the AEF 1.0, an estimated expenditure of 914 million HKD was used to support construction sector in anti-epidemic efforts, benefiting around 7,400 construction establishments and 486,000 workers as reported by October 9, 2020 (HKSAR, 2020). At the AEF 2.0, the expenditure was expanded to more than 6 billion by providing some 600 consulting firms with training subsidies, construction workers with matching grant for skill upgrading, and relief measures to around 530,000 construction workers, 30,000 construction-related enterprises, and around 3,500 construction employers. The Hong Kong construction industry council (HKCIC) handled the applications disbursed the subsidies for the government. HKCIC also assisted the government to deliver 6 million masks, 210,000 bottles of hand sanitizer and other anti-epidemic materials to the construction industry<sup>[18]</sup>. Other measures including the Universal Community Testing Programme from August 2020 and the regular testing at construction sites from February 22, 2021. From March 2021, construction workers are listed in the priority group to inject the vaccination.

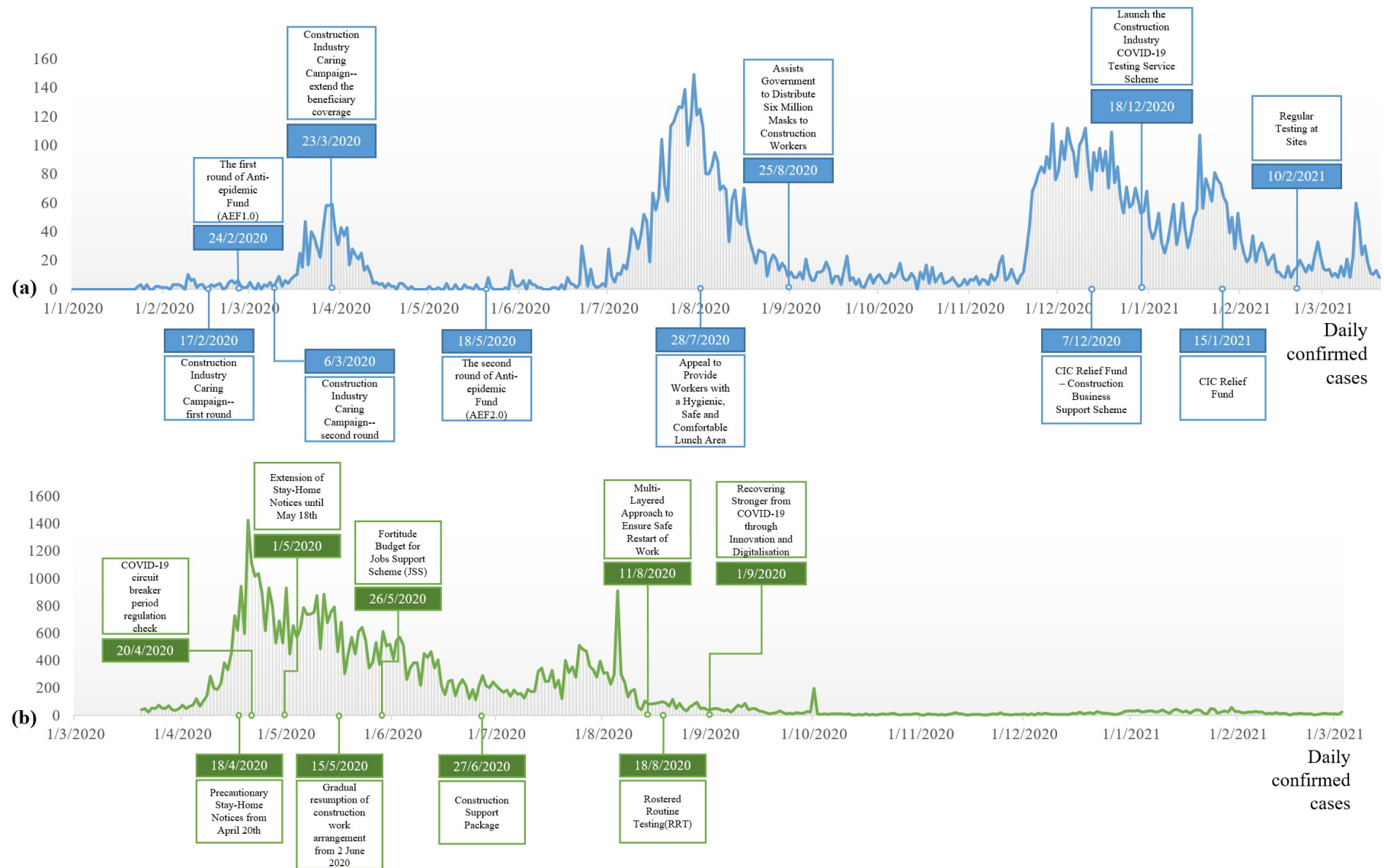


Figure 1. COVID-19 pandemic development and construction industry measures to combat the pandemic [(a) Hong Kong, (b) Singapore]

Different from Hong Kong whose daily confirmed cases keep less than 150, Singapore experienced a period during which its daily confirmed cases rocketed to more than 1000. Thus, the Singapore construction industry undertook elevated safe distancing measures, i.e., the Circuit Breaker Period, from April 7 to Jun 1, 2020. More significantly, the Singapore Ministry of Manpower (MOM) required all work permit holders and S Pass holders in the construction to be placed on mandatory stay-home notices (SHNs) from April 20 to May 18. Thus, almost all construction works were suspended during this period. It was not until June 2, 2020 did the Singapore BCA gradually allow some critical infrastructure construction projects to resume with only about 5% of the construction workers under the conditions of COVID-Safe Workforce, COVID-Safe Worksite and COVID-Safe Worker Accommodation and Transport, and COVID-Safe Training for Workers <sup>[19]</sup>. After the gradual resumption, monetary support, especially the 1.36 billion SD Construction Support Package.

## **4.2 Construction industry performance comparison between Hong Kong and Singapore**

The construction industry performance are represented by the GDP, construction site numbers, construction worker number, construction job vacancy rate before, during, and after the pandemic. Year-on year change rates of the above-mentioned indicators are used to better facilitate comparable measurement of construction industry performance between Hong Kong and Singapore. The rest of this section will display and elaborate the comparison results.

### **4.2.1 GDP**

The total GDP and construction sector GDP changes in 2019 and 2020 are displayed in Figure 2. The total GDP curves of Hong Kong and Singapore in 2020 both showed the process in which the economic first suffered a huge hit mainly reflecting in the sharp decline in the second quarter, and then kept decreasing compared with the same period but with a slightly eased degree. The construction GDP in Singapore kept the same changing path with total GDP but having a more drastic drop, while in Hong Kong, its changing path was quite different especially in the second quarter. Due to the social events in Hong Kong, the total GDP and construction GDP kept decreasing from 2019, which provided a more complicated environment for the construction industry. Compared with the second quarter in 2019, though the construction GDP in the same period in 2020 decreased, its amplitude was the smallest among other quarters. The availability of Hong Kong public and private sector GDP allows a closer investigation. It can be interpreted that the distinctive amplitude of construction GDP was derived from the substantial increase in the construction GDP of public sector. The construction public sector experienced dramatic ups and downs since 2019, quite different from the private sector which started shrinking from 2019 with a gradually aggravated degree through 2020. The completely different changing curves of these two sectors also proved the different extent of the epidemic's impact on them. The public sector seems to be more resilient than its private counterpart.

Different performances of the construction GDP in Hong Kong and Singapore were also derived from the different responses and measures by the government. In Singapore, the government enacted a precautionary stay-home regulation from April 20 and closed all the construction sites in order to control the rapidly spreading epidemic. The construction work didn't get the gradual resumption arrangement until June 2 because of the high number of newly confirmed cases that maintained for a long time. This long-term work stoppage explained the drastic drop of the construction GDP in second quarter in Singapore. While in Hong Kong, the measures and responses made by the government were mainly through anti-epidemic fund and employment support scheme to help the construction industry overcome this hard time instead of shutting down construction sites. Thus, the construction GDP in Hong Kong, although decreased, experienced milder downturn.

### **4.2.2 Construction activity**

Construction site numbers and awarded contract amount could represent the current activity of construction work. The changes of construction site number in Hong Kong and awarded construction contract amount in Singapore are presented in Figure 3. In Singapore, the awarded contract number in public and private sectors had a similar decreasing path during the pandemic, especially after April 2020 because of the precautionary stay-home regulation. Such anti-epidemic measure had an equally effect on both sectors. However, in Hong Kong, different types of construction sites had quite different performance during the pandemic. The number of the total

construction sites remained stable during 2020, fluctuating within the range from 1624 to 1668. Analyzing by the classification of public and private, the year-on-year changing rate of the public construction sites had an almost linear growth in 2020, while that of the private sector showed a sharply decrease. As for the classification of building and civil engineering, the two curves also had opposite changing path. The year-on-year changing rate of the building construction sites kept increasing in 2019; however, its increase began to shrink and finally decreased from the third quarter of 2020 during the pandemic, while that of civil engineering construction sites had a gradually increase during the pandemic compared to the same period in 2019. Because of the increase of the public and civil engineering construction sites, the total changing rate of the construction sites in Hong Kong kept growing during the pandemic, though the degree was gradually shrinking.

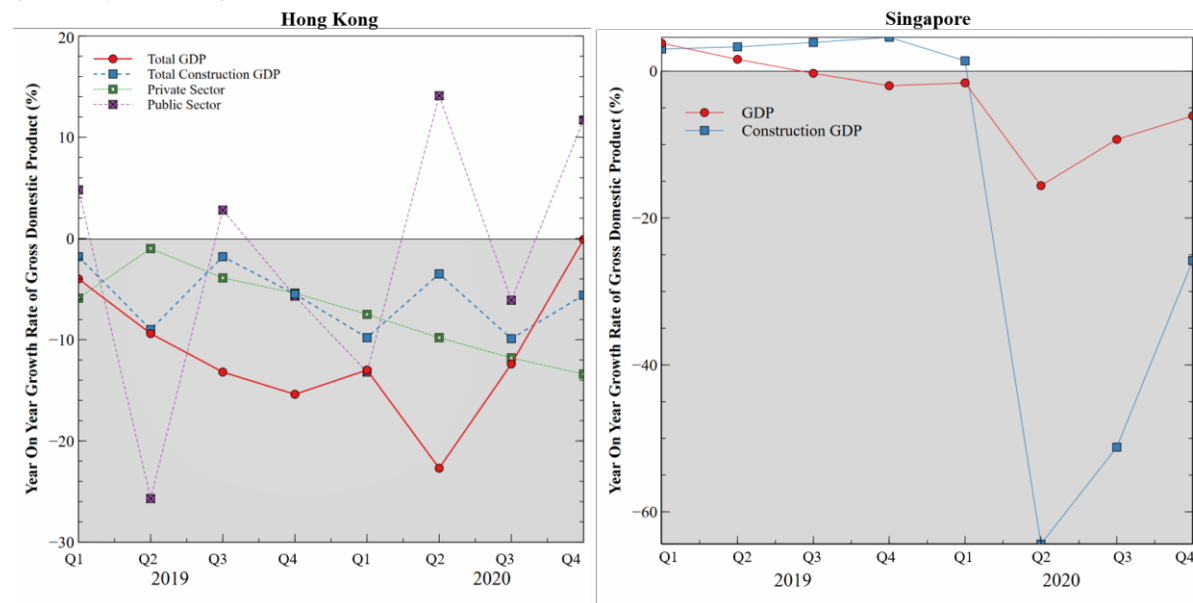


Figure 2. GDP change comparison between Hong Kong and Singapore

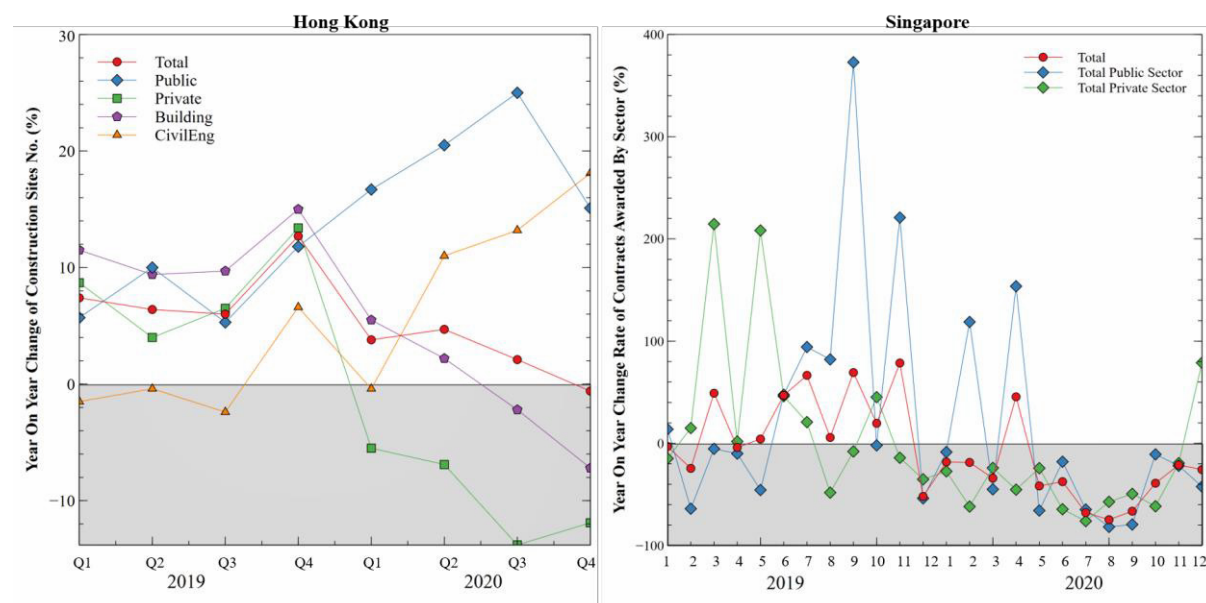


Figure 3. Changes of construction site number in Hong Kong and awarded contract number in Singapore

It should be pointed out that although the changes of construction site number and the awarded contract number can indicate the construction work situation, the difference is that construction site number shows the construction work in progress which was planned earlier while the awarded construction number indicates the construction work being planned now for the future. Therefore, there is a time difference between the two indicators. The numbers in Hong Kong



indicate that the current construction works are not largely influenced by the pandemic, but whether it will have impact on later projects in a longer time awaits further investigation of construction site number in the future. For Singapore, the figures imply the shrink of the near future construction works but cannot fully address the current situation.

#### 4.2.3 Construction worker engagement

The changing paths of the construction worker engagement in Hong Kong and Singapore are quite different during the pandemic, see Figure 4. In Singapore, the recruitment rate had a dramatic drop during the second quarter and the third quarter of 2020 because of the precautionary stay-home regulation since April 20, and only recovered around 0.3% after this long-term stoppage. While in Hong Kong, the year-on-year changing rate of manual workers engaged in construction industry decreased since 2019 but the decline speed of the rate slowed in 2020. And the number of the engagement changed to increase in the fourth quarter. According to the sub-curve of detailed category, the main reason of the slowed decreasing speed was that the public sector hired more workers especially in 2020. However, manual workers hired by private sector were continuously decreasing since 2019, which also indicated a possible larger effect on private sector than public sector by COVID-19. Analyzing by the classification of building and civil engineering, the workers engaged in both building works and civil engineering works decreased but the decline rate reduced in 2020. Specially, the workers engaged in civil engineering works began to increase in the third quarter in 2020 compared with that in 2019.

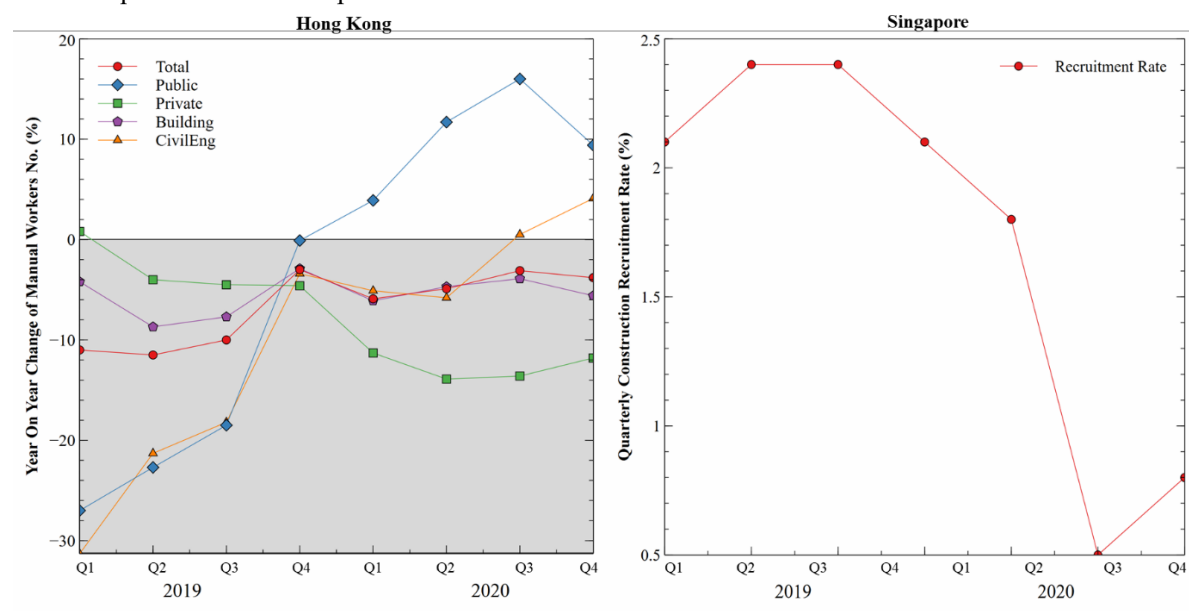


Figure 4. Construction workers engagement changes comparison between Hong Kong and Singapore

The better performance of the Hong Kong public construction sector and civil engineering works may not be simply explained as the higher resilience of the sector. To maintain the stability of the society and the industry, the public sector need to provide more work opportunities for the citizen. Therefore, its performance is not a pure economic behavior but also a governmental behavior which may not reflect the true impact of the COVID-19. Besides, the sharp decrease of the recruitment rate in Singapore only implies that it hired less workers. But whether more people cannot find a job or even loose the job cannot be directly indicated here. Therefore, we need to further investigate the job opportunities and job vacancy rate to see whether construction workers' job are influenced by the pandemic.

#### 4.2.4 Job vacancy rate

Job vacancy is defined as a paid post that is newly created, unoccupied, or about to become vacant. And job vacancy rate (JVR) is calculated as follows:

$$\text{JVR} = \text{No. of vacancies of manual workers} / \text{No. of job opportunities} * 100$$

The curve of job vacancy rate, see Figure 5, showed some similar regular patterns as the curve of construction worker engagement. Overall, in 2019 and the first quarter of 2020, the job vacancy rate in Hong Kong (above 2%) is much higher than Singapore (around 1%). Construction job vacancy rate in Singapore decreased from 2019 until the second quarter in 2020 when it



reached its trough of 0.4% and jumped to the highest rate in the fourth quarter in 2020. The labor force of Singapore construction industry is mainly made up by migrant foreign workers from neighboring Asian countries such as India, Myanmar, and Bangladesh. The final sharp increase at the third quarter of 2020 indicated that the COVID-19 shocked the construction labor force a lot because after the long-term stoppage the gradual resumption of construction work created increasing job demands, however it is hard to hire enough foreign workers due to the border control measures. In Hong Kong, the vacancy rate of construction manual workers remained at less than 1% and kept decreasing from 2019. With almost similar changing path for the curve of different categories, the vacancy rate of public sector is always larger than private sector, and the vacancy rate of civil engineering sites is always larger than building sites. Different from Singapore, construction industry manual works are mainly taken by local registered workers in Hong Kong, so it can maintained a resilience during the COVID-19 pandemic, which even lead to more people working for the construction industry.

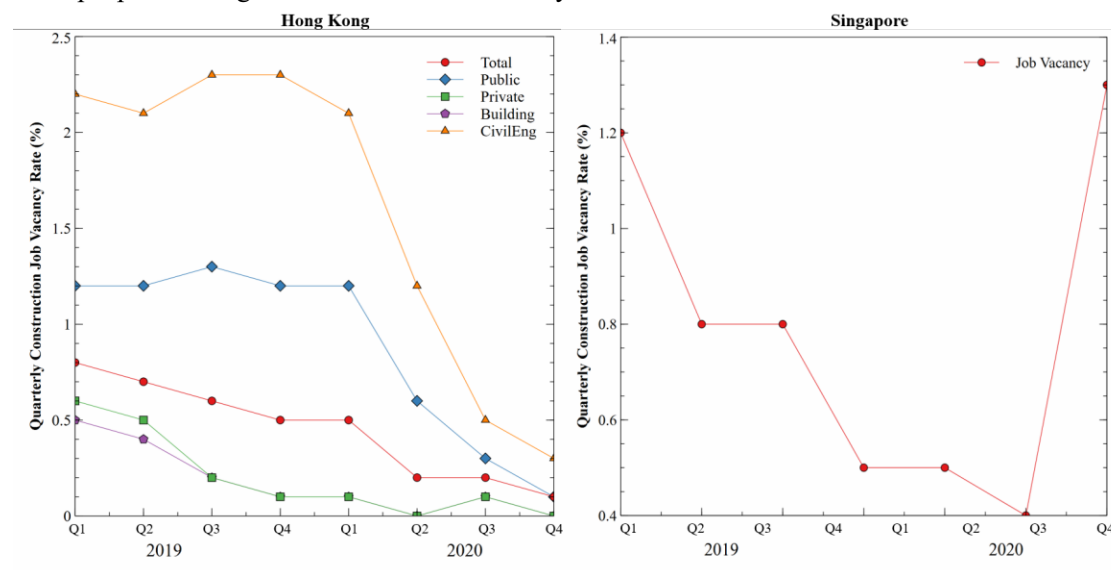


Figure 5. Construction industry job vacancy rate changes in Hong Kong and Singapore

The number of job opportunities in Hong Kong is also recorded, see Table 1. The number of job opportunities dropped in the second quarter but began to increase from the third quarter of 2020. However, the job opportunities in the fourth quarter is still less than that of the first quarter. However, the number of manual worker vacancies keeps sharp decreasing. It indicates that in the fourth quarter, more manual workers are engaged in the construction industry, which may imply the high unemployment rate in other industry in face of the third epidemic strike.

Table 1. No. of vacancies of manual workers and job opportunities in 2020 in Hong Kong

	Q1	Q2	Q3	Q4
Job opportunities	101,558	97,886	94,053	96,195
Vacancies of manual workers	498	244	143	78

## 5 Discussion and conclusion

Different pandemic situations and different institutional arrangements in response result in different performances of construction industry in Hong Kong and Singapore. Facing the rocketed increase of the confirmed cases, the government of Singapore chose to close all the construction sites and implemented the stay-home regulation from April 20 to June 2 which effectively control the fast spread of the pandemic. However, this long-term stoppage had a great effect on the construction industry reflecting in all representative indicators, as showed a dramatic drop of the construction GDP, awarded contracts amount, recruitment rate and a substantial growth of the job vacancy rate. With the gradual resumption of the construction work and stable pandemic situation, all the indicators were recovering by degrees. Although experiencing three spikes, the epidemic situation in Hong Kong was still controlled in a relatively low level compared with Singapore. The measures and responses implemented by the government of Hong Kong were mainly through anti-epidemic funding and construction industry caring campaign, which provided fiscal, goods

and material support to companies and manual workers. Reflecting on the changing path of the indicators, all the curves were relatively smooth without sharp fluctuations. However, since the pandemic is still on going, it is too early to conclude which institutional arrangement is better than the other. A longer span of investigation and more data from broader dimensions are needed for further analysing to get the final results of the comparison between these two different responding measures.

The performance of work engagement and job vacancy rate revealed the different structure of the construction industry workforce in Hong Kong and Singapore. The construction industry in Singapore hired plenty of foreign workers to fill the shortage of local labour with a lower cost. The high proportion of the recruitment of foreign workers ameliorate the labour structure and help the industry achieve a rapid development. However, facing the hit by COVID-19, especially the rocketed increase of the confirmed cases among foreign workers, this kind of labour structure exposed its vulnerability. In Hong Kong, the construction workers are locally registered and their salary are quite high. Even though, the construction industry, due to its tedious work and unsafe nature, is not attractive to workers as evidenced by the high job vacancy rate before the pandemic. However, it is also because of this workforce structure, the Hong Kong construction industry showed higher resilience during the pandemic and it absorbed those who lost the jobs in other industry. That is to say, both workforce structure has their advantages and drawbacks, and advantages can turn to be drawbacks in extreme case, vice versa. A more resilient workforce structure could be a balanced proportion of local workers and migrant workers but it awaits more verification.

The figures of public and private sector comparison also indicate that construction activities of public sector played an important role in maintaining the stability of the whole industry and creating more job opportunities during the hard time. Based on the statistics in Hong Kong, construction GDP, number of construction sites and manual workers in public sector all increased around more than 10% in different degree compared with the same period in 2019, which proved the effect of government intervention. In addition, the continuously decrease of all the indicators in private sector indicated the huge hit by COVID-19 and a lower resilience than the public sector. Public sectors could quickly get rid of the influence of the market economy based on the strong support from the government, and take on more responsibility of the industry and society. In the post-pandemic era, public sector is expected to play a key role in the economy recovery and assist the private sector to regain their merits.

## References

- [1] Ogunnusi, M., et al., COVID-19 pandemic: the effects and prospects in the construction industry. *International journal of real estate studies*, 2020. 14 (Special Issue 2).
- [2] United Nations, U., *Impact of the Pandemic on Trade and Development: Transitioning to a New Normal*. 2020: New York.
- [3] World Bank, T.W.B., *Global Economic Prospects*, January 2021. 2021, The World Bank: Washington DC.
- [4] BBC. (2021). Coronavirus: How the pandemic has changed the world economy, available at <https://www.bbc.com/news/business-51706225>, [accessed on March 4, 2021].
- [5] Shibani, A., D. Hassan, and N. Shakir, The Effects of Pandemic on Construction Industry in the UK. *Mediterranean Journal of Social Sciences*, 2020. 11(6): p. 48-48.
- [6] Alsharef, A., et al. (2021) Early Impacts of the COVID-19 Pandemic on the United States Construction Industry. *International journal of environmental research and public health*, 18(4): p. 1559.
- [7] ONS (Office for National Statistics). (2021). Construction output in Great Britain: December 2020, new orders and Construction Output Price Indices, October to December 2020: December 2020, available at: <https://www.ons.gov.uk/businessindustryandtrade/constructionindustry/bulletins/constructionoutputingreatbritain/december2020#annual-construction-output-growth-in-2020>, [accessed on March 4, 2021].
- [8] BEA (U.S. Bureau of Economic Analysis). (2020). GDP by industry, available at

- [https://www.bea.gov/sites/default/files/2020-12/gdp3q20\\_3rd.pdf](https://www.bea.gov/sites/default/files/2020-12/gdp3q20_3rd.pdf), [accessed on March 4, 2021].
- [9] HKCIC (Hong Kong Construction Industry Council). (2021). Appeal for help, available at: <http://www.cic.hk/chi/main/aboutcic/leadership/ChairmanBlog/blog-106.html>, [accessed on March 8, 2021].
- [10] Jallow, H., Renukappa, S., & Suresh, S. (2020). The impact of COVID-19 outbreak on United Kingdom infrastructure sector. *Smart and Sustainable Built Environment*. Preprint. <https://doi.org/10.1108/SASBE-05-2020-0068>
- [11] Kumar, A., et al., COVID-19 impact on sustainable production and operations management. *Sustainable Operations and Computers*, 2020. 1: p. 1-7..
- [12] ICAO. (2021). Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis, available at: [https://www.icao.int/sustainability/Documents/COVID-19/ICAO\\_Coronavirus\\_Econ\\_Impact.pdf](https://www.icao.int/sustainability/Documents/COVID-19/ICAO_Coronavirus_Econ_Impact.pdf), [accessed on March 5 2020].
- [13] HKCAD (Civil Aviation Department of Hong Kong). (2021). Air Traffic Statistics, available at: <https://www.cad.gov.hk/english/statistics.html>, [accessed on March 5, 2021].
- [14] PwC. (2020). Five Actions Can Help Mitigate Risks to Infrastructure Projects amid COVID-19, available at: <https://www.pwc.com/gx/en/industries/capital-projects-infrastructure/publications/infrastructure-covid-19.html>, [accessed on March 5 2020].
- [15] CNN. (2021). China's economy grows 2.3% in 2020 as recovery quickens, available at: <https://edition.cnn.com/2021/01/17/economy/china-gdp-2020-intl-hnk/index.html>, [accessed on March 8, 2021].
- [16] Statista. (2021). Annual gross domestic product (GDP) growth rate in China in 2020, by sector and industry, available at: <https://www.statista.com/statistics/1184408/gross-domestic-product-gdp-growth-rate-by-sector-or-industry-in-china/>, [accessed on March 8, 2021].
- [17] HKCSD (Hong Kong Census and Statistics Department). (2021). Gross Domestic Product (Quarterly), available at: <https://www.statistics.gov.hk/pub/B10300012020QQ04B0100.pdf>, [accessed on March 8, 2021].
- [18] HKCIC (Hong Kong Construction Industry Council). (2021). Construction Industry Council Assists Government to Distribute Six Million Masks to Construction Workers to Show Support and Care, available at: [http://www.cic.hk/files/press\\_release/241/en/20200825\\_Press%20Release\\_Mask%20Distribution\\_eng\\_FINAL.pdf](http://www.cic.hk/files/press_release/241/en/20200825_Press%20Release_Mask%20Distribution_eng_FINAL.pdf), [accessed on March 8, 2021].
- [19] BCA (Building and Construction Authority). (2020). Resumption of All Renovation Projects, Subject to Availability of Workers, available at: <https://www1.bca.gov.sg/about-us/news-and-publications/media-releases/2020/06/13/resumption-of-all-renovation-projects-subject-to-availability-of-workers>, [accessed on March 8, 2021].