

Pacific Association of Quantity Surveyors

Final Report

for

Impact of Covid-19 on the Construction Industry

International Workshops

on

27th November 2020 ; 4th December 2020

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Executive Summary

Two international workshops entitled “Impact of Covid-19 on the Construction Industry” were successfully conducted online on 20th November 2020 and 4th December 2020 via Zoom. The workshop aimed to identify the impact of Covid-19 on the Construction Industry in various member countries of the PAQS. In order to achieve these aims, the workshop participants had to share the current situation of the construction industry in their different countries/regions, identify the key functions needed, and recommend the best ideas to tackle the impact of Covid-19 on the industry in different countries/regions.

In the first workshop, participants were divided into four groups focusing on the construction industry from different perspectives, namely, industry, procurement, contract management, and supply chain. In the information phase, each team shared the Strengths, Weaknesses, Opportunities, and Threats experienced in the construction industry in their respective countries/regions in the areas of Industry, Procurement, Contract Management, and Supply Chain. An e-worksheet was prepared for the participants to provide their information simultaneously. Each participant then shared their country/region’s situation with their groupmates in the small group first. In order to establish a platform for the whole team, each group was invited to present some highlighted points to all participants in the big group.

During the analysis phase, function analysis tools such as *verb and noun phrases* were used to identify functions for tackling issues related to the pandemic. In total, 169 functions were identified, 55 for Industry, 39 for Procurement, 45 for Contract Management, and 30 for Supply Chain. Five key functions were identified by each group, and later presented to the large group at the presentation session.

A series of creativity tools (e.g., brainstorming, Scamper, and comic association) were used in all groups to generate a large number of ideas for the five key functions. In total, 215 ideas were generated (48 for Enhance Technology, 15 for Digitalize Procurement, 52 for Improve Cashflow, 42 for Avoid Disputes, and 58 for Enhance Cooperation).

In the evaluation phase, members were divided into eight groups according to nationality. Based on the five key functions, each country/region selected the 28 most important ideas worthy of implementation by the PAQS. To **enhance technology**, it is necessary to adopt BIM and the Dfma in the construction industry. Surprisingly, only Malaysia picked *friendly e-procurement* as an essential idea for **digitalizing procurement**. All countries/regions considered that ideas relating to the **cashflow improvement** were very important and should be implemented as soon as possible, including *flexible and shortened payment of items (retention money and bonds), seeking governmental support, rearranging bank loans, etc.* An effective communication channel with simple language, clear standards, matching contact points, comprehensive plans with specific times and costs, and the application of risk management were definitely useful ideas for **avoiding disputes** among parties, particularly under the pandemic situation. Most countries/regions highly recommended ideas relating to **team cooperation** to their countries and the PAQS, including *aligning objectives among all participants; sharing all site information online; and conducting international seminars, workshops, and training via Zoom.*

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1. Introduction

Two international workshops titled “Impact of Covid-19 on the Construction Industry” were conducted by the Research Committee of PAQS via Zoom on 20th November and 4th December 2020.

The first workshop consisted of two major steps: information sharing and function identification, while the second workshop comprised creative and evaluation phases following the Value Management (VM) approach. To facilitate the discussion, participants of the two workshops were allocated to 4 groups (23 for the first workshop, 20 for the second; see Figures 1–2). Five experienced quantity surveyors (i.e., Dr. Mei-yung Leung, Sr. Dainna Baharuddin, Sr. Eric Khoo, Dr. Felicia Yong, and Sr. Nadzirah Hj. Zainordin) played the role of facilitator for each group to ensure positive team discussion.



Figure 1 Participants in the First Workshop



Figure 2 Participants in the Second Workshop

1.1 Workshop Objectives

The international workshops aimed to identify the impact of Covid-19 on the Construction Industry. In order to achieve this, the following objectives were considered:

1. Sharing the current situation of the construction industry (i.e., Strength, Weaknesses, Opportunities, and Threats) during the pandemic in different countries/regions.
2. Identifying and selecting the key functions to tackle the impact of Covid-19 on the construction industry.
3. Proposing creative ideas that meet the functions for tackling the impact of Covid-19 in the industry.
4. Evaluating and selecting the best ideas for carrying out the functions in the pandemic situation in different countries/regions.

1.2 Agenda

The international workshops were held on 20th November and 4th December from 15:00 to 18:00 (Hong Kong Special Administrative Region, China [HKSAR] time) using the VM approach (information, analysis, creativity, and evaluation phases; see Table 1).

Table 1 Agenda

First workshop, on 20/11	
TIME	CONTENT
15:00–15:05	WELCOME SPEECH Sr. Kwan Hock Hai, Malaysia <i>Chairman, The Pacific Association of Quantity Surveyors</i>
15:05–15:15	INTRODUCTION
15:15–16:00	INFORMATION PHASE Small group discussion Large group presentation
16:00–17:30	FUNCTION IDENTIFICATION PHASE Individual function list Function identification Function sharing
17:30–18:00	SUMMARY & CLOSING
Second workshop, on 04/12	
15:00–15:05	Introduction
15:05–15:15	WELCOME SPEECH Dr. Mei-yung Leung, Hong Kong <i>Organizing Chair, PAQS Workshop</i>
15:15–16:20	CREATIVITY PHASE Small group stimulation Group exchange
15:15–16:20	CREATIVITY PHASE
16:20–16:35	Small group stimulation Group exchange
	BREAK
16:00–17:30	EVALUATION PHASE Individual country discussion

Large group presentation		
17:30–18:00	SUMMARY & CLOSING REMARKS	
	Sr. Kwan Hock Hai, Malaysia	
	<i>Chairman, The Pacific Association of Quantity Surveyors</i>	

1.3 Participants of Each Group

To ensure sufficient time for sharing on different perspectives of the construction industry in various regions, the 23 participants who attended the first workshop were allocated to 4 groups (i.e., industry, procurement, contract management, and supply chain & logistics; see Table 2).

Table 2 Participants in the First Workshop

Group	Name	Nationality
Industry	Tom Berliner	New Zealand
	Dona Chitra	Sri Lanka
	Frederick E. Fuentespina	The Philippines
	Mei yung Leung*	HKSAR, China
	Ka Wang Li	HKSAR, China
	Duleesha Wijesiri	Sri Lanka
Procurement	Nadzirah Hj. Zainordin	Malaysia
	Dainna Baharuddin*	Malaysia
	Hiroaki Higashionna	Japan
	Paul Ho	HKSAR, China
	Jason Ongpeng	The Philippines
	B.V. Prasath Sanjeewa	Sri Lanka
	Xiaoyi Wei	Mainland China
Contract Management	Lekan Damilola Ojo	Nigeria
	Annkay Asakura	Japan
	Maresher C. Dela Cruz	The Philippines
	Dasun Fernando	Sri Lanka
	Felicia Yong*	Malaysia
Supply Chain & Logistics	Ojo Damilola Augustine	Nigeria
	David Dooks	Canada
	Eric Khoo*	Malaysia
	Olajide Emmanuel Ogundimu	Nigeria
	Erwin Rokhman	Indonesia

Note: * - identifies the facilitators in the workshop

Based on the discussion in the first workshop, five areas were identified: Enhance Technology, Digitalize Procurement, Improve Cashflow, Avoid Disputes, and Enhance Cooperation. The 20 participants in the second workshop were then assigned to 5 groups for in-depth discussion of these 5 areas (see Table 3).

Table 3 Participants in the Second Workshop

Group	Name	Nationality
Enhance Technology	Dianna Baharuddin*	Malaysia
	Suuny Choi	HKSAR, China
	Xiaoyi Wei	Mainland China
Digitalize Procurement	Paul Ho	HKSAR, China
	Eric Kho*	Malaysia
	Jason Ongpeng	The Philippines
Improve Cashflow	Tom Berliner	New Zealand

	Lijian Li	Mainland China
	Florence Ling	Singapore
	Paul Wong	HKSAR, China
	Nadzirah Hj. Zainordin*	Malaysia
	Lekan Damilola Ojo	Nigeria
Avoid Disputes	Mareshher C. Dela Cruz	The Philippines
	Shang Zhang	Mainland China
	Raymond Kam	HKSAR, China
	Felicia Yong*	Malaysia
	Mohamed Humdhan	Brunei
Enhance Cooperation	Mei yung Leung*	HKSAR, China
	Ka Wang Li	HKSAR, China
	Rex Ying	HKSAR, China

Note: * identifies the facilitators in the workshop

2. Information Phase

In the information phase, each team member shared the current pandemic situation of the construction industry in their respective country/region on the e-worksheet provided.

In the first workshop, the impact of Covid-19 on the construction industry in different countries/regions was divided into four categories: industry, procurement, contract management, and supply chain & logistics (see Tables 4–7).

	Malaysia	China (HK)	New Zealand	Sri Lanka
Participant	Nadzirah (F)	Meiyung	Tom	
Impact Category	<ul style="list-style-type: none"> insufficient labour force lockdown city insufficient material sources slow process in legislative council (argument) dynamic government policy High construction Cost off work no retail business (lunch) limited overseas projects insufficient Land supply 	<ul style="list-style-type: none"> Supply chain issues (difficulty to get materials from others, e.g., Malaysia; etc.) Availability of materials (quarantine) Labour shortage Difficulty of movement between countries Some project on hold Additional costs & programme Unclear contract conditions 1/2 ppt work in 1 room on site (social distance) 	<ul style="list-style-type: none"> not lockdown totally; can go in/out some closing (beside) 100,000 km 10 contractors design housing - slow BOT - delay temporary stop for some sites not much government support labour movement between countries 	<ul style="list-style-type: none"> internet Well developed legal system Convenient Transportation Contractual spirit work from home
Summary		<ul style="list-style-type: none"> Strong current local market The option to operate from home / zoom etc. Quick response to the issues Contract resolve quickly 	<ul style="list-style-type: none"> construction industry moving on government's project going on 	

Figure 3 Information Sharing among Different Countries/Regions

2.1 Industry

The Covid-19 crisis has had a huge impact on the construction industry globally. Some countries/regions chose several measures to *control* the impact, such as full lockdown (Malaysia and New Zealand) or partial lockdown (HKSAR, China, and Sri Lanka). Due to the restriction of labor movement and transportation (HKSAR, China, New Zealand, and Sri Lanka), the construction industry has encountered shortages of construction materials (e.g., HKSAR, China, Malaysia, and New Zealand), and lack of labor (e.g., Malaysia and New Zealand). In this situation, project delivery was affected, put on hold, or delayed (HKSAR, China, Malaysia, New Zealand, and Sri Lanka). Sri Lankan

participants mentioned the slow process of construction design, but some government projects were still ongoing.

With the use of *technology* and good internet communication in the HKSAR, China; the impact of Covid-19 was minimized to a certain extent with the use of IR 4.0, BIM, and online platform enforcement (Malaysia).

The *global economy* has been affected by the pandemic. In particular, participants identified that the economy in Malaysia was affected, dining businesses were restricted in the HKSAR, China (e.g., closed before midnight), and businesses were forced to close in Sri Lanka. However, some countries/regions saw this situation as an opportunity for the construction industry, with low interest rates (HKSAR, China and New Zealand), potential for cooperation (HKSAR, China), strong local and residential markets (New Zealand), increasing new construction developments (New Zealand).

In fact, government played an important role in dealing with the Covid-19 issue. Some governments responded to the issue quickly (e.g., New Zealand), while Sri Lanka's governments gave little support to the industry. The industry sought support from governments, but in the unclear political environment, the decisions process of the legislative council was slow as a result of the dynamic global conditions and the uncertain local governmental policy (HKSAR, China).

To ensure safety, measures were applied for a safer working environment, such as social distancing on site (New Zealand) and working from home (HKSAR, China and New Zealand). However, this had a limited impact in the HKSAR, China due to convenient transportation and food delivery services. Furthermore, slow progress in the payment of contractors and consultants resulted in cashflow problems in Malaysia, while the delay in progress induced high construction costs in the HKSAR, China, New Zealand, and Sri Lanka. With this unexpected situation, disputes arose over unclear contract conditions (New Zealand). In the HKSAR, China and New Zealand, disputes have so far been resolved easily with a well-developed legal system and contractual spirit, while there were concerns about revising contract forms to respond to Covid-19-related issues in Malaysia.

Table 4 Construction Industry Conditions in Different Countries/Regions under Covid-19

Situation	HKSAR, China	Malaysia	New Zealand	Sri Lanka
Material supply	Material sources were closed down (need from Mainland, restricted transportation)	Material shortage	Supply chain issues (difficulty of sourcing materials from others, e.g., Malaysia) Availability of materials (quarantine)	-
Labor supply		Shortage of labor supply	Labor shortage, difficulty of movement between countries	Labor movement between countries
Project delivery	Limited overseas projects	Delay in delivering the project	Some projects on hold	10 contractors designing housing – slow Temporary stop for some sites Construction industry moving on Government project ongoing

Situation	HKSAR, China	Malaysia	New Zealand	Sri Lanka
City situation	Citizens' activities restricted Insufficient land supply	-	Further lockdowns	Not total lockdown Movement possible
Technology	Internet E-communication	IR 4.0 online platform BIM (compulsory) Mandatory use of online platform	-	-
Economic situation	Dinning business were restricted Low interest rate China-HK cooperation	Economic totally stop during lockdown	Strong current local market New projects Strong residential market following the Covid-19 lockdown Increased immigration to NZ Low interest rate	Some closing (seaside)
Political situation	Slow process in legislative council (argument) Dynamic government policy Unclear political environment Seeking support from government Immigration from HK Sanctions from other countries	-	Quick responses to the issues	Not much government support
Cashflow issues	-	Slow payment progress	-	-
Cost and program issues	High construction costs	-	Additional costs & program	EOT – delay
Contractual issues	Well-developed legal system Contractual spirit	Revising contracts to address issues related to Covid-19 (governmental/private projects)	Unclear contract conditions Disputes Contracts resolved quickly	-
Working environment	Convenient transportation Working from home Food delivery	-	1/2 ppl working in 1 room on site (social distancing) The option to operate from home /Zoom, etc.	-

Note: = strengths; = risks

2.2 Procurement

The Covid-19 crisis created serious safety issues around the world, and all countries/regions took multiple actions to ensure safety in the construction industry, namely, lockdown of construction sites (Malaysia), restrictions on mobilization (Sri Lanka), and raising awareness of the importance of cleanliness (the Philippines), conducting Covid-19 tests (the Philippines), and so on. In this period, *international procurement cooperation* was interrupted. Malaysia and the Philippines faced problems

of reduced and delayed importation of materials and equipment and unstable forex. The Covid-19 situation reduced the participation of contractors in the *tendering* process, especially in the private sector in Malaysia and Sri Lanka. Therefore, tendering prices dropped, and some clauses relating to the pandemic were included in tendering documents in Malaysia to attract more contractors to bid. *Manpower* was also affected in this period, especially in the Philippines and Sri Lanka. Work performance was reduced in these two countries, due to fewer workers and experienced staff. On the other hand, more opportunities also emerged for local labor (Malaysia), suppliers (Philippines), and new contractors (Sri Lanka). The Malaysian participants mentioned that various *projects* were delayed, so they planned to find a better way to do construction. The Sri Lankan industry experienced a similar situation. In sum, the *cost* issue was critical for almost all countries/regions in this period. Currently, local materials in Malaysia are cheaper to procure than before, though Malaysian quantity surveyors still have concerns about rising prices in the future. They are afraid that such rises may cause financial problems for contractors because they will not be able to meet tender prices. However, in the Philippines and Sri Lanka, costs increased for different reasons, such as unstable material prices and safety protocols.

During this pandemic period, *e-procurement* was expected to be used to facilitate procurement processes in the construction industry. E-procurement is a relatively new technique and may be difficult to apply in all countries/regions. The application of e-procurement is highly dependent on a good internet connection, which may not be available in some developing countries, such as the Philippines. E-procurement was convenient for work (Mainland China and the Philippines), was free from time or location constraints (Mainland China, the Philippines, and Sri Lanka), and offered benefits to organizations (HKSAR, China and the Philippines). However, several concerns also emerged with e-procurement, such as issues of confidentiality (Japan, Mainland China, the Philippines, and Sri Lanka), and difficulties coordinating product quality (HKSAR, China). In Japan, no further *knowledge* is needed for construction professionals to use e-procurement, while in Mainland China, Malaysia, and Sri Lanka, e-procurement training is essential.

Table 5 Procurement Applications in Different Countries/Regions under Covid-19

Situation	HKSAR, China	Mainland China	Japan	Malaysia	The Philippines	Sri Lanka
Safety issues	-	Avoid virus	-	Lockdown Malaysia Covid Act 2020	Increase awareness on cleanliness Conduct Covid-19 tests	Pandemic may become worse Restrict mobilization
International cooperation	-	-	-	Importation of materials and equipment delayed Forex is unstable	Reduction of imported materials	-
Tendering issues	-	-	-	Less tender is procured in the private sector Lower tender price Bid documents include clauses on pandemic	-	Less contractor involvement in tendering. Tendering documents revised

Situation	HKSAR, China	Mainland China	Japan	Malaysia	The Philippines	Sri Lanka
Manpower				More work provided for local labor	Limited vendors/ staff /workers Possible increase in local suppliers	Lack of workforce & experienced staff Opportunities for new contractors Quality of work could be affected
Project-related				Better way to do construction Project delays		Fewer projects
Cost issues		Corruption		Local materials are cheaper to procure Prices might go up after the situation improves, while contractors cannot meet the price tendered Less financing	Prices of construction materials are not stable Increase cost from Covid-19 safety protocols	Contractors' costs could rise
E-procurement technology	Not very popular in construction	Older people may not accept it			Restrict the information on online bidder conference meeting	Some public projects may not allow it
Internet connection	Sufficient IT network				E-procurement is highly dependent on internet connection	
E-procurement support	Good platform for providers Cost savings for contractors Potential problems in product quality control	Convenient No time constraint Confidentiality issues	Confidentiality	Government assistance available	Easy document sharing Work from home Benefit for the involvement of independent parties New norm of work Data protection and security	Working from home Transparency issues
Knowledge		Training needs to be developed	Need further knowledge	Better understanding of force majeure Study on e-procurement		Unfamiliar New learning opportunity

Note: = strengths; = risks

2.3 Contract Management

Participants from Malaysia, the Philippines, and Nigeria mentioned that they had difficulties in making changes, especially in ongoing projects. Some countries/regions had cashflow problems during the pandemic (the Philippines and Sri Lanka). Fortunately, a grace period for the repayment of bank loans was allowed in Sri Lanka. There was no standard EOT procedure for handling unforeseeable situations in Malaysia and Nigeria. In terms of innovation in contract management, the pandemic was considered an opportunity in Malaysia and the Philippines, while Nigerian participants feared cyber-related issues. To enhance contract management, participants from all countries (Japan, Malaysia, Nigeria, the Philippines, and Sri Lanka) revealed that the pandemic period was a moment of learning computer-related skills and developing provisions or clauses related to crisis management for proper adjustment.

In Malaysia, the need for compensation was apparent due to the suspension of construction activities and disputes among construction stakeholders. To mitigate the risks of Covid-19 and ensure construction workers' compliance with basic rules of hygiene and safety, a mediation center and Standard Operating Procedures (SOP) were set up by the government.

Contract conditions could not be adjusted in the Philippines despite the pandemic. Some contractors had to decline construction projects, while others embraced the sharing of additional costs that arise as a result of the pandemic. The pandemic period was a learning curve and it was necessary to adjust to the new normal of resilience and collaboration with other construction teams.

Nigeria experienced the fear of adapting to the changes brought by the pandemic. Electronic means of undertaking construction activities were seen as a necessity. The pandemic was stated to be a time to sell some abandoned creative ideas in the form of developed software suitable for the construction environment. However, the security of information on the internet was perceived as a risk.

Japan struggled with the challenge of a lack of data for making provision of claims. Claims were made due to various reasons, such as insufficient understanding by the client of what constitutes a claim and a lack of coordination.

Table 6 Contract Management Perspective in Different Countries/Regions

Situation	Japan	Malaysia	Nigeria	The Philippines	Sri Lanka
Adoption of new contract management	-	Operate based on SOP Inability to change in work methods	Fear of adapting to change	Ongoing procurement could not amend terms and conditions	-
Cashflow	-	-	-	Financial availability to cope	Difficulties of contacting banks Insufficient cashflow Overdraft
Professionals	Lack of coordination by PIC of technical/schedule /cost	-	-	Different point person to handle issues	Difficulties of professional gatherings

Situation	Japan	Malaysia	Nigeria	The Philippines	Sri Lanka
Technology	Not mentioned	Opportunities for innovation to do things differently	Electronic means of working become a necessity	Availability of technology to be utilized Costly software Poor internet connection	Not mentioned
Compliance		Compliance with law Compliance with EOT Setting up Covid-19 mediation center	Lack of enforcement Compulsory adjustment	Ongoing preparation of guidelines	
Learning	Challenging (can learn more) Understanding contracts	Familiarization with contracts Look into clauses/provisions in detail	Learning of new skills Taking lifelong learning seriously Critical thinking Webinars to familiarize wi. new normal	Learning curve for all	New challenge to study Improve professional thinking Knowledge of contract conditions More time to look at contract issues
Risk	Overloaded Lack of budget to deal with claims Lack of records to prepare/evaluate claims Lack of client understanding of claims Different points of view held by all parties	Suspension of construction activities More disputes Compensation/loss Mitigation efforts	Security of information Fear of cyber-related issues Opportunistic behavior How to address possible EOT Filial relationship problems	Contractors declining contracts Increase in risk consideration Sharing of burden of additional costs	Lack of funds Disputes Uncertainty of law changes Reduced bank lending rate Difficulty of accessing project data Lack of work from home facilities Difficulty of quality checking
Adjustment		Change in work methods Look into collaboration Innovation Stimulus for SME	Platform for innovation Time to sell abandoned creative ideas	Adjustment to the new normal Understanding other parties' pts of view Resilience Coordination with all parties	Time to think about work from home concept Loan repayment grace period Country economic was affected

Note: = strengths; = risks

2.4 Supply Chain and Logistics



The global supply chain faced material shortage problems (Indonesia and Malaysia) due to import delays (Canada) and long delivery times (Indonesia), which led to rising prices in the construction industry (Canada, Indonesia, Malaysia, and Nigeria). As a result of the supply chain's reduced capacity, demand for local products increased (Canada, Indonesia, and Malaysia).

At the same time, labor shortages were also critical in Canada, Malaysia, and Nigeria,

while the salary of the workforce was reduced in Nigeria. However, in developed countries like Canada, the bid results were not affected by the pandemic. On the positive side, some opportunities were provided in the supply chain. For example, the Canada and Nigeria participants mentioned there were huge demands for infrastructure facilities in their country/region. On the other hand, the Covid-19 era can be seen as a good period for the development of new technology, such as prefabricated assembly.

Table 7 Supply Chain and Logistics Conditions in Different Countries/Regions under Covid-19

Situation	Canada	Indonesia	Malaysia	Nigeria
Material supply	Delays from imports	Material shortage Long delivery	Material shortage	-
Labor supply	Labor shortage	-	Labor shortage	Shortage of labor which further leads to extended delivery time
Construction cost	Lumber prices 2X to 3X Current bids results are stable Higher prices in some commodities	Price increase	Price increase	Increase in the cost of goods importation Salary reduction
Material source	Resourcing local suppliers Wide range of suppliers Unpredictable escalation	Raw material uses local Harnessing locally sourced goods and materials	Use local products	-
Industry	Diverse construction industry Prefabricated assembly expanding Skilled labor at high demand	-	-	-
Market	Infrastructure demands in remote areas	-	-	Shortage of Infrastructures

Note:  = strengths;  = risks

3. Function Analysis Phase

Based on the information shared, an analysis tool with verb and noun phrases was adopted in the second part of the first workshop to generate a total of 169 functions (see Appendix A). After individual voting and discussion, 68 functions were selected as key functions by the workshop participants, and five were identified as primary functions, namely Enhance Technology, Digitalize Procurement, Improve Cashflow, Avoid Disputes, and Enhance Cooperation (see Table 8).

Table 8 Key Functions for Tackling the Impact of Covid-19 on the Construction Industry

Functions	Industry	Procurement	Contract Management	Supply Chain
Enhance technology -on-site /off-site	Establish e-procurement Educate IT knowledge Update technology Establish platform	Adopt innovation* Improve efficiency Keep safe Work online Manage communications	Enhance technology* Embrace changes* Change mindset Utilize technology Adapt change Safeguard information	Emerge technologies* Encourage e-communication* Promote 'green' Enhance internet Pre-modular construction
Digitalize procurement -development	Improve internet	Digitalize procurement*	Safeguard information Simplify procedures	Reduce risk

-construction				
Improve cashflow -inflow : gov.~ -outflow: delay ~	Improve cashflow * Keep cost certainty Recover economy Allow delays Welcome investment	Improve cashflow * Lower costs	Increase funds Provide stimulus Share burden	Support industry * Fund industry Mitigate impacts
Avoid disputes (e.g., t/c /supplier /environment, etc.; existing terms)	Clarify contractual- terms Give flexibility Revise contract forms Set up platform Improve contact tracing	Administrative procedures Record agreements	Comply law* Avoid disputes* Keep records Follow standards Set guidelines Adjust clauses Control risk	Create standards Set policies Enhance delivery
Enhance cooperation	Unite industry * Improve leadership * Train labor * Keep operation Unify people	Improve communication * (control remotely, e.g., VPN)	Enhance co-operation Share knowledge Secure benefits	Set policies * Create standards * Encourage interaction Encourage workforce

Note: * key function

4. Creativity Phase

Creativity was the focus of the first activity in the second workshop. A series of creativity tools (e.g., brainstorming, Scamper, and comic association) were used in the 5 groups to generate a large number of ideas for the five key functions agreed upon in the first workshop. In total, 215 ideas were generated for the functions of Enhance Technology, Digitalize Procurement, Improve Cashflow, Avoid Disputes, and Enhance Cooperation.

4.1 Enhance Technology

In order to **enhance technology**, team members proposed various ideas on *building technology*, such as 3D printing construction, modular design technology, international standardization, robotic technology, industrialization, green building (see Table 9). The *workflow* had to be reviewed, while some *software* (e.g., BIM, site housekeeping, and database storage) and *internet services* must be developed for *communication* among project team members (e.g., block chain, cloud-based communication, and virtual meetings) and for the overall *workflow* (e.g., cloud-based project management systems, online orders of materials, real-time progress display, self-checking, drones for site inspection). Some members further proposed biometric techniques to connect and track the *staff* on-site, or the hiring of IT staff to manage innovative technologies. Additional *research*, *special training*, and *international conferences/workshops* related to the Internet of Things will also play important roles in promoting advanced technologies in the surveying field among the member countries of the PAQS. In sum, *government support* is vital. It might be good to establish institutions for technologies in quantity surveying and join the Belt and Road initiatives for cooperation.

Table 9 Ideas Generated for Enhance Technology (Group 1)

Categories	Mainland China	HKSAR, China	Malaysia
Building technology		t14-Industrialization (Dfma) t15-Enhancing technologies t16-New building materials t17-Enhanced buildability through design	t26-Green building t27-3D printing construction t28-Cheaper machinery t29-Modular design technology t30-Standardizing technology internationally t31-Industrialised building system t32-Robotic construction technology
Workflow		t18-Re-engineer the workflow and the information flow t19-Supply chain management	
Information technology	t1-Develop software for information storage t2-Develop information database	t20-BIM	t20-BIM t33-Construction site housekeeping software
Communication network	t3-Use IOT even for face-to-face meetings	t21-Cloud-based communication	t34-IOT- Improve connectivity t35-Blockchain t36-IOT- Contact tracing
Task network	t4-Procure IT services t5-Enhance internet facilities	t22-Digitized processes t23-Robotic process automation t24-Self-checking before passing down information.	t37-Remote working t38-Cloud-based PM system t39-Order materials online t40-Progress on site shown in real time t41-E-payment platform for purchasing materials t42-Authorities inspection via real-time video t43-Drone for site evaluation
Staff	t6-Hire IT staff		t44-Management of software t45-IOT- Biometric connectivity t46-Foreign labor's biometric tracking
Research	t7-Encourage more research related to IOT t8-Enhance research on IOT in construction		t47-More R&D on machinery
Training	t9-Conduct training t10-Hold international conferences or workshops to exchange IOT information		
Industry	t11-Gain government support to promote technologies t12-Join B&R initiatives to cooperate t13-Establish institutions for technologies in QS	t25-Disruptive transformation	t48-Reduce labor intensive jobs

4.2 Digitalize Procurement

To digitalize procurement, it is suggested to develop enterprise resource planning *software* and identify specific intellectual property rights regarding BIM and drawings shared between parties during the process (see Table 10). Innovative *task network* systems, such as centralized data platforms with blockchain or cloud systems, or compatible e-procurement and e-payment systems, are all required. Private projects may

struggle to adopt digital procurement; therefore, government support is important in the industry.

Table 10 Ideas Generated for Digitalize Procurement (Group 2)

Categories	HKSAR, China	Malaysia	The Philippines
Information technology		p5-Reliable software	p10-Change in contract content - loosen intellectual property rights on BIM /drawings to be shared among parties p11-For private projects: Enterprise Resource Planning (ERP) software is available to aid procurement process
Task network	p1-Cloud platform for data storage and processing p2-Blockchain to support e-procurement documents p3-E-payment (virtual banking) to facilitate transactions p4-IoT to support supply chain management	p6-Centralized data platform with blockchain /Cloud p7-Contract content with e-procurement p8-Secure payment system (i.e., Amazon) p9-Standardizing e-commerce in construction	p12-Develop and enhance online payment systems p13-For government projects: RA 9184 of the Philippines practice digital procurement to some extent
Industry			p14-For government projects: improvement necessary p15-For private projects: Depends highly on the owner but usually no digital procurement

4.3 Improve Cashflow

The cashflow crisis is one of the most significant issues in the construction industry during the Covid-19 pandemic. To reduce the number of disputes and avoid any undue burden sharing, a proper, clear *contract* and a direct *procurement* were recommended (see Table 11). Different parties could support the whole industry with cashflow (e.g., *Government* – financial assistance, tax reduction, guarantees for loans, etc.; *Developers* – expanded investment, long-term selling periods, rent freeze, etc.; *Designers* – selection of local suppliers or materials; *Banks* – flexible repayment/loans, reduced interest rate, shortened payment periods, etc.). It was expected that the burden of Covid-19 relating to *costs* and *time* be shared between clients, contractors, and subcontractors. The client could release payment in advance, shorten payment certification periods, include materials off-site, eliminate retention of money, cap contractors' claims for Covid-19, etc. Some *building technology* (e.g., machines) and *information technology* (e.g., digitalized cashflow management systems) might also be helpful for contractors to accelerate progress and payment procedures.

Table 11 Ideas Generated for Improve Cashflow (Group 3)

Categories	Mainland China	HKSAR, China	Malaysia	New Zealand	Singapore
Contract	c1-Cut out middlemen for direct procurement			c33-Alternative procurement c34-Clear contract conditions c35-Other similar situations, e.g.,	c47-No single stakeholder bears an undue share of the burden imposed by

				natural disasters, wars c36-Reduce disputes	Covid-19
Government support	c2-Government subsidizes cost of shutdown	c10-Government guarantee of contractors' loans due to Covid-19 c11-Grant assistance to contractors	c18-Assistance to protect client & contractor fund c19-Government incentives/ assistance c20-Financial assistance during unprecedented crisis c21-Tax reduction	c37-Government assistance c38-Increase government investment	c48-Government takes biggest share of cost increase, e.g., 50%
Developer/ owner	c3-Sell long-term held property such as office buildings and shopping malls c4-Combination with medical equipment projects to attract investment		c22-Expand client investment c23-Client to arrange the investment	c39-Rent freeze	
Designers	c5-Use local suppliers		c24-Prioritize usage of local products	c40-Use local materials/ suppliers available	
Bank	c6-Banks are cutting back on lending terms c7-Lower interest rates for property buyers c8-Use financial instrument to pay suppliers	c12-Arrange bank facility upon receipt of payment certificate	c25-Financial availability to cope with Covid-19 c26-Banks offer flexible repayment c27-Flexible plans for loans c28-Recalculation of interest rate c29-Financing assistance		
Cost sharing		c13-Share the burden of Covid-19 with common goal for dealing with the cashflow issue c14-Advance payment (secured by advance	c30-Set flexible payment between client and contractor c31-Sustain contractor cashflow	c41-Improve payments terms c42-Reduce costs c43-Insurance c44-Eliminate retention c45-Early retention release c46-Advance payment w/o bond	c49-Sharing of costs to manage Covid-19 pandemic among government, client, contractor, and subcontractor c50-Cost sharing

		payment bond) c15-Increase frequency of payment c16-Shorten the time to value, certify, & honor payments c17-Payments for materials off-site			among project stakeholders and government c51-Maximize /cap contractors' claims for Covid-19
Time sharing					c52-Cost sharing concept can be used for sharing burdens caused by project delay
Building technology	c9-Use machinery instead of construction workers				
Information technology			c32-Digitalization of cashflow management		

4.4 Avoid Disputes

Effective *communication* was considered essential for construction workflow by all member countries in the group, therefore the team proposed detailed discussion and transparent information sharing among all parties (see Table 12). All *information* (objectives, scope of work, and changes such as rescheduling and resource reallocation) must be properly recorded in a comprehensive plan in advance. Clear specific *contract* terms are required, therefore the team suggested using simple language in the agreement, adopting the latest Standard Operating Procedures, negotiating agreement terms for revised payment periods, applying a standard form of contract (FIDIC/ICE), setting penalties for defaulters, ensuring enforcement and compliance, etc. *Information technology*, including software and/or microchips, could be used to synchronize/update contract information, while other *management* methods such as crisis management and/or recognition and reward could be applied to minimize possible risks. It is recommended to seek advice from *experts* such as dispute mediators, lawyers, arbitrators, etc. as early as possible to resolve potential conflicts early. Of course, constant *training/workshops* with other developed countries are always welcome.

Table 12 Ideas Generated for Avoid Disputes (Group 4)

Categories	Mainland China	HKSAR, China	Malaysia	Nigeria	The Philippines
Communication	d1-Sophisticated clients to help in a conflict between parties d2-Parties have	d5-Effective communication channels and matching	d7-Sharing of information with all project parties d8-Communicate issues/ problems with management	d20-Avoid relational interference	

Categories	Mainland China	HKSAR, China	Malaysia	Nigeria	The Philippines
	experience working together d3-Very complicated projects – helpful to have an in-depth discussion to reach common target between parties before contract signing	contact points	or project team during meetings for discussion and resolution d9-Transparent decision-making and information flow		
Clear information			d10-Proper documentation of events/record all changes, i.e., rescheduling of works and reallocation of resources d11-Protect and secure the works at the site	d21-State objectives explicitly d22-Consistency in compliance assessment	d38-Clear scope of work d39-Proper documentation of events d40-Be mindful of time bars, in the session of notices
Contract/legislation	d4-Use a standard form of contract (FIDIC /ICE)		d12-Contracts written in simple language d13-Remind all parties of the latest Standard Operating Procedures (SOP) set by the government, i.e., in meetings/ briefings, etc. d14-Renegotiate agreement terms, i.e., suppliers (longer payment time frames) d15-Draft supplementary/ commercial agreements d16-Incorporate provisions related to the new norm of working	d23-Ensure enforcement and compliance d24-Provide code of ethics d25-Set penalties for defaulters d26-Involve legal backing d27-Revisit existing standards d28-Enforcement of the available standards	d41-Clear standards to be used
Information technology				d29-Software for record-keeping d30-Microchip to keep data, and synchronize/ update contract	d42-As much as possible, a complete set of plans (projects - t/c; BIM)

Categories	Mainland China	HKSAR, China	Malaysia	Nigeria	The Philippines
				information	
Management			d17-Risk management	d31-Dispute management d32-Crisis management d33-Recognition and reward	
Experts		d6-Retaining third party as dispute advisor to identify & resolve potential conflicts/ disputes early	d18-SO, and CA/QS act as intermediary for negotiations/ mediations in resolution of conflicts d19-Get advice from construction lawyers/ involve legal backing	d34-Form committee d35-Involve arbitrators	
Training				d36-Constant training and workshop d37-Learning from developed countries and experts	

4.5 Enhance Cooperation

To **enhance cooperation** among different parties, *industrial* guidelines and rules must be reviewed (see Table 13). The team considered *physical environment* (hygiene, mask vending machines, regular virus tests, quarantine, short meetings, regular site visits, etc.) and proposed a *flexible environment* under this pandemic situation (e.g., workplace confidentiality, working hours, and some rules for working from home). *Information technologies* such as drones, notebooks, mobile devices, and touchless technologies (e.g., eye/facial recognition) might be useful. In order to manage sites remotely, network systems including on-site sensors, common data environments, double authentication systems, digital submission, websites, etc., are required. Project team members could also *communicate via multiple platforms* such as virtual/mixed reality chatrooms, email, online dispute resolution (court hearings/negotiation). It would be good to *recognize* ideas, promote the best articles, and give bonuses to those with good performance. In addition, the organization of international workshops/seminars for professionals and the provision of CPD points and/or certificates to those who complete *training* sessions were strongly recommended by the group as means to offer encouragement.

Table 13 Ideas Generated for Enhance Cooperation (Group 5)

Categories	Brunei	HKSAR, China
Industry	co1-Industry standard guidelines co2-Multitasking co3-Share the burden co4-Don't struggle in isolation co5-Resolve issues	co17-Set rules co18-Provide quarantine subsidies co19-Provide subsidies for IT equipment

Categories	Brunei	HKSAR, China
	co6-Identify areas for collaboration	
Physical environment		co20-Provide mask vending machines co21-Support labors for necessary hygiene co22-Work with medical officer for labor co23-Provide regular virus tests for labor co24-Prerequisite for physical meetings co25-Short meetings co26-Senior officials visit sites regularly
Flexible environment		co27-Set rules for working from home co28-Flexible workplace co29-Ensure confidentiality working environment at home co30-Modify key service hours co31-Flexible working hours
Information technology	co7-Drones or other technology	co32-Provide notebooks or mobile devices to all colleagues co33-Facilitate development of touchless technology (eye/facial recognition)
Task network		co34-Install sensors on-site for monitoring co35-Record all site information and share it online co36-Information website co37-Common data environment co38-Double authentication system co39-Remote site visits co40-Digitalize submissions co41-Different MC & client/developer; defect identification
Communication network	co8-Online surveys co9-Casual online coffee chats	co42-Promote email system co43-Multi-communication platform co44-VR /MR chatroom co45-Recording online co46-Enhancement of hardware and software (audio/video) co47-Online dispute resolution (court hearings/negotiations) co48-Audio and video device
Management	co10-Teamwork	
Recognitions & reward	co11-Collective commitment co12-Reward best articles/journals co13-Incentivize ideas	co49-Contribution from youngsters co50-Bonuses for those with good performance
Training	co14-Circulate pamphlets co15-Provide CPD points co16-Online forum	co51-Arrange workshops co52-Conduct VM workshops regularly co53-International seminars /workshops co54-Engage overseas professionals co55-Local/overseas professional institutions work together co56-International training via Zoom co57-Set training guides co58-Give certificates/qualifications to participants

5. Evaluation Phase

In this phase, team members were divided into eight groups based on country/region for the evaluation of ideas. Each team scored each idea according to its importance to their country/region (0 = not important, 1 = least important, 2 = normal, 3 = most important), and selected a few essential ideas to tackle the pandemic situation in their country/region. Finally, they selected the 28 most important ideas worthy of implementation by the PAQS (see Table 14).

Table 14 Most Important Ideas Considered at Evaluation Phase (refer to Appendix B)

Grouping of ideas	Creative ideas	Br	CM	CHK	MI	Ng	NZ	Ph	SG	Total	PAQS
Enhance Technologies											
Technology	t20-BIM	3	3	3	3	3	3	3	2	23	3
-information											
-building	t14-Industrialization (Dfma)	0	2	3	0	3	0	2	3	13	3
Digitalize Procurement											
Task network	p7-Contract content with e-procurement	3	3	3	3	3	3	3	3	24	3
Improve Cashflow											
Cost sharing	c14-Advance payment (secured by advance payment bond)	3	2	2	3	3	3	3	3	22	3
Gov. support	c37-Government assistance	0	3	3	3	3	3	3	3	21	3
Cost sharing	c16-Shorten the time to value, certify & honor payments	0	2	3	3	3	3	3	3	20	3
	c30-Set flexible payment between client and contractor	0	2	3	3	3	3	3	3	20	3
	c45-Early retention release	3	2	3	3	2	3	2	2	20	3
	c15-Increase frequency of payment	3	1	2	3	2	3	3	2	19	3
	c17-Payments for material off-site	0	2	3	3	2	3	3	3	19	3
Gov. support	c20-Financial assistance during unprecedented crisis	0	2	3	3	2	3	3	3	19	3
	c21-Tax reduction	0	2	3	3	3	2	3	3	19	3
Bank	c27-Flexible plans for loans	0	2	3	3	3	2	3	3	19	3
Technology	c32-Digitalisation of cashflow management	0	3	3	3	3	2	3	2	19	3
-information											
-technology	c9-Use machinery instead of workers	0	3	3	3	2	1	3	3	18	3
Bank	c28-Recalculation of interest rate	0	2	1	3	2	2	3	3	16	3
Cost sharing	c46-Advance payment w/o bond	0	2	3	0	0	3	3	0	11	3
Contract	c36-Reduce disputes	0	0	0	0	0	3	3	0	6	3
Avoid Dispute											
Contract	d12-Contracts written in simple language	3	3	3	3	3	3	3	2	23	3
	d41-Clear standards to be used	3	3	3	3	3	3	3	2	23	3
Management	d17-Risk management	3	3	3	2	2	3	3	3	22	3
	d42-As much as possible; a complete set of plans (projects -t/c; BIM)	3	3	3	3	2	3	3	2	22	3
Communication	d5-Effective communication channels & matching contact points	3	3	3	3	2	3	3	2	22	3
	d20-Avoid relational interference (consultant not taken seriously)	3	3	2	1	3	2	3	3	20	3
Enhance Cooperation											
Management	co10-Teamwork (align objectives among all participants)	3	3	3	3	3	3	3	2	23	3
Task network	co35-Record all site information and share it	3	3	3	3	2	3	3	2	22	3

Grouping of ideas	Creative ideas	Br	CM	CHK	MI	Ng	NZ	Ph	Sg	Total	PAQS
	online										
Training	co53-International seminars /workshops	3	3	3	2	3	3	3	2	22	3
Training	co56-International training via Zoom	3	3	3	2	3	2	3	2	21	3

Notes: 0 = Not important; 1 = Least important; 2 = Normal; 3 = Most important

Grey box = Most important ideas

Br = Brunei; CM = Mainland China; CHK = Hong Kong, China; MI = Malaysia; Ng = Nigeria; NZ = New Zealand; Ph = the Philippines; Sg = Singapore

Most of the ideas were rated as “most important” (i.e., 3 points). Five ideas received the maximum score as the most essential ideas in all member countries (i.e., 24 points in total): including *green building*, *proper documentation*, *Internet of Things*, *crisis management*, and *contract content compatible with e-procurement* (see Appendix B). Mainland China, Malaysia, and New Zealand highly recommended the adoption of *BIM* (t20) in construction projects, while the HKSAR and Nigeria suggested considering the *designs for manufacture and assembly (Dfma)* (t14) in the **Enhance Technology** category. This is expected to simplify construction processes and shorten the construction period.

Surprisingly, only Malaysia picked *contract content compatible with e-procurement* (p7) as an essential idea for **digitalizing procurement**. All countries/regions considered ideas related to **cashflow improvement** very important and to be implemented as soon as possible, including *flexible payment between client and contractor* (c30), *shortening time for payment certification* (c16), *releasing retention money early* (c45), *arranging advanced payment without bond* (c14 and c46), *increasing frequency of payment* (c15), *seeking governmental support* (e.g., financial assistance, tax reduction, etc.; c20, c21, c37). Banks could also propose *flexible plans for loans* (c27) and *recalculate interest rates for companies* (c28). To reduce costs, *machinery could be adopted to replace construction workers on site* (c9), while *reducing disputes* (c36) is another way to improve cashflow.

In order to avoid disputes, *simple language* (d12) and *clear standards* (d41) must be used, while it is necessary to *avoid relationship interference* (d20) during the development process. *Effective communication channels with matching contact points* (d5), a *complete set of plans with specific times and costs* (d42), and the *application of risk management* (d17) are definitely useful for **avoiding disputes** among parties, particularly in the current pandemic situation. Most countries/regions (Mainland China, the HKSAR, Malaysia, New Zealand, and Nigeria) highly recommended ideas related to team cooperation to their countries and the PAQS, including *aligning objectives among all participants* (co10), *sharing all site information online* (co35), *conducting international seminars, workshops, and training via Zoom* (co53 and co56).

6. Conclusion

Two international workshops aimed at identifying the impact of Covid-19 on the construction industry were successfully conducted online. Construction professionals, mostly quantity surveyors from different countries (Brunei, Canada, HKSAR, China,

Mainland China, Malaysia, New Zealand, etc.) participated. A systematic VM approach (i.e., information, function analysis, creativity, and evaluation phases) was adopted to achieve the aim of the workshops.

In the first workshop, groups were formed to share situations experienced in the industry, procurement, contract management, and supply chain in various countries during the pandemic. Thereafter, 169 functions were identified to address the challenges facing the construction industry during the Covid-19 pandemic, and 5 functions (i.e., Enhance Technology, Digitalize Procurement, Improve Cashflow, Avoid Disputes, and Enhance Cooperation) were identified as key functions.

In the second workshop, 215 ideas were proposed in 5 different groups in the creativity phase (48 for Enhance Technology, 15 for Digitalize Procurement, 52 for Improve Cashflow, 42 for Avoid Disputes, and 58 for Enhance Cooperation). In the evaluation phase, five ideas received the maximum score as the most essential ideas in all member countries (i.e., 24 points in total): including *green building*, *proper documentation*, *Internet of Things*, *crisis management*, and *contract content compatible with e-procurement*. The application of *BIM* in construction projects and the *designs for manufacture and assembly (Dfma)* were suggested to **enhance the technology**. Surprisingly, only Malaysia picked *contract content compatible with e-procurement* as an essential idea for **digitalizing procurement**. All countries/regions considered ideas related to **cashflow improvement** very important and to be implemented as soon as possible. In order to **avoid disputes**, *simple language* and *clear standards* must be used, while it is necessary to *avoid relationship interference* during the development process. Most countries/regions (Mainland China, the HKSAR, Malaysia, New Zealand, and Nigeria) highly recommended ideas related to team cooperation to their countries and the PAQS, including *sharing all site information online*, *conducting international seminars, workshops, and training via Zoom*. Participants finally picked 28 ideas as the most appropriate suggestions on how to tackle the Covid-19 situation and recommended them to the PAQS for real-world implementation (see Table 4).

Appendix A Functions Generated

Functions	Industry	Procurement	Contract Management	Supply Chain
Enhance technology -on-site /off-site	Establish e-procurement Educate IT-knowledge Update technology Establish platform More IT investment and awareness IT-BIM knowledge Industrialised building system	Improve efficiency Keep safe Work online Promote green technology Blockchain for recording the agreement IoT to support the supply chain	Enhance technology * Embrace changes * Change mindset Utilize technology Adapt change	Emerge technologies * Encourage e-communication * Promote 'green' Enhance internet Pre-modular construction Green infrastructure /energy efficient
Digitalize procurement -development -construction	Improve internet Digital platform Good internet access	Digitalize procurement * E-payment via virtual banking Evaluate e-procurement	Safeguard information Simplify procedures	Reduce risk E-procedure E-documentation Accessible internet services
Improve cashflow -inflow : gov.~ -outflow : delay ~	Improve cashflow * Keep cost certainty Recover economy Allow delays Welcome investment Release payment Open market Allow delivery Trace logistics Use more local materials Improve flow of materials	Improve cashflow * Lower costs	Increase funds Provide stimulus Share burden	Support industry * Fund industry Mitigate impacts
Avoid disputes (e.g., t/c /supplier /environment, etc.; existing terms)	Clarify contractual-terms Give flexibility Revise contract forms Set up platform Improve contact tracing	Administrative procedures Record agreements Store information Auditing Review documents	Comply law Avoid disputes Keep records Follow standards Set guidelines Adjust clauses Control risk Avoid conflict Minimize disputes Address crisis Mitigate efforts	* Create standards * Set policies Enhance delivery
Enhance cooperation	Unite industry * Improve leadership * Train labor * Keep operation Unify People Connect countries Expand communication Settle social issue	Improve communication * (control remotely, e.g., VPN) Expand network Networking Outsourcing	Enhance co-operation Share knowledge Secure benefits Win-win solutions Enhance collaboration Avoid moral hazard Figure compromise	Set policies * Create standards * Encourage interaction Encourage workforce
Government support	Increase government investment	Seek government support		Government fund Government incentive

	Promote investor confidence Government support			programmes Affordable housing programmes New policy from government
Regulation	New conditions or better interpretation of contracts to suit current situation Set guidelines Clear contract condition Ease the limitation of import control	Develop protocols Follow protocol	Comply law and regulations Enforce law Claim guideline Familiarize contract	New standard procedure Standard guideline Flexible contractual agreement
Industry	Keep the industry in operation Support industry Maintain employment Enlarge space Set-up platforms			Adjust building usage
Leadership		Better organisational leadership		
Hygiene	Minimize infection Build canteens Give hygiene restrooms	Standardized safety practices Work from home improvement Remote working approach	Ensure safety	
Innovation	Adopt innovation	Adopt innovation	Create innovation Publicize creativity Embrace change	Innovate technologies
Communication		Enhance communication Managing communications Ensure transparency Avoid interaction Facilitate working Facilitate calculation Give template	Avoid asymmetric information Coordinate parties Keep contemporary records	
Empowerment	Encourage local entrepreneurs			Empower and encourage local workforce
Risk management		Vendor risk management	Minimize impacts Consider risk	
Performance	More certainty	Reduce cost Value engineering during pre-contract stage Employ local resources	Cost certainty Time certainty	
Training	Organise workshops Better awareness among stakeholders		Teach skills Trainings for contract	
Research	Undertake research			

Note: *Key Function

Appendix B Evaluated Ideas

Functions					Categories	Creative ideas	Regions/Countries								Total	PAQS
ET	DP	IC	AD	EC _o			Br	CM	CHK	MI	Ng	NZ	Ph	SG	sum	
✓					Bldg tech.	t26 -Green building	3	3	3	3	3	3	3	3	24	
				✓	Clear information	d10 -Proper documentation of events /record all changes i.e., rescheduling of works and re-allocation of resources	3	3	3	3	3	3	3	3	24	
✓					Comm. network	t34 -IOT - improve connectivity	3	3	3	3	3	3	3	3	24	
				✓	Management	d32 -Crisis management	3	3	3	3	3	3	3	3	24	
	✓				Task network	p7 -Contract content with e-procurement	3	3	3	3	3	3	3	3	24	3
				✓	Clear information	d38 -Clear scope of work	3	3	3	3	3	3	3	2	23	
				✓	Clear information	d40 -Be mindful of time bars, in the session of notices	3	3	3	3	3	3	3	2	23	
				✓	Communication	d8 -Communicate issue /problems with management or project team during meetings for discussion and resolution	3	3	3	3	3	3	3	2	23	
				✓	Comm. network	co46-Enhancement of hardware and software (audio /video)	3	3	2	3	3	3	3	3	23	
			✓		Cont./legislation	d12 -Contracts written in simple language	3	3	3	3	3	3	3	2	23	3
			✓		Cont./legislation	d41 -Clear standards to be used	3	3	3	3	3	3	3	2	23	3
				✓	Management	co10-Teamwork (align objectives among all participants)	3	3	3	3	3	3	3	2	23	3
				✓	Management	d31 -Dispute management	3	3	3	3	3	3	3	2	23	
				✓	Physical envir.	co21-Support labors for necessary hygiene	3	3	3	3	2	3	3	3	23	
✓	✓				Information tech.	p5 -Reliable software	3	2	3	3	3	3	3	3	23	
✓					Information tech.	t1 -Develop software for information storage	3	3	3	3	3	3	3	2	23	
✓					Information tech.	t20 -BIM	3	3	3	3	3	3	3	2	23	3
	✓				Task network	p8 -Secure payment system (i.e., Amazon)	3	3	3	3	3	3	2	3	23	
✓					Task network	t40 -Progress on site shown in real time	3	3	2	3	3	3	3	3	23	
				✓	Training	co55-Local /overseas professional institutions work together	3	3	3	3	3	3	3	2	23	
✓					Bldg tech.	t17 -Enhanced buildability through design	3	3	3	3	2	3	3	2	22	
✓					Bldg tech.	t31 -Industrialised building system	3	2	3	3	3	3	2	3	22	
			✓		Communication	d5 -Effective communication channels and matching contact points	3	3	3	3	2	3	3	2	22	3
		✓			Cost sharing	c14 -Advance payment (secured by advance payment bond)	3	2	2	3	3	3	3	3	22	3
				✓	Flexible envir.	co28-Flexible workplace	3	3	3	3	2	3	2	3	22	
				✓	Flexible envir.	co31-Flexible working hours	3	3	3	3	2	3	2	3	22	
			✓		Information tech.	d42 -As much as possible; a complete set of plans (projects -t/c; BIM)	3	3	3	3	2	3	3	2	22	3
			✓		Management	d17 -Risk management	3	3	3	2	2	3	3	3	22	3
				✓	Task network	co34-Install sensors on-site for monitoring	3	3	3	3	3	2	2	3	22	

		✓	Task network	co35-Record all site information and share it online	3	3	3	3	2	3	3	2	22	3
		✓	Task network	co40-Digitalize submissions	3	3	3	3	3	2	3	2	22	
✓	✓		Task network	p1 -Cloud platform for data storage and processing	3	2	3	3	3	2	3	3	22	
		✓	Task network	p9 -Standardizing e-commerce in construction	3	2	2	3	3	3	3	3	22	
✓			Task network	t42 -Authorities inspection on real time video	3	3	2	3	3	3	2	3	22	
✓			Task network	t43 -Drone for site evaluation	3	2	3	3	3	2	3	3	22	
		✓	Training	co16-Online forum	3	3	3	3	2	3	3	2	22	
		✓	Training	co53-International seminars /workshops	3	3	3	2	3	3	3	2	22	3
	✓		Training	d37 -Learning from developed countries and experts	3	2	3	3	3	3	3	2	22	
	✓	✓	Gov. support	c37 -Government assistance	0	3	3	3	3	3	3	3	21	3
✓			Bldg tech.	t29 -Modular design technology	3	3	3	3	3	2	2	2	21	
		✓	Communication	d3 -Very complicated projects - helpful to have an in-depth discussion to reach common target between parties before contract signing	2	3	3	2	3	3	3	2	21	
		✓	Communication	d7 -Sharing of information with all project parties	3	3	2	3	2	3	3	2	21	
✓			Comm. network	t21 -Cloud-based communication	3	3	3	3	2	2	3	2	21	
		✓	Cont./legislation	d23 -Ensure enforcement and compliance	3	2	3	3	3	2	3	2	21	
		✓	Cont./legislation	d28 -Enforcement of the available standards	3	3	2	3	2	3	3	2	21	
		✓	Flexible envir.	co29-Ensure confidentiality working environment at home	2	2	2	3	3	3	3	3	21	
		✓	Industry	co6 -Identify areas for collaboration	3	2	3	2	3	3	3	2	21	
		✓	Management	d33 -Recognition and reward	3	3	3	3	3	2	2	2	21	
		✓	Recognition & reward	co49-Contribution from youngsters	3	3	3	2	3	3	3	1	21	
✓			Research	t47 -More R&D on machinery	3	3	3	3	3	2	2	2	21	
✓			Information tech.	t33 -Construction site housekeeping software	2	3	3	3	3	3	2	2	21	
✓			Staff	t44 -Management software	2	3	2	3	3	3	3	2	21	
	✓		Task network	p4 -IoT to support supply chain management	3	2	2	3	3	2	3	3	21	
	✓		Task network	p6 -Centralized data platform with blockchain /Cloud	3	3	2	3	3	2	2	3	21	
		✓	Training	co56-International training via Zoom	3	3	3	2	3	2	3	2	21	3
		✓	Training	co57-Set training guides	2	2	2	3	3	3	3	3	21	
✓			Clear information	d11 -Protect and secure the works at the site	2	2	2	3	3	3	3	2	20	
✓			Clear information	d21 -State objectives explicitly	2	2	3	3	3	3	2	2	20	
	✓		Communication	d20 -Avoid relational interference (consultant not taken seriously)	3	3	2	1	3	2	3	3	20	3
		✓	Comm. network	co48-Audio and video device	2	2	2	3	2	3	3	3	20	
	✓		Cont./legislation	d13 -Remind all parties of the latest Standard Operating Procedure (SOP) set by the government, i.e., in meetings/briefings, etc.	2	3	2	3	2	3	3	2	20	

	✓	Cont./legislation	d16 -Incorporate provisions related to the new norm of working	2	3	2	2	3	3	3	2	20	
	✓	Cont./legislation	d24 -Provide code of ethics	3	3	3	2	2	2	3	2	20	
	✓	Cost sharing	c16 -Shorten the time to value, certify & honor payments	0	2	3	3	3	3	3	3	20	3
	✓	Cost sharing	c30 -Set flexible payment between client and contractor	0	2	3	3	3	3	3	3	20	3
	✓	Cost sharing	c45 -Early retention release	3	2	3	3	2	3	2	2	20	3
	✓	Experts	d18 -SO, and CA /QS act as intermediary for negotiations /mediations in resolution of conflicts	3	2	1	3	3	3	3	2	20	
	✓	Industry	co17-Set rules	3	3	2	2	3	2	3	2	20	
	✓	Industry	co5 -Resolve issues	2	2	2	3	3	3	3	2	20	
✓		Industry	t48 -Reduce labor intensive jobs	3	3	3	2	2	2	2	3	20	
	✓	Information tech.	co7 -Drones or other technology	3	2	1	3	3	2	3	3	20	
	✓	Information tech.	d30 -Microchip that helps keep data, and synchronize /update contract information	3	2	3	3	3	2	2	2	20	
	✓	Recognition & reward	co50-Bonuses for those with good performance	2	3	2	3	3	2	3	2	20	
	✓	Task network	co37-Common data environment	2	2	3	2	3	3	3	2	20	
✓	✓	Task network	p3 -E-payment (virtual banking) to facilitate transactions	2	3	2	3	3	2	2	3	20	
✓		Task network	t22 -Digitized processes	3	2	3	3	2	2	3	2	20	
✓		Task network	t37 -Remote working	2	3	2	3	2	3	3	2	20	
✓		Task network	t38 -Cloud based PM system	3	1	3	3	2	2	3	3	20	
	✓	Training	co15-Provide CPD points	3	3	3	3	1	2	3	2	20	
	✓	Training	co51-Arrange workshops	3	3	3	2	2	2	3	2	20	
	✓	Training	co54-Engage overseas professionals	2	2	3	3	3	2	3	2	20	
	✓	Training	co58-Give certificate /qualification to participants	3	2	3	3	2	2	3	2	20	
	✓	Training	d36 -Constant training and workshop	2	3	3	2	2	3	3	2	20	
✓		Comm. network	t36 -IOT - contact tracing	2	2	2	3	2	3	3	2	19	
	✓	Cont./legislation	d4 -Use standard form of contract (FIDIC /ICE)	2	3	3	2	1	3	3	2	19	
	✓	Cost sharing	c15 -Increase frequency of payment	3	1	2	3	2	3	3	2	19	3
	✓	Cost sharing	c17 -Payments for material off-site	0	2	3	3	2	3	3	3	19	3
	✓	Gov. support	c20 -Financial assistance during unprecedented crisis	0	2	3	3	2	3	3	3	19	3
	✓	Gov. support	c21 -Tax reduction	0	2	3	3	3	2	3	3	19	3
	✓	Bank	c27 -Flexible plans for loans	0	2	3	3	3	2	3	3	19	3
	✓	Information tech.	c32 -Digitalisation of cashflow management	0	3	3	3	3	2	3	2	19	3
	✓	Experts	d6 -Retaining third party as dispute advisor to identify and resolve potential conflicts /disputes early	3	3	3	2	2	3	2	1	19	
	✓	Industry	co1 -Industry standard guidelines	2	2	2	3	3	2	3	2	19	
	✓	Industry	co18-Provide quarantine subsidies	2	3	2	3	3	2	2	2	19	

		✓	Physical envir.	co20-Provide mask vending machines	3	2	3	2	3	2	2	2	19	
		✓	Physical envir.	co25-Short meetings	3	3	3	3	1	1	3	2	19	
		✓	Physical envir.	co26-Senior officials visit sites regularly	3	3	3	2	2	1	3	2	19	
✓			Task network	t39 -Order material online	2	3	2	3	2	3	2	2	19	
		✓	Training	co52-Conduct VM workshops regularly	2	3	3	2	3	2	2	2	19	
✓			Workflow	t19 -Supply chain management	2	2	3	2	2	3	3	2	19	
	✓		Bldg tech.	c9 -Use machinery instead of construction workers	0	3	3	3	2	1	3	3	18	3
✓			Bldg tech.	t16 -New building materials	2	2	2	2	2	3	2	3	18	
✓			Bldg tech.	t30 -Standardizing technology internationally	1	2	2	2	3	2	3	3	18	
✓			Bldg tech.	t32 -Robotic construction technology	2	2	3	2	3	2	1	3	18	
		✓	Clear information	d22 -Consistency in compliance assessment	2	2	2	2	2	3	3	2	18	
		✓	Communication	d9 -Transparent decision-making and information flow	2	2	2	2	3	3	2	2	18	
		✓	Comm. network	co42-Promote email system	1	2	3	3	2	2	3	2	18	
		✓	Cont./legislation	d14 -Renegotiate agreement terms, i.e., suppliers (longer payment time frames)	3	2	1	3	2	2	3	2	18	
		✓	Cont./legislation	d15 -Draft supplementary /commercial agreements	3	2	1	3	2	2	3	2	18	
		✓	Cont./legislation	d25 -Set penalty for defaulters	2	3	2	2	2	2	3	2	18	
		✓	Flexible envir.	co27-Set rules for working from home	2	2	2	2	2	2	3	3	18	
		✓	Flexible envir.	co30-Modify key service hours	3	2	3	3	2	1	2	2	18	
		✓	Industry	co4 -Don't struggle in isolation	2	2	2	2	2	3	2	3	18	
		✓	Recognition & reward	co11-Collective commitment	3	2	2	2	3	2	2	2	18	
		✓	Recognition & reward	co12-Reward best articles /journals	2	2	2	3	2	2	3	2	18	
✓			Staff	t45 -IOT - biometric identification	1	3	1	2	3	2	3	3	18	
	✓		Task network	p2 -Blockchain to support e-procurement documents	2	2	2	3	3	2	1	3	18	
✓			Task network	t23 -Robotic process automation	2	2	2	2	3	2	2	3	18	
		✓	Comm. network	co44-VR- /MR chatroom	1	3	1	2	3	2	3	2	17	
		✓	Comm. network	co47-Online dispute resolution (court hearings /negotiations)	3	1	3	2	1	2	3	2	17	
		✓	Cont./legislation	d27 -Revisit existing standards	2	3	1	2	2	2	3	2	17	
		✓	Industry	co19-Provide subsidies for IT equipment	1	2	1	3	3	2	3	2	17	
		✓	Industry	co2 -Multi-tasking	2	2	2	2	2	2	3	2	17	
		✓	Task network	co36-Information website	2	2	2	3	2	2	2	2	17	
		✓	Task network	co39-Remote site visits	1	3	1	3	1	2	3	3	17	
	✓		Task network	p12 -Develop and enhance online payment systems	3	3	3	1	2	0	3	2	17	
	✓		Contract	c33 -Alternative procurement	0	2	3	3	2	2	3	2	17	
	✓		Bank	c28 -Recalculation of interest rate	0	2	1	3	2	2	3	3	16	3
	✓		Bank	c7 -Lower interest rates for property buyers	0	2	2	3	2	2	3	2	16	
		✓	Communication	d1 -Sophisticated clients to help in a conflict between parties	2	2	1	2	2	3	2	2	16	

✓	✓	Communication	d2 -Parties have experience working together	2	2	2	2	2	3	2	1	16	
	✓	Comm. network	t35 -Block chain	1	1	1	3	3	3	1	3	16	
		Experts	d19 -Get advice from construction lawyers /involve legal backing	2	2	1	2	3	2	2	2	16	
	✓	Industry	co3 -Share the burden	2	2	2	2	2	2	2	2	16	
	✓	Information tech.	co32-Provide notebooks or mobile devices to all colleagues	1	2	2	3	3	0	3	2	16	
	✓	Physical envir.	co22-Work with medical officer for labor	3	2	2	2	2	1	2	2	16	
	✓	Physical envir.	co23-Provide regular virus tests for labor	1	3	2	2	2	2	2	2	16	
	✓	Task network	co38-Double authentication system	3	3	1	3	3	0	1	2	16	
	✓	Comm. network	co45-Recording online	0	3	2	2	2	2	3	2	16	
✓		Task network	t41 -E-payment platform for purchasing materials	1	3	1	3	2	2	2	2	16	
✓		Bldg tech.	t27 -3D printing construction	1	2	2	3	3	2	1	1	15	
✓		Bldg tech.	t28 -Cheaper machinery	1	1	1	3	3	2	3	1	15	
	✓	Comm. network	co9 -Casual online coffee chats	2	1	2	2	2	2	2	2	15	
	✓	Comm. network	co8 -Online surveys	2	2	1	2	2	2	2	2	15	
	✓	Experts	d34 -Form committee	2	1	1	3	3	2	2	1	15	
	✓	Physical envir.	co24-Prerequisite for physical meetings	1	3	3	2	1	1	3	1	15	
✓		Information tech.	p10 -Change in contract content - Loosen intellectual property rights on BIM /drawings to be shared among parties	2	2	3	1	2	0	3	2	15	
✓		Staff	t46 -Foreign labors' biometric tracking	3	1	1	2	3	2	1	2	15	
	✓	Task network	co41-Different MC & client /developers; defect identification	3	3	3	1	1	0	2	2	15	
✓		Information tech.	p11 -For private projects: Enterprise Resource Planning (ERP) software is available to aid procurement process	3	2	3	1	2	0	0	3	14	
	✓	Gov. support	c2- Government subsidizes cost of shutdown	0	1	1	3	2	2	3	2	14	
	✓	Training	co14-Circulate pamphlets	2	2	2	2	1	1	2	2	14	
✓		Bldg tech.	t14 -Industrialization (Dfma)	0	2	3	0	3	0	2	3	13	3
✓		Industry	p14 -For government projects: improvement necessary	3	2	3	1	2	0	0	2	13	
✓		Industry	p15 -For private projects: Depends highly on the owner but usually no digital procurement	3	2	3	1	2	0	0	2	13	
	✓	Bank	c6 -Banks are cutting back on lending terms	0	2	1	1	2	2	3	2	13	
	✓	Recognition & reward	co13-Incentivize ideas (e.g., logo in competition)	2	2	1	1	3	1	1	2	13	
✓		Task network	p13 -For government project: RA 9184 of the Philippines practice digital procurement to some extent	3	2	3	1	2	0	0	2	13	
	✓	Experts	d35 -Involve arbitrators	1	1	1	2	2	2	2	1	12	
	✓	Cost sharing	c46 -Advance payment w/o bond	0	2	3	0	0	3	3	0	11	3
	✓	Contract	c34 -Clear contract conditions	0	0	0	0	0	3	3	0	6	
	✓	Contract	c36 -Reduce disputes	0	0	0	0	0	3	3	0	6	3

✓	Bank	c8	-Use financial instrument to pay suppliers.	0	0	0	0	0	0	0	0	0
✓	Bank	c12	-Arrange bank facility upon receipt of payment certificate	0	0	0	0	0	0	0	0	0
✓	Bank	c25	-Financial availability to cope with Covid-19.	0	0	0	0	0	0	0	0	0
✓	Bank	c26	-Bank offer flexible repayment.	0	0	0	0	0	0	0	0	0
✓	Bank	c29	-Financing assistance.	0	0	0	0	0	0	0	0	0
✓	Bldg tech.	t15	-Enhancing technologies	0	0	0	0	0	0	0	0	0
✓	Clear information	d39	-Proper documentation of events	0	0	0	0	0	0	0	0	0
✓	Comm. network	t3	-Use IOT even when for face to face meetings	0	0	0	0	0	0	0	0	0
	Comm. network	co43	-Multi-communication platform	0	0	0	0	0	0	0	0	0
	Contract	c1	-Cut out middlemen for direct procurement	0	0	0	0	0	0	0	0	0
	Contract	c35	-Other similar situations, e.g., natural disasters, wars	0	0	0	0	0	0	0	0	0
	Contract	c47	-No single stakeholder bears an undue share of the burden imposed by Covid-19.	0	0	0	0	0	0	0	0	0
	Cont./legislation	d26	-Involve legal backing	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c13	-Share the burden of Covid-19 with common goal for dealing with the cashflow issue.	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c31	-Sustain contractor cashflow	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c41	-Improve payments terms	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c42	-Reduce costs	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c43	-Insurance	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c44	-Eliminate retention	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c49	-Sharing of costs to manage Covid-19 pandemic among government, client, contractor, and sub-contractor	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c50	-Cost sharing among project stakeholders and government.	0	0	0	0	0	0	0	0	0
✓	Cost sharing	c51	-Maximize /cap contractors' claims for Covid-19.	0	0	0	0	0	0	0	0	0
✓	Designers	c5	-Use local suppliers	0	0	0	0	0	0	0	0	0
✓	Designers	c24	-Prioritize usage of local products	0	0	0	0	0	0	0	0	0
✓	Designers	c40	-Use local materials /suppliers available	0	0	0	0	0	0	0	0	0
✓	Developer/owner	c3	-Sell long term held property such as office buildings and shopping malls	0	0	0	0	0	0	0	0	0
✓	Developer/owner	c4	-Combination with medical equipment projects to attract investment	0	0	0	0	0	0	0	0	0
✓	Developer/owner	c22	-Expand client investment	0	0	0	0	0	0	0	0	0
✓	Developer/owner	c23	-Client to arrange the investment	0	0	0	0	0	0	0	0	0
✓	Developer/owner	c39	-Rent freeze	0	0	0	0	0	0	0	0	0
✓	Gov. support	c10	-Government guarantee of contractor's loan due to Covid-19	0	0	0	0	0	0	0	0	0
✓	Gov. support	c11	-Grant assistance to contractors	0	0	0	0	0	0	0	0	0

✓ ✓ ✓ ✓		Gov. support	c18	-Assistance to protect client & contractor fund	0	0	0	0	0	0	0	0	0						
		Gov. support	c19	-Government incentives /assistance	0	0	0	0	0	0	0	0	0						
		Gov. support	c38	-Increase government investment	0	0	0	0	0	0	0	0	0						
		Gov. support	c48	-Government takes biggest share of cost increase, e.g., 50%	0	0	0	0	0	0	0	0	0						
✓		Industry	t11	-Gain government support to promote technologies.	0	0	0	0	0	0	0	0	0						
✓		Industry	t12	-Join B&R initiatives to cooperate	0	0	0	0	0	0	0	0	0						
✓		Industry	t13	-Establish institutions for technologies in QS	0	0	0	0	0	0	0	0	0						
✓		Industry	t25	-Disruptive transformation	0	0	0	0	0	0	0	0	0						
	✓		Information tech.	d29	-Software for record-keeping	0	0	0	0	0	0	0	0						
		✓	Information tech.	co33	-Facilitate development of touchless technology (eye /facial recognition)	0	0	0	0	0	0	0	0						
✓			Research	t7	-Encourage more research related to IOT	0	0	0	0	0	0	0	0						
✓			Research	t8	-Enhance research on IOT in construction	0	0	0	0	0	0	0	0						
✓			Information tech.	t2	-Develop information database	0	0	0	0	0	0	0	0						
✓			Staff	t6	-Hire IT staff	0	0	0	0	0	0	0	0						
✓			Task network	t4	-Procure IT services	0	0	0	0	0	0	0	0						
✓			Task network	t5	-Enhance internet facilities	0	0	0	0	0	0	0	0						
✓			Task network	t24	-Self-checking before passing down information.	0	0	0	0	0	0	0	0						
	✓		time sharing	c52	-Cost sharing concept can be used for sharing burdens caused by project delay	0	0	0	0	0	0	0	0						
✓			Training	t9	-Conduct training	0	0	0	0	0	0	0	0						
✓			Training	t10	-Hold international conferences or workshops to exchange IOT information	0	0	0	0	0	0	0	0						
✓			Workflow	t18	-Re-engineer the workflow and the information flow.	0	0	0	0	0	0	0	0						
2	1	15	6	4	Total of Essential Ideas					3	5	5	5	5	9	0	8		28

Note: 0-Not important; 1-Least important; 2-Normal; 3-Most important

Grey box – Most important ideas.

Br-Brunei; CHK-Hong Kong, China; CM-Mainland China; MI-Malaysia; Ng-Nigeria; NZ-New Zealand; Ph-Philippines; SG-Singapore.

ET – Enhance Technology, DP – Digitalize Procurement, IC – Improve Cashflow, AD – Avoid Dispute, ECo – Enhance Cooperation