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Adaptive Mechanism for Water and Wastewater Construction Companies in Coping with the Disruption of Projects Due to Crisis

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Abstract:
The water and wastewater construction company (WWCC) plays an important role maintaining water sustainability for human. It is a very intricate industry vulnerable to disruptions, delays, and disputes in times of crisis or pandemic. It is a system that has internal interactions on its 5Ms of management such as Man, Material, Machine, Method, and Money that are sensitive to change affected by external environment which in turn affected their current projects.
One of the external factors that affected WWCC in the year 2020 is the occurrence of coronavirus covid19. During the pandemic, the global construction industry including WWCC have experienced drastically altered risk environment applied to funding, labor shortages, material delays, suspension, and termination of contracts (Barriere 2020). The pandemic has affected WWCC's 5Ms of management that ranges that eventually affected the triple constraints of projects such as scope, time, and cost.
The study has determined the level of severity of the effect before and during covid19 to WWCC's 5Ms of management that eventually affected the three interdependent constraints of projects. The data gathered before and during covid19 were compared and ultimately utilized in formulating the adaptive mechanism for WWCC in coping with the disruption of projects during crisis. The adaptive mechanism comprises of the precontemplation and contemplation phases. During pandemic, WWCC has to determine if there is a need for change in their organization. They have to adapt through precontemplation through internal and external scanning and situational analysis in order for them to comprehend and adapt to the change. WWCC upon realizing of the needed change, has to continue with the contemplation stage by utilizing the stop, start and continue (SSC) principle. To be more precise with the implementation of change, WWCC has to exercise pause, focus and identify prior to executing the SSC principle, followed by implementation, action, and maintenance.

Keywords: Pandemic, Sustainability, 5Ms of Management, Triple Constraint, Adaptive Mechanism, Precontemplation, Contemplation

CHAPTER I
INTRODUCTION

The construction industry plays an important role in a country's economy. It is an important sector that greatly contributes to the economic growth of a country. Construction develops infrastructures related to health, transport, social, and education sectors, and it is vital in the achievement of national economic development goals by providing employment to a huge number of skilled and unskilled personnel that

generates income, shelter and various infrastructure. The construction industry is very essential for the prosperity of any country (HHI, 2018). Construction represents the building block of a nation. A strong construction sector in a country with the proper health and safety regulations bring in foreign investment that is important in uplifting the living standard of the country. Popular countries and cities like the United Arab Emirates, Egypt, New York, Rome, Barcelona, Athens, and Paris are very popular for historical architecture and landmark structures (https://www.thelearningstation, October 22, 2021).

Construction is a very intricate industry that is susceptible to delays, disputes and exceeding project costs. It plays an important role in the economy but it faces many challenges that can lead to affect project scope, time and costs (https://www.constructiontuts.com/construction-industry, January 22, 2022). The construction industry is considered as a system that has external interactions sensitive to change that can be affected by external environment such as, people, machines, climate, materials, location, economy, politics, client, and many others.

According to a report from The Conversation Journal published on June 08, 2020, lack of drinking water and proper hygienic practices has been a major concern during the covid19 pandemic. This pandemic has affected cities in the developing countries especially in slums, rural areas, and some refugee camps (Adetunji 2020). The construction industry, particularly the water and wastewater construction companies (WWCC), stands in a unique position in assessing the impacts of the covid19 pandemic. As countries around the globe implemented lockdowns and other restrictions, the rate of change for WWCC has been extreme with many changes in their ways of working on current projects (Marsh 2020). WWCC had endeavored to complete their existing projects while at the same time, protect their staff and workers, comply with the Government regulations on covid19, travel restrictions, as well as managing supply chain interruptions, and project suspensions. All countries around the world have intensified the challenges of continuing the project during covid19.

The external factors affecting the construction industry particularly WWCC in the year 2020 is the occurrence of coronavirus covid19 that causes worldwide crisis. According to Barriere & Caplan (2020), the world has experienced drastically altered risk environment applied to funding, labor shortages, material procurement delays, suspensions and terminations, and their impacts on project program eventually led to delays.

No one foresaw or anticipated the extent of the covid19 effects and impacts on various businesses that caused the need of WWCC in addressing both short-term and long-term business challenges (Koger, 2020). Business leaders react to challenges, reassess and reconfigure their companies and reinvent activities to adapt to the disruption and prepare for the new normal. Businesses must remain true to their vision, be empathetic to stakeholders, make quick decisions and adjust those decisions, if necessary, frequently and transparently on the basis of new information in order to adapt quickly (Arndt, 2020).

There were several studies on the impact of covid19 to the construction and infrastructure globally. Many international construction companies, e.g., US, UK, Canada, Middle East, and Asia-Pacific, has plunged in the most challenging times due to restrictions, lockdowns and quarantines. The covid19 has affected many lives around the world in a unique way that has not been experienced in the past (Goodman 2020). However, there were few studies on water and wastewater related construction organizations in Philippine setting. Construction companies have been affected enormously by covid19 in terms of inadequate manpower, unavailability construction equipment, and delayed supply of materials that eventually affected the method (operation) and resources (money) of the organization. The study focuses more on the effect and impact of the covid19 to 5M's of management that impacts the three interrelated constraints of project

(e.g., scope, time, and money) to the water and wastewater construction companies in Metro Manila, Philippines.

According to an article, Industrial Lean News, 5Ms of management is a very important tool in improving workflow. By always focusing on the 5Ms, the managers are able to determine when something is not working in a process, and can also be a tool for risk management (Allred 2019). Many construction companies including WWCC have been affected enormously by covid19 in terms of inadequate manpower, unavailability construction equipment, and delayed supply of materials. This study focuses more on the effect and impact of the covid19 to the 5Ms of management that ultimately affected the three constraints of projects, e.g., scope, time, and money. These are the gaps to be addressed by WWCC on the covid19 outbreak that has brought indiscriminate unfortunate events to the construction of water and wastewater treatment plants, as more organizations have been forced to change the way they do their work due to the series of lockdowns, restrictions, and quarantine orders to help curb the covid19 infection (Thorbecke 2020).

Structure and Rationale of the Study

The covid19 has impacted the construction and infrastructure globally. It is undeniable that the virus has touched many aspects of most people's daily personal and professional activities, and there is no avoidance of these impacts in the construction industry (Holland & Knight, 2020). As construction workers become infected, sick and quarantined due to covid19, labor shortages is anticipated to occur, and covid19 impacts the contractor's ability to engage adequate labor force in keeping the projects on schedule (Brown, 2020). Schnippert (2021), has confirmed that construction firms and project owners understand how covid19 has extremely affected projects and continue to affect the availability and prices of construction materials and supplies. The construction industry has been hit with many problems since the start of the covid19 pandemic particularly on construction materials shortage, huge increase in prices and unemployment (Davis, 2021). Economists and industry experts according to Hutchins (2020) foresees that many of these issues continue to challenge contractors on labor shortage, shrinking backlogs, falling construction costs, less work, price increases, supply chain issues, and diminishing revenue.

The difficulty of slowing down in businesses depends on the timing, effect, and severity of the outbreak when restrictions, quarantines and lockdowns took effect. Asia and the Pacific also experienced slowing down of construction, and the outbreak stopped majority of the construction activities (Brown 2020). In the United Kingdom, the headline workloads indicator slipped into negative territory for the first time in eight years (Hutchins 2020). A similar decline was also evident in the US in the first quarter of year 2020. In Canada, the same effect was observed across all sectors consisting residential, commercial, and infrastructure. Here in the Philippines, labor shortages is observed as the key obstacle to construction activity (https://www.rics.org/uk/news-insight/latest-news 2021).

According to a study on the 'Progress of Water Environment Governance in the Philippines" during the 14th Water Environment Partnership in Asia (WEPA) in February 22, 2019 in Tokyo, Japan, the rapid increase in population, urbanization, and industrial development has led to the river basin degradation and deterioration due mainly to water pollution (Tuddao 2019). In Metro Manila, Philippines, 43 sewage treatment plants (STP) and septage treatment plants (SpTP) service more than a million residents or around nine percent of the region's entire population. Therefore, there is a need to continuously implement the Philippine Clean Water Act or 2004 (Republic Act No.9275) which aims to protect the country's water bodies from pollution and land-based sources (DENR, https://r12.emb.gov.ph/ra-9275-the-philippine-

clean-water-act/, October 22, 2021). Because, water is a unique commodity and nothing else can substitute for it, as it is as universal and as necessary (Fisher 2011).

In the Philippines, particularly on the construction of sewage treatment plants (STP) and pipe network at Muntinlupa and Las Pinas, some projects have been delayed and some have been cancelled or terminated as a result of the impact of covid19 due to inadequate manpower supply, supply chain bottlenecks of construction machineries and unavailability of construction materials. Due to the pandemic, the main proponent of the STP projects have pushed the completion date of its projects towards to latter part of year 2023 due to pandemic-triggered delays (Miraflor 2021). The covid19 has caused widespread concern and economic hardships for consumers, businesses and communities across the country. The number and value of construction projects in the early months of 2020 shrank by over one-fifth putting a stop to construction works in Luzon and most parts of the country are placed under covid19 lockdowns (De Vera 2020). This study focuses on the contractors of water and wastewater plants and facilities in ensuring continuous implementation of projects and business continuity in spite of the difficulty in managing their project's resources impacted by covid19.

Research Questions

The 5Ms of management that comprises of Man, Material, Machine, Method, and Money of water and wastewater construction (WWCC) companies affects the three interdependent constraints of project (e.g., Scope, Time, Cost). The study determines the levels of severity before and during covid19, made comparison of the data collected, and leads to the development of the adaptive mechanism framework in ensuring business continuity during crisis or pandemic;

1. What are the levels of severity of WWCC's 5Ms of management before covid19 and its effect on the three main interdependent constraints on construction projects in terms of;
   a. Scope
   b. Time
   c. Cost
2. What are the levels of severity of WWCC's 5Ms of management during the covid19 period and its effect on the three main interdependent constraints on construction projects in terms;
   a. Scope
   b. Time
   c. Cost
3. What is the comparison of the levels of severity of WWCC's 5Ms of management that affects the three main interdependent constraints of projects before and during the covid19?
4. What adaptive mechanism framework developed for Water and Wastewater Construction Companies in coping with the disruption of projects during crisis or pandemic?

Objectives of the Study

The center of the study has developed an adaptive mechanism for WWCC to continue and thrive in their business in times of pandemic. To make it possible, the study was able to accomplish the following:

1. Determined the levels of severity of WWCC's 5Ms of management before covid19 and its effect on the three main interdependent constraints of construction projects terms of;
   a. Scope
   b. Time

c. Cost

2. Determined the levels of severity of WWCC's 5Ms of management during the covid19 period and its effect on the three main interdependent constraints of construction projects in terms;
   d. Scope
   e. Time
   f. Cost
3. Compared the levels of severity of WWCC's 5Ms of management that affects the three interdependent constraints of project before and during the covid19.
4. Developed an adaptive mechanism framework for WWCC in coping with the disruption of projects during crisis or pandemic.

Significance of the Study

The study on disruption of covid19 to the construction industry is a learning paradigm on the challenges and effects of a pandemic on current projects. This enhances the WWCC in dealing with work stoppage that affects the financial status of their ongoing projects in mitigating the impact in the WWCC as a whole. The study will be significant to the following beneficiaries:

Theory. The findings of the study are inputs in the determination of the sets of interrelated concepts, definitions and propositions that explains or predicts events or situations in defining relations among variables that affects the construction business during pandemic. The study contributes to 'Organizational Adaptation Theory'. In a more philosophical context, the study provides inputs to for organizations to transform their structures, operations, and procedures in coping with the change in environment such as, fluctuating economic landscape, new laws impacting their field or any disruption to the natural systems and processes in an organization (Purna 2017).

The 5Ms of management will be a model for organizations in making optimal and responsible use of its Man, Materials, Machine, Method, and Money on the triple constraints of project, to achieve goals or objectives in a more productive manner (Omoregie, 2017). These can be utilized as environmental scanning as inputs to a framework for looking at factors that could be systematically handled so that problems and challenges as roadblock to project completion can be minimized or mitigated. This study assists future researchers in contributing to the body of knowledge in terms of constructing implications to the theory development about the impact of pandemic to the construction sector. It will be a significant factor for the study to contribute within the world of management best practices that prioritizes the organization's adapting to change that would improve their systems and processes during crisis or pandemic.

Practice. Finding out facts to make better decisions and gain more knowledge in the construction profession. Establish specifics to detect potential problems in the organization and make the necessary actions for mitigation, and assists the contractors on health, safety, and environment (HSE) protocols and risk hazard assessment. The study guides WWCC in developing a proactive approach and more preventive measures in managing pandemic leading to business continuity. This study is a pro-active approach for the construction organization to be able to enhance their performance and manage their construction management operations in times of pandemic.

Policy. The findings of the study contribute in providing the necessary inputs on mitigation by similar organizations in the construction industry. This serves as a guide to construction organizations in making the necessary adjustments in mitigating the impact of pandemic in construction projects. In a broader

perspective, this study provides inputs to WWCC's business continuity plan, and enhance the organization's policies on safety hazards and risk assessment. This also provides additional policies on the Philippine Clean Water Act, Environmental Monitoring Board, and in line with the Sustainable Development Goals.

Social Action. The findings of the study would help all the managers, engineers and technical personnel that are involved in the construction industry to develop and facilitate the most effective program for the organizational needs in time of crisis or pandemic. This would be of assistance to the engineers and technical personnel in developing an effective operational program in times of pandemic, and identify personnel's needs during crisis.

The Researcher and Future Research. The study is significant to the researcher due to his involvement to the construction industry from which the respondents are associated and future research of similar type of study.

Engineering Management Program. The study can be significant to Engineering Management Program in coping with covid19 and similar crisis in the future. The adaptive mechanism would be a toll for the organization to ensure business continuity in terms of engineering management.

Water and Wastewater Construction Companies (WWCC). The study would be important to WWCC to help their organization cope up with crises that may lead to project delay, termination of contracts, and probably company closure.

Project Management. The study would be significant to managing industrial projects and ensure business continuity in times of crises.

Scope and Limitations

The study was conducted on selected WWCC within Metro Manila, Philippines. The key informants comprising the respondent of this study were administered to the project managers (PM), construction managers (CM), project site engineers (PE), and pollution control officer (PCO) involved in the engineering, procurement and construction (EPC) of water and sewage treatment plants (STP). The study has considered the current status of the locale in the year 2020 and 2021, before pandemic and during the pandemic.

The PM, CM, and PCO of selected WWCC were surveyed through structured questionnaires on the status of their organization specifically on the effect of covid19 to the organization's 5Ms of management such as Man, Material, Machine, Method, and Money. No generalizations have been made with respect to other construction companies because the study is limited only to the selected WWCC. Moreover, the findings of the study are considered true and valid to the locale of the study. Any implications to other locales depend on the reader's discretion.

Definition of Terms

The following terms are defined theoretically, conceptually and operationally to ensure better understanding of this study:

Adaptive Mechanism. An organization's ability to adjust with current conditions that drives decision making allowing people most likely to detect changes in the environment to respond quickly and proactively (https://dictionary.reverso.net/english-definition/adaptive+mechanism, April 30, 2022). In this study, adaptive mechanism is a way by which the construction company would have a guideline on business continuity even in times of pandemic.

Before covid19. Operationally defined in the study as the dates covered before the covid19 pandemic, specifically between July 2019 up to 16 March 2020.

Contemplation. Is an essential part of social research in developing innovative ideas on topics, analysis, techniques, and research methods. People contemplate to see what happens between thoughts that are trying to cling to abstract concepts and categories (Konecki, 2021). A person that realizes that there is a problem and considers the advantages and disadvantages of changing.

Crisis. A time of intense difficulty, trouble or danger. It is an event or period that led, or may lead to an unstable and dangerous situation affecting an individual, group, or all of society (https://www.merriam-webster.com/dictionary/crisis, April 30, 2022).

Disruption. A disturbance or problems which interrupt an event, activity, or process. The act or process of disrupting something. A break or interruption in the normal course of continuation of some activity or process that sometimes result into confusion or disorder.

During covid19. The date covered at the height of covid19 pandemic, specifically between 17 March 2020 up to 30 November 2020.

Environmental Scanning. Possession and utilization of information about occasions, patterns, trends, and relationships within an organization's internal and external environment (www.vedantu.com/commerce/environmental-scanning, April 30, 2022).

External Scanning. Acquisition and use of information about events, trends, and relationships in an organization's external environment, the knowledge of which would assist management in planning the organizations' future course of action (CHOO 2001).

Focus. Involves the ability to pay attention to things that will help and avoid distractions that will hurt or affect the organization's efforts. Focus is the gateway to all thinking such as; perception, memory, learning, reasoning, problem solving and decision making.

Identify (Identification). Critical and analytical note. Properly defining the problem beginning with the challenging assumptions and breaking the problem down to ensure that the organization focuses on the root of the problem.

Impact. A forceful consequence. A phenomenon that follows and is caused by some previous phenomenon that has a strong effect or influence that something has on a situation or person.

Internal Scanning. Gathering of information from within the organization for use in issues on management and the strategic decision-making process. It's an early warning system for changes outside the organization to pick up the new or unexpected in order to help top management plan for the organization's future.

Level of Severity. Is operationally defined as the measurement of impact an incident has on the business. In this study, the seriousness of the effect of covid19 to the 5M's of management are measured before and during the pandemic, and compared to determine the impact to the scope, time and cost of projects (www.lawinsider.com/dictionary/severity-level, April 30, 2022).

Machine. Mechanized equipment used to perform construction operations in sequence to achieve a final objective. This refers to heavy-duty vehicles specially designed for executing construction tasks. These are machines that usually comprises of five equipment systems such as, implementation, traction, structure, power train, control and information. In summary, these are group of devices with moving parts that are used to perform specific works.

Man (Manpower). Workers employed by a construction company that performs many basic tasks that require physical labor on construction sites. They are responsible for preparing equipment, operating

construction machineries, and building the structures from the foundation up to the building above ground. In many construction organizations, "Manpower" refers to "Man" in dealing with human resources (Omoregie 2015)..

Materials. An article, Material or supply brough to the construction site by the contractor for incorporation into the structure. These are tangible property that becomes or is intended to become an ingredient or component part of a construction project.

Method. It is the technique of understanding problems, needs and controlling the use of resources, cost, time, and scope of work. It is the application of skills, tools and techniques to project activities in order to meet client and stakeholder's needs and expectations from a project (Omoregie 2015).

Mitigation. The action of reducing the severity, seriousness, or painfulness of something by reducing the risk of loss from the occurrence of any undesirable event, or reducing the severity of a negative consequence of some kind (https://economictimes.indiatimes.com/definition/Mitigation).

Money. In 5M's of management is the amount of money spent by the organization that has a direct effect on the fruitfulness of projects. It is operationally defined as the required resources utilized that can motivate workers, get sufficient materials, the right machines, and maintain them to ensure that time is properly managed in making sure that the construction schedule is met (Omoregie 2015).

Organizational condition. The situation of the company's people, organization, technology, and their relationships at the time of the study. This highlights on theory and learning on organizational conditions for knowledge operations, management prerequisites, and barriers (Springer, et al. 2002).

Pandemic. A widespread occurrence of an infectious disease over a whole country or the world at a particular time. It is an outbreak of a disease that occurs over a wide geographic area such as multiple countries or continents that typically affects a significant proportion of the population (https://www.merriam-webster.com/dictionary/pandemic).

Precontemplation. It is a stage wherein the organization do not still recognize that there is a problem with substance, or they recognize the problem but are not ready to change. The behavior or condition of the organization is not yet acknowledged as problematic and there is no intention yet to change in the foreseeable future.

Pause. A temporary stop in action or speech. A sudden silence or pause that gives a person the chance to have a deeper meaning for future actions. This enhances a meaningful and respectful communication.

Resources requirements. The means used to achieve project objectives. The primary resource are people with applicable skills and competencies. The other main grouping of resources includes capital, facilities, equipment material and information. (Joubert, 2010).

Situation Analysis. The environmental scan that will be based on changes happening in an organization such as local policy, national policy, the natural environment, industry trends, and competition. Situational analysis will help assess the organizational aspirations and the results need to be seen before the aspirations are achieved**.**

Stop Start Continue. This is strategic decision-making model that offers as way of being proactively prepared to meet the challenges of introducing change in the organization. This is a business management model that can be used as an assessment tool applied for a range of purposes by people of different department in the organization.

The 5Ms of Management. Management process optimizing the use of man, materials, machine, method and money (Omoregei 2015). These are the moving parts of any organization on managing business

processes. In construction, the most essential part is man followed by materials and machines in order to implement the methodology to gain profit (money).

Triple constraint: Cost. The financial aspect of a project also knows as the project budget. Cost or amount of money required to complete the project according to the contract between the client and the contractor.

Triple constraint: Scope. The tasks or works required to fulfill project's goals, also known as the interrelated works that needs to be completed to determine the completion of a project according to the agreed contract between client and contractor.

Triple constraint: Time. The schedule for a project to reach the completion date, also known as the duration required by the contractor to complete the project up to the acceptance of the client.

Triple Constraint of Project Management. The most important concept of in the history of project management (Westland 2018). These are the aspects that drive construction projects to succeed. The triple constraint is often referred to as the project management triangle associated with scope, time and cost.

Water and Wastewater Construction Company (WWCC). The construction companies involved in the construction of infrastructures like; water supply, sewage treatment plants, waste management infrastructures, effluent treatment plants and drainage network. These are the companies that carry out detailed engineering, procurement of materials and equipment, and then construct to deliver a functioning facility or assets to respective clients (Arup).

Water and Wastewater Treatment. Wastewater treatment is a process used to remove contaminants from wastewater or sewage and convert it into an effluent that can be returned to the water cycle with minimum impact on the environment, or directly reused (https://www.intechopen.com/books/8804, April 30, 2022).

CHAPTER II
REVIEW OF RELATED LITERATURE

This chapter contains the review of related literature (RRL) that provides background to the achievement of the objectives of the study. It also gives the readers a much clearer definition of the research voids on the study and presented in a manner that provides clarity and focus. The arrangement of the literature review shows the transitions in connecting the ideas in helping future readers or researchers understand how ideas work and built on one another, and the transitions of related articles and references have been pieced together in creating an overview and explanation of the circumstances presented in the study.

The RRL provided in this study includes the discussion of the importance of construction industry to the economy, problems experienced in constructing a project, and the associated risks in the construction industry during covid19. Since the study is about the impact of pandemic to the construction industry, related articles also presented the history of covid19, its impact to the construction industry, the ways pandemic affects on-going projects and various studies on the adverse effects of pandemic in the Philippines and other countries.

The covid19 pandemic has affected the market and commercial activity in presenting a range of challenges to the engineering and construction industry that deepens the severity and length of the crisis. The construction which is most of the time human driven, is considered one of the most significant industries. According to Majumber & Biswan (2021) on World Health Organization's Covid19 Global Literatures on Coronavirus Disease, construction sites are being halted due to fear on the infection of covid19, and some clients are not only facing cost escalation but are also afraid of the spread of covid19 to their projects.

The duration and severity of the crisis is uncertain making it hard to anticipate the recovery process for the industry.

In the Philippines, particularly on the construction of sewage treatment plants and pipe network at Muntinlupa and Las Pinas, some construction projects have been delayed and some have been cancelled or terminated as a result of the impact of covid19 due to inadequate manpower supply, supply chain bottlenecks of construction machineries and unavailability of construction materials. The covid19 has caused widespread concern and economic hardships for consumers, businesses and communities across the country. The number and value of construction projects in the early months of 2020 shrank by over one-fifth putting a stop to construction works in Luzon and most parts of the country are placed under covid19 lockdowns. As reported by Ben O. De Vera (2020) on Inquirer.net, the Philippine Statistics Authority's (PSA) latest construction statistics based on building permits approved from January to March showed that the number of construction projects fell 22.4 percent to 30,838 from 39,762 in 2019. This shows that covid19 has severely affects the construction industry. The succeeding related literatures comprises of international local studies starting on the importance of the construction industry, effects of the covid19 to the construction sector, and related national laws and policies on water management in the Philippines shows the impact of covid19.

The literature is arranged chronologically starting from the importance and the contribution of the construction industry to the economy but the industry, it is an open system susceptible to disruption by major risks that affects on-going projects. Covid19 which is considered by the World Health Organization (WHO) as one of the disruptions to the organization causes global impact to the construction industry. Latest effects of covid19 in UK and around the world are also included to give the readers a bird's eye view on the effect. At the middle part of the literature presents the potential impact of covid19 to the labor sector and supply chain. It also includes how the construction sector are adapting to the disruptions caused by the pandemic, and the impact assessment on the local sector. Later part of the review of related literature pertains to the governing bodies that are related to water and wastewater, regulatory bodies, annual reports, and best practices that can be used in the study and can be a reference to WWCC in coping with the disruption of projects due to crisis or pandemic.

Importance of Construction Industry in the Economy

Construction is defined as the process of making something, the occupation of building or the way that is something to put together, the basic physical and organizational structures and facilities such as buildings, roads, bridges, power supplies and industrial plants and facilities. Contractors are professional disciplines that deals with designing, planning, organizing, controlling, and managing human and other resources with the objective in constructing structures that contributes to the economic growth of a country (Khan, 2005).

According to a study by Abdullah, R. (2014) on the role of the construction industry in the national economics, the construction industry represents the one of the important sectors in a country. Without this industry, there are no schools, hospitals, or residential houses that represents the fundamental foundations of a strong economy. The construction industry helps in playing a key role in boosting a country's economy by attracting foreign investments and tourists (Sukriti 2020). It drives growth for other sectors, creates job, and attracts talents. A strong construction sector with the right health and safety can help bring in foreign investment to the country (Abdullah 2014).

Major Risks in Construction Projects

Taking into consideration the possible risks in constructing a project is very challenging, as risk is a fortuitous event that would delay the entire project. Hazem, Z. (2021) of Plan Radar has compared construction to other industries. Accordingly, it becomes clear that managing risk is so much more complicated for contractors. Other sectors also deal with fairly stable or predictable risks. The biggest threats to a manufacturer's projects are supply shortages or labor problems, while agriculture's biggest worries are the weather and pests. But building is, by its nature, much more unpredictable because every project is entirely unique and different from each other. Construction involves large numbers of independent companies working together, and project managers must deal with all the supply, weather, labor issues and many other different kinds of crisis (Plan Radar, 7 Major Risks in Construction Projects and How to Avoid them, Zeina Hazem, February 22, 2021, retrieved from https://www.planradar.com/builders-risk/, September 14, 2021).

In a construction project site, this may involve a medical emergency, a natural disaster, a fire, a structural failure, or any other situation that endangers the project or the people. There may also be a crisis of malevolence, misdeeds, or fraud. No matter what kind of emergency that arises, a crisis requires action by any organization to control and minimize the potential impact of such events.

Definition of Pandemic

A pandemic is the worldwide spread of new disease. An influenza pandemic occurs when a new influenza virus emerges and spreads around the world, and most people do not have immunity. Some aspects of pandemics can appear similar to seasonal influenza while other characteristics may be quite different. Both seasonal and pandemic influenza can cause infections in all age groups, and most cases result in self-limited illness in which the person recovers fully without treatment (World Health Organization, What is a pandemic, 24February2010, https://www.who.int/csr/disease/frequently_asked_questions, August 31, 2021.).

The coronavirus outbreak has been labelled as pandemic by the World Health Organization (WHO). A pandemic is an infectious disease where we see significant and ongoing person-to-person spread. The rapid spread of covid19 has created major news outlets and the World Health Organization (WHO) saying that COVID-19 is a pandemic. The effects of covid19 across the world are unprecedented. According to WHO, a pandemic is "an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people. The Center for Disease Control (CDC) defines a pandemic as an epidemic that has spread over several countries or continents, usually affecting a large number of people (BBC News, Coronavirus: What is a pandemic and why use the term now, 11March2020, https://www.bbc.com/news/health-51358459, August 31, 2021).

The History and a Look at Covid19

The novel coronavirus also popularly known as covid19, was first recorder in Wuhan, Hubei Province in China in December 2019. Common signs of covid19 infection are similar to the common colds that includes respiratory symptoms such as dry cough, fever, shortness of breath, and breathing difficulties. The covid19 infection is spread from one person to other person through droplets produced from the respiratory system of infected people during coughing or sneezing. The WHO officially declared it a pandemic on March 11, 2020 (Lab Health and Safety, Covid19: A History of Coronavirus, Vince McLeod,

16March2020, https://www.labmanager.com/lab-health-and-safety/covid-19-a-history-of-coronavirus-22021, August 31, 2021).

Lexology, an article by Holland (2020) discovered that covid19 has touched many aspects of most people lives and professional activities. One of the areas that has experienced a significant level of disruption aside from man is the material supply chains. The ripple effect of material delays or shortages are likely to be felt for a long period of time on any project, and perhaps even for the duration of projects (Holland 2020).

Global Impact of Covid19 to Construction and Infrastructure

During the coronavirus pandemic, many construction companies were not able to continue their normal operations. According to the article Marsh, there are five ways covid19 has impacted the construction companies. The covid19 pandemic has plunged many global contractors into the most challenging times on their history as countries across the globe introduced lockdowns and other restrictions. The pace of change for contractors has been extreme, with many of them change their ways of working overnight (https://www.marsh.com/us/industries/construction/insights/five-ways-covid-19-has-impacted-construction-companies.html).

Consequences might keep coming as companies struggle financially that might delay major construction projects going forward. From managing safety of its workforce to capitalizing on available relief, the construction sector has plenty to work through during the pandemic and the recovery from it. Any organization, whether big or small, undertake projects at one time or another to improve company operations to meet client requirements. In project management, it is important to understand that a "project" is not a part of normal business operations of an organization. It has a temporary completion schedule and a specific goal (13d.cs.colorado.edu/Ostwald, October 15, 2021)

According to the UK news insights on how covid19 impacted the construction and infrastructure globally, the construction and infrastructure professionals reported decline in workloads and activities in the first quarter of 2020. The severity of slowdown appeared to depend on the timing and severity of covid19, and when restrictions, quarantines, and lockdowns took effect. In Asia Pacific, the covid19 outbreak stopped some construction activities in several countries. It has also led to difficulties in sourcing labor and materials for construction. Japan and India are slightly more robust. The Indian government did not announce its lockdown until near the end of the quarter, and measures adopted in Japan appear to be much less restrictive than elsewhere. By contrast, China saw the sharpest contraction in workloads after being shut down for most of the quarter. Throughout the Middle East and Africa (MEA), economic problems mounted over the quarter with varying severity; no country was shielded completely from the global decline in trade, asset prices and mobility dur to covid19. The impact was also felt in the Middle East following the collapse of oil prices, and uncertainties around a deal with OPEC. Saudi Arabia was the only middle east country to report an increase in construction activity, potentially following their economic diversification program (How has Covid19 impacted construction and infrastructure globally, News & Opinion, 07May2020, https://www.rics.org/uk/news-insight/latest-news/news-opinion/, October 05, 2021).

Latest Effects of Covid19 in the Construction Industry in UK and Worldwide

As contractors prepare to return to work on sites that have been shut down by shelter-in-place initiatives, they face an industry that has been drastically changed by the both public health and economic effects of

the pandemic (Goodman 2020). From a renewed emphasis on jobsite safety to longer project delivery times and the increased influence of organized labor, the virus has upended many facets of the industry.
The covid19 pandemic has affected many people around the world. Reinhart (2020) reported that, after many months of lockdowns, multiple waves of infections and skyrocketing death tolls, four out of five people in 116 countries and territories in the second half of 2020 said that covid19 has affected their lives to at least some extent. Construction businesses the world over is doing their best to change the way they work in order to accommodate regular updates in keeping their construction workers, staff and the general public safe.
Construction companies are trying to minimize or at least limit the disruption of covid19 to their construction projects. Despite everyone's best efforts to mitigate covid19, the outbreak is having a massive impact on the construction industry worldwide. While office-based staff have the inconvenience of working from home as they switch to face-to-face meetings and video conferences. The effects of the pandemic to some construction projects brought current projects to a complete standstill, and creates a massive additional financial, contractual and social and employment challenge (Thomas & Hackett 2020). An article by Bailey et al (2020) on the current impact of covid19 to the construction and engineering projects during the covid19 stage, has caused delay and disruption leading to severe impact in the supply chain.

Construction Industry Bracing for Potential Impact of Covid19

With the virus expanding in the US, the impact on major construction activities have become more intense. As workers become infected, sick and quarantined, labor shortages are experienced by the construction industry. Construction projects always have a 'time for completion' and many contractual provisions may certainly come into play in any construction project which is affected by labor shortages from the coronavirus. As the coronavirus impacts the labor force and the availability of workers to satisfy the contractor's scheduling and other obligations on construction projects, we see additional claims and litigation. Contract provisions relating to scheduling, timing, completion of work, and other contractual covenants may be implicated in disputes between owners and contractors as a result of covid19 (Brown 2020).

Covid19 Impact on Construction Sector

Industry insight estimates that up to 140,000 formal jobs could be affected by covid19 as activity levels in the construction sector drops (Cokayne 2020). According to an article on Capitol Technology University on the impact of covid19 on the construction industry, many workers in the year 2020 has been adjusting to work from hope arrangements. But for some sectors which includes the construction industry, working from home is not an option for the obvious reason that workers must be on the jobsites in order to progress the work. University of Texas News in October 29, 2020 have shown a study that, workers that reports to the project sites have a greater risk of covid19 exposure, and studies have shown that the virus has hardly hit the construction industry. According to researchers, the higher vulnerability for construction workers stems from the continuation of construction works throughout the pandemic, even during stay-at-home orders and other community-wide mitigation measures. The nature of the work in the construction sites intensified the risks of people getting infected due to close contact with one another. An article on insurance journal reported that, covid19 pandemic forced individuals and businesses to stand still for a moment in time, a pause that was challenging for many and cost jobs, income and growth. Savino (2020)

has identified that while many industries are transitioning back to work, some businesses including those in the construction industry faces new challenges because of the pandemic.

Impact of Covid19 on the Labor Sector

According to an article from the International Labor Organization (ILO), the covid19 pandemic has had a significant impact on the construction sector, which is sensitive to economic cycles. Yet, on the upside, construction holds much potential to stimulate recovery, thanks to its potential to create jobs; and in turn, recovery measures can support the sector's transformation towards sustainability and digitalization. Tripartite cooperation and social dialogue, together with international labor standards, are key to promote a human-centered recovery of the construction sector from the crisis.

The ILO Sectoral Brief in January 2021 pointed out that, the covid19 pandemic has devastated the world of work. Its impact, which varies across different sectors but significant in the construction sector. As construction in sensitive to economic cycles, construction enterprises and workers are vulnerable to the drastic decline in economic activity resulting from the pandemic (ILO Global Dialogue Forum on Good Practices and Challenges in Promoting Decent Work in Construction and Infrastructure in Geneva, 19-20 November 2015, retrieved from https://www.ilo.org/wcmsp5/groups/public/---dialogue/---sector/documents/ meeting-document/ wcms_431634.pdf, October 20, 2021).

Ways Companies Cope with Covid19 Crisis

Due to covid19, some companies including the construction sector have been forced to shift into a work-from-home (WFH) setting and set skeletal workforces in their offices. Executives from some reputable construction companies shared how their organizations are coping with the national government's restrictions on the spread of covid19 (Conoza 2020). One major challenging issue is the connectivity for companies in activating remote work settings. It has been observed that not all areas in the country have fiber optic footprints and that, connections with the different communications service providers that are shared with multiple mobile users. These gaps have to be addressed by the companies and the service providers. The covid19 outbreak has caused indiscriminate blow to businesses as everything from small companies to multinational corporations were forced to change the way they do their work (Thorbecke 2020).

Covid19 Case Studies: Business is Adapting to Covid19

Over the past few months after the outbreak of covid19, diginomica has been documenting how companies are adapting to the covid19 pandemic (Preez 2020). According to the author of the article Preez, since the covid19 overwhelmed the world in early 2020, countries went into nationwide lockdowns and businesses have to quickly change and adapt their operations in order have business continuity. It has become clear over the pandemic period is that companies that had been making digital investments as the most resilient and best placed to adapt with the onslaught of covid19. Also, there were evidence that trends such as cloud, digital collaboration, and analytics that were happening in the market have now accelerated and that technology investment decisions are the prime considerations of many companies.

Supply Chain Adapting to Covid19 Lockdown

Seifert (2020) of IMD Research and Knowledge reported that supply chains are finding themselves squarely within the public eye and experiencing unique challenges. For weeks at the start of the year, as

COVID-19 was taking its toll on China. As covid19 crisis deepened and countries began instituting lockdowns, the supply chain have been experiencing systemic demand shocks. People are stocking up supplies in order to comply with the restrictions on movements. Adding to the complexity is the ability to develop robust demand plans. It is impossible to predict how consumers behave since the extent and duration of restricted movement is uncertain.

Construction Adapting to Supply Chain Disruptions

During the covid19 crisis, the construction industry includes adapting to disruptions caused by covid19 in the jobsites and supply chain in the corporate planning strategies. Shultz (2020) has observed that certain changes are easy to see on construction jobsites due to the effect of covid19 pandemic. Social distancing, face masks, hand sanitizing stations and other precautions deemed as the new normal for essential operations during the crisis. Construction has been considered an essential activity but the interpretation of that term varies in different countries. Ken Simonson, chief economist, Associated General Contractors of America (AGC), pointed out that more and more owners are halting their projects and cancelling ones that had been expected to start in the next few months. This goes to show that covid19 has obviously affected current projects including prospective project due to the uncertainties of the pandemic.

Actions on the effects of Covid19 to Construction Projects

The National Law Review, Volume X1, Number 293 in April 15, 2020 reported in an article that the global spread of covid19 has generated unprecedented delays, disruptions and uncertainty on construction projects (Epstein et al 2020). Travel restrictions, social distancing and quarantines are disrupting supply chains, contractor's manpower and the availability of personnel for project inspections. This lack of personnel resulted in delays and increased costs. The article provided guidance to developers and owners on how to deal with projects affected by covid19. It also highlights the actions they should consider in mitigating the impact to their projects.

Project owners and developers as advised by The National Law Review through Epstein et al (2020) should consider the following actions to projects that have stopped, delayed and disrupted due to the impact of covid19;

1. Identify and assess relevant local and state restrictions on construction activities;
2. Identify and assess relevant contractual provisions;
3. Communicate and work with the contractors to identify, assess, and mitigate project impacts;
4. Consider contract notice requirements and respond to notices from the contractors;
5. Consider project suspension and termination options, and;
6. Consider contractor claims for time extensions and delay damages.

The above recommendations are offered by The National Law Review as general guidance so that the facts and circumstances of each project, including considerations such as financing documents, leasing, joint venture partnerships, market conditions, and contract terms, may warrant deviations from the general guidance.

Preserving Project Continuity in the Face of Covid19

McKinsey and Company through Banaszak et al (2020) pointed out that, continuation of infrastructure projects in the time of covid19 means, owners must protect the people involved in the projects. This require continually assessing risks, and adjusting operations. The covid19 pandemic is a health crisis that

made leaders across the world struggling with the well-being and livelihoods of their communities. The economic challenges continue to increase and add up much uncertainty about the future. Projects have been hit hard with worker absences, supply-chain disruption, and deteriorating investor confidence (Banaszhak 2020). According to McKinsey and Company, although projects may continue, project owners require agility to mitigate the three challenges that resulted in the disruption caused by covid19:
Policies must be put in place to flatten the curve of the effect of covid19 that disrupted the availability of labor, materials and equipment.
Market conditions. Supply chains, contractors, and project owners must be prepared for the possibility of insolvency or bankruptcy and cashflow shortages.
Cash and Working Capital. Challenges may be compounded by low cash reserves. The COVID-19 crisis tests even the most sophisticated project owners. The tests focus on three core priorities: protecting people, the project, and performance (Banaszak et al, 2020).
Protect people. Project owners need to develop new working norms, adopt a more flexible working system, and address broader concerns associated with the pandemic to protect their staff and workers.
Protect the project. Projects are now facing unforeseen market conditions, contracts challenges (including potential bankruptcies or invocations of force-majeure clauses), supply-chain bottlenecks, and cash-flow shortages. The organization must launch a value-improvement exercise that could identify risks on continuing projects and opportunities that take on new relevance in the face of covid19. Owners should also analyze contracts in preparing potential change orders and claims. They should map out their entire supply chain to take more proactive measures during COVID-19, including identifying alternatives, considering where to stockpile, and reviewing contingency budgets to source and expedite critical materials.
Protect performance. Owners must modernize engineering processes and adopting digital solutions. Contractors shall create a supply-chain nerve center for procurement. In the face of disruption, a supply-chain nerve center must be an active, coordinated, cross-functional team that can help manage and optimize procurement processes. The nerve center's objectives must diversify the supply chain, manage demand more efficiently, enable agility, and manage the use of off-site assembly and modular approaches.

Impact Assessment of Covid19 on Philippine Business Firms

Key findings of the United Nations Industrial Development Organization (UNIDO) in their survey dated May-June2021 on the impact of covid19 on manufacturing firms in the Philippines, the covid19 pandemic has left very few nations unharmed. In the Philippines, efforts around health concerns and response measures were intensified, including enhanced community quarantine (ECQ) causes disruptions across various economic and social sectors, endanger employment and livelihood, and results to urgent issues around food security and safety, nutrition and income generation. UNIDO's study showed that during the implementation of the containment measures on covid19, respondent firms from the manufacturing sector encountered difficulties in coordinating their supply chains. This has resulted in half of the firms registering a 40 percent reduction in operating hours. Approximately 50 percent loss of employment and 60 per cent reduction in both revenue and production volume.
The lack of available transport and employees' anxiety in going to work contributed to worker shortages. Only a handful of firms capable of successfully implementing work-from-home arrangements. The majority of firms also experienced difficulties in coordinating their supply / value chains leading to shortages in the supply of raw materials and obstacles to distribution, shipping and logistics. These

challenges were further compounded because the majority of firms did not have clear and responsive plans for business continuity, especially during extraordinary situations (UNIDO 2021).

The 5Ms of Management: Organizing Them Effectively

According to Omoregie (2015), managing business organizations has always been a challenge to man since it became scientific. Since man became victorious in the industrial revolution, every business has been using these five M's: Man, Material, Machine, Method and Money; to operate with, or without, success. It is problematic for organizations to not properly and effectively organize the 5Ms for business success. None of the M's is useless no matter the perspective it is viewed from. When man took time off work, there were economic downturns as precious time was expended to right perceived wrongs. Successful management means, optimizing and responsible use of man, materials, machines, method and money for the organization's success (https://www.linkedin.com/pulse/5-ms-business-management-organising-them-effectively-henry-omoregie).

Organizational Adaptation Theory

Organizational adaptation theory suggests that organizations, transform their structures or procedures to cope with a change in environment, such as a fluctuating economic landscape, new laws impacting their field or any disruption to the natural systems and processes in an organization.

Organizational adaptation is necessary to correct imbalances and improve inefficient processes within an organization, and in how that organization works in the world at large (Purna 2017). The adaptation can be reactive or pro-active that comes up after experiencing or observing a change in the internal or external environment, or it can be preventive. Managers may implement changes in an organization's systems and procedures to anticipate a change in the organization. Organizational adaptation theory generally refers to how a change in the environment dictates changes in groups of organizations, rather than how a specific organization changes to adapt (Purna 2017).

Organizational change can be challenging. Maintaining is more difficult. An organization shall retain those aspects of the change that management intends to keep, continuous improvement, and making sure that all members of the organization shall not be complacent by involving them soliciting suggestions for change. All members shall also be informed of the successful implementation of the change as well as the ones that are not. Reward the members of the organization that are enthusiastically adopting change and encourage them to more active in the changes initiated by the management.

The Importance of Risk Mapping

Building a risk map brings valuable benefits. This will have a thorough understanding of the risk environment and how individual risks compare to one another (Webb, 2020). This can be used strategically in prioritizing the risks and determine where to use the limited resources (Webb 2020).

A risk map is made by plotting the frequency of a risk on the Y-axis of the chart and the severity on the x-axis. Frequency is how likely the risk is or how often you think it will occur. Severity is how much of an impact it would have it did occur. The higher a risk for these qualities, the more threatening it is to the organization. Risk maps are valuable tool as they allow the organization to:

a) Understand the risk environment. Requires the organization to assess each risk and its causes and consequences individually. It also allows the organization to look at the risk environment as a whole by understanding how frequencies and severities compare.

b) Prioritize mitigation strategies. Allows the organization to determine the steps to take first, implement prevention strategies for the most frequent and severe risks before moving on to other risks.
c) Allocate limited resources. Allows the organization to use the map in preventing primary risks. The organization can monitor the risks that are low control so that they can determine where to spend more time and money (resources).

Risk maps are recommended for any organization to augment their risk management culture. These maps can bring understanding and prioritization to the risk management department. A risk map is built by involving people from all parts of the organization, understand each risk, seek guidance, and revisit and modify. One of the best ways to visually display risks is a concise manner is to use a risk map which is also known as 'Risk Heat Map'. A Risk Map shown on the figure is simply a diagram which very quickly highlights the key risks to the organization's program or project (https://www.clearrisk.com/risk-management-blog/importance-of-risk-mapping-1, May 03, 2022).

95-100	Almost certain	Medium	Medium	High	Extreme	Extreme
65 - 95	Likely	Medium	Medium	Medium	High	Extreme
35 - 65	Possible	Low	Medium	Medium	High	High
05-35	Unlikely	Low	Low	Medium	Medium	High
0 - 05	Rare	Low	Low	Low	Medium	High
		Insignificant	Minor	Moderate	Major	Severe
		1.00 - 1.49	1.50 - 2.49	2.50 - 3.49	3.50 - 4.49	4.50 - 5.00

Figure 1. Risk heat map of severity vs likelihood

Sustainable Development Goals (SDG)

The Sustainable Development Goals (SGD's), also known as the Global Goals that were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet and ensure that by 2030, all people enjoy peace and prosperity (UNDP 2015).

There are 17 SDG's integrated recognizing action in one area that affects the outcomes in others, and that development must balance the social, economic and environmental sustainability. Countries have committed to prioritize progress for those countries who are behind. The SDGs are designed to end poverty, hunger, AIDS, and discrimination against women. Sustainable Development Goal (SDG 6) pertains to clean water and sanitation ensuring availability and sustainable management of water and sanitation for all.

The Importance of Wastewater Treatment

Essential for life, clean water is one of the most important natural resources on the planet. Wastewater,

which is basically used water, is also a valuable resource, especially with the recurring droughts and water shortages in many areas of the world (Admin 2017). Wastewater contains many harmful substances and cannot be released back to the environment until it is treated. The importance of wastewater treatment plant is two-fold, to restore water supply and protect the planet from toxins. Wastewater if properly treated, is a good source of water for many purposes. Good wastewater treatment allows the maximum amount of water to be reused instead of going to waste.

Republic Act 9275: The Philippine Clean Water Act

The Philippine Government's aim to protect the country's water bodies from pollution due to land-based sources that emanates from industries and commercial establishments, agriculture and community/ household activities (DENR 2004). It provides for a comprehensive and integrated strategy to prevent and minimize pollution through multi-sectoral and participatory approach involving stakeholders. It is a mandate by the Manila Waterworks and Sewerage System (MWSS) to develop new water sources. MWSS' role is to abstract raw water from available sources, treat it to become potable and distribute it to customers, and provide sanitation and sewerage services.

Philippine Government Water and Wastewater Regulating Bodies

DENR Administrative Order No.26 – A: Series 1994. The new standards covering the requirements for acceptable water values of determined parameters in measuring water quality that includes, microbiological, physical, chemical, and radiological composition of the water.

Environmental Management Bureau (EMB), RA 9512. The Philippines enacted the EMB-RA 9512 which provides for the promotion of environmental awareness through environmental education which shall encompass environmental concepts and principles, environmental laws, the state of international and local environment, local environmental practices, the threats of environmental degradation and its impact on human well-being, the responsibility of the citizenry to the environment, and the value of conservation, protection, and rehabilitation of natural resources.

EMB Annual Report on Status of Water Quality (2020)

The objective of monitoring priority rivers is to improve the quality of water and comply with DENR Administrative Order No. 2016 – 08 or the Water Quality Guidelines and General Effluent Standards of 2016. Out of forty-three (43) rivers mentioned in CY2020, thirty-two (32) water bodies passed the water quality standards for dissolved solids (DO) while thirty-three (33) water bodies passed the water quality standard for dissolved oxygen (BOD). The three (3) waterbodies were not monitored due to strict implementation of community quarantine where waterbodies are located. In CY2020, out of eighty-three (83) rivers monitored for DO, sixty (60) or 72% are within the water quality guidelines, those that are monitored for BOD (82 rivers), fifty-four (54) or 66% only passed the water quality guidelines.

National Water Resources Board (NWRB).

The authoritative national organization tasked by the Philippine Government to coordinate and integrate all activities in water resources development and management. Its main objective is to achieve scientific and orderly development and management of all water resources in the country consistent with the principles of optimum usage, conservation and protection to meet present and future needs.

Laguna Lake Development Authority (LLDA)

The LLDA by virtue of the Philippine Republic Act No.4850, was created to promote and accelerate the development and balanced growth of the Laguna Lake area and its surrounding provinces, cities, and towns. It was created to carry out provisions for environmental management and control, preservation of the quality of human life and ecological systems, and prevention of undue ecological disturbances, deterioration, and pollution.

ISO 31000:2018 Risk Management Guidelines

This provides guidelines on managing risk faced by organizations. The application of these guidelines can be customized to any organization and its context. It provides a common approach to managing any type of risk and is not industry or sector specific which can be used throughout the life of the organization and can be applied to any activity, including decision making at all levels (https://www.iso.org/standard/65694.html).

ISO 14001 Environmental Management System

ISO 14001 sets out the criteria for an environmental management system and can be certified to. It maps out a framework that a company or organization can follow to set up an effective environmental management system. Designed for any type of organization, regardless of its activity or sector, it can provide assurance to company management and employees as well as external stakeholders that environmental impact is being measured and improved (https://www.iso.org/iso-14001-environmental-management.html).

Inter-Agency Task Force (IATF) Philippines

The IATF manages the emerging infectious disease such as the covid19 that was created by the National Government through Executive Order No. 168, series of 2014 in pursuance to the constitutional policy enshrined in Article II, Section 15 of the 1987 Philippine Constitution, which provides that the State shall protect and promote the right to health of the people and instill health consciousness among them. is an inter-sectoral collaboration created to establish preparedness and ensure efficient government response to assess, monitor, contain, control, and prevent the spread of any potential pandemic in the Philippines. The IATF is mandated by the National Government to establish a system to identify, screen, and assist Filipinos suspected or confirmed to be infected with the emerging infectious disease, and to prevent and/or minimize the entry of suspected or confirmed individuals with covid19 infection in the country, as well as prevent and/or minimize local spread of the covid19 in the country (https://iatf.doh.gov.ph/).

The Triple Constraint in Project Management: Time Scope & Cost

The Triple Constraint might be the single most important concept in the history of project management (Westland 2018). These are defined as follows:

1. Cost. The financial constraints of a project, also known as the project budget.
2. Scope. The tasks required to fulfill the project's goals.
3. Time. The schedule for the project to reach completion.

Basically, the Triple Constraint states that the success of the project is impacted by its budget, deadlines and features. Changing the constraints of one means that the other two constraint suffer to some extent.

the Triple Constraint provides a framework that everyone in the project can agree on. These metrics drive the project forward while allowing for adjustments as needed when issues arise.

Synthesis

Synthesis combines a number of different pieces or articles into a whole. It concisely summarizes and links different sources or references in order to review the literature on a certain topic. All the information gathered are pieced together that forms the review of related literature (RRL) for the readers and researchers to have a clearer understanding on the core of the study.

One of the RRL defines the importance of the construction industry to the economy that helps in improving a country's economy. According to Sukriti (2020), the construction industry helps in playing a pivotal role in boosting the country's economy. This is reinforced by Abdullah's (2020) study that construction represents the building block of a community with the objective of constructing structures that contributes to the economic growth of a country (Khan 2005). However, the construction industry experience possible risks that are challenging. Construction risks such as supply shortages and labor problems (Hazem 2021) contribute to delaying the projects that might eventually lead to project suspension or stoppage.

Crisis is one of the causes of delay in WWCC's projects. One of the crises that have significant impact to current WWCC construction projects is pandemic such as the one caused by covid19. It has brought on lockdowns, strict restrictions and quarantines in many of the current projects. Covid19 is a pandemic occurring worldwide crossing international borders, and affecting a large number of people (BBC News 2020). In order to understand more on covid19 pandemic, the history and effect of the virus to human is included in the RRL for readers to know the extent of infection worldwide and how the virus is spread from person-to-person. This supports the study that covid19 is a viral disease that was labeled as pandemic by the WHO that affects many people, including the human resources of WWCC. It also affects not only the labor sector but has ripple effect on material delays or shortages that eventually led to project delays (Holland & Knight 2020). There are many studies on the impact of covid19 to the construction industry but few studies are related to WWCC. Since WWCC is a construction company, effect of covid19 to the construction industry would be similar to WWCC.

The impact of covid19 to the construction and infrastructure has been unprecedented. Throughout the Middle East and Africa (MEA), economic headwinds mounted over the quarter with varying severity. The impact was amplified in the Middle East following the collapse of oil prices, and uncertainties around a deal with OPEC. According to the UK news insights, the covid19 impacted the construction and infrastructure globally, the construction and infrastructure professionals reported a marked downturn in workloads and activity in the first quarter of 2020. In Asia Pacific, not only has the outbreak stopped the construction activity in several economies, but it has also led to difficulties in sourcing labor and materials for construction (https://www.rics.org/uk/news-insight/latest-news/news-opinion/what-has-been-the-impact-of-covid-19-on-construction-and-infrastructure).

The covid19 pandemic has affected the lives of people around the world in a way that has most probably never been seen before. Reinhart (2020) reported that, after many months of lockdowns, multiple waves of infections and skyrocketing death tolls, four out of five people in 116 countries and territories in the second half of 2020 said that covid19 has affected their lives to at least some extent. While office-based staff have the inconvenience of working from home and switching face-to-face meetings to video conferences, the effects of a shutdown to on-site construction would by definition bring live projects to a

complete standstill and create massive additional financial, contractual and social and employment challenges (Thomas & Hackett 2020).

Due to covid19, some companies including WWCC have been forced to shift into a work-from-home (WFH) settings, and set skeletal workforces in their offices. One major challenging issue is the connectivity for companies in activating remote work settings (Conoza 2020). The covid19 outbreak has delivered an indiscriminate blow to businesses as everything from small companies to multinational corporations have been forced to change the way they do their work amid the series of lockdowns, restrictions, and quarantine orders to help curb the covid19 infection (Thorbecke 2020).

In strengthening the merits of the study, RRL includes the key findings of the United Nations Industrial Development Organization (UNIDO) on the impact of covid19 on manufacturing firms in the Philippines, have determined the causes of disruption to various economic and social sectors endangering employment, livelihood, food security and safety, nutrition and income generation. UNIDO's survey also includes the lack of public transport and employee's anxiety in going to work that contributed to worker shortages, shortages in the supply of materials, and obstacles to distribution, shipping and logistics. These findings of UNIDO strengthened the information gathered from various articles, journals and references related to the effect of covid19 to the construction industry. Various National Government's laws and policies are also included in the study to support the need for water sustainability in the country.

Research Gap

There were several studies on the impact of covid19 to the construction and infrastructure globally. Many international construction companies, e.g., US, UK, Canada, Middle East, and Asia-Pacific, has plunged in the most challenging times due to restrictions, lockdowns and quarantines. In the review of related literature (RRL) of this study includes the latest effects of covid19 in the construction industry worldwide. The covid19 has affected many lives around the world in a unique way that has not been experienced in the past (Goodman 2020). There are cases on international and national setting on the construction industry however, there were few studies made specifically on water and wastewater construction industry in Philippine setting.

Many WWCC have been affected enormously by covid19 in terms of inadequate manpower, unavailability construction equipment, and delayed supply of materials. This study focuses more on the effect and impact of the covid19 to the 5Ms of management that affects the three constraints of projects, e.g., scope, time, and money. According to Conoza (2020), one of the related literature, executives from some of the country's reputable companies shared how their organizations are coping with the national government's restrictions on the spread of covid19. There are gaps to be addressed by the companies on the covid19 outbreak that has delivered indiscriminate blow to businesses as everything from small companies to multinational corporations have been forced to change the way they do their work amid the series of lockdowns, restrictions, and quarantine orders to help curb the covid19 infection (Thorbecke 2020). Many companies have resorted to work-from-home arrangement but this is not totally applicable to construction projects because, the construction industry needs warm bodies in order to have production at the project sites.

This study contributes to knowing the levels of impact it has caused to Philippine's WWCC resources, e.g., Man, Material, Machine, Method and Money that eventually affected the Scope, Time, and Cost leading to huge delays and possible termination of on-going projects. This also provides the necessary mitigation and management processes in addressing those gaps by utilizing the adaptive mechanism for

WWCC in coping with the harmful effects of crisis or pandemic for business continuity that minimizes loss. WWCC may have been mitigating the effect of pandemic on their organization but not as precise or as organized as the adaptive mechanism. The adaptive mechanism offers contributes to the systems and practices of WWCC and other organizations to be more coordinated in implementing change in case of disruption or change.

Theoretical Perspectives

Theories and models form the basis for empirical inquiries. In empirical research, researchers are not only interested in variations in the data (what we observe happening in the world), but also intends to test whether the data fits to the model or a theory. Others want to develop theories or even build new ones based on the previous ones and/or new empirical evidence.

In theory, one can find arbitrary evidence from the data and develop a theory around it to "confirm" the observations. This is how human brains mostly work: we see patterns ("evidences") around us and try to explain them. Therefore, good scientific research is based on some type of theoretical reasoning, either taken as given and tested against empirical data or developed over the course of data exploration and carefully linked with an existing body of empirical research and theories, (https://blogs.helsinki.fi/quantitative-communication/quantitative-research/theory-and-models/, 02 September 2019).

Theoretical Framework

The theoretical framework of the study was grounded on the 5M's of Business Management (Omoregie 2015), with the general systems theory (GST) outlined by Ludwig von Bertalanffy (1968), in its premise that complex systems share organizing principles that can be discovered and modeled mathematically. These were the main processes for the framework of the study. It is an interdisciplinary approach that has generated applications in a growing number of fields including philosophy, mathematics, ecological sciences, management, and family therapy (Heylighen & Joslyn, 2000). This is the framework used to describe the level of severity of covid19 to the 5Ms of WWCC's management as input to the process in the proposed adaptive mechanism.

Another important aspect to consider on the effect of covid19 to WWCC was the ability for the organization in coping with the change in environment. In the emergence of covid19, there was a huge disruption to the construction industry specifically, the WWCC wherein new laws have been implemented by the National Government to prevent infection. These have created disruption to the normal systems and procedures in WWCC organization. Organizational adaptation theory, which was considered in this study, generally refers to how a change in the environment dictates changes in groups of organizations, rather than how a specific organization changes to adapt (Purna 2017).

Managing business organizations has always been a challenge to man since it became scientific (Omoregie 2015). Since man became victorious in the industrial revolution, every business has been using the 5M's in management such as man, materials, machines, method and money. Man, the first of the 5M's is the most important. People make sure materials, machines, method and money are utilized in a productive manner to achieve goals or aims and objectives of organizations and enterprises. Without materials, human resource is made redundant. Every right thinking and right planning in the organization understand that materials needed in any business especially in the construction or service must be in place. Machines make men fulfill almost effortlessly in creating various work. Machines have replaced man in tilling,

planting, harvesting and other forms of construction activity. Figure 1 shows the interrelatedness of the 5Ms of management.

Figure 2. 5Ms of Management

Conceptual Framework

The components of theoretical considerations provided basis in the conceptualization of the study. Other prerequisites are considered like the effects and impact of covid19 to WWCC's 5Ms of management such as; Man, Materials Machine, Method, and Money that affected the triple constraints of projects (e.g. Scope, Time, and Money) that led to the delay of on-going projects.

The covid19 pandemic has a tremendous impact on WWCC's project execution, worker's morale, and productivity. A dynamic adaptive mechanism in the workplace that energizes the employees, promote safety and builds confidence in necessary to boost the morale of the whole organization during the pandemic. WWCC needs to create an environment that convey goals and expectations, that engenders a collaborative attitude, and most importantly, that which cannot be ignored (Carillo & Robinson, 2004).

In applying the concept to the adaptive mechanism, the study explores the status of WWCC by assessing the effect and impact of covid19 to the organization's 5Ms of management. Upon determining the effects and impact of covid19 to WWCC, the study determines the needed intervention and strategic management processes in mitigating the impact of covid19, and lastly, formulate an adaptive mechanism for the organization to cope with crisis and continue the business even during pandemic. The adaptive mechanism started from measuring the severity or effect of WWCC's 5Ms of management to the scope, time and cost of projects. Afterwhich, the data obtained from the respondents before and during covid19 were processed and compared to determine the difference. The data obtained from the research questions are inputs to the adaptive mechanism framework considering systems theory coupled with the organizational adaptation theory. The conceptual framework of the study is shown in figure 2.

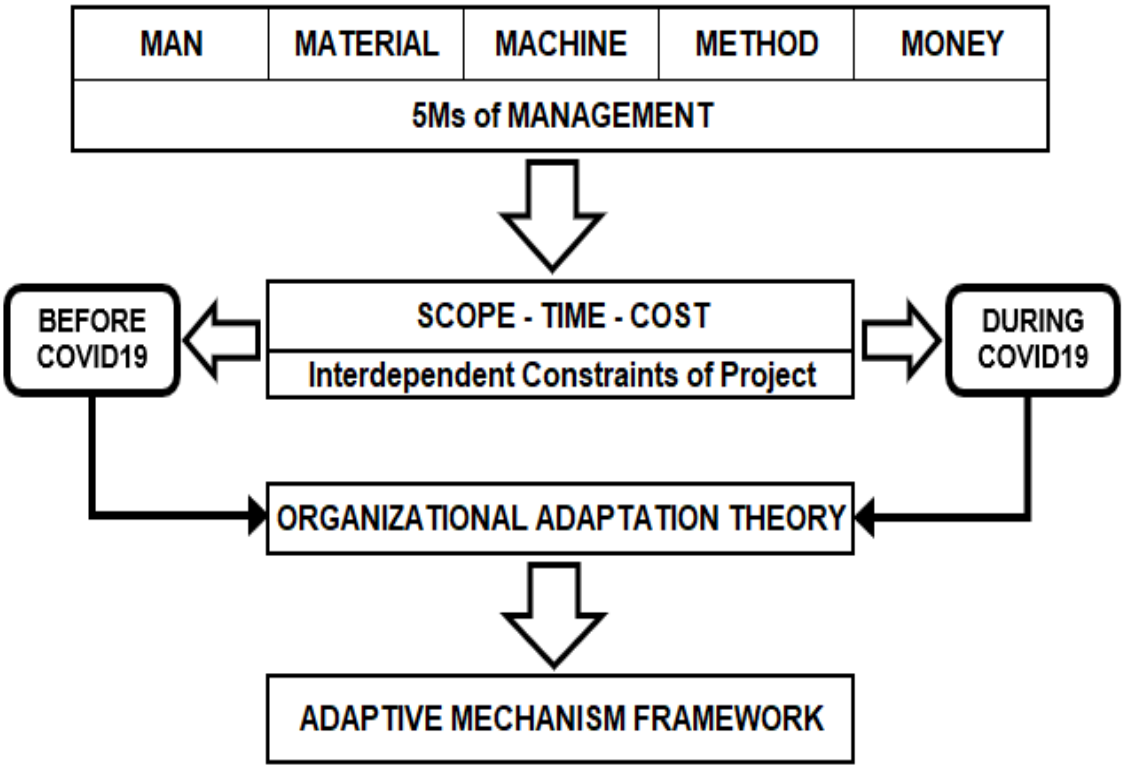

Figure 3. Conceptual framework

Philosophical Underpinning

Research is used to investigate phenomenon in solving problems in which the aim is to primarily increase or gain new knowledge (Shah, 2013). It is a systematic approach in exploring the developing new knowledge. The approach used in this research is according to the lens of positivism in looking at different scenarios on the selected WWCC.

Positivism started in the 17th and 18th century also known as the enlightenment era when philosophers and scholars lay emphasis on the importance of the use of worldview of knowledge in finding realities. The development of positivism leads to discovery of objectives and the use of experimentation in discovering evidence based truth (Collins, 2010). Positivism was first proposed by a French Philosopher Auguste Comte, which he define it as a paradigm of research based on scientific method of investigation (Kivunja, 2017). Positivist research emphasizes on measuring variables using experimental design that focuses on numerical collection of data are presented quantitatively to explain and make generalizations of events (Bhandari 2020). Positivist views the reality as independent researcher that relies heavily on the objective of the research that does not interact with the respondents during data collection in order not to influence the results (Peersman 2014). This type of research approach has been utilized in determing the condition of WWCC organization, and the level of severity experienced during covid19 on the 5Ms of management. Its priorities that has been categorized in formulating the adaptive mechanism of WWCC during crisis or pandemic.

CHAPTER III
METHODOLOGY

This chapter discusses the research design of the study and the methodology used in gathering data from

selected respondents. This also includes the population of the study, the research locale, types and sources of data, sampling technique, research instruments, and data gathering procedure. It also includes the data analysis plan and interpretation of data to be gathered.

Ethical Considerations

In achieving the confidentiality on the responses, and in order not to create bias in the result of the survey, anonymity and confidentiality was applied. The study strictly followed the data privacy policy in making sure that the collection and processing of the data collected are according to the law and with full consent of the involved respondents. The name of the selected companies as well as their company representatives who acts as the key informants were not mentioned in the report. In order to protect the sample employees, their names and other personal information not necessary in the study are not be collected during the conduct of the survey.

In promoting ethical practices, the data protection and confidentiality was provided with consent of the company head or the authorized company representative. The researcher only provided the questionnaires to the respondents, e.g., project manager, construction manager, project engineer, and pollution control officer as the key informants in the survey.

Research Design

Research design involves a whole range of techniques and methodologies from the use of questionnaires that produces data to be quantified in describing the relation of various studies used in investigating the relationship between variables. The research design used in this study was the descriptive method in obtaining information concerning the current status of the phenomena in describing "what exists" and "what is there" with respect to variables and conditions in a situation. It is a process that systematically describe and analyze features, properties or characteristics of something considering its trends and frequencies. This type of research design helps the study in defining the characteristics of the population in which the study is performed, and enable develop an in-depth understanding of the topic or subjects. This method was used to take indications from the data, processes, conclusions, and the whole study which is a reflection at varying levels of emergent characteristics within that research process (Pailthorpe, 2017). Thus, the study aimed not only to describe what actually exists such as the challenges, gaps and problems of water and wastewater construction companies but also determined the levels of severity of the disruption of covid19 to WWCC's 5Ms of management caused by the covid19 pandemic. The advantage of using descriptive research is that, it describes the population, situation, or phenomenon that is being studied, and focuses on answering the questions of the research problem. This is mainly because it is important to have a proper understanding of what a research problem is about before investigating why it exists in the first place (https://www.formpl.us/blog/descriptive-research, October 26, 2021).

Research Locale

The study was conducted to water and wastewater treatment plant contractors (WWCC) primarily within Metro Manila, Philippines (NCR). NCR was identified as the locale due to the reason that, this region in the Philippines have the most existing water and wastewater treatment plant (WWTP) under construction before and during the pandemic. This was the primary consideration in the study because of the complicated nature of WWTP construction where it requires huge manpower, construction machineries, and supply of many equipment locally and abroad. These contractors in the region have experienced the

disruption caused by covid19 on their projects that has either stopped, suspended or terminated due to lack of manpower and supply chain challenges.

The respondents in this study comprises of ten (10) WWTP construction companies labeled as WWCC, all of which are situated in NCR. In each of the ten WWCC, structured questionnaires were administered to the top three positions of each company which are considered as the key informants of each WWCC. These are the project managers (PM), construction managers (CM), project engineers (PE) and pollution control officers (PCO) who have knowledge of the organization's condition before and during covid19. They were requested to participate in the study by providing their lived experiences on the effects of covid19 to the company's 5Ms of management that eventually affected the triple constraints of projects. The information gathered comprises of two different scenarios. These are the condition of WWCC's 5Ms of management before and during covid19. The scenarios or conditions of WWCC before and during covid19 are analyzed and compared with each other in creating part of the adaptive mechanism for WWCC in coping to the disruption due to pandemic. Table 1 below shows the respondents and composition of the key informants of the study.

Table 1. Number of respondents and key informants of the study

WWCC	No. of Respondents
Contractors A - J	10
Three (3) in each of WWCC (e.g., PM, CM, PCO)	

Data Gathering Tools

Structured questionnaire, a method constituted by Emile Durkheim, a French Sociologist which falls under quantitative research, is also known as closed questionnaire as a positivist research method that asks direct and closed questions. This type of questionnaire is the primary measuring instrument in this survey research consisting set of standardized question with a fixed scheme, that specifies the exact wording and order of the questions for gathering information from respondents (Marsden and Wright 2010). It can accumulate large amounts of valuable data that provides insights into a large number of people that answer the questions.

Quantitative data collection methods were used for sampling and data collection that fits the diverse experiences of the respondents into predetermined response categories. In this study, structured questionnaires were administered to the respondent's key informants through emails and face-to-face meetings as appropriate. Results of the data obtained were also validated through face-to-face and through virtual platform verification from the project managers, and reviewing secondary data of WWCC such as the weekly accomplishment reports, manpower deployment, availability of materials and equipment before and during covid19. The data collected by the structured questionnaires verified by secondary data were used to find patterns, averages, make predictions, and generalize results that represents a wider population. To validate the results gathered from the questionnaires, verification from project managers of WWCC were done to ascertain if the covid19 effects on their 5Ms of management. They were requested to present secondary data such as weekly and monthly reports indicating possible reduction of manpower and probable delay in construction materials or machineries, disruption in the construction method, and increase in their financial resources.

The structured questionnaires used passed expert's external validation. Initial questionnaires were submitted to an expert in water and wastewater construction project and project management. The comments and suggestions provided by the expert were included in the revision of the questionnaires. The revised instrument containing the expert's inputs was returned to the expert for further validation. In addition to the expert's inputs, the comments made by the panelists during the proposal defense were also included prior to utilizing on the key informants. The reliability of the instrument was determined by comparing the consistency of the results. The key informant's responses to the effect of the 5Ms of management that eventually affected the three constraints of project shows consistency.

Data Gathering Procedure

The data gathering procedure started by inquiring the on-going water and wastewater projects within NCR. After the list of on-going projects are obtained from the consultants and contractors of two huge water concessionaires in NCR, the WWCC contractors involved on the projects are determined. The researcher also determined that only the projects that are currently in progress at least one year before the pandemic, and continue during the pandemic are considered to be the respondent. Letters of request are sent to the representatives of the selected WWCC through emails and personal meetings by informing the company about the details of the study and survey questionnaires. They were informed that the personnel that answers the questionnaire must be at the three high ranking positions (e.g. project manager, construction manager, pollution control officer) of their site organization who are knowledgeable of the covid19 situation. The three high ranking position of each of the WWCC are considered as the key informants.

The three high ranking personnel of each of WWCC which are considered as key informants, are briefed on the purpose of the study, the statement of the problem and the significance of their responses to the questions. The method of collecting data from key informants were carried-out through electronic mail surveys, face-to-face meetings, and personal interactions. The key informants are briefed on the manner of accomplishing the questionnaires, and the researcher sends electronic mail surveys to the target key informants through their respective email addresses. In many occasions, the researcher visited the project sites and meet the company's representatives through face-to-face, explaining the purpose and guiding the informants in accomplishing the questionnaires.

The key informants read the questions and accomplished by either checking the corresponding box or putting the appropriate level of severity. In personal face-to-face interaction, the questionnaires are retrieved right away after the respondents are through with their responses. After the questionnaires are collected, the researcher reviews their responses, checks the consistency of their responses, and determine if there are erroneous response. Verification and validation of the inputs are carried-out after receipt of the accomplished questionnaires. The researcher was able to retrieve 100% survey from the key informants from the ten water and wastewater construction companies.

Validation of the results of the survey was accomplished through face-to-face and virtual platform interaction with the project managers of WWCC to determine the effects of covid19 on their organization. Secondary data such as weekly and monthly accomplishment reports were requested from them to confirm the reduction in manpower compared before the pandemic, and information were gathered on the effect of covid19 to their supply chain to ascertain the impact of the pandemic before and during pandemic. Another means to validate the observation of the respondents aside from the secondary data was the use of risk heat map. This gives the organization a thorough understanding of the risk environment and how individual risks compare to one another (Webb 2020). The risk heat map used is a 5 x 5 square by plotting

the frequency of risk on the Y-axis of the chart and the severity on the X-axis. The severity is how much an impact it would have occur while the frequency is how often it occur. The higher a risk for these qualities, the more threatening it is to the organization. The frequencies at the Y-axis represents the percentages at which WWCC observed as the severity of the effect of covid19 to the 5Ms of management that eventually affected the three interdependent constraints of project. The risk heat map matrix was used on the severity of the effects during covid19 to validate the key informant's response to the research question no. 03 and the secondary data provided by WWCC. Each of the 5Ms of management is represented by a risk heat map in the results and discussion on chapter 4.

The information gathered from the key informants are tabulated in excel with programmed totals and averages. The average from the three key informant on each of the WWCC as a respondent, represents as one sampling unit. As the data that are entered into the excel sheet, the program automatically calculates the total and averages of the respondent's interpretation. These are presented in a table and graph as visual presentation of the levels of severity of the 5Ms of management in determining its impact to the three constraints of project. The presentation of data gathered are tabulated in such a way that specifically answer the research questions and verified through secondary data requested from the project managers, and risk heat map on the frequency and severity of the effects of covid19.

Data Analysis

The results of the accomplished research questionnaires are tabulated and analyzed using descriptive statistics. The level of severity of the company's 5Ms before and during pandemic to the disruption of WWCC's man, machines, materials, method, and money that were identified by the respondents with major and severe consequences are considered as priority concerns. These are the basis for the formation of the needed innovations and strategic management process for the companies in coping with the determined effects and impact, which also be the basis for developing the adaptive mechanism in mitigating crisis and ensuring business continuity in times of pandemic.

Statistics was used to analyze the collected quantitative data. The measure of central tendency to describe the set of data collected are used to identify the central position within a set of data, which sometimes called the measures of central location. The mean, often called the average was the most likely measure of central tendency to be used in the study. This is equal to the sum of all the values of the collected data divided by the total of values in a data set. The mean was used to measure the level of criticality of WWCC's 5Ms that affects the scope, time, and cost of projects before and during covid19 pandemic. Appropriate descriptive statistics, such as the mean as a measure of central location, as all the numerical values in the data set are used to give an average. It is used to define the central location in a normally distributed set of data. Table 2 and 3 illustrates the data analysis of the study.

Table 2. Data Analysis

Objective of the Study	Data	Source of Data	Analysis
To determine the levels of severity of WWCC's 5Ms of management before covid19 and its effect on the three main interdependent constraints of construction projects terms of; Scope	Rank (Interval Like)	Survey Questionnaire Secondary Data	Percentages Mean

Time Cost			
To determine the levels of severity of WWCC's 5Ms of management during the covid19 period and its effect on the three main interdependent constraints of construction projects in terms; Scope Time Cost	Rank (Interval Like)	Survey Questionnaire Secondary Data	Percentages Mean
To determine the comparison on the levels of severity of WWCC's 5Ms before and during the covid19.	Rank (Interval Like)	Result of Research Question (1 & 2) Secondary Data	Descriptive Difference
Proposed Adaptive mechanism framework that can be developed for WWCC in ensuring business continuity during crisis or pandemic	-	-	-

Table 3. Level of severity of covid19 to the organization's 5Ms of management

SCALE	RANGE	INTERPRETATION	DESCRIPTION
5	4.50 – 5.00	Severe	Respondents agree that covid19 has severe impact to the organization
4	3.50 – 4.49	Major	Respondents agree that covid19 has major impact to the organization
3	2.50 – 3.49	Moderate	Respondents agree that covid19 has moderate impact to the organization
2	1.50 – 2.49	Minor	Respondents agree that covid19 has minor impact to the organization
1	1.00 – 1.49	Insignificant	Respondents agree that covid19 has insignificant or no impact to the organization

Table 4. Interpretation of the 5-point scale

MEAN	VERBAL INTERPRETATION	DESCRIPTION
4.50 – 5.00	Severe	Respondents agree that covid19 has severe impact to the organization. Very high level of criticality. Mitigation measure is very high.

3.50 – 4.49	Major	Respondents agree that covid19 has major impact to the organization. High level of criticality. Mitigation measure is high.
2.50 – 3.49	Moderate	Respondents agree that covid19 has moderate impact to the organization. Moderate level of criticality. Mitigation measure is moderate.
1.50 – 2.49	Minor	Respondents agree that covid19 has minor impact to the organization. Low level of criticality. Mitigation measure is low.
1.00 – 1.49	Insignificant	Respondents agree that covid19 has insignificant or no impact to the organization. Very low level of criticality. Mitigation measure is not required.

CHAPTER IV
RESULTS AND DISCUSSION

The covid19 has affected many lives around the world in a unique way that has not been experienced in the past (Goodman 2020). Many construction companies have been extremely affected by covid19 in terms of the organization's 5Ms of management that leads to the bad effects on the three interdependent constraints of projects.

The study was pursued to determine the whether the occurrence of covid19 has impacted the construction industry, and if there has been a severe effect of the pandemic to the 5Ms of management that leads to the disruption to the three constraints of projects. In an attempt to formulate the adaptive mechanism for WWCC to cope with the disruption to projects due to crisis, this chapter presents the results of the study that (1) determined the levels of severity of WWCC's 5Ms of management during the covid19 and its effect on the three main constraints of construction projects, (2) determined the levels of severity of WWCC's 5Ms of management during the covid19 and its effect on the three main constraints of construction projects, (3) compared the levels of severity of 5Ms before and during covid19, and (4) developed an adaptive mechanism framework for WWCC in ensuring business continuity during crisis or pandemic. To validate or confirm the data gathered from the questionnaires, the project managers of WWCC were requested of the secondary data such as weekly and monthly reports of their projects. The information gathered through the face-to-face and via virtual interactions which are considered secondary data that supports the observations of WWCC's key informants.

This study is conducted with the desire to contribute to WWCC's business continuity in the face of crisis. The results gathered in this study were processed, analyzed, and interpreted to have a precise result that would benefit WWCC's business continuity in times of crisis. This chapter describes how the data and information gathered complemented with the results of the study supported by secondary data to validate the key informant's observation. The processing and results of the survey are discussed in the succeeding parts of the study.

Level of Severity of the 5Ms of management and its effect on the Triple Constraints of Project Before Covid19

The result of the study illustrated in the succeeding table and figures show that the impact of WWCC's 5Ms of management before covid19 to the triple constraints of projects ranges from insignificant to minor

effects. The succeeding results and discussions show the details of the respondent's observation on the organization's 5Ms of management such as, Man, Material, Machine, Method and Money:

Table 5 below shows that man has a minor impact to the triple constraints of project. All the respondents believe that before covid19, their 5Ms of management related to scope, time and money according to the verbal interpretation have low levels of criticality.

Table 5. Effect of man to the triple constraints of project before covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	1.67	Minor	1.67	Minor	1.67	Minor
B	1.78	Minor	1.56	Minor	2.00	Minor
C	1.89	Minor	1.78	Minor	2.22	Minor
D	2.00	Minor	2.00	Minor	1.89	Minor
E	1.89	Minor	1.89	Minor	1.89	Minor
F	2.00	Minor	2.22	Minor	1.89	Minor
G	2.00	Minor	2.33	Minor	1.89	Minor
H	2.00	Minor	2.22	Minor	1.78	Minor
I	2.11	Minor	2.33	Minor	2.11	Minor
J	2.22	Minor	2.22	Minor	2.11	Minor
Average	**1.96**	**Minor**	**2.02**	**Minor**	**1.94**	**Minor**

Table 6 likewise show that the effect of material on the 5Ms of management to the triple constraints of project ranges from insignificant to minor. According to the result of the survey, there are three insignificant effects of material to scope. 70% of WWCC believe that material has affected the scope of their projects while 30% have insignificant effect. Two other constraints such as time and money have minor effect.

Table 6. Effect of material to the triple constraints of project before covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	1.67	Minor	1.67	Minor	1.67	Minor
B	1.33	Insignificant	2.00	Minor	2.00	Minor
C	1.67	Minor	2.33	Minor	2.22	Minor
D	1.67	Minor	2.00	Minor	1.89	Minor
E	1.67	Minor	2.00	Minor	2.00	Minor
F	1.67	Minor	2.33	Minor	2.00	Minor
G	2.00	Minor	2.33	Minor	2.00	Minor
H	1.67	Minor	2.00	Minor	1.78	Minor
I	1.33	Insignificant	2.33	Minor	1.67	Minor
J	1.33	Insignificant	2.00	Minor	2.00	Minor
Average	**1.60**	**Minor**	**2.10**	**Minor**	**2.00**	**Minor**

Table 7 show that machine has minor effect to the triple constraints of project. 100% of all WWCC believed that covid19 effect on the three constraints of project has low level of criticality.

Table 7. Effect of machine to the triple constraints of project before covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	2.00	Minor	1.67	Minor	2.00	Minor
B	1.67	Minor	2.00	Minor	2.00	Minor
C	1.67	Minor	2.33	Minor	2.22	Minor
D	1.67	Minor	2.00	Minor	1.33	Minor
E	1.78	Minor	2.00	Minor	2.00	Minor
F	1.67	Minor	2.33	Minor	2.00	Minor
G	2.00	Minor	2.33	Minor	2.00	Minor
H	1.67	Minor	2.00	Minor	2.33	Minor
I	1.67	Minor	1.67	Minor	1.67	Minor
J	1.78	Minor	2.33	Minor	1.67	Minor
Average	**1.70**	**Minor**	**2.17**	**Minor**	**2.00**	**Minor**

Table 8 show that 90% of WWCC believe that method has insignificant effect to the scope of their projects. 50% considers minor effect on time while 50% believe to be insignificant. In terms of cost, 60% believe that method has insignificant effect on the cost of project while 40% considers minor effect. In terms of the overall effect of method to the triple constraints of project, all are observed to be insignificant.

Table 8. Effect of method to the triple constraints of project before covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	1.33	Insignificant	1.67	Minor	1.33	Insignificant
B	1.33	Insignificant	1.67	Minor	1.33	Insignificant
C	1.67	Minor	2.00	Minor	1.67	Minor
D	1.33	Insignificant	1.67	Minor	1.67	Minor
E	1.33	Insignificant	1.67	Minor	1.67	Minor
F	1.33	Insignificant	1.33	Insignificant	1.67	Minor
G	1.00	Insignificant	1.00	Insignificant	1.33	Insignificant
H	1.00	Insignificant	1.00	Insignificant	1.33	Insignificant
I	1.33	Insignificant	1.33	Insignificant	1.33	Insignificant
J	1.00	Insignificant	1.33	Insignificant	1.00	Insignificant
Average	**1.23**	**Insignificant**	**1.47**	**Insignificant**	**1.43**	**Insignificant**

Table 9 show that 100% of WWCC believe that money has minor effect to the scope of their projects. 90% considers minor effect on time while 10% believe to be insignificant. In terms of cost, 60% believe that method has minor effect on the cost of project while 40% consider insignificant effect. In terms of the overall effect of money to the triple constraints of project, all are observed to be minor.

Table 9. Effect of money to the triple constraints of project before covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	2.00	Minor	1.67	Minor	1.67	Minor
B	1.33	Minor	1.67	Minor	1.33	Insignificant
C	1.67	Minor	2.00	Minor	1.67	Minor
D	1.67	Minor	1.67	Minor	1.67	Minor
E	1.33	Minor	1.67	Minor	1.67	Minor
F	1.67	Minor	2.00	Minor	1.67	Minor
G	1.67	Minor	1.67	Minor	1.33	Insignificant
H	1.33	Minor	1.33	Insignificant	2.00	Minor
I	1.00	Minor	2.00	Minor	1.33	Insignificant
J	1.67	Minor	2.00	Minor	2.33	Insignificant
Average	**1.53**	**Minor**	**1.74**	**Minor**	**1.83**	**Minor**

The results of the survey on WWCC before covid19 show that the effect on the 5Ms of management to the triple constraint of projects ranges from insignificant to minor. Table 10 and figure 3 below show that before covid19, man, materials, machine, and money have minor effect to the triple constraints of project while method has insignificant.

Table 10. Effect of 5Ms of management to the triple constraints of project before covid19

5Ms	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
Man	1.96	Minor	2.02	Minor	1.94	Minor
Materials	1.60	Minor	2.10	Minor	2.00	Minor
Machine	1.70	Minor	2.17	Minor	2.00	Minor
Method	1.23	Insignificant	1.47	Insignificant	1.43	Insignificant
Money	1.53	Minor	2.00	Minor	1.83	Minor

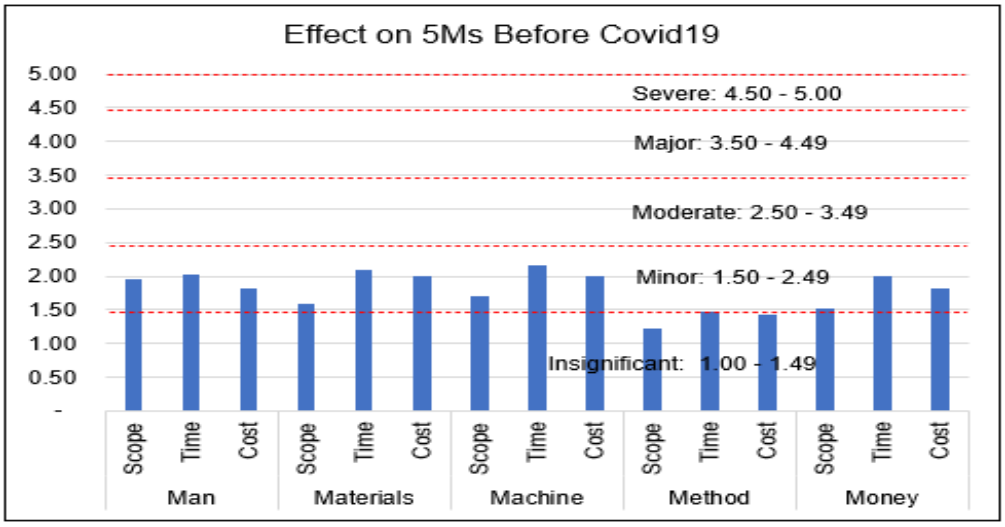

Figure 4. Visual presentation of the effect on WWCC's 5Ms before Covid19

Level of Severity of the 5Ms of management and its Effect on the Triple Constraints of Project During Covid19

On the effect of covid19 to the 5Ms of WWCC's management to the three constraint of projects ranges from major to severe impact. The occurrence of covid19 has severe impact to Man, Material and Machinery. While method and money have major effect. Details of the analysis obtained from the respondents and its effect on the three constraints of projects can be referred to Tables 11 to 14.

Table 11 below shows that the man has adversely affected the scope, time and costs of current projects. 50% of WWCC believe that man's effect on scope is major while 50% believe severe effect. In terms of time, 100% of WWCC believed severe impact on time, while 80% considers severe on project costs. Overall results show a severe impact to the three interdependent constraints of project which ranges from 4.5 to 5.0, a very high level of criticality.

The result of the study supported the article on preserving project continuity in the face of covid19 by Banaszak et al (2020) that, covid19 has disrupted the supply of labor, materials and equipment bringing the scarcity of construction resources. Construction workers have a higher risk of being infected with covid19 due to close contact with other people (Cokayne 2020).

Table 11. Effect of man to the triple constraints of project during covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	4.67	Severe	5.00	Severe	4.67	Severe
B	4.33	Major	4.67	Severe	5.00	Severe
C	4.33	Major	4.67	Severe	4.33	Major
D	4.67	Severe	4.67	Severe	4.67	Severe
E	4.67	Severe	4.67	Severe	5.00	Severe
F	4.33	Major	4.67	Severe	5.00	Severe
G	4.67	Severe	5.00	Severe	4.67	Severe
H	4.67	Severe	5.00	Severe	5.00	Severe
I	4.33	Major	4.67	Severe	5.00	Severe
J	4.33	Major	5.00	Severe	4.33	Major
Average	**4.50**	**Severe**	**4.80**	**Severe**	**4.77**	**Severe**

Figure 5 below shows the risk map of the severity of the effect of covid19 to Man that eventually impacted the triple constraint of management. Data gathered from the respondents demonstrated extreme effect to both time and cost, and high on scope. This reinforces the observation of the key informants that covid19 adversely affected Man.

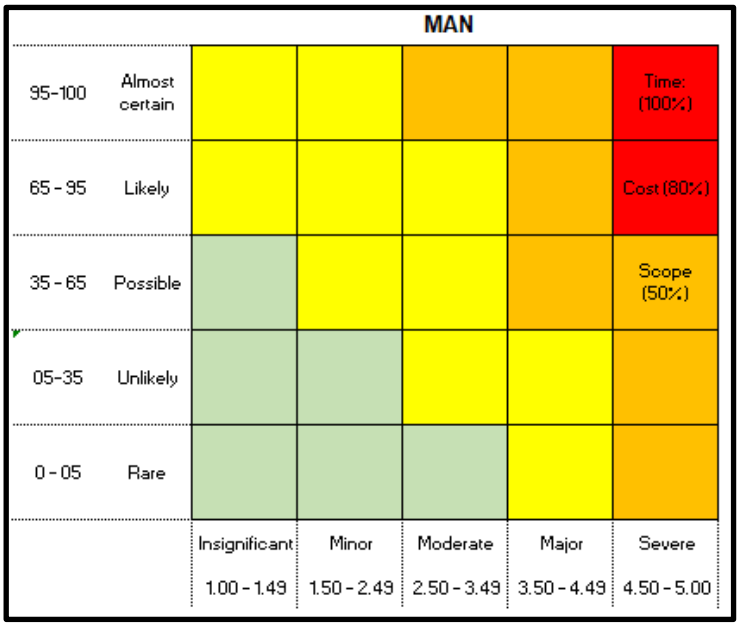

Figure 5. Risk heat map showing the effect of man to scope, time and cost

Table 12 below shows that 80% consider major effect of material to the scope of projects, 70% on time, and 90% on cost. Result of the survey to WWCC show that material has major effect on scope and cost, while severe on time. This strengthen the article by Shultz (2020) that, during the covid19 pandemic, the construction sector is trying their best to adopt with the new normal not only in projects sites but in the supply chain.

Table 12. Effect of material to the triple constraints of project during covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	4.00	Major	4.00	Major	4.33	Severe
B	4.00	Major	4.33	Major	4.33	Severe
C	4.67	Severe	4.67	Severe	4.33	Major
D	4.00	Major	4.67	Severe	4.67	Severe
E	4.33	Major	4.67	Severe	4.33	Severe
F	4.00	Major	4.33	Major	4.67	Severe
G	4.33	Major	4.67	Severe	4.33	Severe
H	4.00	Major	4.67	Severe	4.67	Severe
I	4.00	Major	4.67	Severe	4.33	Severe
J	4.67	Severe	4.67	Severe	4.33	Major
Average	**4.20**	**Major**	**4.50**	**Severe**	**4.47**	**Major**

Figure 6 below shows the risk map of the severity of the effect of covid19 to Material that eventually impacted the triple constraint of management. Data gathered from the respondents demonstrated high effect to both time, cost, and scope. This reinforces the observation of the key informants that covid19 ranges from major to severe effect on Material.

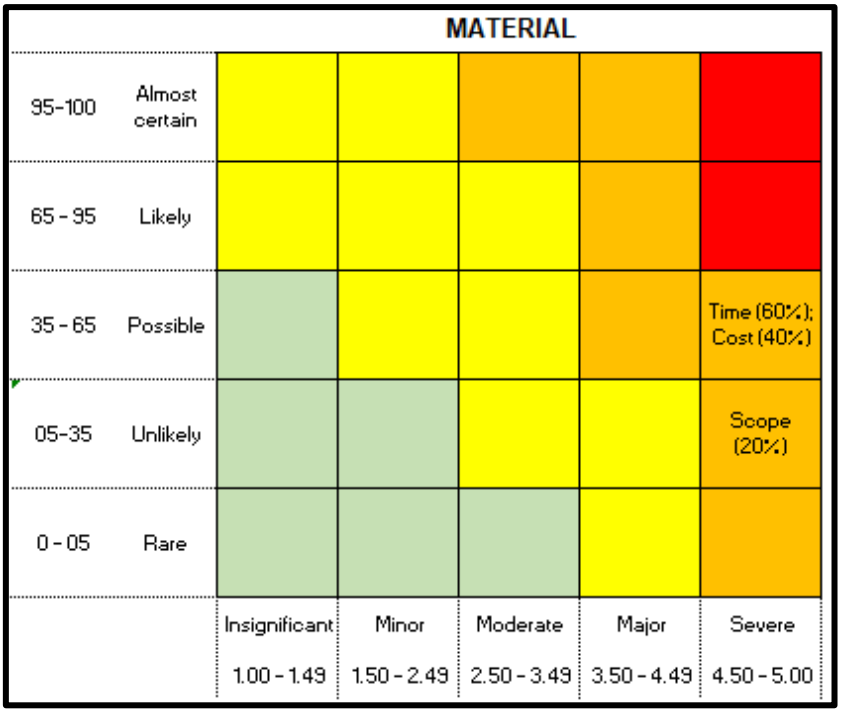

Figure 6. Risk heat map showing the effect of material to scope, time and cost

Table 13 below show that 100% of WWCC considers to have major effect of machine to the scope of project, 50% on time, and 70% on cost. 50% WWCC believed that machine has severe effect on time, while 30% on project cost. Result of the survey to WWCC show that machine has major effect on scope and cost, while severe on time. This reinforces the study by Snippert (2020) on supply chain that, according to Construction Group's January 2021 Price Index Report, the price of construction commodities increased by 50% since January 2020, and multiple cost increase since middle of year 2021.

Table 13. Effect of machine to the triple constraints of project during covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	4.67	Major	4.00	Major	4.00	Major
B	4.00	Major	4.33	Major	4.00	Major
C	4.33	Major	4.67	Severe	4.00	Major
D	4.00	Major	4.33	Major	4.00	Major
E	4.00	Major	4.33	Major	4.33	Major
F	3.67	Major	4.33	Major	4.33	Major
G	3.67	Major	4.67	Severe	4.67	Severe
H	4.00	Major	5.00	Severe	4.67	Severe
I	3.67	Major	5.00	Severe	4.33	Major
J	3.67	Major	4.67	Severe	4.67	Severe
Average	**3.97**	**Major**	**4.50**	**Severe**	**4.33**	**Major**

Figure 7 below shows the risk map of the severity of the effect of covid19 to Machine that eventually impacted the triple constraint of management. Data gathered from the respondents demonstrated high

effect to both time, cost, and scope. This reinforces the observation of the key informants that covid19 ranges from major to severe effect on Machine. The severity of effect on Machine is similar to Material.

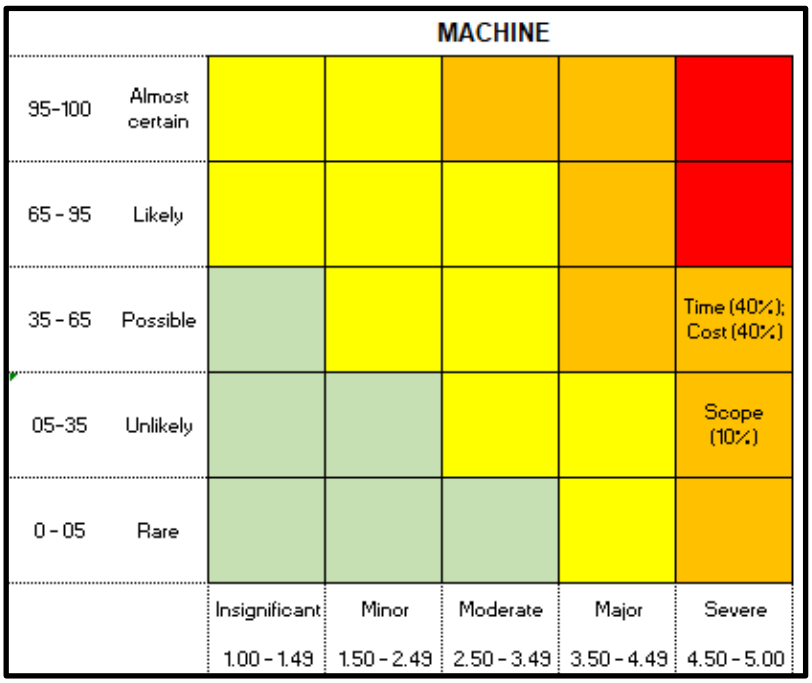

Figure 7. Risk heat map showing the effect of material to scope, time and cost

Table 14 show that method has a major effect on the scope, time and cost of project. Respondents agree that method has a high level of criticality therefore mitigation measure will be high. Results show the scope has the lowest impact on the effect of method while major effect on time and scope.
Table 14 below show that 80% of WWCC considers to have major effect of method to the scope of project, 100% on time, and 100% on cost. The other 20% of WWCC believed that method has moderate effect on scope. Result of the survey to WWCC show that method has major effect to all three constraints of projects.

Table 14. Effect of method to the triple constraints of project during covid19

Contractor	Scope		Time		Cost	
	Average	Effect	Average	Effect	Average	Effect
A	4.33	Major	3.67	Major	3.67	Major
B	4.00	Major	4.00	Major	4.00	Major
C	4.00	Major	4.33	Major	4.33	Major
D	4.00	Major	4.00	Major	4.00	Major
E	4.00	Major	4.33	Major	4.00	Major
F	4.00	Major	4.33	Major	4.33	Major
G	3.67	Major	4.33	Major	4.00	Major
H	3.67	Major	3.67	Major	4.00	Major
I	3.33	Moderate	3.67	Major	4.33	Major
J	3.33	Moderate	4.33	Major	4.00	Major

Average	**3.83**	**Major**	**4.20**	**Major**	**4.07**	**Major**

Figure 8 below shows the risk map of the severity of the effect of covid19 to Method that eventually impacted the triple constraint of management. Data gathered from the respondents demonstrated high effect to both time, cost, and scope. This reinforces the observation of the key informants that covid19 has major effect on Method. 100% of the respondents agree that Method effect on time and cost is almost certain while 80% of the respondents agree that scope is likely affected.

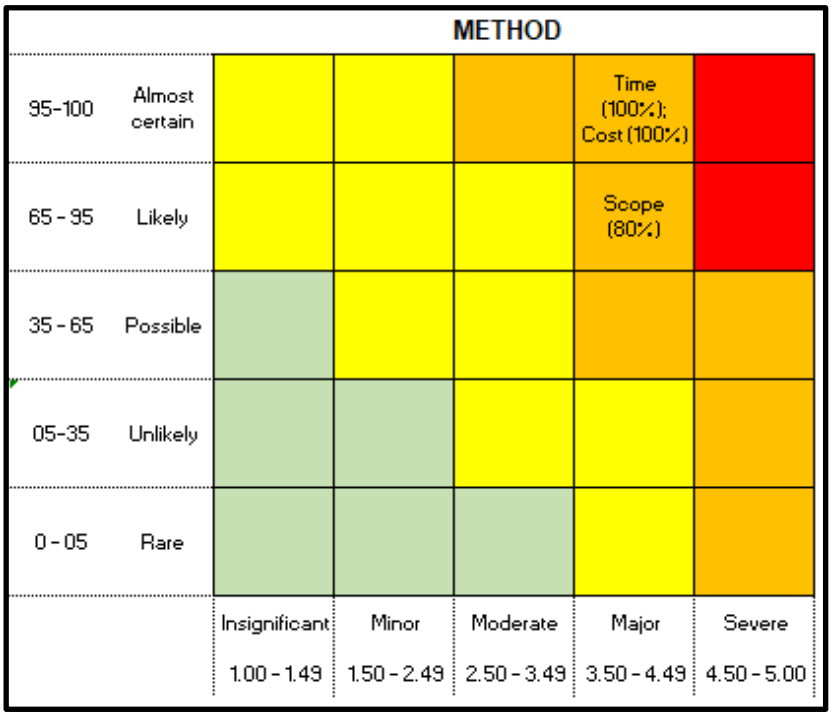

Figure 8. Risk heat map showing the effect of method to scope, time and cost

Table 15 below show that 80% of WWCC consider to have major effect of money to the scope of project, 100% on time, and 100% on cost. 20% WWCC believed that money has severe effect on scope. Result of the survey on WWCC show that money has major effect on scope, while severe on time and cost.

Table 15. Effect of money to the triple constraints of project during covid19

Contractor	**Scope**		**Time**		**Cost**	
	Average	**Effect**	**Average**	**Effect**	**Average**	**Effect**
A	4.33	Major	4.67	Severe	4.67	Severe
B	4.33	Major	5.00	Severe	5.00	Severe
C	4.00	Major	5.00	Severe	4.67	Severe
D	4.33	Major	4.67	Severe	4.67	Severe
E	4.33	Major	4.67	Severe	4.67	Severe
F	4.67	Severe	4.67	Severe	5.00	Severe
G	4.33	Major	5.00	Severe	5.00	Severe
H	4.67	Severe	5.00	Severe	4.67	Severe
I	4.33	Major	5.00	Severe	4.67	Severe

J	4.00	Major	4.67	Severe	5.00	Severe
Average	**4.33**	**Major**	**4.83**	**Severe**	**4.80**	**Severe**

Figure 9 below shows the risk map of the severity of the effect of covid19 to Money that eventually impacted the triple constraint of management. Data gathered from the respondents demonstrated extreme effect to both time, cost, and high effect on scope. This reinforces the observation of the key informants that covid19 has a range of major to severe effect on Method. 100% of the respondents agree that Money's effect on time and cost is almost certain while 20% of the respondents agree that scope is unlikely to be affected.

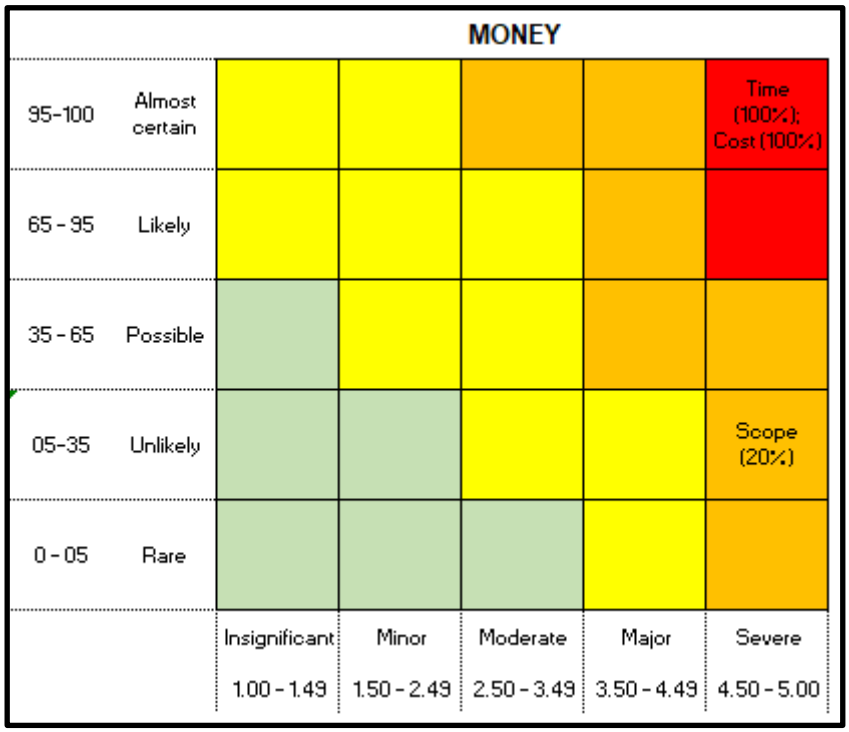

Figure 9. Risk heat map showing the effect of method to scope, time and cost

Table 16 below show that man has severe effect to all the three constraints of project. Material and machine have major impact on scope and cost while severe on time. Method has major impact while money is major on scope and severe for both time and cost. The outcome of the study reinforces UNIDO's study that, inadequate transport of employees including worker's concern of getting sick contributes to manpower shortages, and majority of firms experiences difficulties in coordinating their supply and value chains that contributes to the lack of materials and construction machineries (UNIDO 2021). In addition to UNIDO's study, these problems during covid19 were intensified because, majority of WWCC do not have a clear plan for construction business continuity.

Table 16. Effect of 5Ms of management to the triple constraints of project during covid19

5Ms	**Scope**		**Time**		**Cost**	
	Average	**Effect**	**Average**	**Effect**	**Average**	**Effect**
Man	4.50	Severe	4.80	Severe	4.67	Severe

Material	4.20	Major	4.50	Severe	4.47	Major
Machine	3.97	Major	4.50	Severe	4.33	Major
Method	3.83	Major	4.20	Major	4.07	Major
Money	4.33	Major	4.83	Severe	4.80	Severe

Figure 4 below shows the visual presentation of the overall effect of covid19 to WWCC's 5Ms of Management to the triple constraints of project that ranges from major to severe. The lowest level is the effect of method to the scope while the highest level of criticality is on man and money against time and cost.

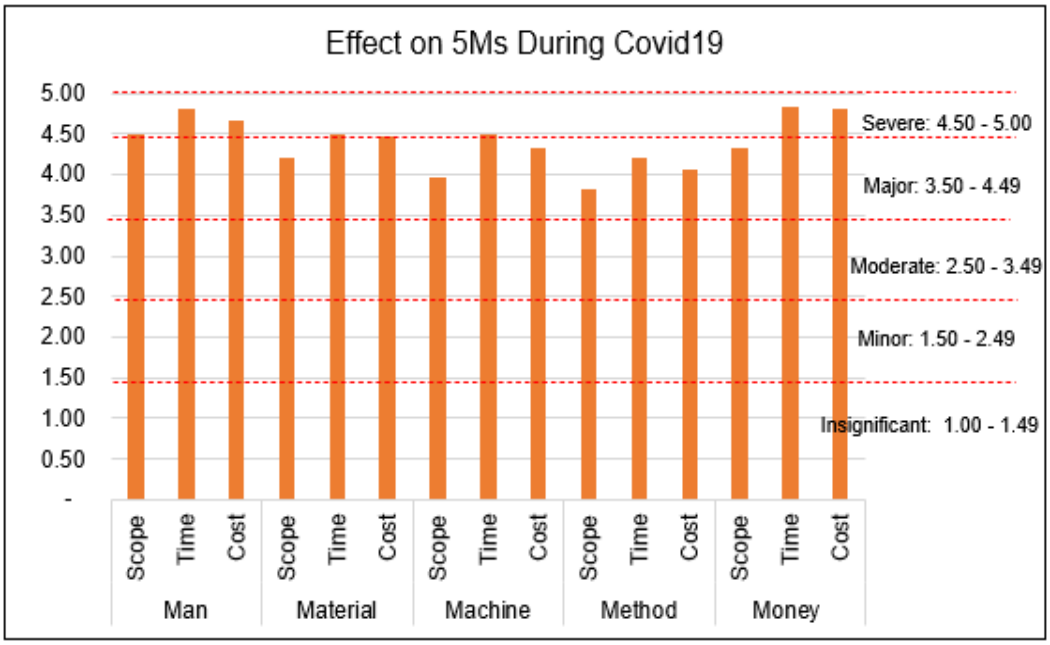

Figure 10. Visual presentation of the effect on WWCC's 5Ms During Covid19

Comparison of the Level of Severity on the 5Ms of management and its Effect on the Triple Constraints of Project Before and During Covid19

Table 17 below shows that before covid19, the effect of man, material, machine, and money to the triple constraints of project are all minor. While the effect of covid19 ranges from major to severe. The data gathered before and during covid19 shows the increase in severity that ranges from a minimum of 53% increase to 68% increase of the impact on the three constraints of projects. This information is consistent with the details provided by the project managers of WWCC during the interaction with them as validation to the acquired data from the questionnaires.

Table 17. Comparison on the effect of 5Ms to the triple constraint of projects before and during covid19

5Ms of Management & Project Constraints		**Before Covid19**	**During Covid19**	**Difference**	**% Increase of Impact**
Man	Scope	1.94	4.50	3.06	61%
	Time	2.02	4.80	2.81	58%

	Cost	1.94	4.67	2.54	57%
Material	Scope	1.60	4.20	2.40	53%
	Time	2.10	4.50	2.43	55%
	Cost	2.00	4.47	2.47	61%
Machine	Scope	1.70	3.97	2.33	52%
	Time	2.17	4.50	2.33	54%
	Cost	2.00	4.33	2.13	56%
Method	Scope	1.23	3.83	2.73	65%
	Time	1.47	4.20	2.63	65%
	Cost	1.43	4.07	2.60	68%
Money	Scope	1.53	4.33	2.97	60%
	Time	2.00	4.83	3.13	63%
	Cost	1.83	4.80	2.80	65%

Figure 5 below is a graph showing the effect of covid19 to WWCC's 5Ms of management affecting the triple constraints of project. This also depicts the difference or percent increase in severity of 5Ms relative to the triple constraints.

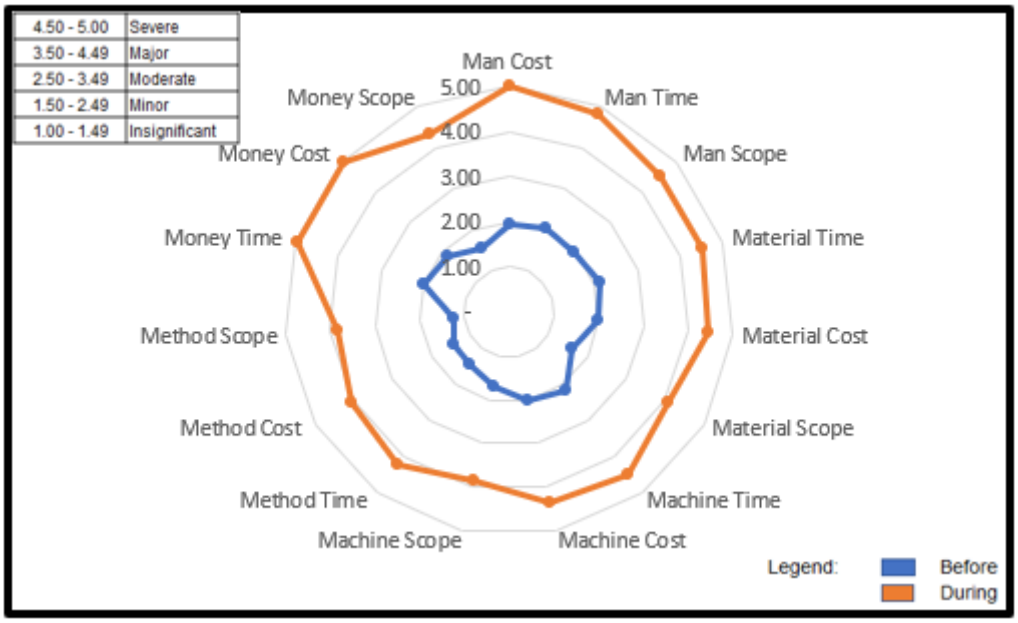

Figure 11. Visual presentation of the effect on WWCC's 5Ms before and during covid19

To summarize the comparison between the results obtained before and during covid19, it has a strong indication that current projects of WWCC have been disrupted. This disruption has impacted the projects in terms of inadequate manpower, delay in the delivery of construction materials specifically the items coming from abroad, and lack of manpower to operate machineries eventually affects the methodologies in work implementation and foreseeable increase in project costs. The results of the survey are further validated through consultation with WWCC's project managers attesting to the survey results. According to the project managers of WWCC, normal work operations are being observed on the projects before covid19 but, it has drastically changed during the pandemic. WWCC's manpower has considerably

reduced between 80% - 90% at the start of covid19 soon after the National Government through the Inter Agency Task Force (IATF) on covid19 implemented a nationwide enhanced community quarantine (ECQ). The project managers of WWCC have shown the reports from year 2019 up to 2020. This supports the results of the study that Man is a problem for all WWCC. Table 18 shows the IATF's implementation of lockdown and quarantine restrictions of workers starting from ECQ in 17March2020 (IATF 2020).

Table 18. IATF lockdown and quarantine restrictions during covid19 (IATF Guidelines 2020)

Dates/ Duration	Quarantine Status	% Workers Allowed on Essential Projects
17March – 15May2020	ECQ	Not Allowed
16May – 31July2020	MECQ GCQ (July 2020)	30%-50% Allowed with restrictions
01August – 15August2020	MECQ	30%-50% Allowed with restrictions
16August – 31October2020	GQC	75%-100% Allowed with safety protocols

Materials also suffered huge disruption due to the lack of transport. Machines for construction lay idle at the project sites due to restrictions totally banning the movement of persons on the onslaught of covid19. The effect of covid19 to Man, Material, and Machine of WWCC have also greatly affected the method and money. These findings are being supported by many studies on the effect of covid19 to the construction industry. One of the studies by Hazem (2020) of Plan Radar, confirmed that covid19 is an unexpected event that would delay projects due to shortage of manpower and disruption to the supply chain. Another study also confirmed that consequences might keep coming as companies struggle financially that might delay major construction projects going forward (Marsh 2020). As contractors, WWCC included prepare to return to work on sites that have been shut down by shelter-in-place initiatives, they face an industry that has been drastically changed by the both public health and economic effects of the pandemic. From a renewed emphasis on jobsite safety to longer project delivery times and the increased influence of organized labor, the virus has upended many facets of the industry (Goodman 2020).

Table 19 shows the effect of the 5Ms of management to the triple constraint of projects during covid19. Overall result of the study shows that man's effect to scope, time and cost are all severe, material and machine have major effect on scope and cost while severe on time, method's effect are all major, while money's effect on time and cost are severe, but only major on scope. As shown on the table, man has severely affected all the constraints of project. This reinforces the literature on the impact of covid19 on construction sector that, the construction industry estimates that up to 140,000 formal jobs could plummet due to covid 19 University of Texas News in October 29, 2020, have shown that workers reporting to projects sites are more likely to have greater exposure to covid19 hardly hitting the construction industry (Cokayne 2020). Covid19 has affected the lives of many people around the world due to many months of lockdowns and quarantine where many infections and death are experienced on man (Reinhart 2020). Since all WWCC's 5Ms of management affects the three constraints of projects, an adaptive mechanism was created for WWCC in coping with the disruption of projects during crisis or pandemic. The next section of this study shows how WWCC react to problems and ensure business continuity during crisis.

Table 19. Effects of 5Ms to the triple constraints of projects

5Ms of Management & Project Constraints		Major	Severe
Man	Scope		√
	Time		√
	Cost		√
Material	Scope	√	
	Time		√
	Cost	√	
Machine	Scope	√	
	Time		√
	Cost	√	
Method	Scope	√	
	Time	√	
	Cost	√	
Money	Scope	√	
	Time		√
	Cost		√

Adaptive Mechanism for WWCC in Coping with the Disruption of Projects During Crisis

Adaptive mechanism is the organization's ability to adjust with current conditions that drives decision making, allowing people most likely to detect changes in the environment to respond quickly and proactively (https://dictionary.reverso.net/english-definition/adaptive+mechanism, April 30, 2022). This is a framework by which the construction industry, WWCC as its main beneficiary, would have a guideline in mitigating disruption to projects ensuring business continuity in times of pandemic.

The adaptive mechanism was adapted with WWCC's operations, and considered all the prevailing laws and regulations related to water and wastewater. Since water is one of the most essential commodities for human, the National Government shall ensure water sustainability to align with the universal call by the United Nation's Global Goal on Sustainable Development Goal (SDG 6) ensuring continuous availability of water and sanitation to all men (UNDP 2015). On a national level, the framework can be a tool to be utilized by WWCC to adhere with the Philippine Clean Water Act, RA 9275 and DENR AO 26 as the Government's aim to protect water bodies from pollution (DENR 2004). The adaptive mechanism will also alleviate the protection of water bodies and alleviate an orderly development and management of underground water sources (NWRB) and Laguna Lake. The Laguna Lake Development Authority (LLDA) by virtue of the Philippine Republic Act No.4850, promotes and accelerates the development of the lake and its surrounding cities and towns that includes the preservation of the ecological systems, and prevention of undue ecological disturbances, deterioration, and pollution.

Figure 12 below shows the adaptive mechanism framework for WWCC in adapting to crisis and ensure business continuity in times of crisis. The adaptive mechanism as a system comprises of the precontemplation stage, contemplation stage and the feedback mechanism.

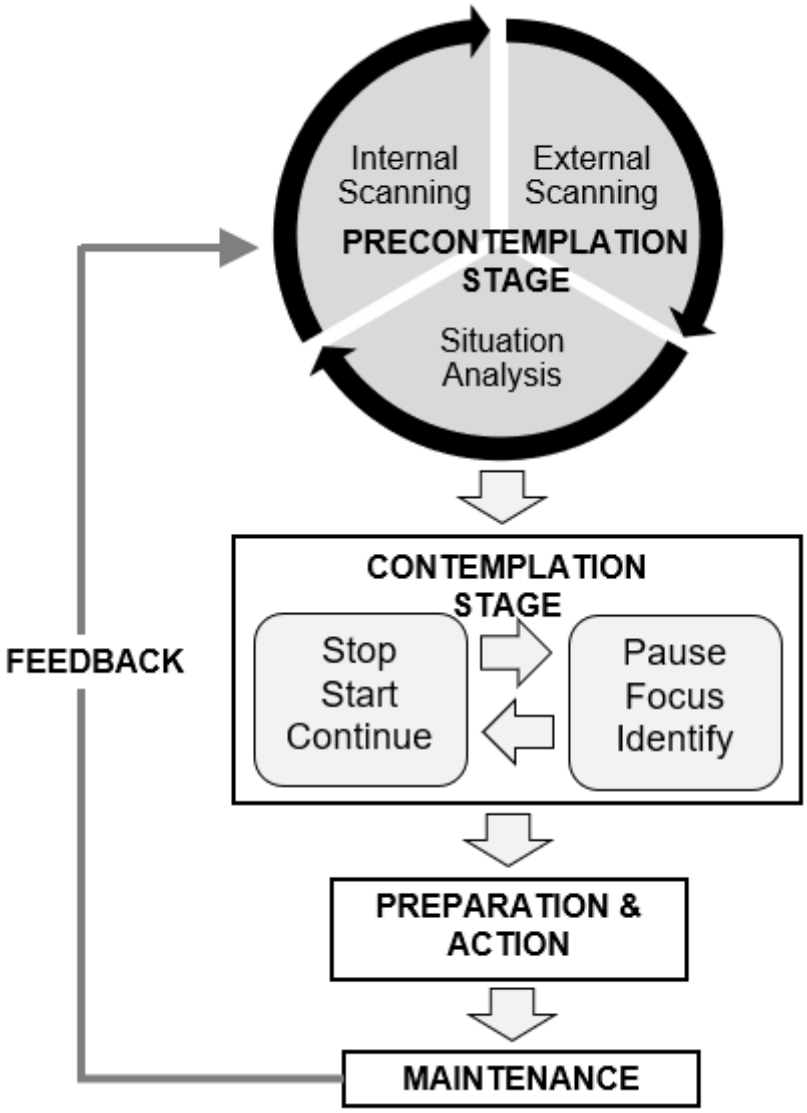

Figure 12. Adaptive mechanism of WWCC in coping with crisis

The first stage which is the precontemplation, is generally termed as environmental scanning (ES) that involves internal scanning, external scanning and situational analysis. ES is a continual and precise analysis of the internal and external situation of an organization to detect opportunities, threats, and weaknesses that can impact the current and future strategies of the organization (Bhasin 2019).

The first step for ES is the internal scanning, which is sometimes labeled as internal analysis of the environment. These were done through surveys, face-to-face verification, and discussions that helps in determining the disruptions in the organization. External scanning on the other hand pertains to analysis of the industry environment, national environment, political, economic, social, and technological aspects. The information gathered during the ES will be subjected to situational analysis to complete the precontemplation stage. The internal and external scan will be analyzed by the changes happening in the organization in the emergence of crisis. This will help assess the organizational goals and the results need to be seen before the aspirations are achieved (Bhasin 2019).

Results of the survey and corresponding validation, reinforces the findings of the comparison on the effect before and during covid19, which shows a range from major to severe effect of WWCC's 5Ms of management to the triple constraints of projects. The data obtained serves as input to the precontemplation

stage. WWCC through the precontemplation stage determines that a problem exists and the level of severity of the effects on the triple constraint of projects affected the current projects. It is at this stage that WWCC consider the implementation of change to the organization.

The second stage of the adaptive mechanism is the contemplation stage. This is the stage where the organization realizes the there is a problem, and consider the advantages and disadvantages of change. It is at this stage for the management to implement the stop – start – continue (SSC) change model. This model as an assessment tool, can be adopted as a way of proactively meet the challenges in any change in environment (Petersen 2017). At every stage of the SSC, the organization shall also pause, focus and identify the gathered data and information from the precontemplation stage. Pause is a temporary state of action for the management to time and think about a situation before acting on it. Focus is an action by which it allows us to concentrate and have a deeper meaning of the current situation, while identify is an action to determine the issues and problems that is changing the current situation. In this study, the management must focus and identify the disruption on the projects caused by the emergence of covid19 in order for the management to make the appropriate decision. The initial step in contemplation stage is pause, focus, and identify in order to make a decision to stop, start, and continue. WWCC does not only execute the SSC but each of the 5Ms of management shall also be analyzed in detail to determine which activities are to be stopped, start, and continue. The SSC model is a useful tool for giving and receiving feedback. This can also be utilized as a technique for creating ideas, solving problems, and decision making. Table 20 shows a detailed description of actions to be performed in applying the SSC in the contemplation stage associated with the key informants and validated with WWCC's project managers.

Table 20. Implementation of the SSC to the 5Ms of management

STOP	START	CONTINUE
What WWCC should stop doing	What WWCC should start doing	What WWCC should continue doing
List of items/ ideas that: Not working for WWCC Not having the desired outcome Proved to be impractical Situation or circumstances that disrupts the achievement of goals	WWCC is not doing but think should be New ideas that came up or have not been considered before Ideas to address new situations that may have not existed at the beginning of the project Things to begin to get better results	Are working well and the team wants to keep The team likes and think are successful Things or action that we want to keep Worth continuing to determine if they are worthwhile

The preparation phase of the contemplation stage are actions, systems or processes that the organization intends to change or options that will improve the situation in attaining the organization's objectives. Action is a point by which changes have been made and the organization adapts to the new situation. Lastly, the maintenance period after the organization has demonstrated a commitment to long term change by keeping to the new changes.

One good example for the implementation of the adaptive mechanism is the situation in one of the sewage treatment plant (STP) in Muntinlupa City during the emergence of covid19. At the onslaught of covid19, the National Government has restricted the movement of people in order to control the infection of

covid19. Quarantine, lockdown and restrictions are implemented at the national level. The construction sector of the entire country including that of Muntinlupa has caused much disruption to current projects. The contractors have started investigating the disruption caused by the National Government's order. Similar to precontemplation stage, the contractor has not yet acknowledged the effects of covid19 as problematic at the early stages of the pandemic. They have started studying the cause and effect of covid19 to their resources like internal scanning (within the organization), external scanning (outside the organization), and situational analysis. They gathered information about the effects, events, patterns, trends, and current conditions within the organization's internal and external environment to raise their level of concern and awareness to the risks associated with the pandemic.

Next is the contemplation stage. The contractors contemplate to see the extent of the effect of covid19 to the 5Ms of management (e.g., man, materials, machine, method, and money) to the triple constraints of projects. Once the organization realizes that there is a problem, they have to pause, focus, and identify the problem. After verifying that there is a problem, the contractor has to make a decision on whether to stop, start, or continue the normal course of activities they are doing. As a result of the study conducted, man emerges as the topmost of the 5Ms affected by covid19. Man's effect on the three constraints of project is all severe. Therefore, there is a need to list the activities that need to stop, start, and continue to mitigate further effect on projects. Table 21 shows the activities involving man during the covid19 and determined which activities are to stop, start and continue:

Table 21. List of activities for man to stop-start-continue during crisis

STOP	START	CONTINUE
What WWCC should stop doing on man	What WWCC should start doing on man	What WWCC should continue doing on man
Use of public transport from house to the project and vice versa Face-to-face meeting Interaction with other persons outside the project sites Going home every day to prevent their family and co-workers from being infected Going to work if a person is not feeling well	Provide own transport for workers Provide additional staff houses for staff and workers Virtual meetings to avoid person-to-person interaction Wearing of masks, gloves, and cleaning of hands by alcohol, sanitizers, etc. Providing testing centers before entering the premises Training employees on covid19 infection and prevention	Stay at home if they are sick Continue monitoring their health Continue using PPE Continue communications via virtual arrangement Virtual inspections at project sites

The same analysis has been done with the other 5Ms of management's effect on the three constraints of projects to determine which are going to stop, start or continue to determine the preparation, action and maintenance to be done. Table 22 shows the list of activities for the SSC on Materials.

Table 22. List of activities for material to stop-start-continue during crisis

STOP	START	CONTINUE
What WWCC should stop doing on materials	What WWCC should start doing on materials	What WWCC should continue doing on materials
Procurement of materials/ equipment from abroad Delivery of materials that easily deteriorate Installation of materials that require skilled personnel	Procure materials that are easy to procure and deliver Planning the procurement and delivery of materials that can reach the project sites even during pandemic Program the delivery of materials considering "just-in-time" principle.	Installation of materials that require least manpower to install Planning the on-time delivery of materials Protecting material storage to prevent from deterioration Preventive maintenance of materials and equipment

The same thing will be done with the other 5Ms of management's effect on the three constraints of projects to determine which are going to stop, start or continue to determine the preparation, action and maintenance to be done. Table 23 shows the list of activities for the SSC on Machines.

Table 23. List of activities for machine to stop-start-continue during crisis

STOP	START	CONTINUE
What WWCC should stop doing on machines	What WWCC should start doing on machines	What WWCC should continue doing on machines
Using machines that require skilled operators to operate Using machineries that require regular preventive maintenance that are not readily available once needed	Protecting idle machines that are not being used Planning the rental of machines to maximize output	Using machines that are easy to maintain Conduct preventive maintenance in order to avoid fast deterioration Cleaning and protecting machines that are idle

The preparation, action, implementation and maintenance of the process needs to be reviewed and feedback on the outcome, advantages, and disadvantages. These will be an additional input to precontemplation stage. Repeat the process as necessary and if required.

CHAPTER V
RESEARCH IMPLICATIONS

This chapter presents the summary, findings, conclusions and recommendations of the study.

Summary of Significant Findings

The study was focused on the problems encountered by contractors on the occurrence of covid19 that affected not only the Philippines but the entire world. This has impacted the construction and infrastructure globally as workers became infected, got sick, and quarantined leading to the delay of on-going projects of WWCC. The covid19 has impacted the 5Ms of WWCC's management affecting the

three interdependent constraints of projects. The study was centered on the effect before and during covid19 to the 5Ms of WWCC's management to determine the impact to the triple constraints of project (e.g., scope, time, and money). The following research objectives were formulated to; (1) determine the effect of 5Ms of management to the triple constraint of projects before covid19; (2) determine the effect of 5Ms of management to the triple constraint of projects before covid19; (3) compare the effects to the 5Ms of management before and during covid19; (4) create an adaptive mechanism for WWCC in coping with the disruption of projects during crisis.

The study started in February 2022 by administering structured questionnaires to ten WWCC considering three highest ranking positions (e.g., project manager, construction manager, pollution control officers) in the organization who have clear knowledge on the effect of covid19 to the 5Ms of management (e.g., Man, Material, Machine, Method, and Money) that eventually disrupted the triple constraint of their current projects. The information and data gathered from the respondents before and during covid19 were processed and compared to come up with an adaptive mechanism for WWCC in coping with the disruption of projects during crisis. The results were validated through face-to-face and virtual consultation with the highest-ranking personnel of WWCC on site, the project managers. The results of the survey complemented with the secondary data shown by the project managers. The weekly and monthly reports of WWCC before and during covid19 manifested huge difference. As shown in the results and discussions, there was disruption on the current projects of WWCC due to lack of manpower and disturbance to the supply chain.

Overall result of the study showed that Man's effect to scope, time and cost are all severe, Material and Machine have major effect on scope and cost while severe on time, method's effect are all major, while money's effect on time and cost are severe, but only major on scope. This reinforces the literature on the impact of covid19 on construction sector that, the construction industry estimates that up to 140,000 formal jobs could plummet due to covid 19 University of Texas News in October 29, 2020, have shown that workers reporting to projects sites are more likely to have greater exposure to covid19 hardly hitting the construction industry (Cokayne 2020). Covid19 has affected the lives of many people around the world due to many months of lockdowns and quarantine where many infections and death are experienced on man (Reinhart 2020). Since all WWCC's 5Ms of management affects the three constraints of projects, an adaptive mechanism was created for WWCC in coping with the disruption of projects during crisis or pandemic. The adaptive mechanism created not only cater to contractors but it can also be used in other sectors such as education, manufacturing, and services.

Conclusion

Result of the study showed that before covid19, the effect on the 5Ms of management to the triple constraint of project ranges from insignificant to minor. Thus, it can be considered that before pandemic, WWCC has not observed or experienced major effect on their 5Ms of management. However, compared during covid19, study showed that man emerged as the topmost aspect of management severely affected. The severe effect of covid19 to man contributed huge impact to the scope, time and cost of projects. This reinforces other studies that man is the most at risk in times of pandemic due to lack of transport and the nature of the work at project sites where workers are in close contact with one another. As workers become infected with covid19, sick and quarantined, labor shortages are experienced by the construction industry. Contract provisions related to construction program, timing, and completion of work are impacted. On the other aspects of management such as material, machineries, and money, came in second with levels of

severity ranges from major to severe while method has the least effect of covid19 to the 5Ms of management.

Since during covid19, all the 5Ms of management affected the three constraint of project management, an adaptive mechanism was created for WWCC in coping with the disruption of projects during crisis.

Recommendation

The study was pursued with the understanding of the impact of covid19 to the 5Ms of management that eventually affected the three interdependent constraints of project. The researcher being in the field of engineering and construction industry, the effect of covid19 is observed through lived experience on the current water and wastewater projects in Muntinlupa, Philippines. Three water and wastewater projects in Muntinlupa were terminated due to the effect of covid19 to their staff and labor.

In line with the findings and conclusion of the study, the following recommendations using the adaptive mechanism that are relevant in achieving the organization's objectives and become resilient against the effects of pandemic or any crisis. The adaptive mechanism comprises of stages to be applied. The first stage is the precontemplation stage once crisis or pandemic emerge. WWCC shall conduct internal scanning, external scanning and situational analysis to determine the change that occurred resulting to the impact of crisis or pandemic. The information or data gathered from the precontemplation stage will be an input to the contemplation stage.

The contemplation stage determines the unintended change in the organization. It is at this stage where the organization realizes that there is a problem brought by crisis. Therefore, the stop start continue change model coupled with pause, focus, and identify will be applied by the organization, followed by preparation, action, and maintenance in that order. The pause, focus, and identify phase compliments the stop, start and continue because, changes in organizations are not implemented in an abrupt manner. Managers shall be precise in introducing change in order to avoid disruption within the organization. The outcome or the result of the contemplation stage will be utilized to continue the practices that are beneficial to the organization. The information that proves to be impractical or circumstances that disrupts the achievement of goals by the organization serves as feedback to precontemplation stage for a more thorough investigation. The cycle will be continuously applied to the organization whenever unintentional or unplanned change is observed. Lastly, the organization shall record all the lessons learnt from the cycle which serves as inputs to the next application of adaptive mechanism.

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