

BEYOND THE IRON-TRIANGLE: ACCOMMODATING SUSTAINABLE CONSTRUCTION IN THE NEW-NORMAL CONDITIONS

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ABSTRACT

As one of the economic stabilisers in Sri Lanka, the construction industry is affected severely due to the Corona Virus Disease (COVID-19) pandemic. Unbalance of the Iron-triangle which refers to key Construction Project Goals (CPG) (i.e., time, cost, and quality) is one of the phenomena that can be addressed while Sustainable Development (SD) (i.e., economic, social, and environmental sustainability) has been streamlined to worse condition. Even though, sustainability must be prioritised in developing countries e.g., Sri Lanka, where significant construction works are currently underway, especially during this situation. Further, the appropriate construction and implementation in a construction project can make a dramatic contribution to the mandate of sustainable development. Hence, this research intends to investigate how the Iron triangle would be unbalanced during the new-normal situation where it has a significant impact on SD simultaneously. A qualitative survey strategy was used to achieve the research aim. A semi-structured interview survey was conducted to solicit the perception of experts. Nine experts were selected purposively, who had experience in both Sustainable Construction (SC) and project management, especially proceedings during the new-normal condition. To analyse the empirical data, the manual content analysis method was used. As the decisive outcome, the 'Iron-star' model was developed by merging the Sustainable triangle and Iron-triangle which pertained to the interrelation between SD and Construction Project Goals (CPG). Initially, interrelations between SD measures and CPG were cogitated by literature findings. Economic depletion, health-related issues, supply chain disruption, and cash flow issues were identified as interventions to achieve CPG through SD measures. Further, it revealed that the Iron-star can implement as the way forward for the construction industry in the Sri Lankan (SL) context.

Keywords: Construction Project Goals; COVID-19; Sri Lanka; Sustainable Development.

1. INTRODUCTION

The construction industry has always been different and dynamic, coping with a wide range of risks with inter and various cultural backgrounds (Acharya, Lee and Kim, 2006). Construction work entails interconnected and multi-criteria set of success factors, posing challenges to construction firms (Turkyilmaz, et al., 2019). Osei (2013) stated that the construction sector and its operations have a huge impact on the environment, the

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economic system, and the community. As a result, it is constantly looking for applicable tactics to make construction more sustainable (Abidin, 2010). Realising the major implications of construction activities on SD has contributed to the growth of several management methodologies for project success. Further, Johnson and Babu (2020) stated that project success is mostly measured by its ability to complete projects on schedule and under budget while maintaining top quality as the main goal. Even though, the inability to satisfy the major goals of time, cost, and quality can have a long-term impact on clients, contractors, and all stakeholders, especially during pandemic situations (Assaf and Al-Hejji, 2006; Nega, 2008). Meanwhile, the recent outbreak of COVID-19 had a large influence on the global economy by affecting numerous industries e.g., construction, tourism, and exports (Shibani, Hassan and Shakir, 2020). Besides, Chopra and Nagar (2020) stated that the severity of the effect would be determined by the length of the shutdown and the time required for the economy to return to normal.

Meanwhile, Mahawatta (2021) discussed that there is no assurance that the Sri Lankan economy will return to normal towards sustainable development, where the capability to suppress the intensification of dollars with unsustainable debts and interest for the next few decades. Yet, the sustainability performance of a single construction project throughout its life span is an essential component in accomplishing the objective of SD (Athapaththu and Karunasena, 2018). However, SD is still considered by stakeholders as a 'nice-to-have' practice that reinforces standard practice without being integrated into making decisions (Du Plessis, 2002). Sri Lanka, as a developing country, has a high demand for SC, even though the country lacks sufficient SC practices (Jayalath and Gunawardhana, 2017). Further, Gbahabo and Ajuwon (2017) discussed that poor-quality construction projects, lengthy delays, and budget overruns stymie economic progress, which can be crippling, particularly in most developing countries. Moreover, the Differences-in-Differences model assesses the effect of COVID-19 on performance in organisations through the construction industry along with sustainability and project goals as two dimensions can be used (Shen, et al., 2020). Although different studies had been carried out on SD and CPG which studied the impacts of the COVID-19 Pandemic regarding SL context, none of them covered how CPG are affected by SD measures during the COVID-19 Pandemic unanimously. In this COVID-19 pandemic, the economic, social, and environmental pillars must be combined not late into arguments on developing sustainability to achieve CPG (Eizernberg and Jabareen, 2020). This research aims to investigate the impact of CPG (i.e., time, cost, and quality – Iron triangle) in sustainable projects in new-normal conditions. Critically reviewing the interrelations of SD and CPG to analyse the impact of the COVID-19 Pandemic on SD measures and appraise the new-normal sustainability challenges against the Iron triangle through developing the Iron-star as a conceptual framework was the outcome.

2. LITERATURE REVIEW

In Sri Lanka, Construction Project Goals (CPG) at project success zone, since the recent outbreak of Corona Virus Disease (COVID-19) which had a large influence on the global economy by affecting numerous industries e.g., construction, tourism, and exports (Shibani, Hassan and Shakir, 2020). As illustrated by Kawmudi, et al. (2020), Sri Lanka without reservation is affected by the harmful situation and restricted people to stay home and keep social distance to minimise the exposure and stop the spreading of the virus and subsequently instructed to work from home. During the lockdown, fewer construction

workers can be able to pass, and there will be limited access to and supply of inputs, causing CPG (Chopra and Nagar, 2020). Nonetheless, construction projects need naturally everybody at a construction site to be joined with workers to perform several tasks according to the specifications (Okema, 2000). Further, import and export facilities of materials have been obstructed due to a pandemic that will impact on construction industry (Hasanat, et al., 2020). This circumstance will have an impact on construction materials, technical equipment, and electrical equipment, and enterprises will have to pay a higher price to purchase these products in the future, prolonging the process (Kawmudi, et al., 2020).

When it comes to the concept of sustainability i.e., social, economic, and environmental factors represent, as mutually three intersected circles in which the centre has become ubiquitous (Purvis, Mao and Robinson, 2019). Huovila and Koskela (as cited in Durdyev, et al., 2018) defined sustainability as follows:

“The balance between the three elements of sustainability plays a significant role in the construction industry compared to other industries, and it is strongly recommended that the industry’s success must be considered based on the triple-bottom-line, rather than traditionally used measures focusing on time, cost and quality”. (p.04)

Among three pillars, social sustainability consists of three components, i.e. (i) basic needs, (ii) individual capacity, and (iii) social capacity (Fiorini and Jabbour, 2017). Further, Nidheesh and Kumar (2019) stated that environmental characteristics should be viewed as capital instruments, as natural and social capital. Apart from environmental and social sustainability, Ahmad and Thaheem (2018) explained that although economic sustainability appears to be a simple concept in the construction sector, it is a complex process involving capital and life cycle costs, adaptability, and other factors. However, there is a major positive and long-term impact on economic sustainability, decisions, and policies by social and environmental sustainability especially in developing countries (Ahmadi, Kusi-Sarpong and Rezaei, 2017). Referring to three pillars, various sustainability techniques have been created to assess the success of growth at various phases of the project lifespan in terms of balancing energy and environment while taking social and technological elements into account (Clements-Croome D. e., 2004). In most cases, rigid focus on project budget and schedule management has affected the prejudice of project quality, which tends to project deliverables are not fit for the purpose or without applying the requirements even in SC for project success (Wright and Lawlor-Wright, 2019). Aga, Noorderhaven and Vallejo (2016) suggested that the triangular factors of time, budget, and quality are used to determine the success of a construction project.

Meanwhile, Maqsoom, et al. (2018) stated that the capacity to reduce project time, and cost, and enhance quality may define a construction firm's degree of success referring to the Iron-triangle. According to Atkinson (1999) technically balancing three main project goals in the construction industry refers to the “Iron triangle” that remains in constant tension regarding the successful project. The author further elaborated those traditional measures of project success are time, cost, and quality, also known as the iron triangle. These project success criteria have been adopted in many projects. Denoting the Iron-triangle, once the planned completion date has been exceeded due to both internal and external issues, the time to complete will be extended (Al-Nijjar, 2008). As well as the excess of actual cost over the budget by escalation or increase can be recognised as a cost

overrun (Zhu and Lin, 2004). Moreover, Laughlin, et al. (2012) explained that the quality aspect represents the operations and measures a contractor undertakes to manage the project which is expected from end-users in successful projects.

Researchers intend to analyse the project success that is contributing to sustainability which makes a competitive advantage (Rabechini and Carvalho, 2006). Further, Raut, et al. (2018) ascertained the significance of a holistic view and balancing the triple bottom line of sustainability during the implementation process towards project success. Figure 1 shows the evolvement of the emerging two criteria with real-world implications.

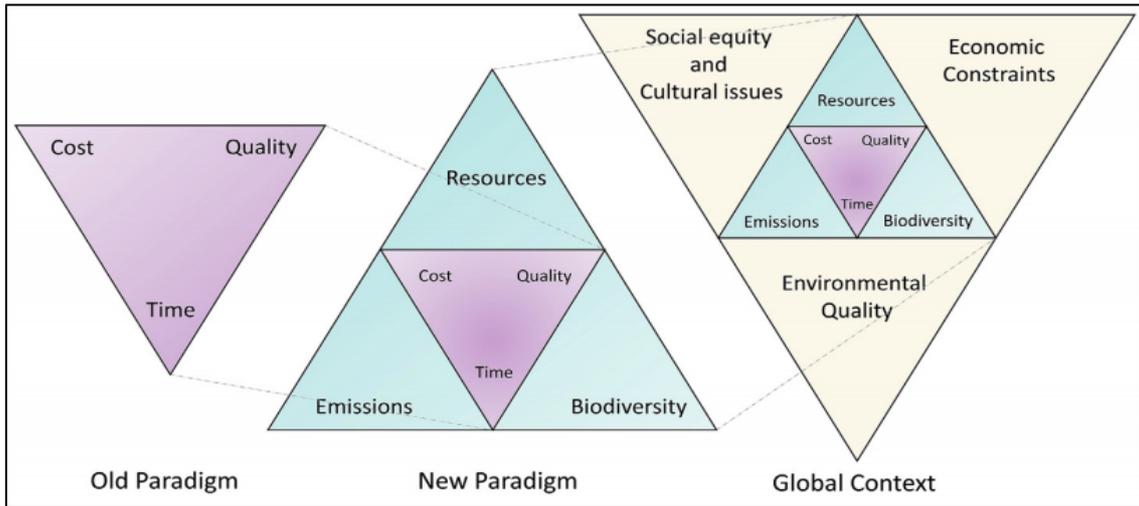


Figure 1: The evolvement of context

Source: Ahmad, et al. (2019)

According to Ahmad, et al. (2019), economic constraints, social equity and cultural issues, and environmental quality are indirectly broadcast around the Iron triangle (refer Figure 1). The authors further explained that cost performance may be impacted by environmental and social sustainability, as well as time and quality performance and vice versa. Meanwhile, Ahmad, et al. (2019) confirmed that in many developing countries, social, economic, and environmental benefits tend to increase the ecological cost. Unstable political and social conditions may result in strikes, and military attacks affect material supply suspensions which further leads to increased market prices (Enshassi, Al-Najjar and Kumaraswamy, 2009). Additionally, Ahmad, et al. (2019) have interpreted time performance may be impacted by economic sustainability while environmental sustainability may be impacted by time performance and vice versa. Nevertheless, when establishing the linkage between sustainability and project management, it is required to transcend beyond an axiological mentality on sustainability associated tools in the triple bottom line in a project viewpoint (Bolis, Morioka and Szelwar, 2014). Further, the authors discussed that genre of this linkage is better than using those concepts sporadically to overcome issues in construction projects. Therefore, impacts on CPG from each pillar of sustainability make sense on potential all project success factors (Ahmad, et al., 2019).

Ultimately, developing the Iron-star (refer Figure 2) based on the interrelation of SD and CPG would be a worthwhile impression aligned with the following conceptual framework to uplift the SD in the SL context. The Iron-star developed based on each aspect of the Iron triangle is affected by each pillar of sustainability. Two triangles which represent the

triple bottom line of sustainability (i.e., economic, social, and environmental sustainability) and the iron triangle (i.e., time, cost, and quality) are merged one to one (refer Figure 2). Each goal has direct impacts from both right and left side sustainable pillars, while the indirect impact from the facing pillar.

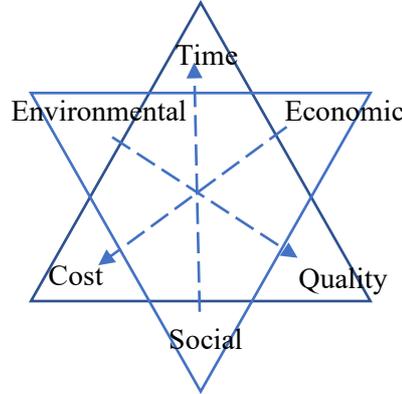


Figure 2: The Iron-star

3. METHODOLOGY

This study aimed to ascertain unbalance in key project goals in SC while new-normal conditions. The qualitative research approach was selected to collect data. Through semi-structured interviews with the invited professionals for their perceptions. There were nine experts with more than ten years of experience with sound knowledge of sustainable development and project management as well as currently working under new-normal conditions placed by the COVID-19 Pandemic. Experts were selected through purposive sampling, including three quantity surveyors, five project managers, and two civil and structural engineers. These interview discussions provide valuable comments on the impacts on SD measures and CPG. Qualitative data obtained from expert interviews were analysed through manual content analysis by tracking the findings within identified themes.

4. RESULTS

Initially, the findings of the expert survey can be elaborated on the impacts of the COVID-19 Pandemic situation based on the interrelation between SD and CPG as identified in the literature review. Through the manual content analysis, the interviewee’s opinions were analysed and the obtained summary is presented in Table 1.

Table 1: Impacts on SD and CPF from COVID-19

Sustainable pillar/CPG	Impacts of COVID-19 Pandemic
Time	Suspensions and prolonged suspensions Lack of skilled labour and specialised labour Reduction of per-day-working hours Scarcity of materials and equipment Health issues (Coronavirus spread) Reworks Arrange and manage further health facilities

Sustainable pillar/CPG	Impacts of COVID-19 Pandemic
Cost	Lengthy permission procedures
	Cash flow issues with payment lags
	Various COVID guidelines with Newly enacted laws
	Resource idling
	Resource acquiring process is gone slow manner
	Absenteeism of workers
	Chaos of workflow
	New high prices for materials and equipment
	Additional incentives for staff and labours
	Additional cost for additional PPE, and facilities
Quality	Project acceleration cost
	Cost for reworks
Economic sustainability	Various compensations
	Usage of alternative materials
	Changes in exchange rates (increase)
	Country's Economic depletion
	Disruption of supply chain
	Individual income depletion
	Progress of other industries have been curtailed
Social sustainability	Foreign funds are suspended
	Health and mental well-being are damaged
	Communication and management issues
	Newly enacted laws and regulations
	Social/travel restrictions
Environmental sustainability	Additional wastage

According to developed Iron-star, 21 impacts on CPG are affected by 12 SD measures directly or indirectly. Ascertained new normal sustainability challenges against the construction industry's key project goals are discussed hereupon.

4.1 IMPACT OF CPG FROM SD MEASURES THROUGH ECONOMIC SUSTAINABILITY

While advanced economies are concerned about economic sustainability, developing countries are concerned about economic development rather than sustainability. Besides, during the new-normal conditions, the increasing exchange rate of the Sri Lankan (SL) Rupee is one of the major impacts on the country's economy. Therefore, the inflation rate is going up day by day. Simultaneously, the purchasing power of the SL Rupee is gone down while GDP has fallen. Apart from the COVID-19 restrictions, disrupted importations are arisen due to the increase in the exchange rate. As well, with this scarcity situation, resources are sold at high rates with high demand and a low supply chain. Experts highlighted that especially cement, reinforcement bars, tiles, electrical items, and service items are inadequate day by day and Letter of Credit openings for special

importing materials are suspended for most of the contractors these days. Consequently, suspensions occur in many projects since the contractors cannot afford price fluctuations of materials, as well as machinery rates, leading to scarcity within the country. When it comes to the situation where the scarcity of materials and slow acquiring process of materials, time delays generally occur. If the time delays occurred where the critical path is lagged, there is more chaos within the workflows.

As evident through experts, manufacturing, transportation and agriculture sector have been waddled due to scarcity of essentials, broken economy, and spread of coronavirus. Moreover, taxation for numerous goods and services becomes high rate and individual economic status is become a damask due to this economic depletion. The contractor's cash flow led to negative due to these factors, especially the low-rate progress of construction activities. Further, even some contractors face situations where cannot apply for interim payment with inadequate progress. That foreign-funded construction projects are terminated by funding agencies, due to the country's bad economy. As evidenced by experts' depletion of economic sustainability is affected by time and cost overruns while quality factor changes from time to time.

4.2 IMPACTS ON CPG FROM SD MEASURES THROUGH SOCIAL SUSTAINABILITY

The social sustainability concept is related to the long-term survival of the upgrade corporation in the construction sector concerning social issues. When it comes to social sustainability, there are various separate guidelines to follow during the first wave, second wave, and third wave of COVID-19. The maximum volume of workers to be maintained, and some health rules to be followed are included in those guidelines. Due to the inadequacy of labour requirements of the sites maintaining with social distances, low per-day labour productivity, and health regulations lead to suspensions and delays of construction projects. Moreover, low labour productivity due to some of the labours are (skilled, unskilled, and specialised) being infected with viruses and quarantined for long weeks and trapped in hometowns with restrictions. This will lead to time overrun of the projects and then definitely it will affect cost overrun by project acceleration.

Mainly health services, manufacturing industry, transport services, educational services, and other industries are curtailed due to various occurrences during this crisis. When it comes to COVID-19 positive cases, the whole construction site needs to be quarantined and get tested (PCR) by all the persons on the site. Then virus-positive persons are transferred to the quarantine centres and site activities are continued in the usual way. These procedures consume time as well as a cost since the general PCR test is around Rs. 6000 and Rapid Antigen Test is around Rs. 2500 in the country. As well as there are considerable time-consuming procedures viz washing hands, sanitising site premises and equipment, cleaning procedures more than previous days, and COVID-19 prevention seminars to the labours with proper guidance which can be recognised when to consider construction site as a sample of the construction industry, due to pandemic situation and various regulations.

4.3 IMPACT OF CPG FROM SD MEASURES THROUGH ENVIRONMENTAL SUSTAINABILITY

In today's world, social and, especially, environmental sustainability is established indecently within various business lexicons. The situations like COVID-19 Pandemic,

there can be considerable delays in schedule aligned with a cost overrun of a budget with these managing and controlling protecting environment by additional wastage within the construction sites as illustrated by all the experts. As a whole, environmental sustainability is not affected harmfully in this pandemic, even though there is additional wastage with health proceedings considering the construction industry. Yet, a construction site as a sample, there can be a considerable amount of additional waste, even though a low percentage of polythene usage, gas emission, etc. These mechanisms lead to additional time and additional cost to the project as well as sometimes contractors have to bear all the additional costs.

Impacts on SD are shown in the red boxes and impacts on CPG are shown in the blue boxes under Figure 3. Besides, literature findings were focused on the global context while expert findings were focused on the Sri Lankan context. Concerning both literature and expert findings, the Iron-star was developed to highlight challenges on CPG against SD measures during these new-normal conditions. Identified challenges were accelerated impact on CPG. When it comes to mitigating and compromising the situation affected, these challenges will be helpful rather than concerning either project management tools or sustainable tools in an ad-hoc manner. Yet, the strategies are born out of challenges against construction operations in the countries in these situations. Therefore, by apprising all the potential impacts, the Iron-star has become a congruent solution for the current construction industry. Figure 3 shows the updated Iron-star after analysing the expert findings.

5. CONCLUSIONS

The COVID-19 disease has the potential to annihilate individual livelihoods and day-to-day lifestyles, business industries, and the whole economy in both developing and developed countries all over the world. For the construction industry, it affects various means by challenging project goals i.e., time, cost, and quality. This paper concludes that the direct challenges on CPG and sustainable impacts in new-normal conditions. Further, the Iron-star developed concerning the direct challenges on CPG by COVID-19 and SD measures indirectly. It was identified that 21 impacts on CPG have been affected by 12 SD measures directly or indirectly. The interrelation between two concepts was the main context under the development of the Iron-triangle. It helped to ascertain all the potential impacts on project success matters. Therefore, strategies can be appraised towards sustainable development. There will be no necessity for conventional project management tools. Altogether 33 impacts were identified that influenced time, cost, and quality based on the Iron-star. However, these findings will be helpful for industry professionals to restrain the intensification of impacts on project goals with unstable conjunctures like the COVID-19 pandemic.

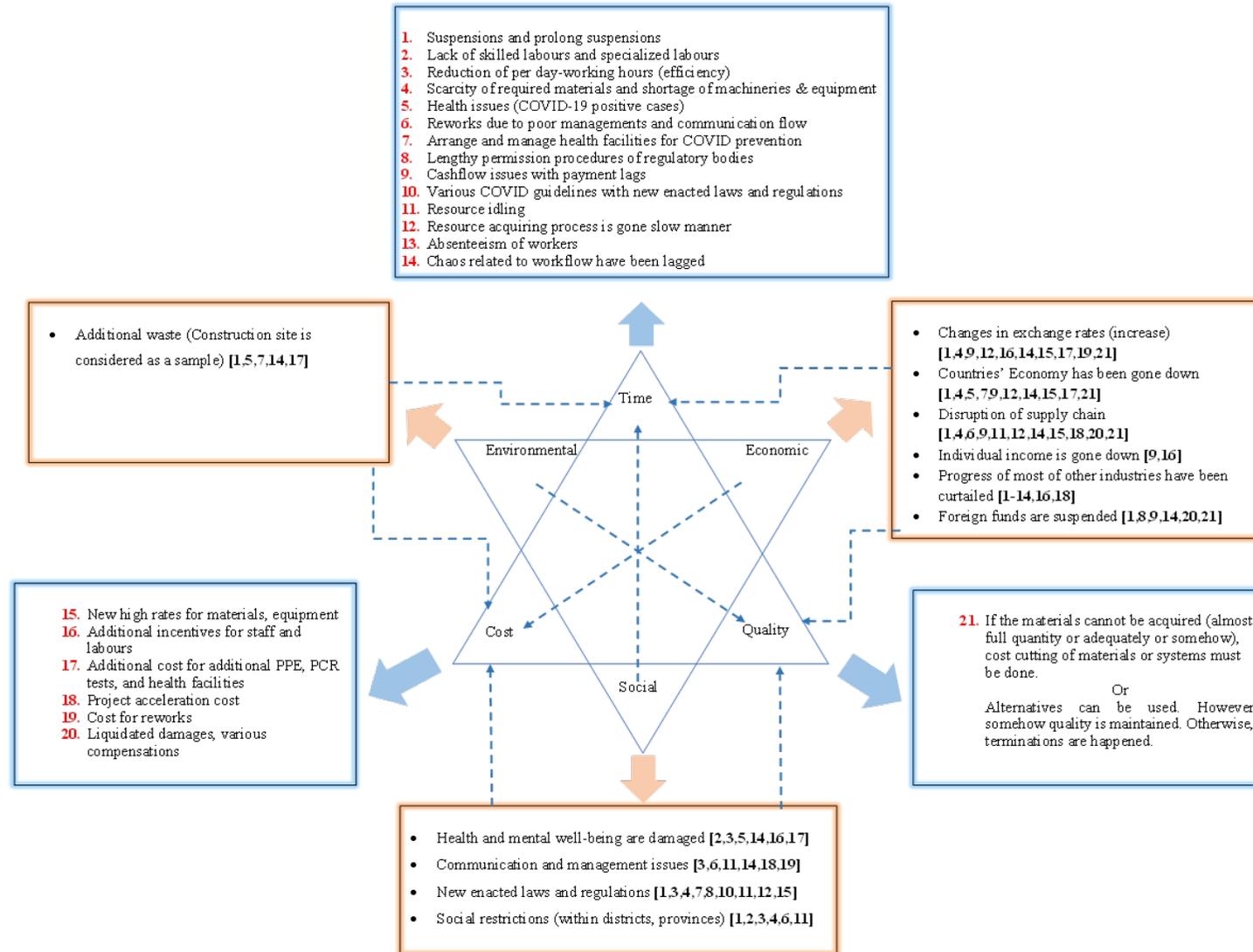


Figure 3: The updated Iron-star

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