



# A STUDY ON SUPPLY CHAIN OPERATIONS IN CONSTRUCTION FIELD DURING COVID - 19

<sup>1</sup>SAI SANKARA NARAYANAN B, <sup>2</sup>DR. S.UMA MAHESWARI

## ABSTRACT

COVID – 19 seriously cause severe damages to construction industry with lot of workers, professionals, engineers not able to work for their industry due to lockdown. It also cause serious economical issues with the clients not able to support the contractors for ongoing projects and planned money transaction were impossible due to pandemic. The huge loss blown to the industry created the impact of supply chain activities due to the pandemic. This paper reviews on supply chain operations that focusses on changes and innovation that connects the supply chain to other network, including transport, command and control. This paper results were mainly based the persons such as construction workers, contractors, engineers, entrepreneurs and various supply chain workers who involved in different supply chain activities in construction field. It also discuss about the challenges faced over by them during the pandemic. It mainly prescribes on the factors and effects of pandemic on their daily routine, the measures taken over by them to handle the situation, the safety precaution guidelines issued over by the government and the implications done by them to over come it. The main principle of this paper is that whether the construction workers are able to survive the pandemic and the change over to new normal are analyzed and discussed. We are now also seeing evidence of significant supply chain disruptions in building and construction industry which was the main source of the country's GDP. An unpredictable shutdown of the whole industry would be a huge loss that is been blown to various entrepreneurs, contractors and the clients who were in expectation over their planned activities. This article explains about the projects that are taken over by contractors and how they managed to give a solution to their clients and the time management, delays in projects are studied. The lifestyle of the workers and the new normal activities to be followed and the implications that are been done are also been analyzed. Overall, the main impact on the work and routine of the various construction professionals are been studied and the changes due to pandemic are adopted by them or caused serious challenges to them.

## CHAPTER – 1 INTRODUCTION

### 1.1 INTRODUCTION

The COVID-19 pandemic that has swept through the world this year has caused unprecedented health and economic distress globally. To curb the rapid spread of infection through their populations, several countries imposed and continue to impose widespread lockdowns. This has caused significant disruption in demand and supply around the world. A number of our clients in the commercial construction, engineering and manufacturing industries have already sought our advice about the effect of recent shutdowns in China on critical supply chains. We are now also seeing evidence of significant supply chain disruptions in the local residential building industry. An unprecedented shutdown of the construction industry as a whole may also be imminent. Impacted contractors need to act quickly and with care to protect themselves as delays and disruptions arise. This article discusses some ways that contractors can do so. A contractor facing supply chain constraints or a business shutdown often will have no entitlement under their contract to claim an extension of time, nor to claim their costs associated with any delay. Construction contracts commonly allow these kinds of relief only in a narrow range of circumstances that does not include supplier delays or shutdowns. Contractors may also consider their rights under the suspension clauses that are included in most construction contracts. Again though, construction contracts usually do not allow contractors to suspend work unilaterally and then claim the time and cost impacts of suspension. The construction industry stands in a unique position when gauging the impacts of the response to the COVID-19 pandemic. Largely declared an essential industry, many construction projects were not shut down, even in the early months of the pandemic. However, the public funding on which infrastructure projects rely and the general economic health of the nation both threaten to significantly slow down the market. This is why getting the perspective of contractors on their business expectations and on how they are responding to the new requirements and conditions is essential.

Each of the recent studies also looked at the way contractors have changed the way they do business due to the COVID-19 outbreak. About three quarters of both civil and commercial contractors report that they have changed work procedures to increase social distancing. However, allowing remote work options for office employees is more common among commercial (67%) than civil (50%) contractors. While few contractors in general report that they have had to adjust employee salaries, furlough or lay off

employees, there has been a greater need to do so among commercial contractors (20%) than civil contractors (10%).

The construction supply chain is highly impacted, generating project slippage and/or extra costs. Enhanced focus on worker safety and increased cost pressure could accelerate the move to offsite construction methods. The efficiency and controlled environment of factory production can help in leveraging labor costs and in optimizing project schedules. To increase competitiveness, engineering and construction companies should improve the balance between site work, office engineer and factory assembly. With project complexity and risks continuing to increase and additional pressure due to work method changes and supply chain disruption, the compression of costs is likely to translate into project margin slippage and occasionally corporate failures. Engineering and construction companies need to find innovative ways of absorbing these impacts. The path forward is to understand the impact of the COVID-19 crisis on each project, review and adjust project planning, predict slippages in costs and time, and communicate (and negotiate) new milestones with all stakeholders.

A large share of solutions, like Building Information Modelling and integrated project management platforms to name a few, were already identified as digital building blocks for the construction industry. There's been a paradigm shift in many areas that is leading engineering and construction companies to do many things differently than they did in the past.

Companies who **fast-track their digital adoption** by augmenting workers and engineers with digital collaboration capabilities, automating low value-added activities and sharing data for rational and insight-driven decision making, **and who reinvent their relationship with third parties - clients, suppliers, subcontractors** - will be strengthened and ready to succeed in a post-COVID-19 world.

## 1.2 STATEMENT OF THE PROBLEM:

The supply chain is a network of organizations involved, from the supplier of the supplier until the client of the client, on the different processes and activities that produce value in the form of products and services for the final client. Its major components are

the suppliers' network, the transformation unit and the clients' network. The effective management of the supply chain is necessary for successful competition in today's global markets. The increasingly global context in which businesses operate support innovation, but also increases uncertainty around supply chain disruptions. Construction field is one among it which faced a huge impact on its supply chain operations due to Covid-19. The Covid-19 pandemic clearly shows the lack of frontline workers and lack of transport facilities cause a huge blow to construction field that disrupts the global network scale as individual supply chain connections and nodes fail. In many projects, there is no contractual obligation for the client to support the main contractor with additional costs, and even where clients do provide such payments it is difficult to know how these are being cascaded down the supply chain. This paper reviews on supply chain operations that focusses on changes and innovation that connects the supply chain to other network, including transport, command and control. This paper presents the main results of a diagnostic study about the relationships between the participants of the supply of construction. It also provides a general methodology for the application of SCM in construction after Covid-19. Finally, it discusses about its main application problems and their causes, its benefits and the requirements for its effective application in future. A proactive approach that seeks sound and practical legal advice will be essential to making cost-effective decisions as new impacts from the pandemic materialize with industry members. One of the principal conclusions of the paper is that the application of SCM in the local construction sector will require the introduction of several changes in the way that participants of the supply chain interact currently. Some of these changes are analyzed and discussed.

### **1.3 INDUSTRY PROFILE:**

In order to handle the complexity in terms of stage of completion, size of project and the geopolitical situation. Each region catered to the demand of specialized construction services in that region and had its own materials department.

The materials department of the construction got its own ISO-9002 certified indicating the level of importance it gave to the management of suppliers. They adopted a sound and effective supply chain management strategy in order to keep the supply chain costs minimum. Its quality policies emphasized minimum landed costs, transparent practices and optimum inventory levels.

One constant challenge faced was integrating and collaborating its supply chain participants. The root cause of the challenge was the construction industry itself. The project sites being spread out in various locations and the large supplier base made it difficult to minimize the supply chain cost.



**Figure 1.1 Supply chain in construction industry**

The construction industry is a key sector of every country and the application of supply chain-related techniques holds much promise to improve performance of construction firms in many ways. According to an extended view, which encompasses the construction of industrial and residential buildings, of civil engineering and infrastructure projects, there is a number of major actors that must be coordinated in some way to reach ETO decisions, leading to performance outcomes and metrics. The need to co-ordinate information across the supply chain is a persistent and pressing challenge for ETO companies. Procurement helps to establish the conditions for the supply chain to function effectively. New technologies such as product configurators or cloud manufacturing are being applied. Planning and decision making is a critical driver. In the future, the

challenges of applying supply chain management techniques to a construction environment, will require more quantitative studies, to cast light on some potential gains from better information management and use of digital technologies. Then there is also an opportunity to integrate clear upfront planning and procurement with the project delivery processes, and choose the right configurations, focus and relational types.

The Construction industry in India consists of the Real estate as well as the Urban development segment. The Real estate segment covers residential, office, retail, hotels and leisure parks, among others. While Urban development segment broadly consists of sub-segments such as Water supply, Sanitation, Urban transport, Schools, and Healthcare. Indian real estate attracted \$5 billion institutional investments in 2020.

The Construction industry in India is expected to grow at 5.6% during 2016-20, compared to 2.9% during 2011-15. The activities that registered the highest growth include export cargo (10%), highway construction/widening (9.8%), power generation (6.6%), import cargo (5.8%) and cargo at major ports (5.3%).

The present study reports profile of construction industry in India. It points that construction industry is one of the oldest industries providing ample employment to the people from village level to metropolitan cities. The size of construction industry ranges from small company owned by one or two individuals to a large industry employing thousands of people. Thus it can be said that any attention to optimize construction activity will lead to reduction in waste of material, saving of energy and saving of time. This will certainly lead to reduction in cost over runs of other projects. Thus, construction sector is directly or indirectly influences the overall economy of the country.

#### Market size

Turnover of the capital goods industry was estimated at US\$ 92.00 billion in 2019 and is forecast to reach US\$ 115.17 billion by 2025. India exports engineering goods mostly to US and Europe, which account for over 60% of the total export. Engineering exports reached US\$ 75.90 billion in FY20 and reached US\$ 39.90 billion in FY21 (between April 2020 and October 2020). Index of industrial production (IIP) for electrical equipment industry stood at 105.5 in FY20.

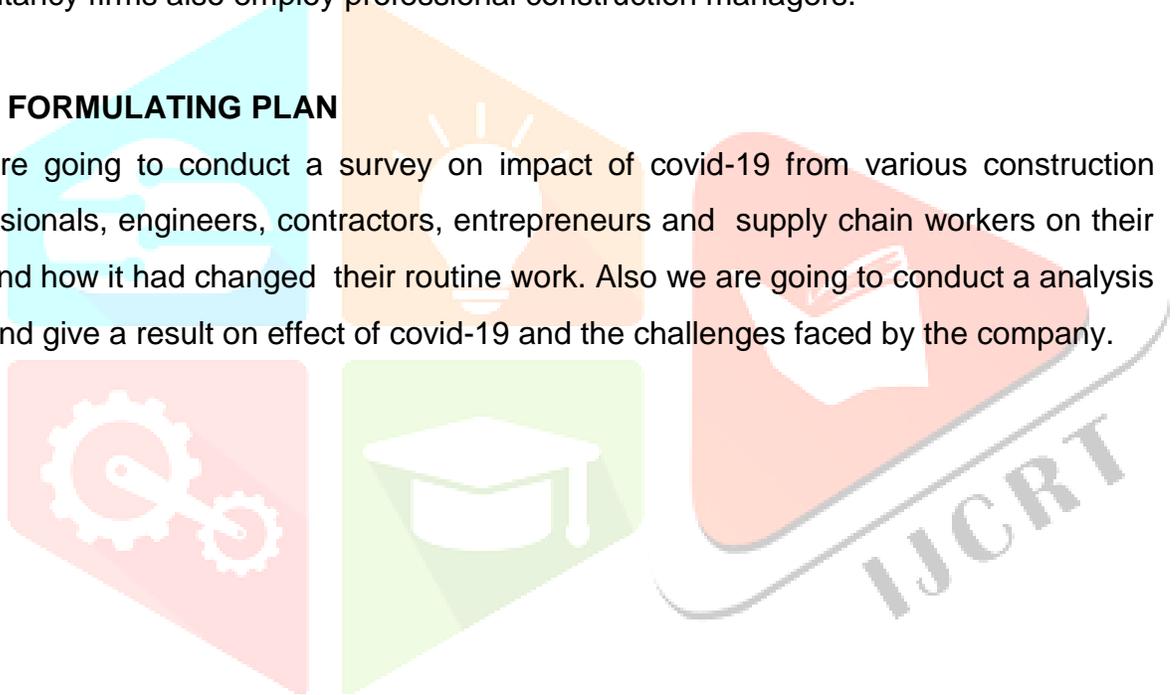
## Properties

Human capital is the most important asset to the construction company. Clearly the success of the construction industry mostly depends upon the quality of its people and this quality of human capital will depend upon possible employment opportunities. Indian construction industry is looking for leaders who likes to shape the world in which we live at.

The private sector offers wide employment opportunities, particularly for those who trained in architecture and construction project management. Large construction houses, multinationals, builders and promoter firms, real estate developers and construction consultancy firms also employ professional construction managers.

### 1.4 FORMULATING PLAN

We are going to conduct a survey on impact of covid-19 from various construction professionals, engineers, contractors, entrepreneurs and supply chain workers on their field and how it had changed their routine work. Also we are going to conduct a analysis on it and give a result on effect of covid-19 and the challenges faced by the company.



## CHAPTER – 2 LITERATURE REVIEW

### 2.1 REVIEW OF LITERATURE

**Akintola Akintoye, George Mc Intosh, Eamon Fitzgerald** suggests that the paper details the results of a questionnaire survey of supply chain collaboration and management in the top the UK construction industry contractors. The results indicate the formation of a significant number of partnerships/ collaborative agreements between contractors, suppliers and clients following the publication of the Latham (1994) and Egan (1997) reports. It appears that construction supply chain management (SCM) is still at its infancy but some awareness of the philosophy is evident. Contractors identified improved production planning and purchasing as key targets for the application of SCM in construction. Barriers to success included: workplace culture, lack of senior management commitment, inappropriate support structures and a lack of knowledge of SCM philosophy. Training and education at all levels in the industry are necessary to overcome these barriers. Supply chain collaboration and management has been used in many industries to gain competitive advantage. From the retail industry to the automotive and the agricultural industries, the philosophy has examples of successful applications. Japanese car manufacturers have enjoyed the benefits of a close relationship with suppliers, enabling a close two-way flow of information and benefits. Following this success, The Supply Chain Council developed a supply chain operations reference model in order for different industries to apply the philosophy and improve their own strategy.

**Ruben Vrijhoef, Lauri Koskela** suggests it is argued that due to construction peculiarities, supply chain management has four specific roles in construction. Practical initiatives in each role to advance the construction supply chain are analyzed. The present status of construction supply chains is investigated by means of case studies and a comparison with previous research. Three main conclusions are drawn regarding the present status. Firstly, even in normal situations the construction supply chain has a large quantity of waste and problems. Secondly, most of these are caused in another stage of the construction supply chain than when detected. Thirdly, waste and problems are largely caused by obsolete, myopic control of the construction supply chain. These results concur with the findings made on make-to-order supply chains in general. Finally, the subjective and objective limitations of the four roles are analyzed, this being based on empirical findings and the generic theory of supply chain management. This paper contains three contributions to knowledge. Firstly, various existing initiatives towards constructure supply chain development are explicitly related to a generic SCM methodology. In this context,

four roles of SCM have been identified. Previous research has often been partial, focusing solely on one role at a time. Secondly, the present status of construction is empirically assessed from a supply chain viewpoint. The result of this investigation is revealed to be compatible both with previous observations in construction and in make to order supply chains. The result provides a new, empirically founded understanding of construction supply chains and shows that great potential exists for their improvement. Thirdly, based on the new empirical understanding and generic theories of SCM, limitations in each role have been recognized and discussed. All in all, it can be assumed that the generic body of knowledge accrued in the framework of SCM leads to improved understanding of the nature of construction supply chain problems, and provides direction for action. However, the practical methods for SCM implementation have to be developed so they take into account the characteristics and the specific situation of construction.

**George O fori** it is acknowledged that construction activity has major impacts on the environment. Moreover, the construction process is usually fragmented, and involves several parties with different objectives. Thus, often, none of them normally assumes direct responsibility for protecting the environment. The concept of supply chain management (SCM) is now commonly applied in business for the mutual benefit of enterprises in the supply chain (from the organization extracting the basic raw material to the final customer). A basic principle of SCM is “integration”. However, SCM is not well known in the construction industry. This paper considers the potential of applying SCM to integrate the construction process in Singapore, and thereby, address its pressing problems including its poor environmental performance. It is found that SCM can help to green the construction supply chain in Singapore. Some recommendations on how awareness of SCM can be enhanced, and its application by construction enterprises made most likely to succeed are offered. There is scope for the application of SCM in Singapore construction. Its focus on integration, the entire product life-cycle and the inclusion of parties involved in all stages of the production process as well as stakeholders is particularly relevant. SCM offers a suitable approach to the effort to enhance the performance of the Singapore construction industry, as it will help to reduce the fragmentation, and the win lose short-term views which characterize relationships within the industry. SCM can also help to effectively green the construction supply chain in

Singapore. However, several major obstacles will have to be overcome before SCM can be widely implemented in Singapore construction, including the conceptual problems of designing the appropriate supply chain, and practical ones of entrenched business practices and attitudes, and lack of knowledge about SCM or its benefits. Moreover, despite its potential, SCM will not be a panacea for all the problems of the industry. SCM should be implemented in the Singapore construction industry in its most comprehensive form if its full potential is to be realized. Environmental purchasing should be an integral element of the form of SCM which is applied in Singapore.

**Stuart Tennant & Scott Fernie** suggests supply chain management in construction continues to attract considerable academic and industry interest. With its origin in manufacturing, successful implementation of supply chain management is argued to enhance customer value whilst simultaneously reducing business costs. In the UK construction industry, supply chain management strategies remain largely synonymous with best practice initiatives such as construction partnering, strategic alliances and more recently construction framework agreements. In contrast to this arguably misleading and impoverished viewpoint, the purpose of this research is to develop fresh perspectives and present a contextually sympathetic typology of supply chain management in construction. Drawing on new organizational institutionalism, economic governance and transactional cost economics (TCE), the utility and performance of supply chain management in construction is portrayed as rational choice among multiple strategies, instrumentally bound by contract and context. This contextually sensitive interpretation of supply chain management captures complex, diverse and often unique characteristics of construction practice. Challenging mainstream assessment of supply chain management can clearly help construction stakeholders focus attention on discrete supply chain strategies that best suit their organizational and project needs. Construction framework agreements are currently the subject of intense scrutiny. Despite BAA (the construction client's unofficial flag bearer of industry best practice) turning its back on framework agreements (Wright, 2009), frameworks remain firmly part of the construction landscape (Chevin, 2011). Exploring framework agreements through the lens of neoclassicism has contributed to the current scrutiny, understanding and debates focused upon their relevance. Drawing upon the three axioms at the center

of neoclassicism, explanations for their current relevance. within construction are clear. Firstly, individualism and self-interest remain at the heart of construction practices regardless of whether or not framework agreements are in place. The adoption of framework agreements therefore does not necessarily suggest a shift away from self-interest, opportunism and adversarial working relationships. Secondly, instrumentalism supports explanations that organizations within framework agreements may rationally choose to adopt practices (and discourse) associated with collaboration rather than being driven to adopt best practice. Adoption is underpinned more by self-interest and commercial optimization in pursuit of a successful business outcome. Similarly, the adoption of practices associated with opportunism and arm's length contracting is also underpinned by the self-interests, commercial optimization and need for a successful outcome. Thirdly, an understanding of equilibrium suggests that framework agreements address two key points: the need for clients to secure supply in a buoyant market; and contractor's ongoing search for continuity of workload. Commercial relationships therefore owe much more to self-interest, commercial optimization and the 'shadow of future workloads' than to notions of trust rooted in personal relationships. Commercial incentives to collaborate, such as framework agreements, cast in a shadow of future workload (for the medium term, see Skaperdas and Syropoulos, 1996) support 'cooperation based on reciprocity' (Welling and Kamann, 2001, p. 4), not necessarily because organizations trust one another. The attractiveness of working collaboratively has more to do with commercial advantage founded on corporate self-interest – which may be enhanced by working cooperatively rather than notions of 'fairness', social conscience or altruism.

**Mukesh Kashyap, Xian guang Li, Carl Abbott** suggests knowledge Management (KM) is becoming increasingly important for organizations across a wide spectrum of industry sectors, especially for the naturally fragmented construction industry. There has been a growing realization that it is very important for each project participant to effectively capture, share and utilize strategic knowledge and project knowledge, as well as process knowledge within the construction supply chain for better performance. This paper highlights the benefits of integrated construction supply chain management through effective KM. The paper reviews the general literature in construction supply chains and KM and presents some initiatives in the abovementioned area, followed by a

full theory analysis and case study. The case study was conducted with a public sector client organization in the UK. It explored their strategies for an integrated construction supply chain through KM, knowledge capture and knowledge sharing. It also studied the reuse by their employees as well as by the other organizations they worked with to deliver construction projects in north-west England. The paper concludes that KM would effectively improve the integration of construction supply chains and thus improve overall production performance. This paper has explored the role and method of KM to achieve an integrated and effective supply chain through literature review, theory analysis and a case study. The paper started with defining the concept of supply chain management within the construction industry as well as KM across construction supply chain. The CoP concept with focus on KM was only observed in one of the four case studies conducted; therefore, the other three case studies and their findings were out of the scope of this paper. The later part of the paper presented a case study within which CoP have been identified as an effective way of managing organizational knowledge and integrate construction supply chain. The case study described a client-driven initiative in the construction industry where three subcontractors and their supply chains have become a community of practice, through KM to facilitate supply chain integration and cooperation, hence delivering better value to the client. The three main contractors involved themselves voluntarily in the whole process of capturing and sharing both tacit and explicit knowledge with their competitors in the region. The incentive of participation in KM is identified by the continuous work and opportunities for future work with the same client for at least five years. The process has been a valuable learning experience and lessons learnt have resulted in achieving improvement in Key Performance Indicators and better client satisfaction. The adoption of KM has improved the integration of the specific construction supply chain and facilitated the development of a community of practice focused on helping the client to fulfil their aims related to regeneration and sustainable communities (Khalfan and McDermott, 2006; 2007). The main contribution of the paper is to identify and highlight the applicability of KM to achieve construction supply chain integration to illustrate how this can be implemented using tools.

**Sulafa Bad, Niamh Murtagh** suggests the construction industry is responsible for significant environmental impact. Mounting ecological and societal concerns are driving construction to 'go green'. Green supply chain management offers the potential of a systemic approach to facilitate transformation of the sector. Research on green supply chain management in construction has been growing in recent times but to date has not been systematically brought together. A systematic literature review (SLR) is presented, applying the high standards of rigourous and transparency required by the methodology. From an initial search result of 207 papers, 44 were included in the detailed analysis. The papers are described in terms of publication outlet, date of publication, geographic setting, methods used, tools and techniques, conceptual definition, the role of stakeholders and practical implications. The findings are synthesized to propose a categorization of approach and a comprehensive definition of green supply chain management in construction. An agenda for future research is outlined which emphasizes the need for an end-to-end perspective, engagement with the unique characteristics of the industry, a focus on the ultimate goals of environmental sustainability, and on gaps in practical guidance, use of insights from relevant theoretical perspectives, and expansion to include critical stances. This study applied a systematic literature review to offer a comprehensive and rigorous perspective on Green SCM research published before the end of August 2017 in the construction industry. The scholarly work reviewed is of significant value in advancing Green SCM in construction. The reviewed sources have been described according to the publication outlet, date of publication, geographic setting, methods used, tools and techniques, conceptual definition, and the role of stakeholders. The practical implications deriving from the papers were also underlined. Synthesis has resulted in a proposed categorization of research approaches and a comprehensive definition of Green SCM in construction was also developed. The review opens interesting opportunities for future research and underlines the need for an end-to-end perspective, engagement with the unique characteristics of the industry, a focus on the ultimate goals of environmental sustainability, and on gaps in practical guidance, use of insights from relevant theoretical perspectives, and expansion to include critical stances. Green SCM may hold the competitive edge in the 21st century's construction industry as increased ethical and environmental awareness among communities as well as construction clients grows. The

pressure on the construction industry to transform itself to address its role in environmental and climate damage will only increase. It is hoped that the research agenda proposed some timely insights and reminders which may prove useful in future research in this vibrant and vital research domain.

**H. Ping Tserng, Ren-Jye Dzeng, Yu-Cheng, Lin Sheng-Tai Lin** suggests that construction project control aims to effectively obtain real-time information and enhance dynamic control by utilizing information sharing and connecting involved participants of the projects to reduce construction conflicts and project delays. However, extending the construction project control system to job sites is not considered efficient because using notebooks in a harsh environment like a construction site is not particularly a conventional practice. Meanwhile, paper-based documents of the site processes are ineffective and cannot get the quick response from the office and project control center. Integrating promising information technologies such as personal digital assistants (PDA), bar code scanning, and data entry mechanisms, can be extremely useful in improving the effectiveness and convenience of information flow in construction supply chain control systems. Bar code scanning is appropriate for several construction applications, providing cost savings through increased speed and accuracy of data entry. This article demonstrates the effectiveness of a bar-code-enabled PDA application, called the mobile construction supply chain management (M-ConSCM) System, that responds efficiently and enhances the information flow between offices and sites in a construction supply chain environment. The advantage of the M-ConSCM system lies not only in improving the efficiency of work for on-site engineers, but also providing the Kanban-like visual control system for project participants to control the whole project. Moreover, this article presents a generic system architecture and its implementation. This article presents a web-based portal system that incorporates wireless technology and mobile devices to improve the efficiency and effectiveness of data acquisition on site and information sharing between participants to assist the managers to control and monitor the construction supply chain delivery progress. The MConSCM system not only improves the data acquisition on site efficiency by using automated bar-code-enable PDA, but also provides a monitor to control the construction progress. On the client side, on-site engineers use PDAs to overcome time and space constraints, enabling them to read and

record/edit all necessary or important information. On the server side, the M-ConSCM system offers a hub for the information and control center to provide suppliers and subcontractors real-time updated project-related information and to monitor the construction progress. In the case study, the application of the MConSCM system assists in improving operation progress monitoring for precast building construction (real-case application for office buildings in the Nankang Software Park of Taiwan, Taipei). The integration of real-time production and delivery information from precast supplier makes it easy for the GC manager to monitor and control the whole construction progress. Furthermore, the precast supplier may update the erection progress to reschedule the precast components production and assessment in real time. Real-time feedback regarding the status of progress on-site is provided to the fabricator off-site, so process steps can be re-sequenced opportunistically. In comparison with the current methods, all the information/data communication in the site can be improved by using automated barcode-enabled PDAs and the information sharing among participants and is made quicker and more efficient through the portal technology.

**Soo-Yong Kim & Viet Thanh Nguyen** suggest that Supply chain management (SCM) is considered to be the future of the construction industry. However, it is applied slowly because of barriers against its implementation. In addition, the potential benefits brought from construction supply chain management (CSCM) may not be achieved as expected if the barriers are not identified and removed. The barriers to the CSCM implementation seem to have not been thoroughly explored and analyzed by previous studies. This study identifies the barriers and discovers the underlying relationships among them. The results of the study showed that lack of effective leadership, lack of competence of parties in SCM, lack of understanding the supply chain concept, passive sub-contractors and suppliers, and organizational resistance to SCM were the five most significant barriers. The underlying relationships among the barriers were discovered under five factors, namely lack of knowledge and competence, lack of support and active participation from parties, confronting culture and adversarial behaviour, deficiencies in the contract system, and inherent difficulties in SCM. The findings could help practitioners to fully understand the barriers and to come up with appropriate strategies for promoting the development of the CSCM. The study contributes to the field of knowledge related to

the CSCM. This study identified twenty-two barriers to the CSCM implementation. In general, all four groups of respondents, including owners, contractors, designers, and consultants had a convergence of perceptions on ranking the 22 barriers. They agreed that 'lack of effective leadership' and 'lack of competence of parties in SCM' were the two most important barriers, whereas 'complexity and harshness of SC process' and 'fragmented characteristics of the construction industry' were the two least important barriers. Using factor analysis method, the identified barriers were combined into five factors, including (1) lack of support and active participation from parties, (2) confronting culture and adversarial behavior, (3) inherent difficulties in SCM, (4) lack of knowledge and competence, and (5) deficiencies in the contract system. Among these factors, factor 4, factor 1, and factor 2 are the most significant factors, which practitioners should pay attention immediately to promote the development of the CSCM implementation. The study indicated that owners do not seem to care about the unfairness of sharing risks and benefits and so they do not consider it as the main barrier to the CSCM implementation. This can be a common practice so that owners transfer most of the risks to contractors as much as possible. In the CSCM implementation, owners may believe that the power domination and frequent contractual non-commitments from one of the parties is a significant barrier while the others may think that it is the inevitable problem in relationships and they may withstand it to ensure something like maintaining relationships. The results of the study also showed that owners emphasized understanding customer requirements more than the others. This implies that they always ask the other parties to fully understand their requirements, thereby achieving the best project results. Contractors have a significant interest in the trust among the parties in SC. This interest is probably because contractors play an intermediary role as a tier in the CSC to link between upstream members and downstream members, so they may believe that a successful implementation of SCM requires the trust among the parties in SC.

**Xiaolong Xue, Yaowu Wang, Qiping Shen, Xiaoguo Yu** suggests the construction industry in general is characterized with high fragmentation, low productivity, cost and time overruns, and conflicts compared with other manufacturing industries. Supply chain management as an innovative management mode provides a new solution for resolving these problems from systems perspective. Coordination is the core issue to

improve construction performance in construction supply chain (CSC). In this paper, the concepts of CSC and CSC management are defined. Furthermore, the inter-organization problems that effect CSC coordination are identified. Considering the Internet fosters the integration of construction processes and provides an efficient platform for CSC coordination, this paper presents two types of Internet-enabled coordination mechanisms: market mechanism, such as auction and contracting, and coordination flow, including information hub and electronic marketplace, for improving construction performance and to accelerate the innovations in the construction industry.

**Lung-Chuang Wang, Yu-Cheng Lin, Pao H.Lin** suggests construction project control attempts to effectively obtain real-time information and enhance dynamic control and management via information sharing and analysis from involved participants of the projects to reduce construction conflicts and project delay. However, extending the construction project control system to job sites is considered inefficient since construction sites are unconventional practice. Integrating promising information technologies such as radio frequency identification (RFID) technology, mobile devices PDA and web portals can help improve the effectiveness and convenience of information flow in construction supply chain control systems. Radio frequency identification is appropriate for various construction applications, and provides cost savings through increased speed and accuracy of data entry. This study demonstrates the effectiveness of a RFID-based supply chain management application called the mobile construction RFID-based dynamic supply chain management (M-ConRDSCM) system in construction projects, demonstrating that it responds efficiently and enhances the information flow among offices and sites in a construction supply chain environment. The M-ConRDSCM system is then applied to a selected case study involving a HighTech factory building in Taiwan to verify the proposed methodology and demonstrate the effectiveness of information sharing of project control in the construction phase. The advantage of the M-ConRDSCM system lies not only in improving work efficiency for on-site engineers, but also in providing dynamic operation control and management to enable project participants to control the whole project. Moreover, this study presents a generic system architecture and its implementation.

**Chong Wu, David Barnes** suggests stricter governmental regulations and rising public awareness of environmental issues are pressurizing firms to make their supply chains greener. Partner selection is a critical activity in constructing a green supply chain because the environmental performance of the whole supply chain is significantly affected by all its constituents. The paper presents a model for green partner selection and supply chain construction by combining analytic network process (ANP) and multiobjective programming (MOP) methodologies. The model offers a new way of solving the green partner selection and supply chain construction problem both effectively and efficiently as it enables decision-makers to simultaneously minimize the negative environmental impact of the supply chain whilst maximizing its business performance. In presenting a model for green partner selection and supply chain construction, this paper makes the following contributions: Firstly, the proposed model can enable organizational decision-makers to simultaneously meet the highly desirable objectives of both minimizing the negative environmental impact of the supply chain whilst maximizing business performance. This is an advance on existing methods, which do not offer this capability. Secondly, the proposed model can achieve the goal of partner selection and supply chain construction (i.e. the lot-sizing problem) simultaneously. Thereby, managers of GSCs can identify the most suitable potential partners and construct the optimal GSC structure at the same time. The results of these two decisions can be mutually corroborated if they are made during the same phase of decision-making. Thirdly, the proposed model combines two established techniques, namely analytic network process (ANP) and multi-objective programming (MOP) methodologies, to a new context, namely that of meeting environmental goals in business. Whilst the use of a model based on a combination of ANP and MOP for supply chain partner selection is not new (Wu et al., 2009), this is the first time that such a model has been applied to the green partner selection and supply chain construction problem. As such, this represents an advance on existing approaches, as it offers a new way of solving the green partner selection and supply chain construction problem effectively and efficiently. Fourthly, through the extension of the proposed model to develop the concepts of the environmental difference, the business difference and the eco-efficiency ratio, the paper provides an additional tool for decision-makers to quantify the trade-offs between environmental and business performance. Furthermore, the

ecoefficiency ratio could also be used by government and other regulatory bodies to help them to adjust the intensity of their environmental regulations in order to improve the environmental performance of specific industries. Last but not least, the paper makes an additional contribution through the use of the ANP sub-model, which can balance the different green criteria and business criteria more reasonably and efficiently. This is an advance on existing models, such as the optimum mathematical planning model for partner selection in GSCs, in which main objectives are treated equally.

**Fredrik Persson, Mirko Araldi** suggests the supply chain operations reference (SCOR) model is developed and maintained by the supply chain council (SCC). The SCOR model is a reference model that can be used to map, benchmark, and improve supply chain operations. SCOR provides companies with a basic process modelling tool, an extensive benchmark database, and defines a set of supply chain metrics. The software ARENA is a commercial simulation tool that can be used for simulation modelling in various applications. An integration of SCOR and ARENA provides the supply chain analyst with a comprehensive and dynamic tool. This paper reports on the ongoing work to integrate the SCOR methodology and a discrete event simulation tool. SCOR is basically used to study the static operations of a supply chain. However, there is also a need to study the dynamic effects e.g. of changes in production rate, poor quality in raw materials, and other effects related to the “bullwhip” behavior of a supply chain. During the construction of the SCOR template and the implementation of the two cases, it became clear that the SCOR model and the new SCOR template offers solutions to some of the problems with supply chain simulation, outlined in the two introductory sections. At the same time, new and unforeseen problems surfaced. This concluding section discusses these issues and provides an outlook for future development of the SCOR template.

**Elisa Alonso, Jeremy Gregory, Frank Field, Randolph Kirchain** suggests that market forces are inadequate to successfully manage the problems of resource availability and use. The fundamental question is whether these inadequacies are intrinsic to the market or if they arise from a failure of firms to detect and respond to subtle market signals. This paper explores the latter by describing mechanisms that can limit materials availability, effects of such limits on the firm, preliminary metrics to diagnose these risks,

and strategies to reduce a firm's risk exposure. Case analyses of two materials systems are used to suggest that private firm interests, when properly informed, can motivate strategies that drive toward sustainable materials use. These strategies include improving production efficiency, developing technology to use more sustainable substitute materials, and facilitating a more effective materials recycling infrastructure. The materials scarcity literature suggests a number of metrics that indicate increased risk of limited availability. The problem for those attempting to ascertain risk is the complexity of a materials economy. Reducing this complexity to a manageable indicator requires simplification and abstraction. Ultimately, no single approach retains complete generality and none captures all of the dynamics of materials use. Nevertheless, the copper case illustrates that careful application of metrics offers insights that should help guide a firm's strategy. The range of metrics explored proved to be both analytically feasible and able to distinguish materials as being potential sources of risk for firms. Exercising the breadth of risk metrics against copper offered a nuanced look at the nature of the risk. This exercise suggests that firms that utilize materials at risk should undertake more sophisticated assessments that comprehend the many interrelated dynamics of supply, demand, and substitution. Given the breadth of the impacts that can derive from limited materials availability, post facto responses are unlikely to be effective. Supply chain-managers need to assess their risks to materials availability and, when appropriate, prepare for possible future problems. Fortunately, specific strategies exist to mitigate this risk. Dealing with risk and uncertainty within the supply chain is a topic addressed by a growing literature intended to drive more robust and resilient supply chains (34-38). First of all, this literature suggests that supply-chain managers must know their supply chain (34, 35). In the case of materials availability, this includes not only monitoring metrics of risk but also fostering the existence and exchange of information to ensure accuracy of those metrics. Armed with information, managers can identify how and when to modify their supply chain practices.

**Joseph Sarkis, Qinghua, Zhu Kee-hung Lai** suggests Green supply chain management (GSCM) has gained increasing attention within both academia and industry. As the literature grows, finding new directions by critically evaluating the research and identifying future directions becomes important in advancing knowledge for the field. Using organizational theories to help categorize the literature provides opportunities to

address both the objectives of understanding where the field currently stands and identifying research opportunities and directions. After providing a background discussion on GSCM, we categorize and review recent GSCM literature under nine broad organizational theories, with a special emphasis on investigation of adoption, diffusion and outcomes of GSCM practices. Within this review framework, we also identify GSCM research questions that are worthy of investigation. Additional organizational theories which are considered valuable for future GSCM research are also identified with a conclusion for this review. We can make a number of observations of this initial review and integration of the literature. First, the organizational theory provides a very valuable source of theoretical underpinnings for investigating and furthering research in GSCM. Second, there are ample opportunities for future research and investigation with theories that have already been applied. Significant questions still exist that require investigation. Third, there is also an ample room for new theories examining the GSCM management, introduction, and diffusion that have not seen significant investigations. Fourth, much of the literature on the applications and uses of theory in GSCM research has been relatively recent. This observation means that we are at the growth stages of GSCM and organizational theory linkage. Fifth, additional and emergent organizational theories may exist that can help address unforeseen and nascent GSCM issues. Finally, even though we identify some additional theories, researchers in GSCM could be able to develop theories that may explain other organizational phenomena. We believe that this paper can serve as a good foundation for those seeking to develop theories and broaden research in GSCM. We did not discuss various methodologies and tools that could be used to investigate the linkage of GSCM and the organizational theory. Methodological developments and application for supply chain and GSCM research are also promising areas for future studies. We believe that significant growth and opportunities to understand our world exist at the nexus of these imp

**VSR Krishna Nemani, Shaligram Pokharel & Abdulla Yagoub Al Sayed** proposes a multi-criteria decision-making (MCDM) framework and demonstrates the impact of competitive conditions on supplier evaluation process for construction supply chains. The paper focuses on the supply chain of a large-scale housing project in order to illustrate the role of competitive capability and suppliers' profile and its influence on

supplier evaluation based on prevailing supply/market conditions. Various scenarios are investigated to demonstrate the impact of competition on supplier evaluation. The contribution of the study lies in highlighting the impact of supply/market conditions on MCDM decisions causing supplier evaluation 'imbalance' and MCDM usage. It is expected that the study will be useful for project management, construction, supply chain management, sourcing professionals. The findings of the study are generalizable to projects-based situations such as petroleum refinery and ship building where bill of materials typically consists of thousands of items and a large number of suppliers are involved. In accordance with the research questions raised, authors investigated supplier evaluation in context to an affordable mass housing project construction supply chain. The authors have assessed the impact of competitive capability and supplier profile in perfectly competitive supply/market environment and highlighted imbalance. Various methods were shown in order to lead the ABC company to make the right decision on the choice and use of MCDM for supplier evaluation. These evaluations are very important both at planning and execution stages of project when various baselines like cost, scope, time and quality are extensively analyzed to ensure best possible outcome keeping other considerations in mind. While using AHP, authors and experts were careful about the use of scale, pairwise comparisons, consistency checks (Saaty 1980), and other necessary conditions. Calculations coupled with consistency checks and sensitivity analysis validates study. One can notice that the difference between rankings is insignificant which indicates ranking practically remains the same. It happens due to perfect supply/market conditions and clearly highlights a tilt in the evaluation framework, indicating imbalance in criteria sets. This also creates a need to incorporate supply/ market conditions and the nature of competition while carrying out evaluations by decision makers and project managers.

**Jan Stentoft Arlbjørn, Henning de Haas & Kristin Balslev**

**Munksgaard** suggests Supply chain management promises competitive advantages for industrial organizations. The introduction of new products and services, or entry into new markets, is likely to be more successful if accompanied by innovative supply chain designs, innovative supply chain management practices, and enabling technology. This is a widely accepted premise in business practice today. However, systematic research

and knowledge about supply chain innovation (SCI) is little developed. There is a lack of common terminology, of agreement about the conceptual understanding, and of related empirical work. This paper presents an exploratory study that aims to provide a better understanding of SCI, mirroring leading edge practice, and providing a sound terminological and conceptual basis for advanced academic work in the field.

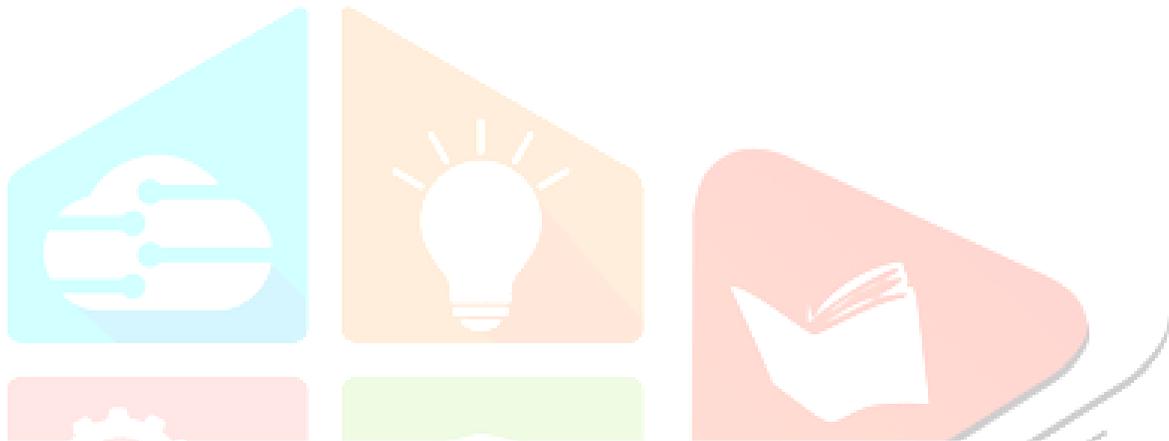
**PengxingYiMin, Huang Li jun Guo, TielinShi** suggests concentrating on the optimal design of a retailer oriented closed-loop supply chain network for the end of life construction machinery remanufacturing, we develop a mixed integer linear model incorporating the reverse logistics network into the forward logistics network, and apply an improved hybrid genetic algorithm, the performance of which has been evaluated by the optimization software LINGO, to solve how to optimize the structure of the closedloop supply chain network. By conducting a real-life case study on a target construction machinery remanufacturing firm in China, our research confirms that the proposed model can successfully determine the location of different types of function centers and manage the flows of used products, various components and remanufactured products. In addition, the influence of the collection ratio and the capacity of facilities is also elaborately explored to give manage insights to the firms on future strategies making and gaining profits in the execution of this environmentally friendly practices.

**Togar M.Simatupang, Ramaswami Sridharan** suggests heavy equipment refers to heavy-duty vehicles that hold an important role in executing construction projects and production operations. The available literature lacks sufficient information to provide an understanding of the characteristics of the heavy equipment supply chain. The purpose of this research is to examine the heavy equipment supply chain in Indonesia and to identify barriers and opportunities. This research was conducted based on a two-stage research design, starting with qualitative interviews and followed by a focus group discussion. The heavy equipment supply chain shows unique characteristics of production, distribution, and utilization cycles. The findings from the analysis show typical problems faced by the heavy equipment supply chain in Indonesia are that it lacks communication and incentives.

**Tae-HongShin, Sangyoon Chin Su-Won Yoon Soon-Wook Kwon** suggests as buildings are now taller, larger, and more complex, it has become increasingly more difficult to secure stockyards for materials and to resolve the surrounding traffic problems, creating an increased need for Just-In-Time (JIT) delivery. To support JIT delivery, it is necessary to build a framework that can facilitate the collection and share of information on construction components and material flow throughout the whole supply chain process. Many researchers have suggested that radio frequency identification (RFID) and wireless sensor network technologies could improve the effectiveness and efficiency of JIT management. In addition, service-oriented architecture(SOA), the services of which enable the interfacing of a heterogeneous system environment of parties involved in the supply chain management process, is suggested in the manufacturing industry as one of the solutions for effective collection and sharing of information in supply chain management. However, the construction industry has limits in applying the framework suggested in the manufacturing industry since the supply chain process in the construction industry is extremely dynamic due to frequent changes in the design and plans of construction projects. Therefore, the objective of this research is to develop a seamlessly integrated information management framework that can provide logistics information to project stakeholders for their decision making. The pilot test of the framework developed in this research showed that it can improve time efficiency by about 32% compared to the traditional supply chain management. The result of this research is expected to be utilized effectively as a basic framework to manage information in RFID/WSN based construction supply chain management (CSCM) environments.

**R.V.Silva J, de Brito R.K.Dhir** delivers a response to the great disparity in the recycled aggregates (RA) evaluated in most investigations and those sourced from recycling plants, this paper presents an overview on the subject and seeks to provide information on the present waste issue in the construction life cycle. Several factors related to the wider recognition and use of RA in construction are also described and analyzed in this paper, including the main barriers to reuse and recycling, economic and environmental impacts, the choice of demolition methodology, the recycling procedure and certification of the final product. Increased governmental intervention, with ensuing strict legislation and comprehensive standardization, have been found to be key drivers

for a greater pro-active engagement of construction and demolition related entities. Furthermore, with recent developments on the classification of RA, which can facilitate certification, it will become increasingly easy to increase the stakeholders confidence on the products' quality and resulting materials' predictable performance, consequently increasing demand for a technically feasible and potentially more economical substitute to their natural counterparts.



## CHAPTER – 3

### METHODOLOGY

#### 3.1 RESEARCH METHODOLOGY

This study is a cross-sectional investigation which was based on a self-administered online questionnaires. Construction industry, which is a main pillar of the national economy of several Middle Eastern countries, is also facing a unique challenge due to the spread of COVID-19 in these countries, and the subsequent economic effect of a nationwide lockdown. The study included civil engineers, contractors, supply chain workers and various construction professionals aging between 22 and 65 years, who are currently working either in an office job or a field job in a construction firm whose offices and projects are all located in India. The data collection took place between February

1, 2021 to March 10, 2021 during which 127 professionals filled the questionnaire. From the collected data analysis are been done and result is been discussed.

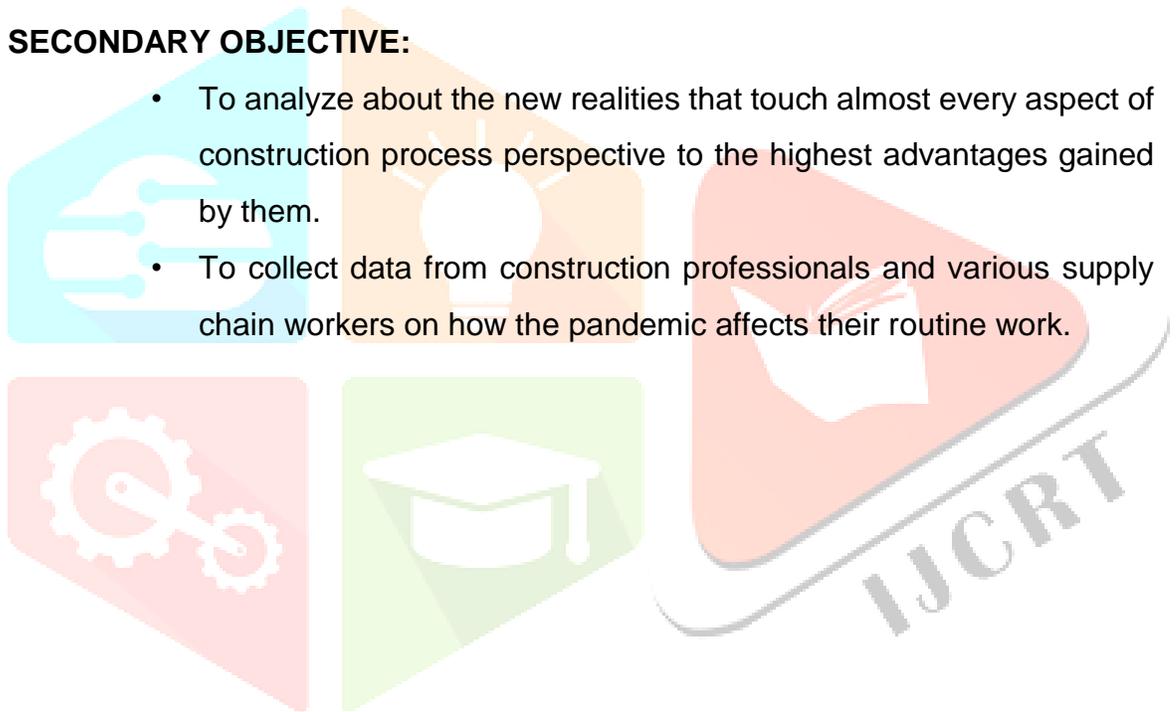
### 3.2 OBJECTIVES

#### PRIMARY OBJECTIVES:

- To study about the contractual obligation between the client and the main contractor on how the transportation, costs, site work productivity, labour shortage, healthy and safety risks assessment and further procedures are resolved during Covid-19.

#### SECONDARY OBJECTIVE:

- To analyze about the new realities that touch almost every aspect of construction process perspective to the highest advantages gained by them.
- To collect data from construction professionals and various supply chain workers on how the pandemic affects their routine work.



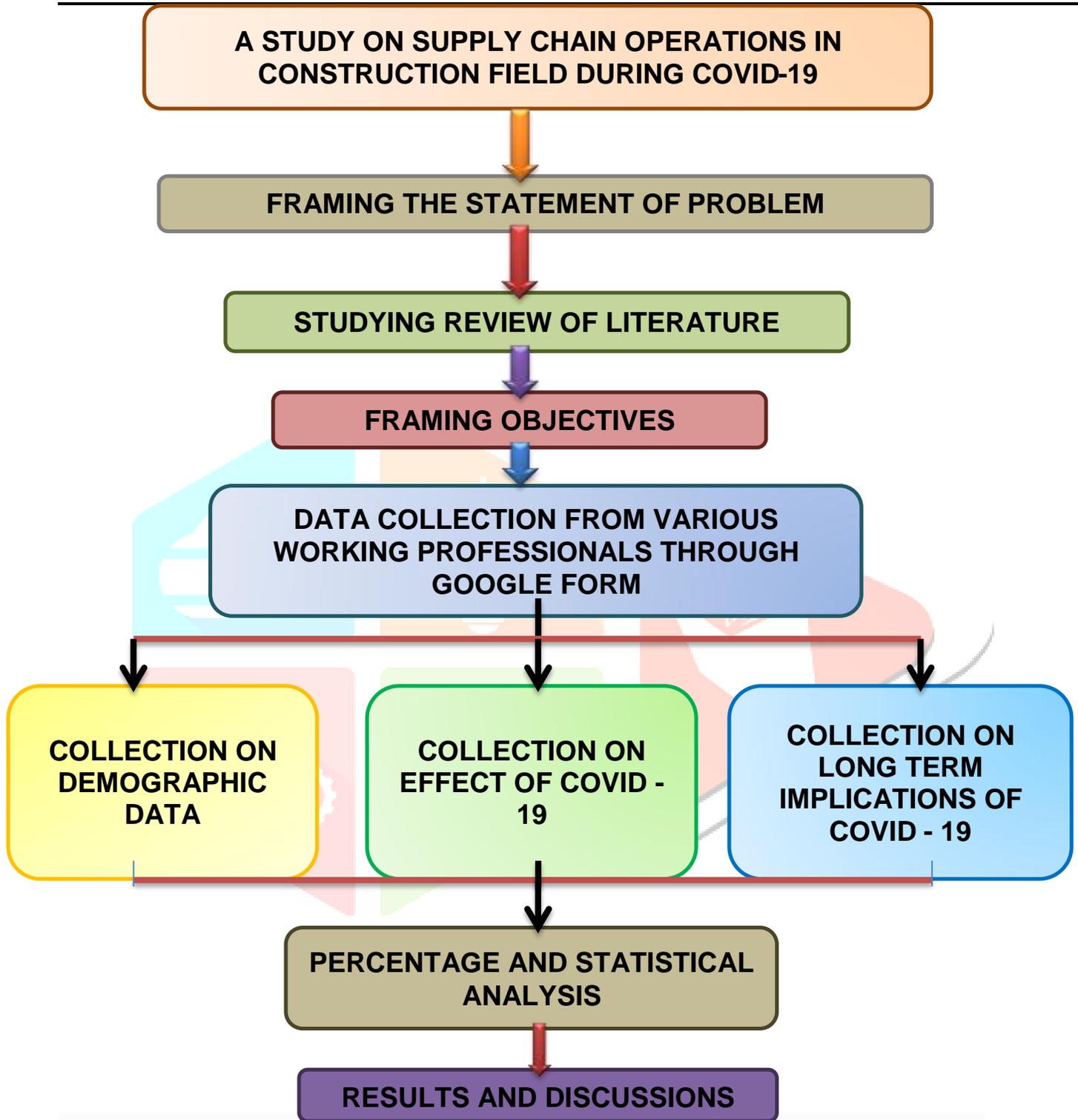


Figure 3.1 Research Methodology

### 3.3 POPULATION, SAMPLING AND QUESTIONNAIRE SURVEY

Sampling is a vital strategy in a statistical analysis, which comprises a selection of a few portions of a potential population so as to assess or learn something from the population at a cheaper cost. Simple random sampling (SRS), popularly known as “random sampling”, includes the selection of sample at arbitrary from the sampling frame utilizing either random number tables or an internet arbitrary number generator. The questionnaire comprises close-ended and open-ended questions with multiple choice options. The survey questionnaire is designed online, hosted in google drive and shared in a google form. Link to the google form is shared on professional platforms such as LinkedIn and construction professionals’ forums, as well as direct emails sent to the key players in the built environment. A total of 127 responses were received. The survey questionnaire was structured under the following subheadings of demography, project status due to covid-19, impacts of covid-19, and other comments. To obtain general information about the respondent companies, including type of company, area of work, annual operational volume and number of employees. To understand the relationships between companies and their suppliers. To understand the relationships between companies and their clients. To identify and understand the more relevant aspects of the relationships between construction companies internal clients and suppliers especially between construction sites and the main office. As agreed previously with the industrialists, a week prior to the main visit, three different questionnaires are sent to appropriate personnel. One questionnaire is aimed at internal operational information while the other two are aimed at the supplier and customer interfaces data acquisition. It is a converging supply chain directing all materials to the construction site where the object is assembled from incoming materials. The construction factory is set up around the single product, in contrast to manufacturing systems where multiple products pass through the factory, and are distributed to many customers. It is, apart from rare exceptions, a temporary supply chain producing one construction projects through repeated reconfiguration of project organizations. As a result, the construction supply chain is typed by instability, fragmentation, and especially by the separation between the design and the construction of the built object. The needs of the construction industry in mind, to obtain and analyze information regarding the key internal processes and those

that are related to the workings of the supply chain. The data collection tools being configured for companies working in both public and private sectors of the housing industry, as was the case with the industrial partners.

### 3.4 GOOGLE FORMS

Forms are among the internet's most versatile tools. Whether you need a contact form or a checkout page, a survey or a student directory, a form is all you need to easily gather that information. With Google Forms, it only takes a few minutes to make one for free. Google Forms along with Docs, Sheets, and Slides is part of Google's online apps suite of tools to help you get more done in your browser for free. It's easy to use and one of the simplest ways to save data directly to a spreadsheet, and it's the best sidekick to Google Sheets' spreadsheets.

When you need to gather data for your spreadsheets, a form is your best friend. In this chapter, let's take an in-depth look at Google Forms' features, hidden tools, and add-ons to help you make the forms you need in minutes.

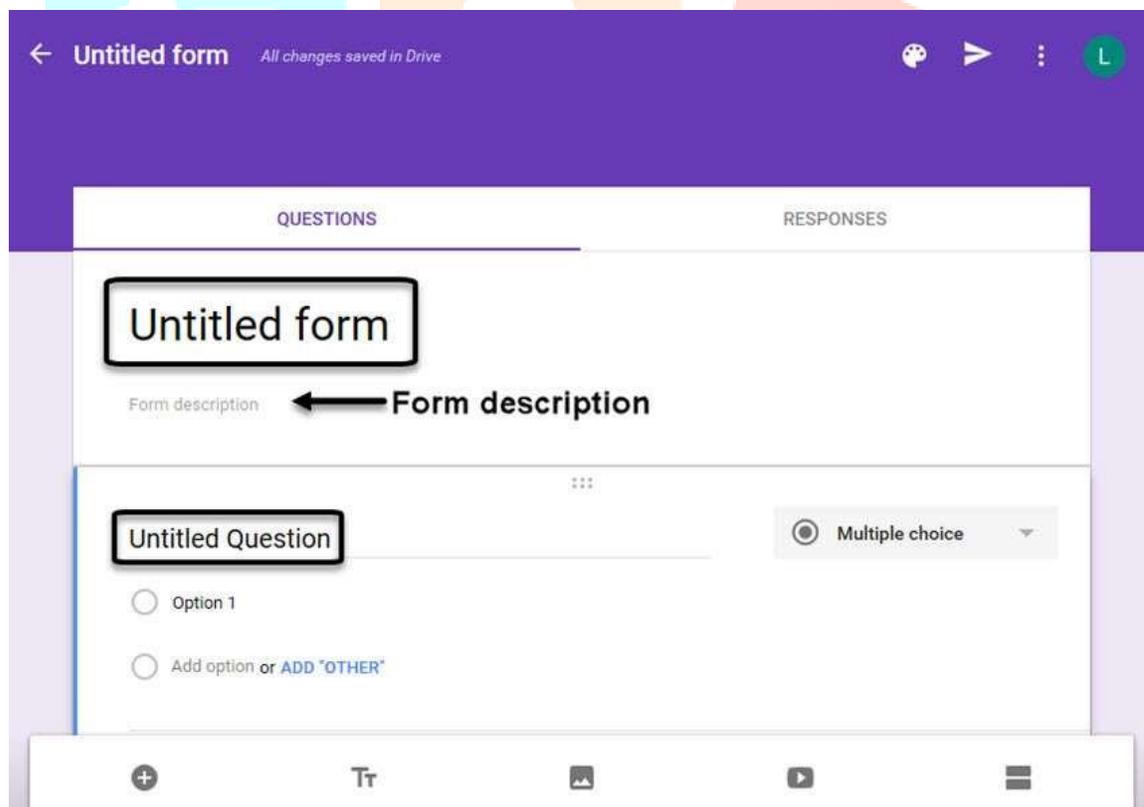


Figure 3.2 Google forms

### 3.5 PERCENTAGE ANALYSIS

Percentage analysis is the method to represent raw streams of data as a percentage (a part in 100 - percent) for better understanding of collected data. A percent change analysis shows how two items changed as a percentage from one period to another period. Used on a balance sheet, a percent change analysis shows how a balance sheet account changes from year to year, or quarter to quarter. The balance sheet accounts are assets, liabilities and stockholders' equity. Percentage Statement Analysis is an analysis which highlights important relationships in the percentage statements. Percentage Statement analysis embraces the methods used in assessing and interpreting the results of past performance and current percentage position as they relate to particular factors of interest in investment decisions. It is an important means of assessing past performance and in forecasting and planning future performance.



Figure 3.3 Percentage analysis

Percentages are often used to express a proportionate part of a total. If 50% of the total number of students, long before the existence of the decimal system, computations were often made in fractions. The term "percent" is derived from the Latin per centum, meaning "hundred" or "by the hundred". The Percentage increase and decrease. Due to inconsistent usage, it is not always clear from the context what a percentage.

Percentage are used to understand and interpret data. The  $n$ th percentage of a set of data is the value at which  $n$  percent of the data is below it. In everyday life, percentage are used to understand values such as test scores, health indicators, and other measurements. For example, an 18-year-old male who is six and a half feet tall is in the 99th percentage for his height. This means that of all the 18-year-old males, 99 percent have a height that is equal to or less than six and a half feet. An 18-year-old male who is only five and a half feet tall, on the other hand, is in the 16th percentage for his height, meaning only 16 percent of males his age are the same height or shorter.

The original variation between the actual value and the calculated value extracted in the form of percentage is termed to be the percentage error. This tool is used to measure whether the data collection is progressing in the right direction and is mostly used by corporate companies and statistic experts. If taken the context of academic career, the percentage error formula is very crucial for the students pursuing their degrees in the discipline of economics and science. While conducting a study or calculations from the figures provided in a database, various errors could occur.

Majorly the percentage error formula is used to determine how accurate the calculated value is by keeping in mind the actual value. I mentioned in a very rough language, it is the variation of the gap between the calculated value and the genuine value expressed in the form of a percentage. Commonly, the extent of the percentage error is expressed in the positive denominations, although having a negative percent error is not a wrong approach. Relying on the sign of the percentage error measure, it could be analyzed whether the calculated value is being paced below or higher to the actual value. The tool

of percentage error formula is one of the most reliable and accurate tools in calculating the relative error by keeping the original measure as the basis.

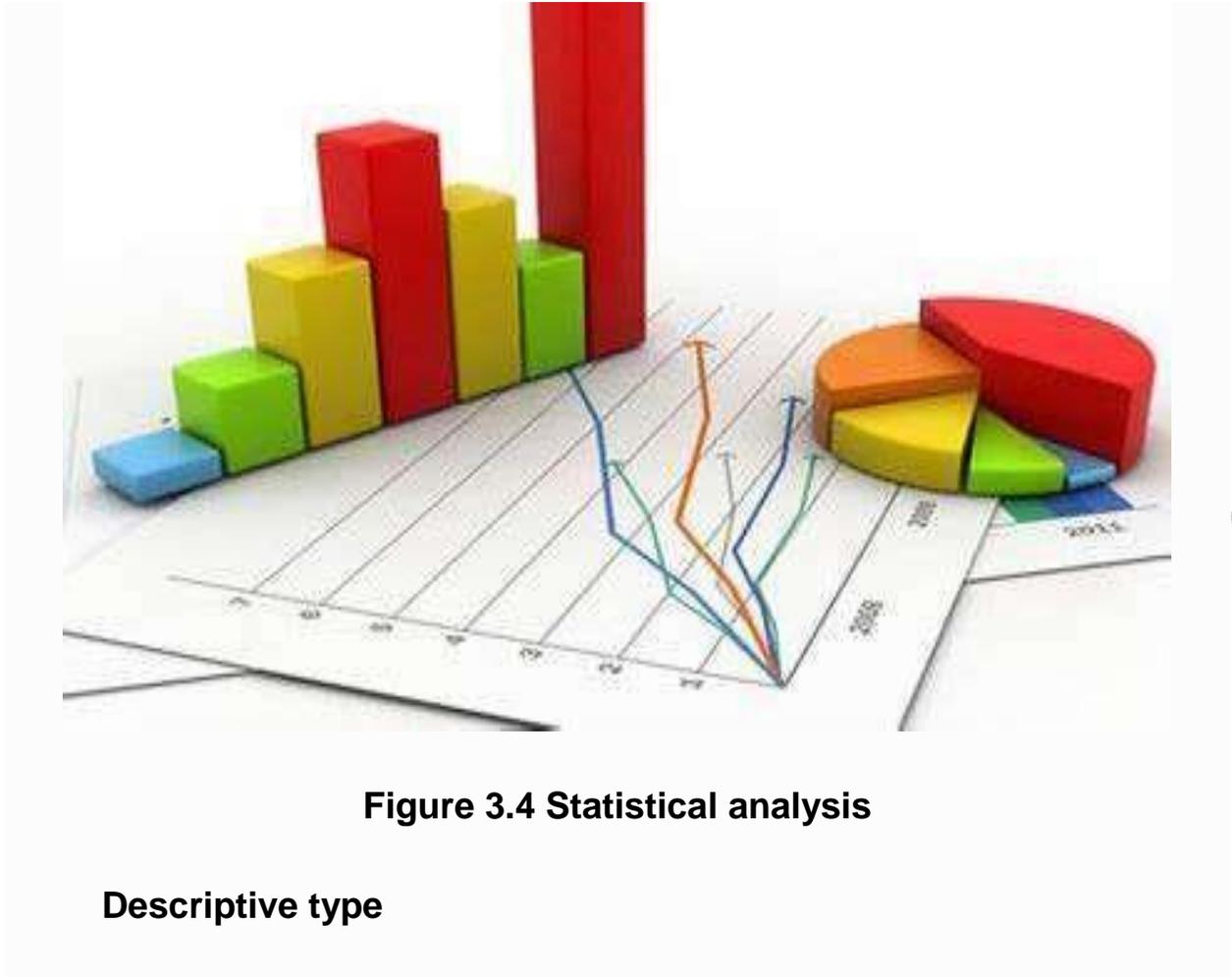
### 3.6 STATISTICAL ANALYSIS

Statistical analysis is the science of collecting, exploring and presenting large amounts of data to discover underlying patterns and trends. Statistics are applied every day – in research, industry and government – to become more scientific about decisions that need to be made.

#### Main uses

- Manufacturers use statistics to weave quality into beautiful fabrics, to bring lift to the airline industry and to help guitarists make beautiful music.
- Researchers keep children healthy by using statistics to analyze data from the production of viral vaccines, which ensures consistency and safety.
- Communication companies use statistics to optimize network resources, improve service and reduce customer churn by gaining greater insight into subscriber requirements.
- Government agencies around the world rely on statistics for a clear understanding of their countries, their businesses and their people.
- Identify the actions that will produce the best results based on many possible options and outcomes. Scheduling, simulation, and related modeling processes are used to optimize business processes and management challenges.
- Powerful computer techniques for implementing your own statistical methods and exploratory data analysis using row operation algorithms.
- A mathematical approach to reviewing the quality and safety characteristics for all aspects of production.
- Fast, interactive statistical analysis and exploratory capabilities in a visual interface can be used to understand data and build models.

- From traditional analysis of variance and linear regression to exact methods and statistical visualization techniques, statistical programming is essential for making data-based decisions in every field.
- Modeling, forecasting and simulating business processes for improved strategic and tactical planning. This method applies statistics to economics to forecast future trends.



**Figure 3.4 Statistical analysis**

### **Descriptive type**

The descriptive statistic is used to describes the basic features of information and shows or summarizes data in a rational way. Descriptive statistics is a study of quantitatively describing.

This type of statistics draws in all of the data from a certain population (*a population is a whole group, it is every member of this group*) or a sample of it.

Descriptive statistics can include numbers, charts, tables, graphs, or other data visualization types to present raw data.

However, descriptive statistics do not allow making conclusions. **You can not get conclusions** and make generalizations that extend beyond the data at hand. With descriptive statistics, you can simply describe what is and what the data present.

**For example**, if you have a data population that includes 30 workers in a business department, you can find the average of that data set for those 30 workers. However, you can't discover what the eventual average is for all the workers in the whole company using just that data. Imagine, this company has 10 000 workers.

Despite that, this type of statistics is very important because it allows us to show data in a meaningful way. It also can give us the ability to make a simple interpretation of the data.

### **Inferential type**

As you see above, the main limitation of the descriptive statistics is that it only allows you to make summations about the objects or people that you have measured. It is a serious limitation. This is where inferential statistics come.

Inferential statistics is a result of more complicated mathematical estimations, and allow us to infer trends about a larger population based on samples of "subjects" taken from it.

This type of statistical analysis is used to study the relationships between variables within a sample, and you can make conclusions, generalizations or predictions about a bigger population. In other words, the sample accurately represents the population.

Moreover, inference statistics allows businesses and other organizations to **test a hypothesis and come up with conclusions** about the data. One of the key reasons for the existing of inferential statistics is because it is usually too costly to study an entire population of people or objects.

To sum up the above two main types of statistical analysis, we can say that descriptive statistics are used to describe data. Inferential statistics go further and it is used to infer conclusions and hypotheses.

### **Importance**

Statistical analysis is a study, a science of collecting, organizing, exploring, interpreting, and presenting data and uncovering patterns and trends. Many businesses rely on statistical analysis and it is becoming more and more important. One of the main reasons is that statistical data is used to predict future trends and to minimize risks.

## **3.7 RESEARCH DESIGN**

From the objective we have studied the transportation, costs and migrant of workers are the challenges mainly faced in supply chain of construction sector after Covid-19. To analyze this different data have to be collected from various construction industries such as in what way the government played a vital role in reconstructing their industry and in what way the transactions are made between the contractors and clients and payoffs are been made to workers and short time duration during the pandemic. The contraction in economy in the period of March 2020 has emerged prominently in the construction sector, and monetary policy tools for reducing negative effects have been implemented in intact. As the second wave of the crisis, which was expected, there was an increase in the number of residential sales, but since beginning of process, the perception of construction in general and housing in particular has varied are also been discussed.

### **SAMPLE PLAN**

In this study the data to be collected from various constructions are around the world and on the basis of effective and innovative measures taken by them to handle the situation and mainly the man power management over the supply chain operations

through questionnaire.

## **POPULATION**

In this study the population are those contractors and clients and other workers who are been in contact or related to the supply chain operation of construction field. Those are the persons who possess some common characteristics among the persons as a whole on initiating the study.

## **SAMPLING FRAME**

Sampling frame are those each set of employees within the working frame such as owners, contractors, sub contractors, masons, help men, drivers, agents and their way of excellence in thinking on what way they could adjust and make profit during Covid-19 and innovations made by them after Covid-19.

## **SAMPLING UNIT**

These are the set of employees been considered as a unit on the individual industry where there are been large number of units been present over there. Most probably the different teams been available for the supply chain operations on the construction industry.

## **SAMPLE SIZE**

The size of the unit varies according to the small, medium and large enterprises. For many construction workers around the world the terms of employment have always been poor. But many others have seen a significant deterioration in the past 30 years, as the construction industry has led the way in the adoption of “flexible” labor practices.

## **SAMPLING DESIGN**

Here the enterprise itself holds or own some of the employees and doesn't require any contract based workers so that they give some attractive bonuses and

additional wages to make the employee available over the pandemic situation and how they could manage to convenience the employees for the project continuation.

### 3.8 SUMMARY

Construction sector had been categorized as leading and locomotive sector in the world economy. Despite the percentage instability observed in the construction sectors, which had serious supply surplus in the pre-pandemic period. In order to reduce both supply surplus and burden caused by the crisis, the government enacted important regulations aimed at issuing low-interest rates and long-term housing loans from public banks, performing land registry transactions via online, switching to flexible working order in public and private sectors, prohibiting layoffs and short time work allowances during the pandemic period, reducing land registry fees and preventing percentage bankruptcies. The contraction in economy in the period of March 2020 has emerged prominently in the construction sector, and monetary policy tools for reducing negative effects have been implemented in intact. As the second wave of the crisis, which was expected, there was an increase in the number of residential sales, but since beginning of process, the perception of construction in general and housing in particular has varied.

## CHAPTER – 4 DATA ANALYSIS AND INTERPRETATION

### 4.1 PERCENTAGE ANALYSIS

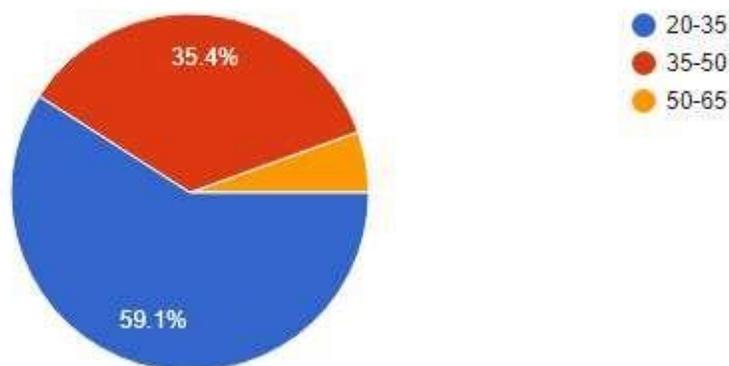
**Age of the respondents TABLE 4.1 representing Age of respondents**

S.NO	PARTICULARS	NO OF RESPONSES	PERCENTAGE
1	20-35	75	59.1%
2	35-50	45	35.4%
3	50-65	7	5.5%
	TOTAL	127	

Source: Primary data

Age

127 responses



**Chart 4.1 Age of respondents Interpretation**

From the above table it is interpreted that the no of respondents between 20-35 years of age is 59.1%, 35-50 years of age is 35.4%, 50-65 years of age is 5.5%.

**Income of respondents TABLE 4.2 representing Income of respondents**

S.NO	PARTICULARS	NO OF RESPONSES	PERCENTAGE
1	Less than 20,000	47	37%

2	20,000-50,000	46	36.2%
3	50,000-1,00,000	28	22%
4	Greater than 1,00,000	6	4.8%
	TOTAL	127	

Source: Primary data

Income

127 responses



**Chart 4.2 Income of respondents**

### Interpretation

From the above table it is interpreted that no of respondents having income less than 20,000 are 37%, 20,000-50,000 are 36.2%, 50,000-1,00,000 are 22%, greater than 1,00,000 are 4.8%.

### Gender of respondents

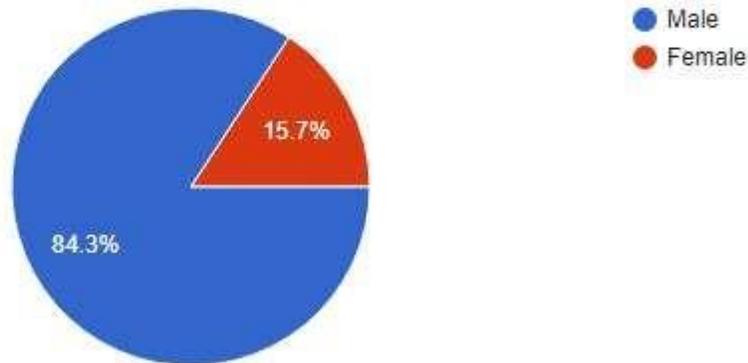
**TABLE 4.3 representing Gender of respondents**

S.NO	PARTICULARS	NO OF RESPONSE	PERCENTAGE
1	Male	107	84.3%
2	Female	20	15.7%
	TOTAL	127	

Source: Primary data

Gender

127 responses



**Chart 4.3 Gender of respondents**

**Interpretation**

From the above table no of male respondents are 84.3%, female respondents are 15.7%.

**Work field of respondents**

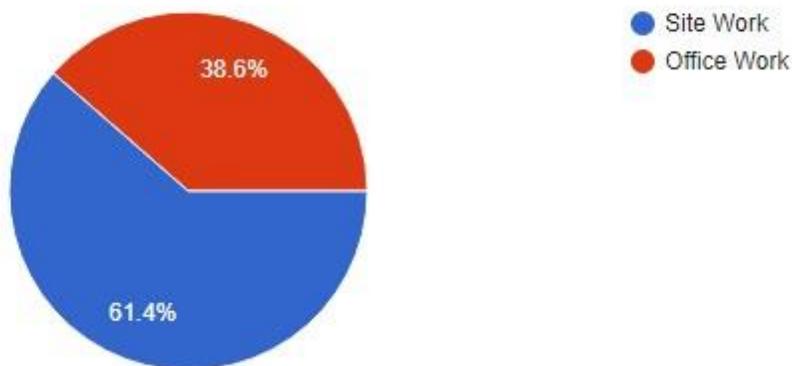
**TABLE 4.4 representing Work field of respondents**

S.NO	PARTICULARS	NO OF RESPONSES	PERCENTAGE
1	Site work	78	61.4%
2	Office work	49	38.6%
	TOTAL	127	

Source: Primary data

Work field

127 responses



**Chart 4.4 Work field of respondents**

**Interpretation**

From the above table the no of respondents on site work are 61.4%,office work are 38.6%.

**Productivity during pandemic**

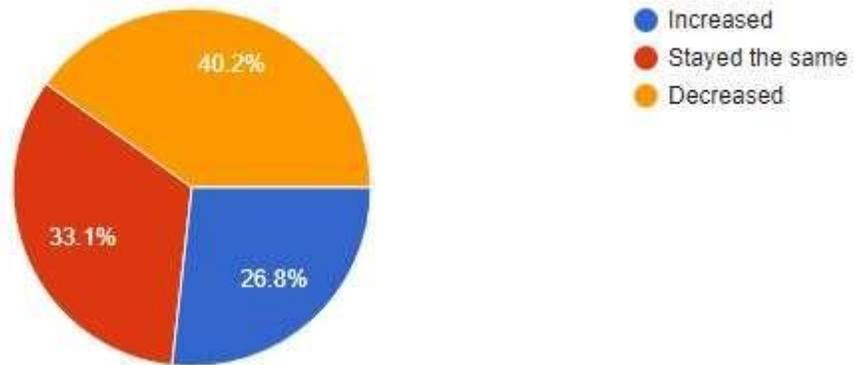
**TABLE 4.5 representing Productivity during pandemic**

S.NO	PARTICULARS	NO OF RESPONDENTS	PERCENTAGE
1	Increased	34	26.8%
2	Stayed the same	42	33.1%
3	Decreased	51	40.2%
	TOTAL	127	

Source: Primary data

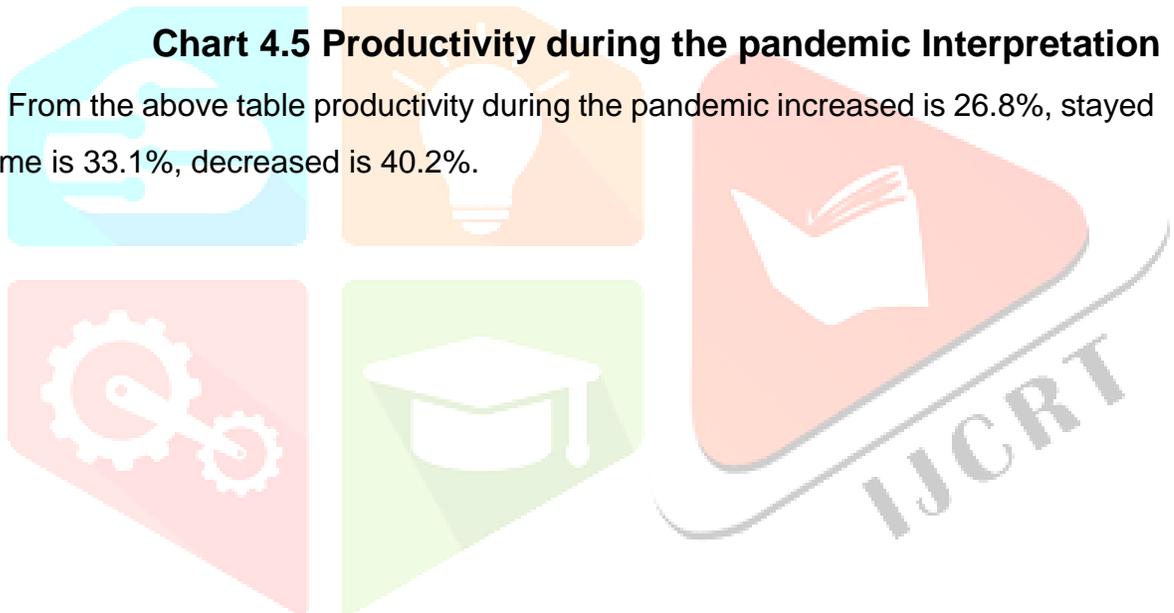
### Productivity during the pandemic

127 responses



### Chart 4.5 Productivity during the pandemic Interpretation

From the above table productivity during the pandemic increased is 26.8%, stayed the same is 33.1%, decreased is 40.2%.



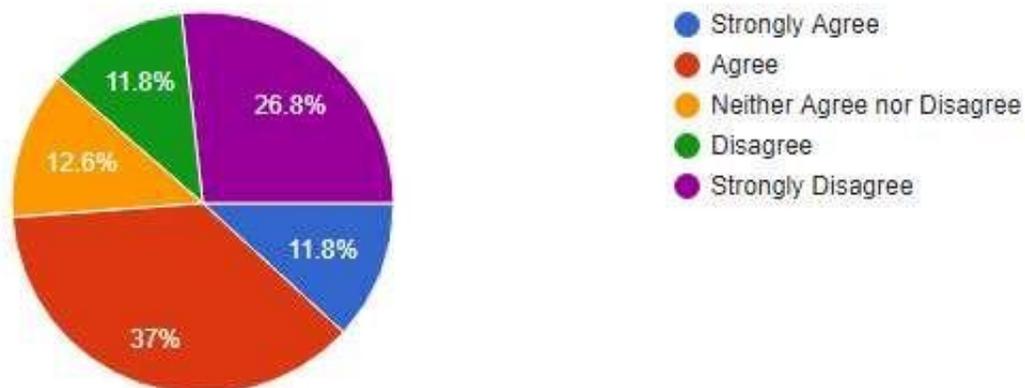
**Effect of pandemic TABLE 4.6 representing Effect of pandemic**

S NO	Particulars	No. of Respondents					Total
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
1.	The firm adopted working at home during lockdown	15 (11.8%)	47 (37%)	16 (12.6%)	15 (11.8%)	34 (26.8%)	127
2.	Believe working at home will substitute office work	12 (9.4%)	46 (36.2%)	7 (18.4%)	22 (4.5%)	40 (31.5%)	127
3.	Materials are effectively transported to site on time	15 (11.8%)	60 (47.2%)	18 (14.2%)	26 (20.5%)	8 (6.3%)	127
4.	Other state workers returned to their state during pandemic	23 (18.1%)	64 (50.4%)	13 (10.2%)	15 (11.8%)	12 (9.4%)	127
5.	Local workers are available to substitute other state workers	12 (9.4%)	49 (38.6%)	24 (18.9%)	28 (22%)	14 (11%)	127

Source; Primary data

The firm adopted working at home during lockdown

127 responses

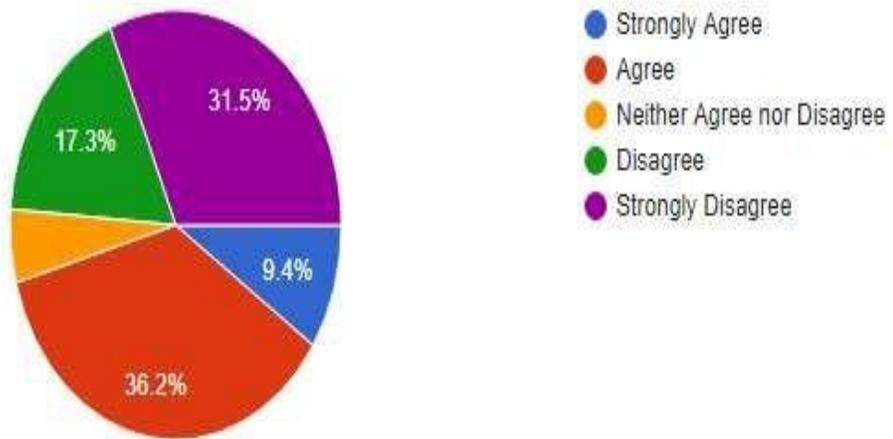


### Chart 4.6 The firm adopted working at home during lockdown Interpretation

From the above table the respondents for firm adopted working at home during lockdown (strongly agree (11.8%), agree (37%), neither agree nor disagree (12.6%), disagree (11.8%), strongly disagree (26.8%) ).

Believe working at home will substitute office work

127 responses



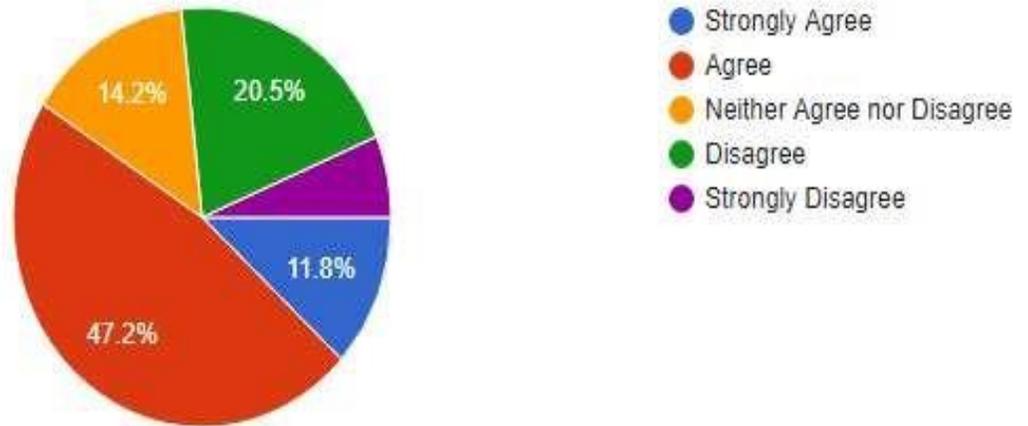
### Chart 4.7 Believe working at home will substitute office work

#### Interpretation

From the above table the respondents for believing working at home will substitute office work (strongly agree (9.4%), agree (36.2%), neither agree nor disagree (18.4%), disagree (17.3%), strongly disagree (31.5%) ).

### Materials are effectively transported to site on time

127 responses



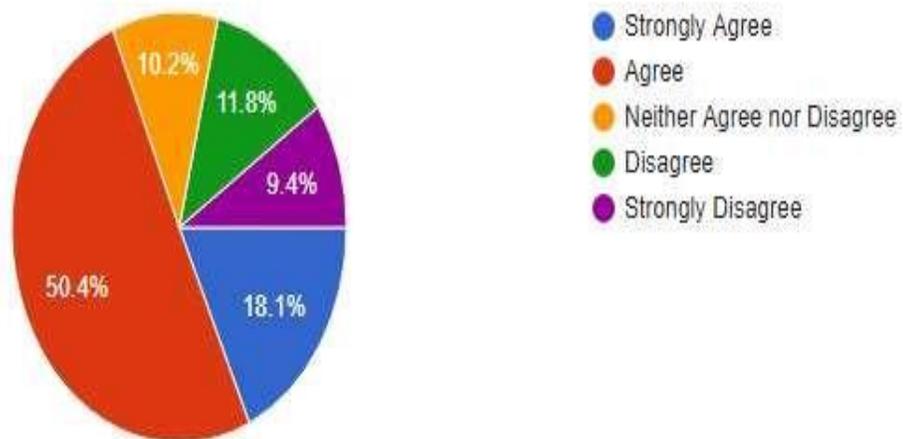
**Chart 4.8 Materials are effectively transported to site on time**

#### Interpretation

From the above table the respondents for materials are effectively transported to site on time (strongly agree (11.8%), agree (47.2%), neither agree nor disagree (14.2%), disagree (20.5%), strongly disagree (6.3%) ).

### Other state workers returned to their state during pandemic

127 responses



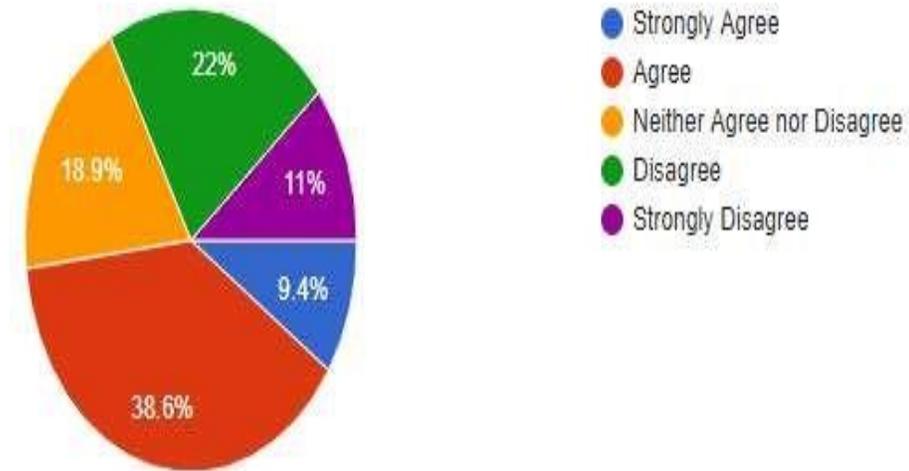
**Chart 4.9 Other state workers returned to their state during pandemic**

#### Interpretation

From the above table the respondents for other state workers returned to their state during pandemic (strongly agree (18.1%), agree (50.4%), neither agree nor disagree (10.2%), disagree (11.8%), strongly disagree (9.4%) ).

### Local workers are available to substitute other state workers

127 responses



**Chart 4.10 Local workers are available to substitute other state workers**

**Interpretation**

From the above table the respondents for local workers are available to substitute other state workers (strongly agree (9.4%), agree (38.6%), neither agree nor disagree (18.9%), disagree (22%), strongly disagree (11%) ).

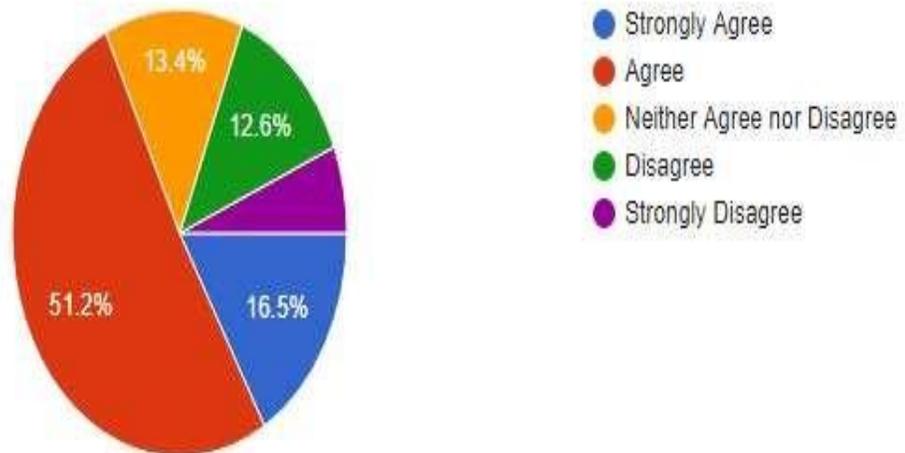
**Long term implications due to pandemic****TABLE 4.7 representing Long term implications due to pandemic**

S NO	Particulars	No. of Respondents					Total
		Strongl y Agree	Agree	Neutral	Disagre e	Strongl y Disagre e	
1.	After lockdown, for covid-19 infection control is fully implemented in working site	21 (16.5%)	65 (51.2%)	17 (13.4%)	16 (12.6%)	8 (6.3%)	127
2.	Applicability of social distancing in workplace	23 (18.1%)	61 (48%)	19 (15%)	20 (15.7%)	4 (3.2%)	127
3.	Concerned about safety of field work during pandemic	28 (22%)	61 (48%)	17 (13.4%)	11 (8.7%)	10 (7.9%)	127
4.	Believe there will be legal implications for delays in ongoing and planned projects	27 (21.3%)	52 (40.9%)	21 (16.5%)	20 (15.7%)	7 (5.5%)	127
5.	The contracts of the company included the section for unforeseen events as an acceptable cause	28 (22%)	51 (40.2%)	20 (15.7%)	15 (11.8%)	13 (10.2%)	127
6.	Expecting negative financial effect on your sector due to lockdown	22 (17.3%)	52 (40.9%)	19 (15%)	16 (12.6%)	18 (14.2%)	127
7.	Aware of the availability of financial aid for business negatively affected by covid-19	36 (28.3%)	51 (40.2%)	15 (11.8%)	12 (9.4%)	13 (10.2%)	127

Source: Primary data

After lockdown, for Covid-19 infection control is fully implemented in working site

127 responses



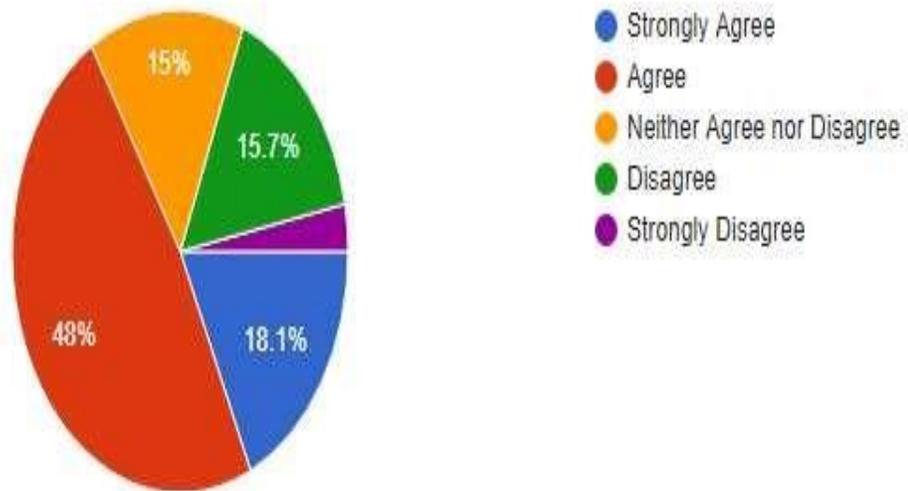
**Chart 4.11 After lock down the covid-19 infection control is fully implemented in working site**

### Interpretation

From the above table the respondents for, after lockdown the covid-19 infection control is fully implemented in working site (strongly agree (16.5%), agree (51.2%), neither agree nor disagree (13.4%), disagree (12.6%), strongly disagree (8%) ).

### Applicability of social distancing in workplace

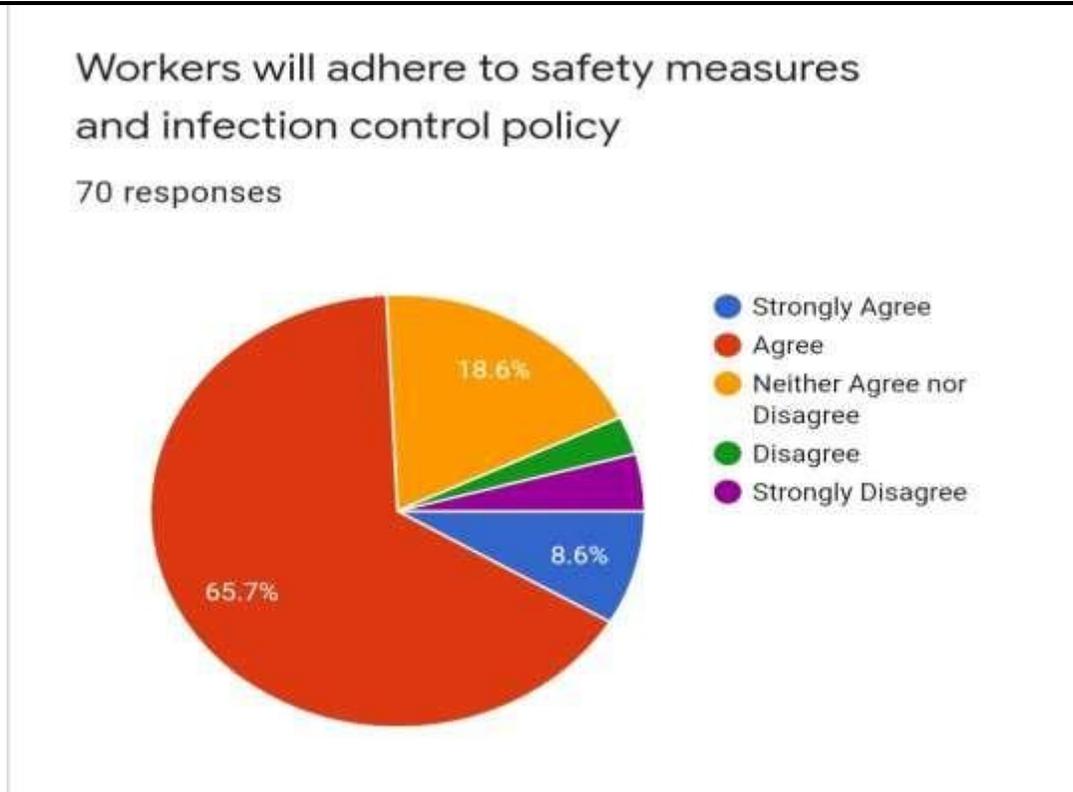
127 responses



**Chart 4.12 Applicability of social distancing in workplace**

#### Interpretation

From the above table the respondents for, applicability of social distancing in workplace (strongly agree (18.1%), agree (48%), neither agree nor disagree (15%), disagree (15.7%), strongly disagree (2.9%) ).



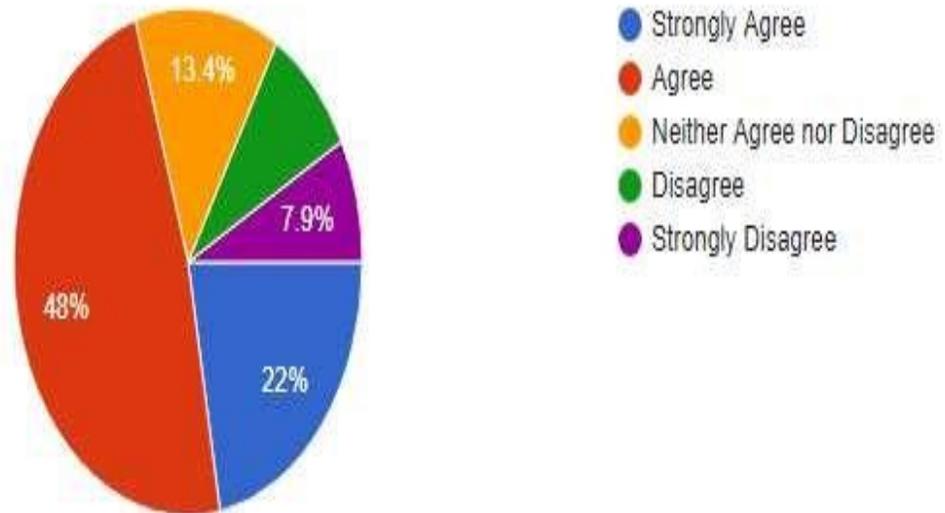
**Chart 4.13 Workers will adhere to safety measures and infection control policy**

### Interpretation

From the above table the respondents for, workers will adhere to safety measures and infection control policy (strongly agree (19.5%), agree (49.7%), neither agree nor disagree (14.2%), disagree (8.7%), strongly disagree (7.9%) ).

### Concerned about safety of field work during the pandemic

127 responses



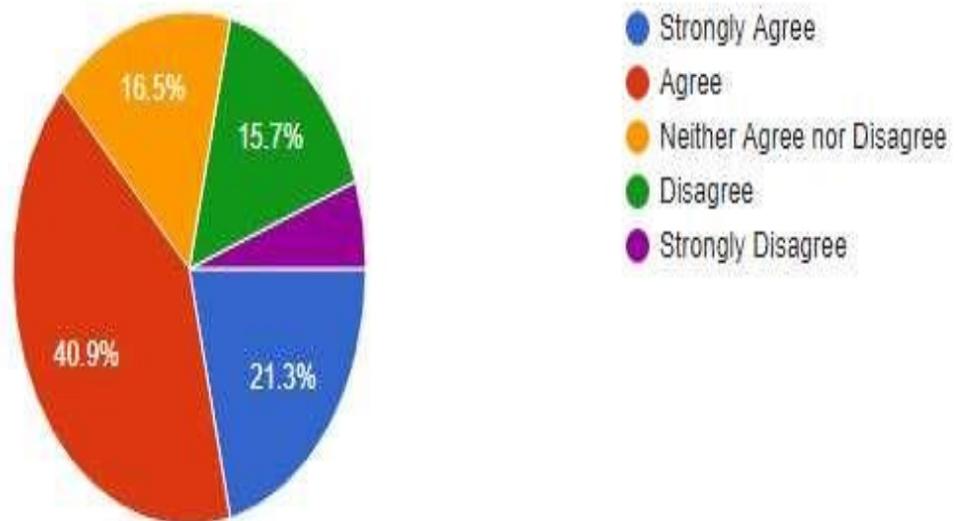
**Chart 4.14 Concerned about safety of field work during pandemic**

#### Interpretation

From the above table the respondents for, concerned about safety of field work during the pandemic (strongly agree (22%), agree (48%), neither agree nor disagree (13.4%), disagree (8.7%), strongly disagree (7.9%) ).

Believe there will be legal implication for delays in ongoing and planned projects

127 responses



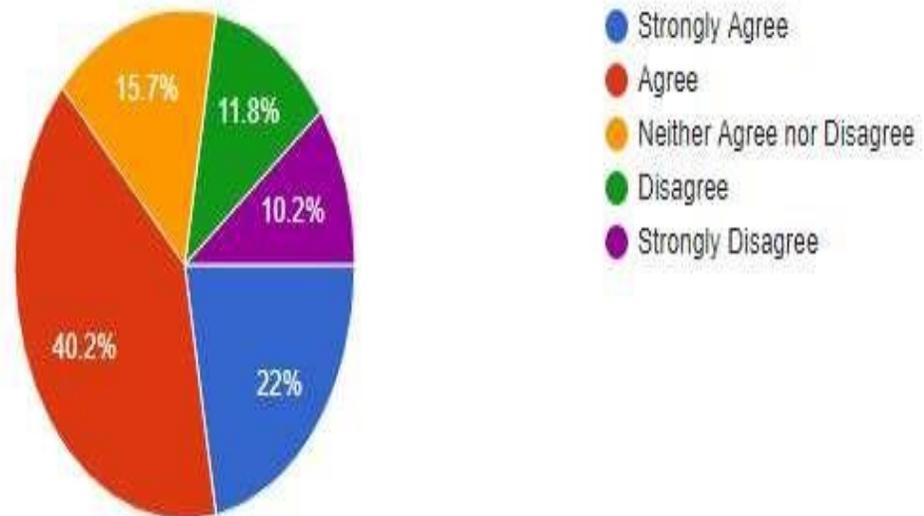
**Chart 4.15 Believe there will be legal implication for delays in ongoing and planned projects**

### Interpretation

From the above table the respondents for, believing there will be legal implications for delays in ongoing and planned projects (strongly agree (21.3%), agree (40.9%), neither agree nor disagree (16.5%), disagree (15.7%), strongly disagree (5.6%) ).

The contracts of the company included the section for unforeseen events as an acceptable cause

127 responses



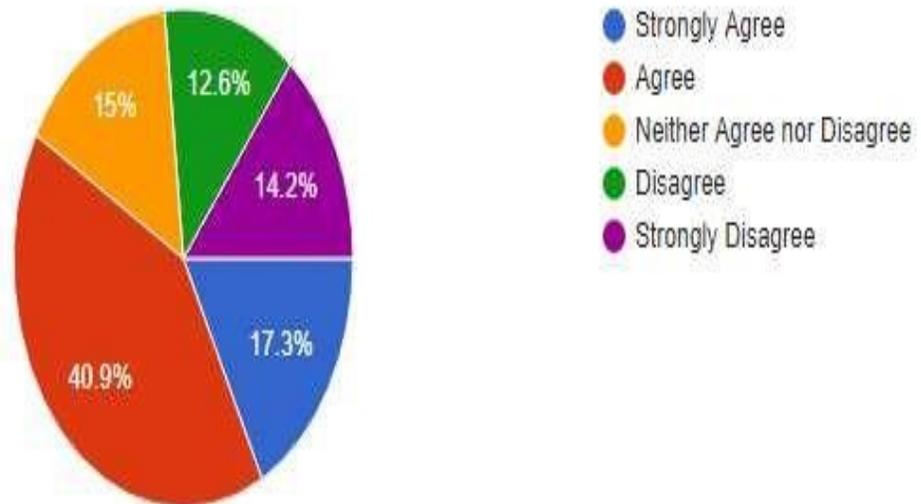
**Chart 4.16 The contracts of the company included the section for unforeseen events as an acceptable cause**

### Interpretation

From the above table the respondents for, the contracts of the company included the section for unforeseen events as an acceptable cause (strongly agree (22%), agree (40.2%), neither agree nor disagree (15.7%), disagree (11.8%), strongly disagree (10.2%) ).

### Expecting negative financial effect on your sector due to lockdown

127 responses



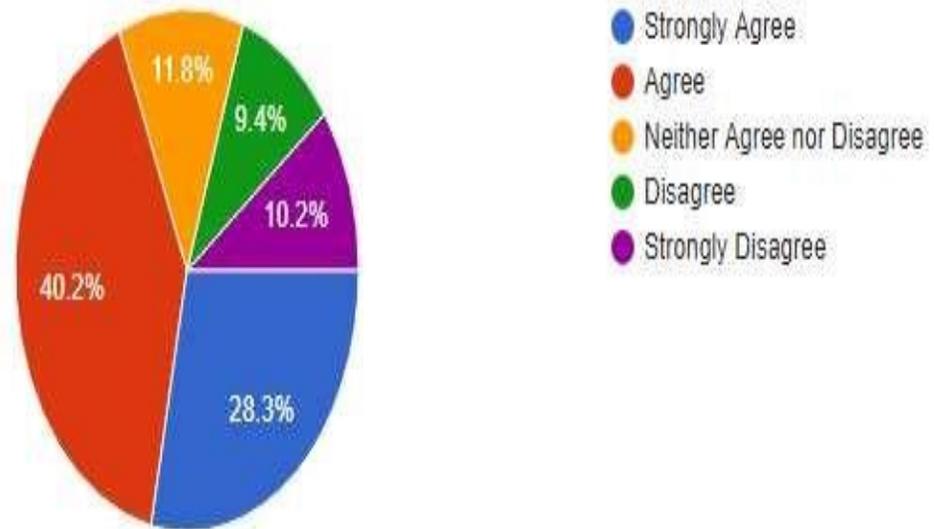
**Chart 4.17 Expecting negative financial effect on your sector due to lockdown**

#### Interpretation

From the above table the respondents for, expecting financial effect on their sector due to lockdown (strongly agree (17.3%), agree (40.9%), neither agree nor disagree (15%), disagree (12.6%), strongly disagree (14.2%) ).

### Aware of the availability of financial aid for business negatively affected by Covid-19

127 responses



**Chart 4.18 Aware of the availability of financial aid for business negatively affected by covid-19**

#### Interpretation

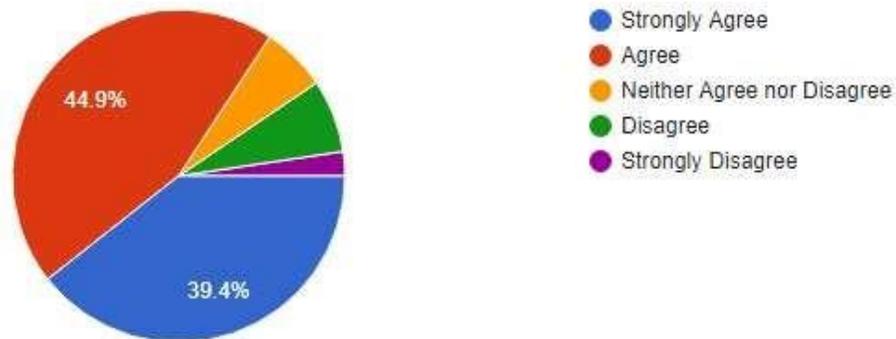
From the above table the respondents for, aware of the availability of financial aid for business negatively affected by covid-19 (strongly agree (28.3%), agree (40.2%), neither agree nor disagree (11.8%), disagree (9.4%), strongly disagree (10.2%) ).

**Changes due to pandemic TABLE 4.8 representing Changes due to pandemic**

S NO	Particulars	No. of Respondents					Total
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
1.	Work affected due to covid-19	50 (39.4%)	57 (44.9%)	8 (6.2%)	9 (7%)	3 (2.5%)	127
2.	Lifestyle affected due to covid-19	27 (21.3%)	55 (43.3%)	13 (10.2%)	20 (15.7%)	12 (9.4%)	127

Source: Primary data

Work affected during covid-19  
127 responses



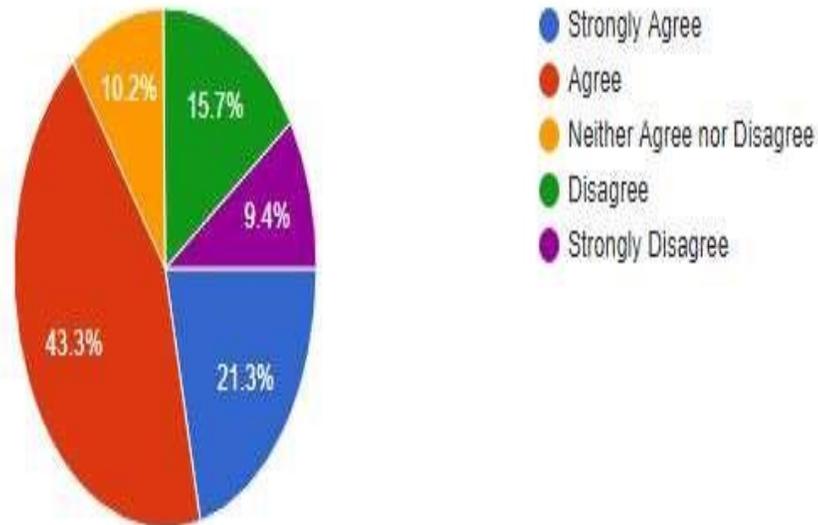
**Chart 4.19 Work affected during covid-19**

**Interpretation**

From the above table the respondents for, work affected during covid-19 (strongly agree (39.4%), agree (44.9%), neither agree nor disagree (6.2%), disagree (7%), strongly disagree (2.5%) ).

### Lifestyle affected during covid-19

127 responses



**Chart 4.20 Lifestyle affected during covid-19**



#### **Interpretation**

From the above table the respondents for, lifestyle affected during covid-19 (strongly agree (21.3%), agree (43.3%), neither agree nor disagree (10.2%), disagree (15.7%), strongly disagree (9.4%) ).

## 4.2 STATISTICAL ANALYSIS

### Age of respondents

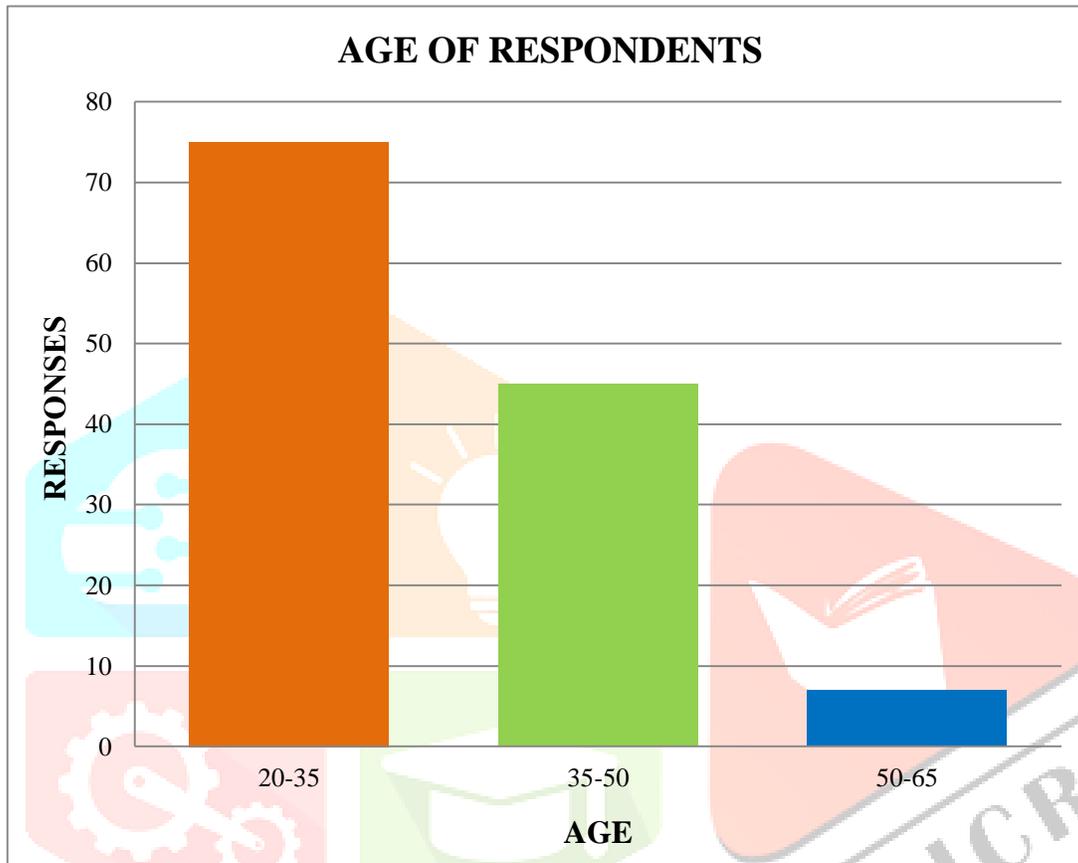
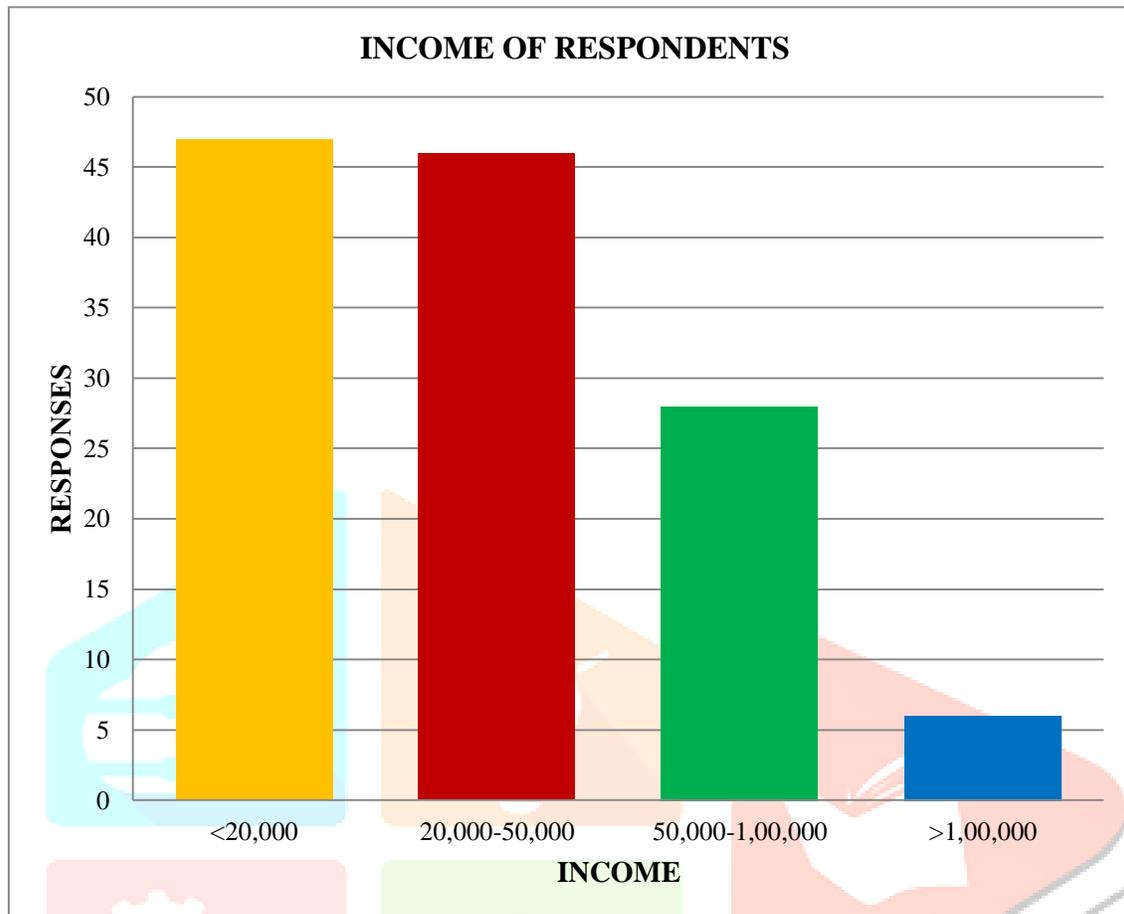


Chart 4.21 Age of respondents

### Interpretation

From the above Chart 75 respondents are aging between 20-35, 45 respondents are aging between 35-50, 7 respondents are aging between 50-65.

### Income of respondents

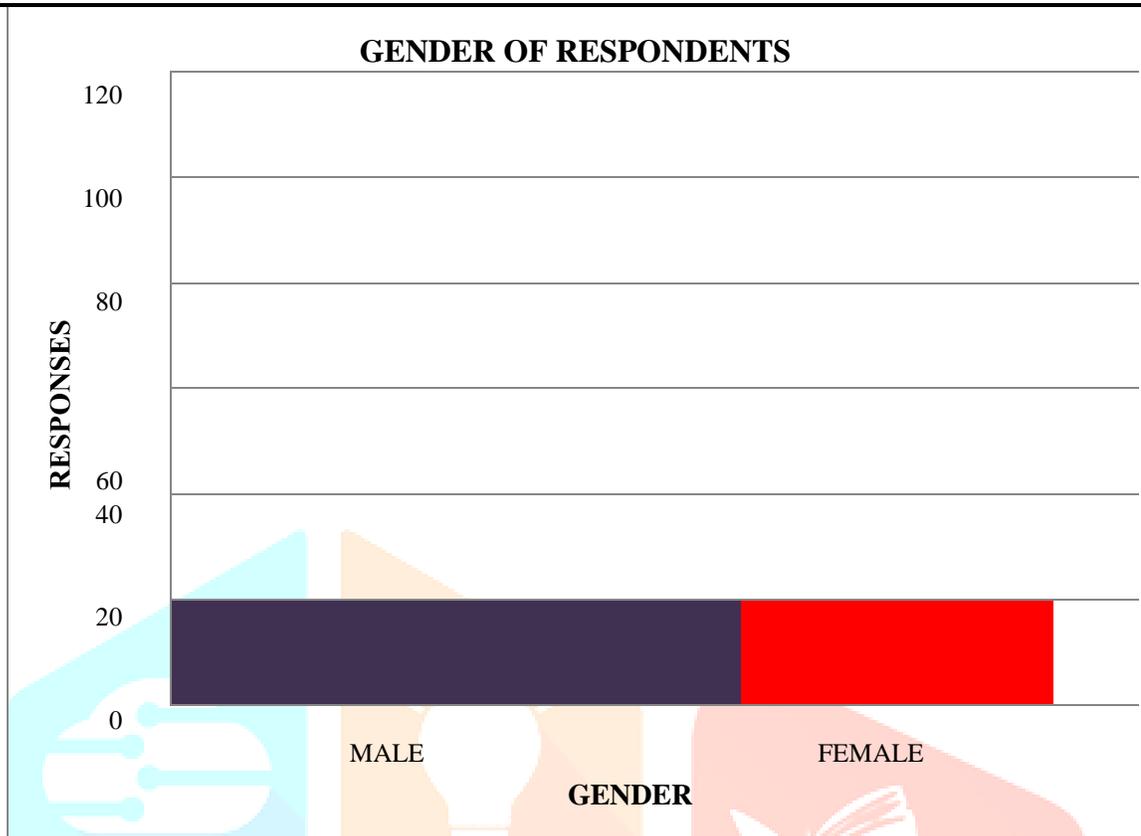


**Chart 4.22 Income of respondents**

**Interpretation**

From the above Chart 47 respondents are having income below 20,000, 46 respondents having income ranging between 20,000 – 50,000, 28 respondents having income ranging between 50,000 – 1,00,000 and 6 respondents having income greater than 1,00,000.

**Gender of respondents**



**Chart 4.23 Gender of respondents**

### Interpretation

From the above Chart there are 107 male respondents and 20 female respondents.

### Work field of respondents

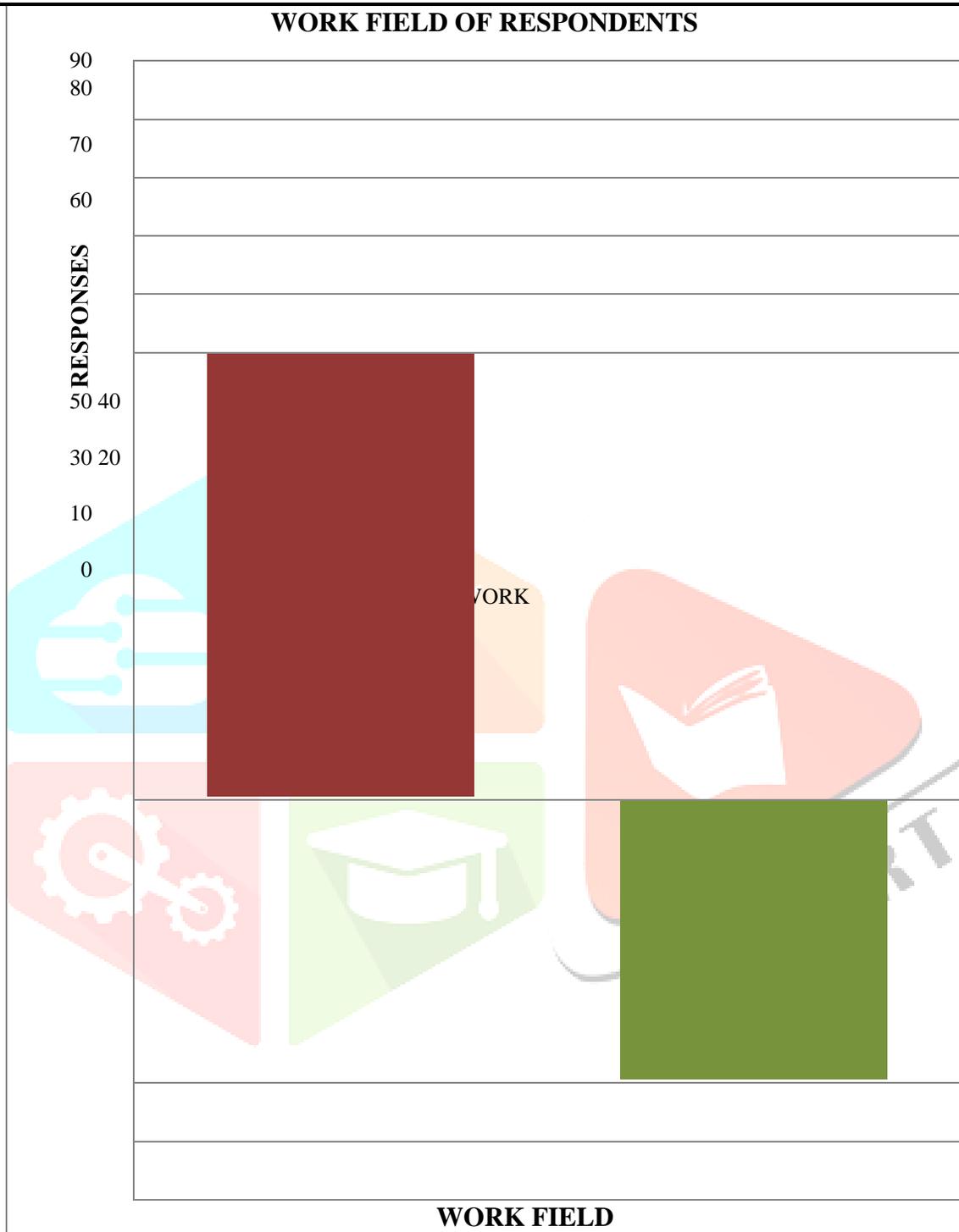


Chart 4.24 Work field of respondents

## Interpretation

From the above Chart 78 respondents work on site work and 49 respondents work on office work.

### Work affected during COVID – 19

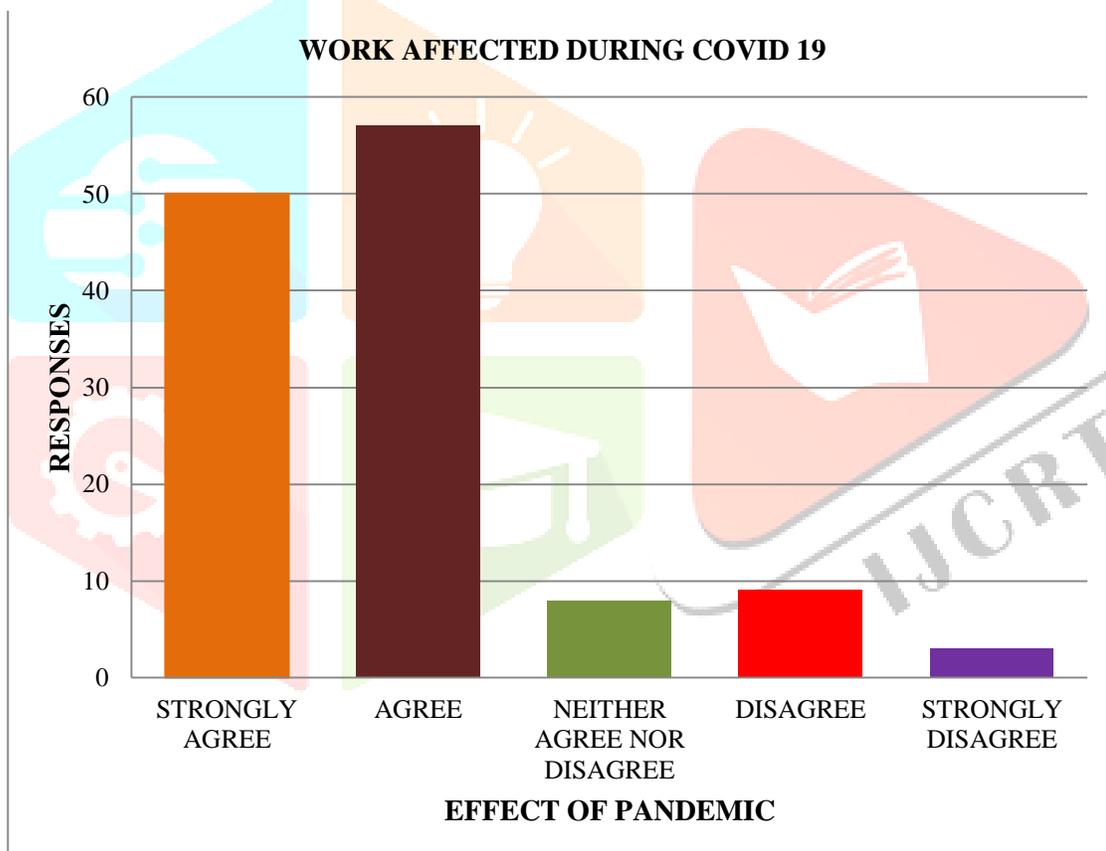


Chart 4.25 Work affected during COVID – 19

### Interpretation

From the above Chart, for work affected during COVID – 19, 50 respondents strongly agreed, 57 respondents agreed, 8 respondents neither agreed nor disagreed, 9 respondents disagreed, 3 respondents strongly disagreed.

### Lifestyle affected during COVID – 19

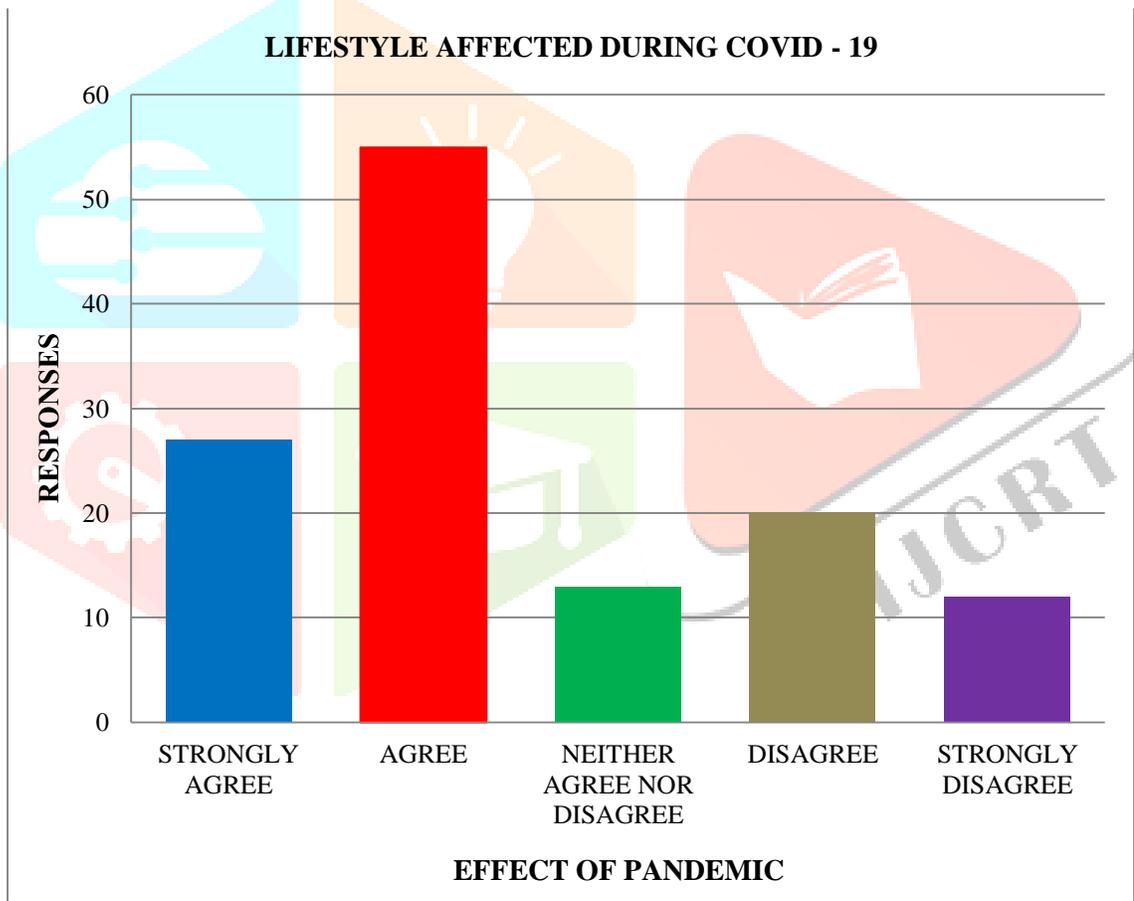


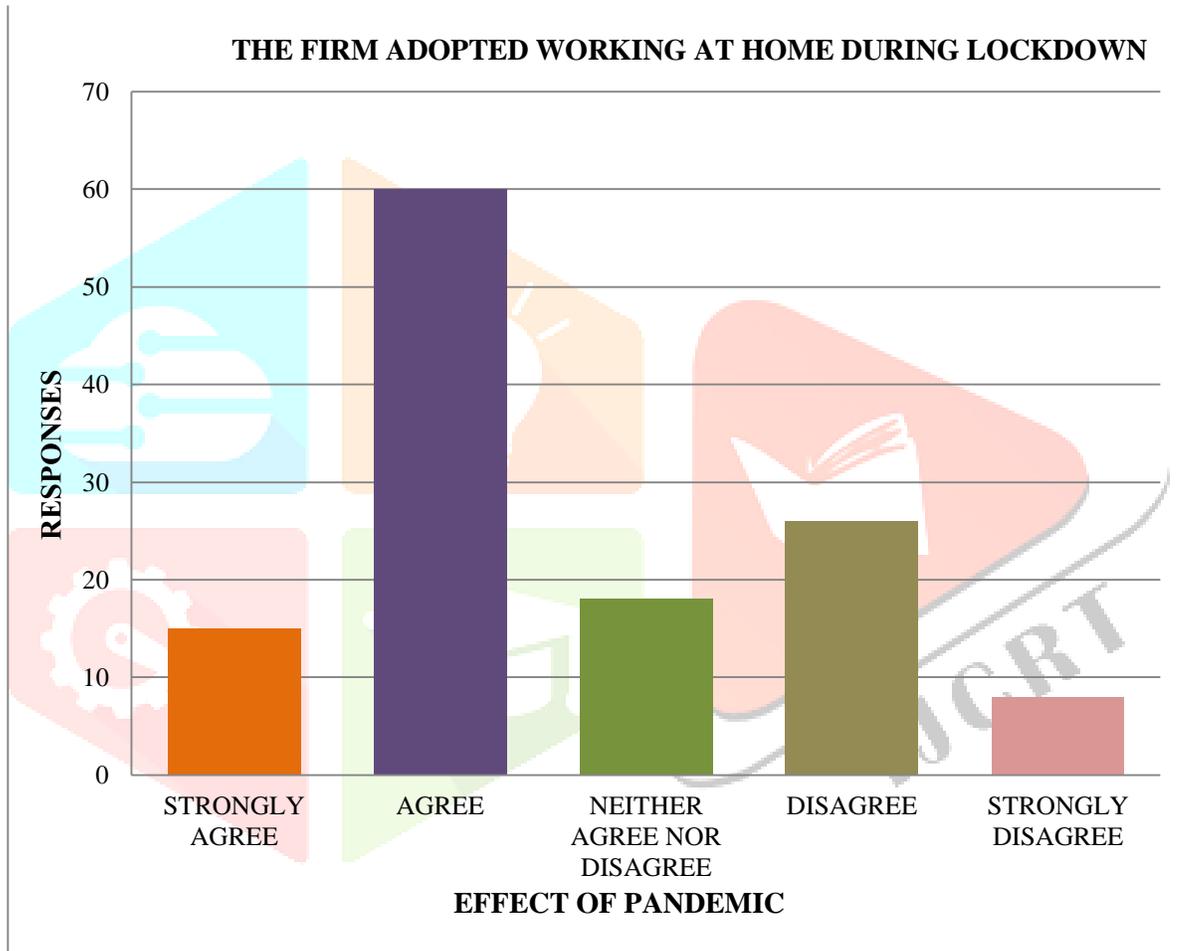
Chart 4.26 Lifestyle affected during COVID – 19

### Interpretation

From the above Chart, for lifestyle affected during COVID – 19, 27 of the respondents strongly agreed, 55 of the respondents agreed, 13 of the respondents

neither agreed nor disagreed, 20 of the respondents disagreed, 12 of the respondents strongly disagreed.

### The firm adopted working at home during lockdown

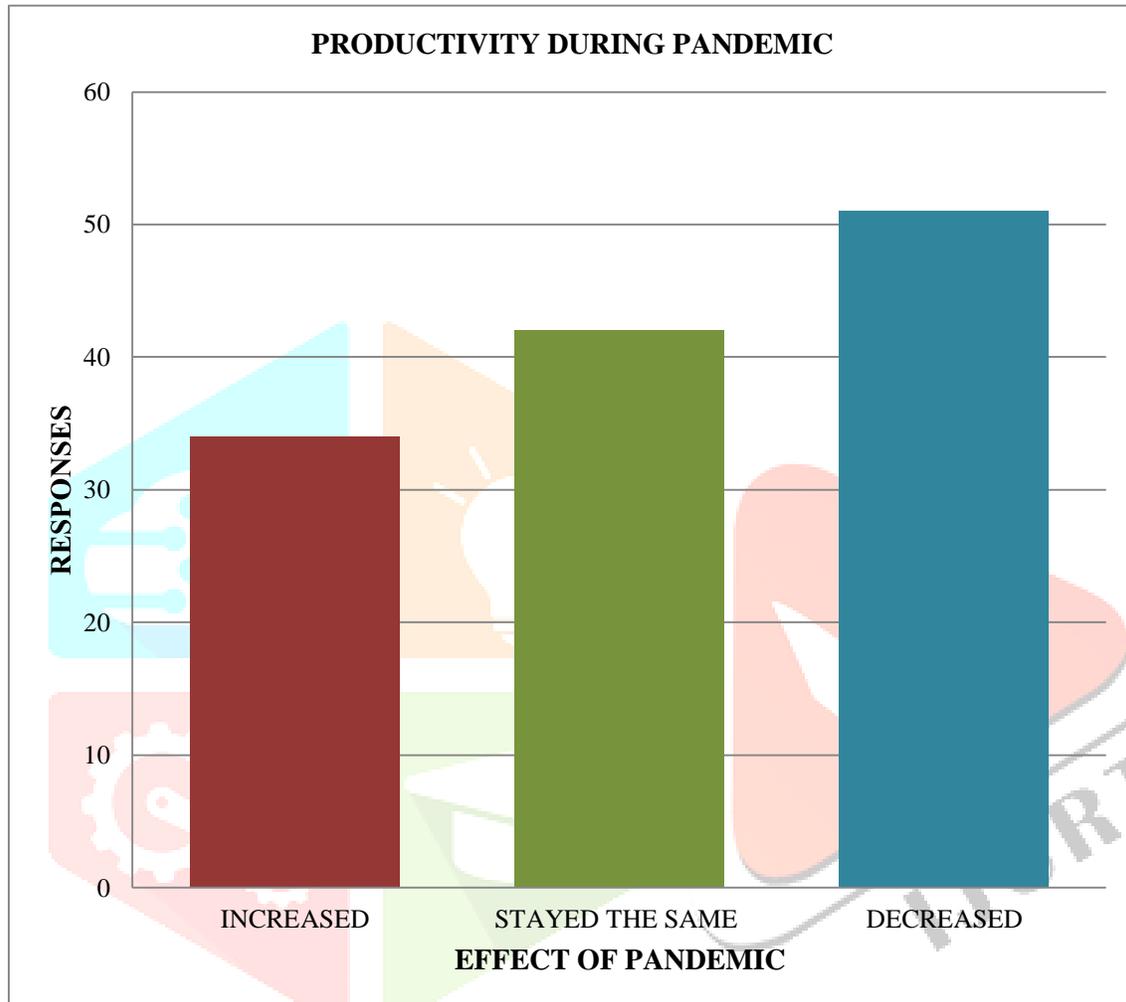


**Chart 4.27 The firm adopted working at home during lockdown**

#### Interpretation

From the above Chart, for the firm adopted working at home during lockdown 15 of the respondents strongly agreed, 47 of the respondents agreed, 16 of the respondents neither agreed nor disagreed, 15 of the respondents disagreed, 34 of the respondents strongly disagreed.

## Productivity during the pandemic

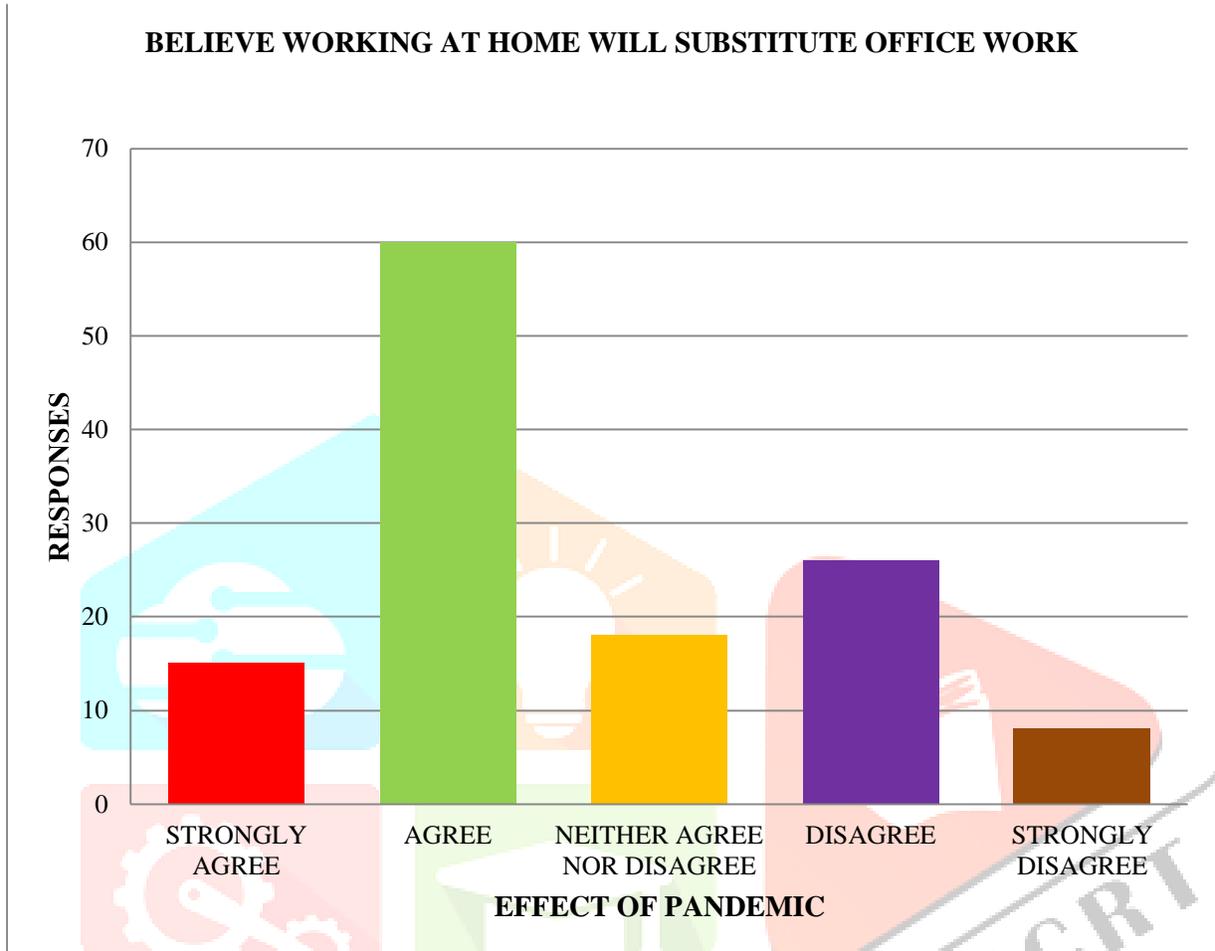


**Chart 4.28 Productivity during pandemic**

### Interpretation

From the above Chart, for productivity during pandemic, 34 of the respondents says its increased, 42 of the respondents says its stayed the same, 51 of the respondents says its decreased.

## Believe working at home will substitute office work

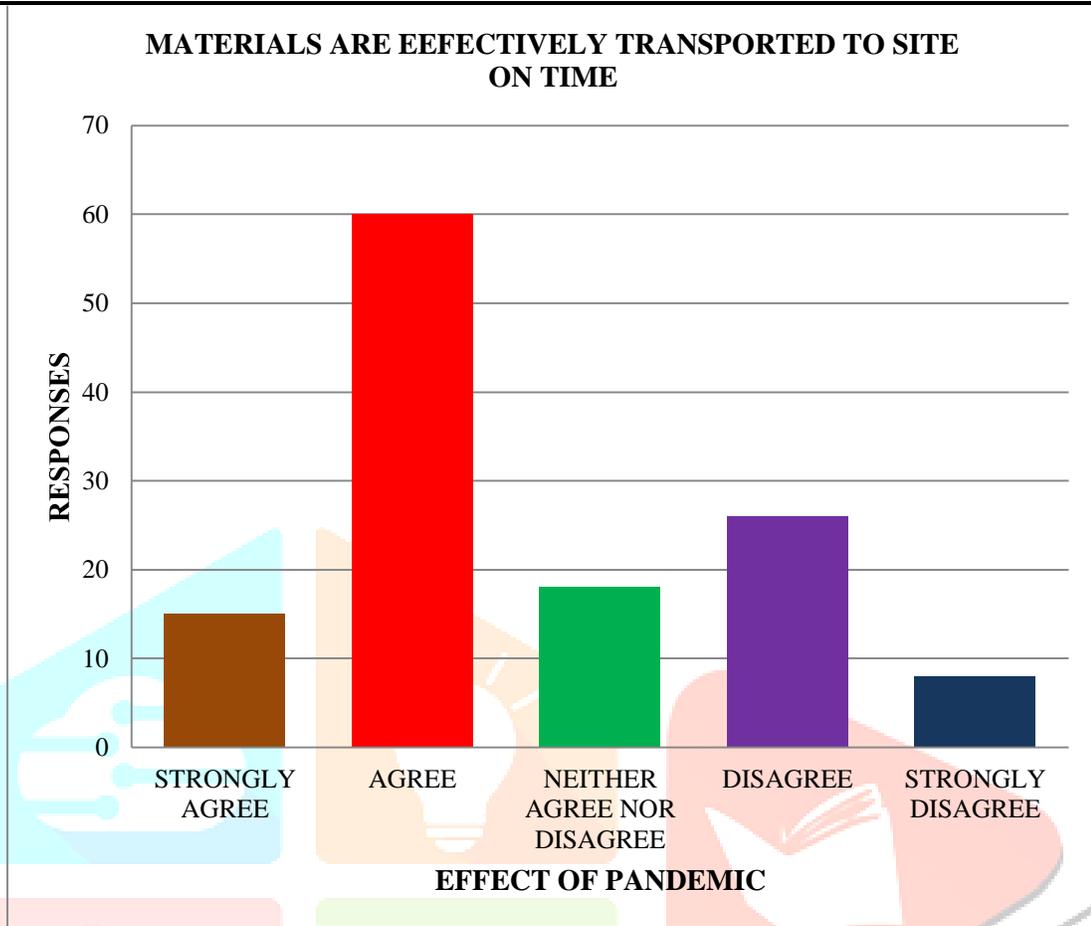


**Chart 4.29 Believe working at home will substitute office work**

### Interpretation

From the above Chart, for believe working at home will substitute office work 12 of the respondents strongly agreed, 46 of the respondents agreed, 7 of the respondents neither agreed nor disagreed, 22 of the respondents disagreed, 40 of the respondents strongly disagreed.

### Materials are effectively transported to site on time

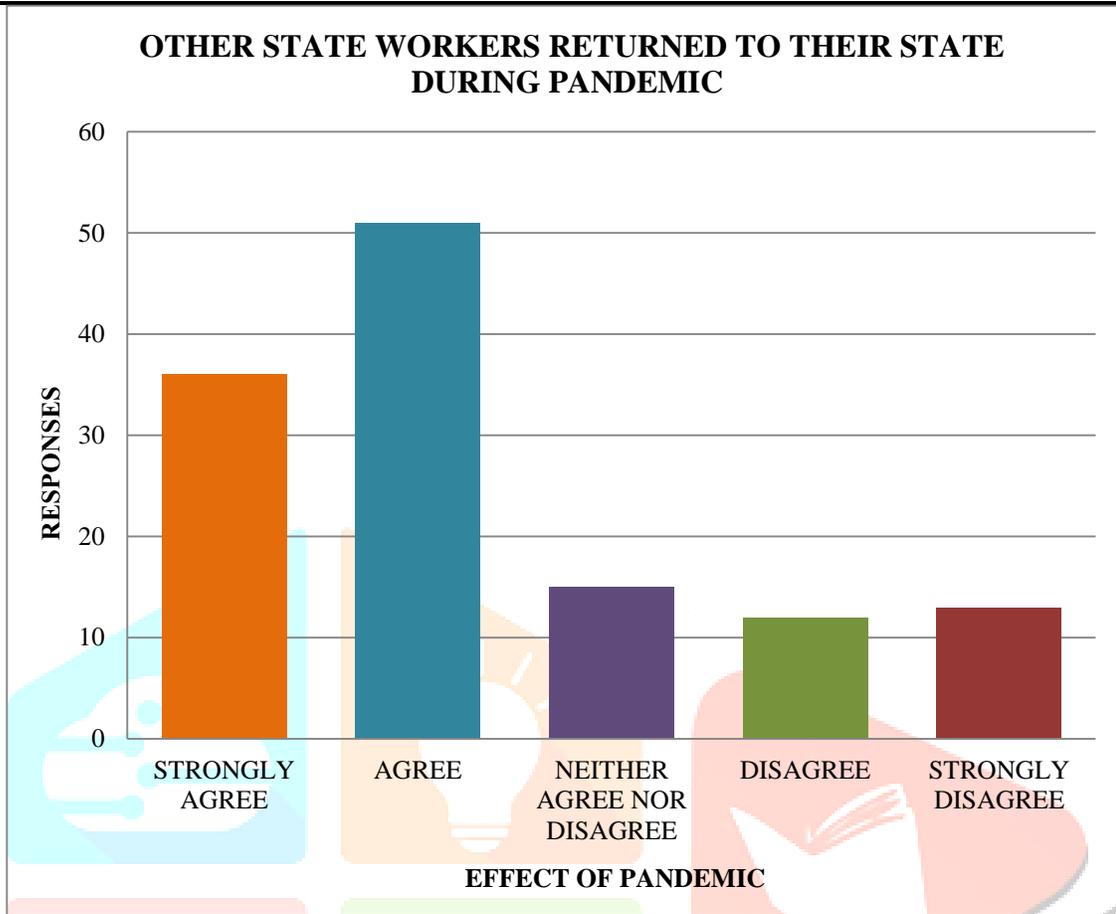


**Chart 4.30 Materials are effectively transported to site on time**

**Interpretation**

From the above Chart, for materials are effectively transported to site on time, 15 of the respondents strongly agreed, 60 of the respondents agreed, 18 of the respondents neither agreed nor disagreed, 26 of the respondents disagreed, 8 of the respondents strongly disagreed.

**Other state workers returned to their state during pandemic**

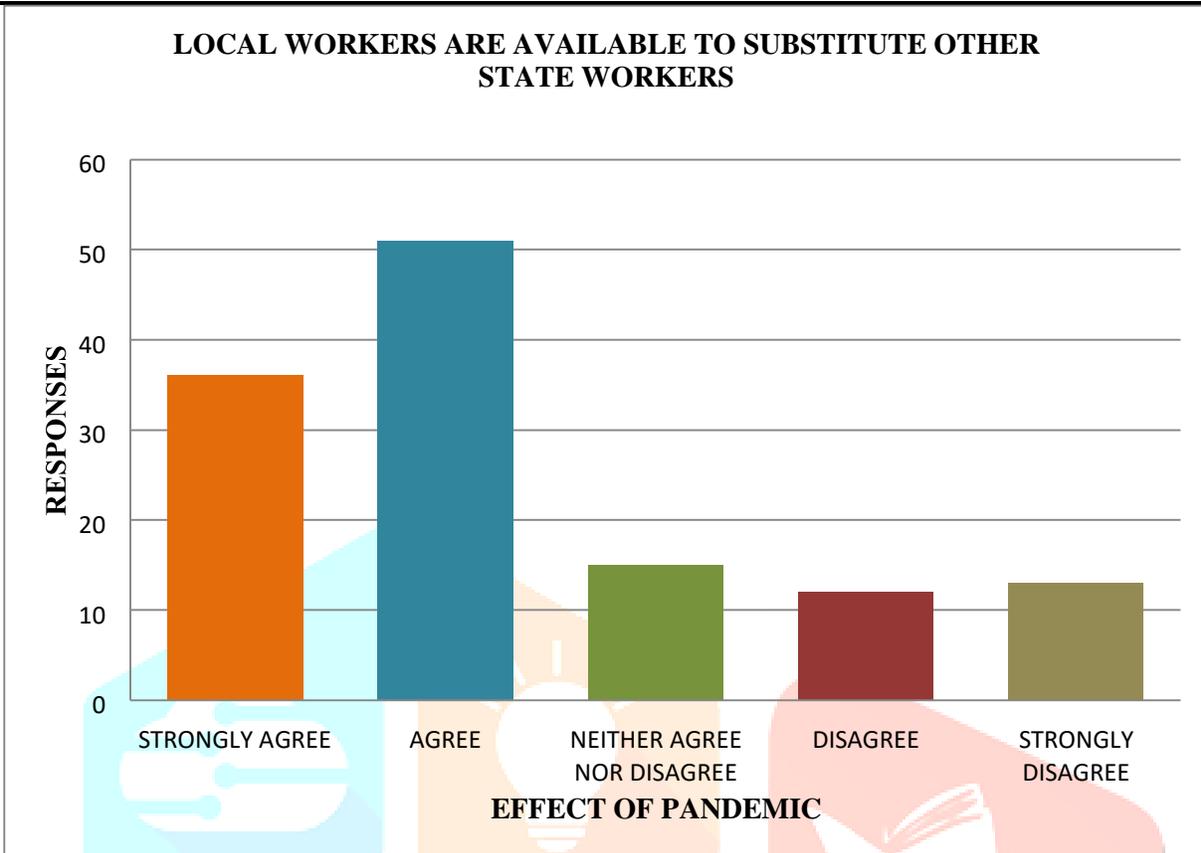


**Chart 4.31 Other state workers returned to their state during pandemic**

**Interpretation**

From the above Chart, for other state workers returned to their state during pandemic, 23 of the respondents strongly agreed, 64 of the respondents agreed, 13 of the respondents neither agreed nor disagreed, 15 of the respondents disagreed, 12 of the respondents strongly disagreed.

**Local workers are available to substitute other state workers**

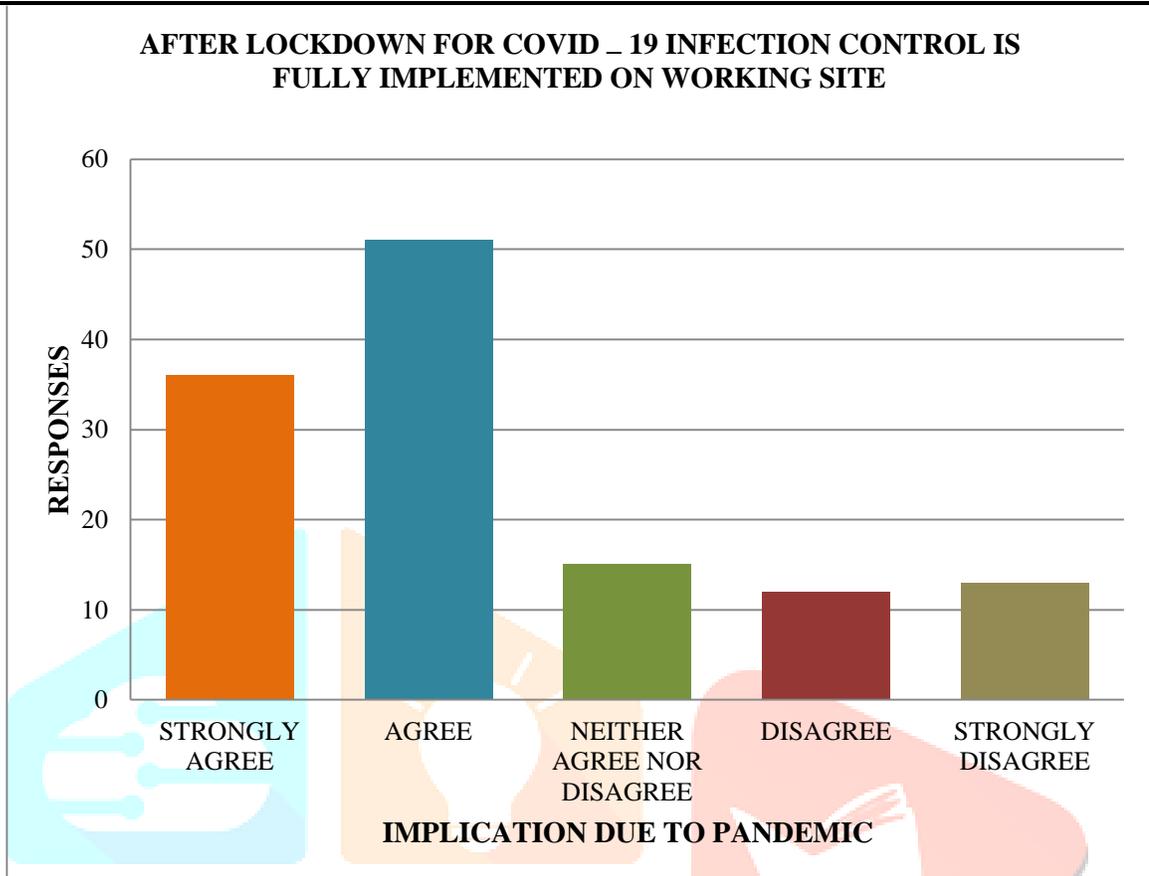


**Chart 4.32 Local workers are available to substitute other state workers**

**Interpretation**

From the above Chart, for local workers are available to substitute other state workers, 12 of the respondents strongly agreed, 49 of the respondents agreed, 24 of the respondents neither agreed nor disagreed, 28 of the respondents disagreed, 14 of the respondents strongly disagreed.

**After lockdown for COVID – 19 infection control is fully implemented on working site**

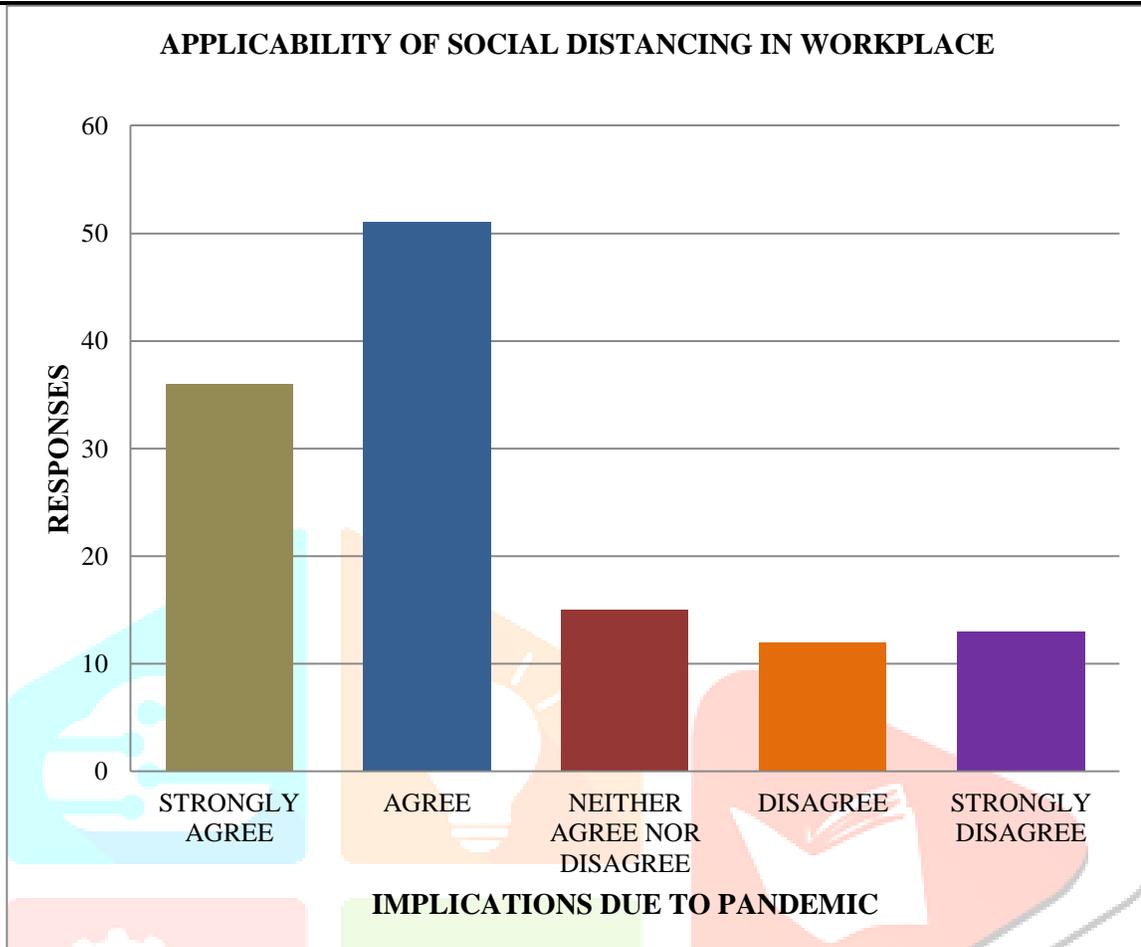


**Chart 4.33 Infection control is fully implemented on working site**

**Interpretation**

From the above Chart, for after lockdown for COVID – 19 infection control is fully implemented on working site, 21 of the respondents strongly agreed, 65 of the respondents agreed, 17 of the respondents neither agreed nor disagreed, 16 of the respondents disagreed, 8 of the respondents strongly disagreed.

**Applicability of social distancing in workplace**

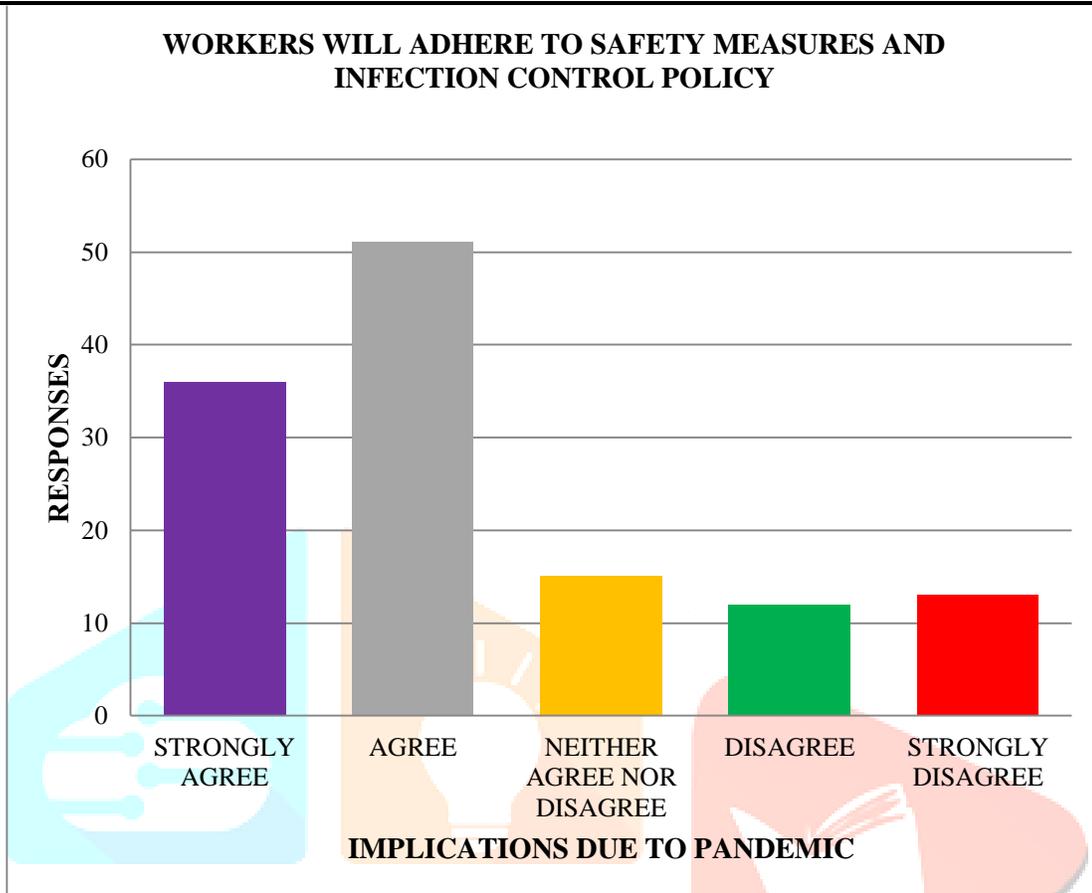


**Chart 4.34 Applicability of social distancing in workplace**

**Interpretation**

From the above Chart, for after lockdown for applicability of social distancing in workplace, 23 of the respondents strongly agreed, 61 of the respondents agreed, 19 of the respondents neither agreed nor disagreed, 20 of the respondents disagreed, 4 of the respondents strongly disagreed.

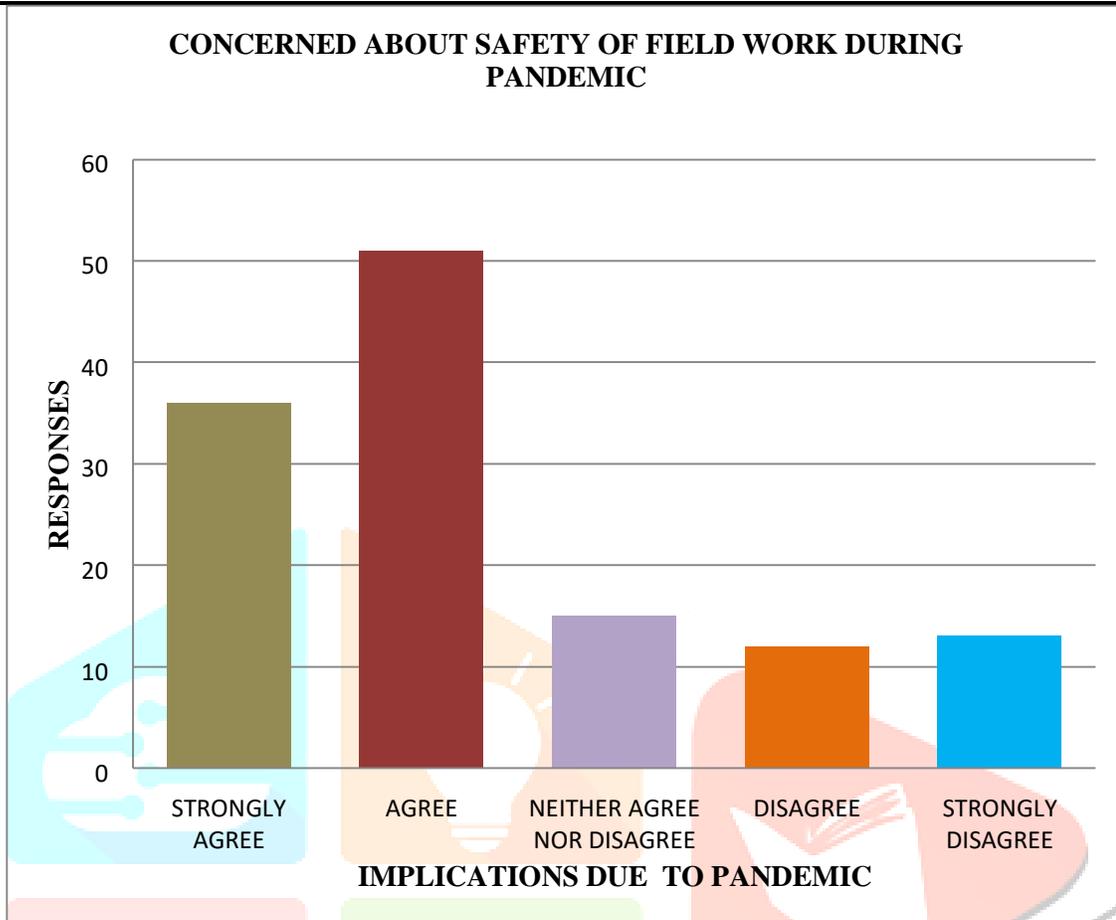
**Workers will adhere to safety measures and infection control policy**



**Chart 4.35 Workers will adhere to safety measures and infection control policy Interpretation**

From the above Chart, for workers will adhere to safety measures and infection control policy, 25 of the respondents strongly agreed, 63 of the respondents agreed, 18 of the respondents neither agreed nor disagreed, 11 of the respondents disagreed, 10 of the respondents strongly disagreed.

### Concerned about safety of field work during pandemic

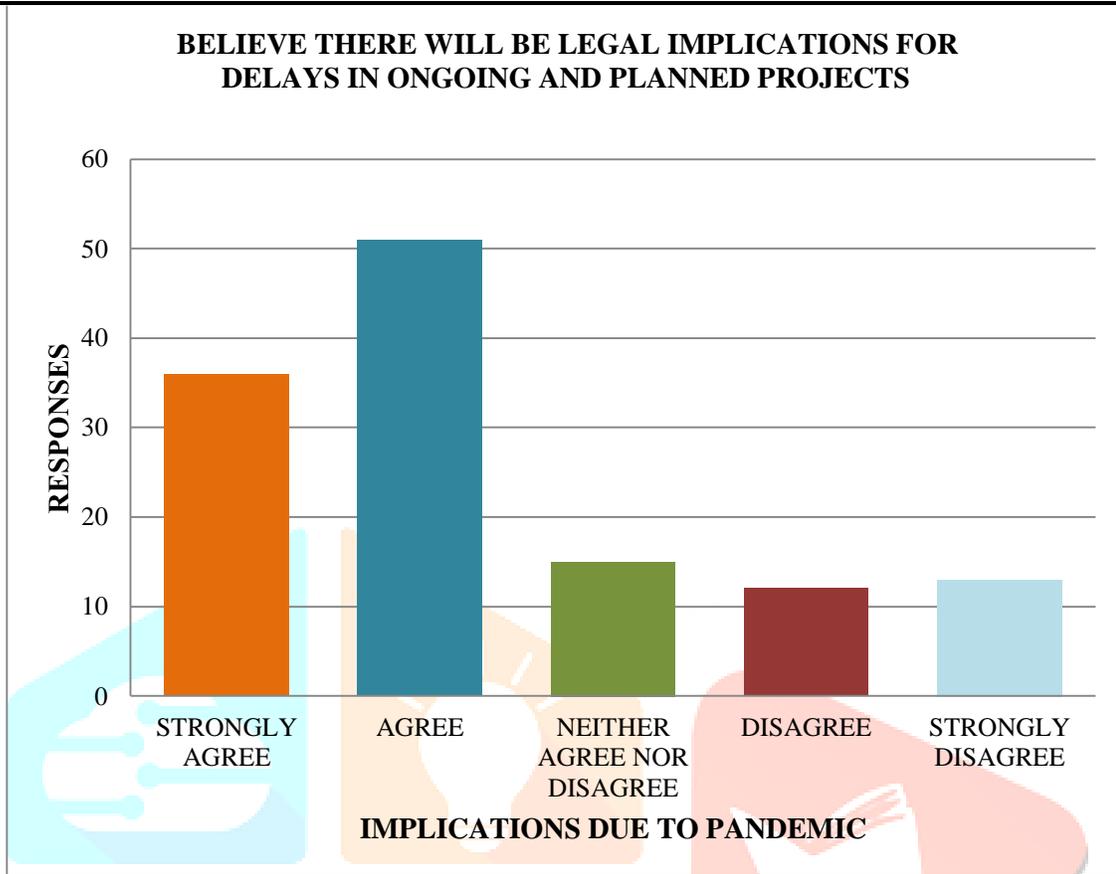


**Chart 4.36 Concerned about safety of field work during pandemic**

**Interpretation**

From the above Chart for concerned about safety of field work during pandemic, 28 of the respondents strongly agreed, 61 of the respondents agreed, 17 of the respondents neither agreed nor disagreed, 11 of the respondents disagreed, 10 of the respondents strongly disagreed.

**Believe there will be legal implications for delays in ongoing and planned projects**

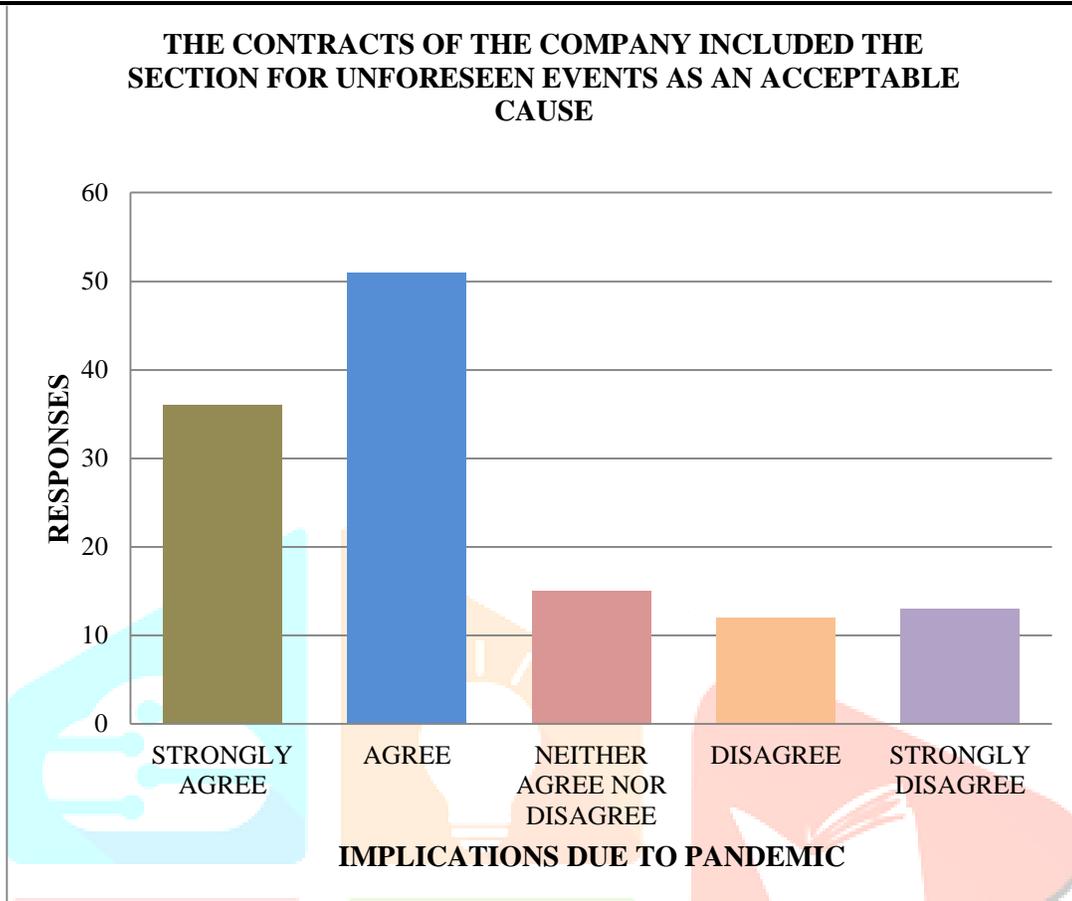


**Chart 4.37 Believe there will be legal implications for delays in ongoing and planned projects**

**Interpretation**

From the above Chart for believe there will be legal implications for delays in ongoing and planned projects, 27 of the respondents strongly agreed, 52 of the respondents agreed, 21 of the respondents neither agreed nor disagreed, 20 of the respondents disagreed, 7 of the respondents strongly disagreed.

**The contracts of the company included the section for unforeseen events as an acceptable cause**

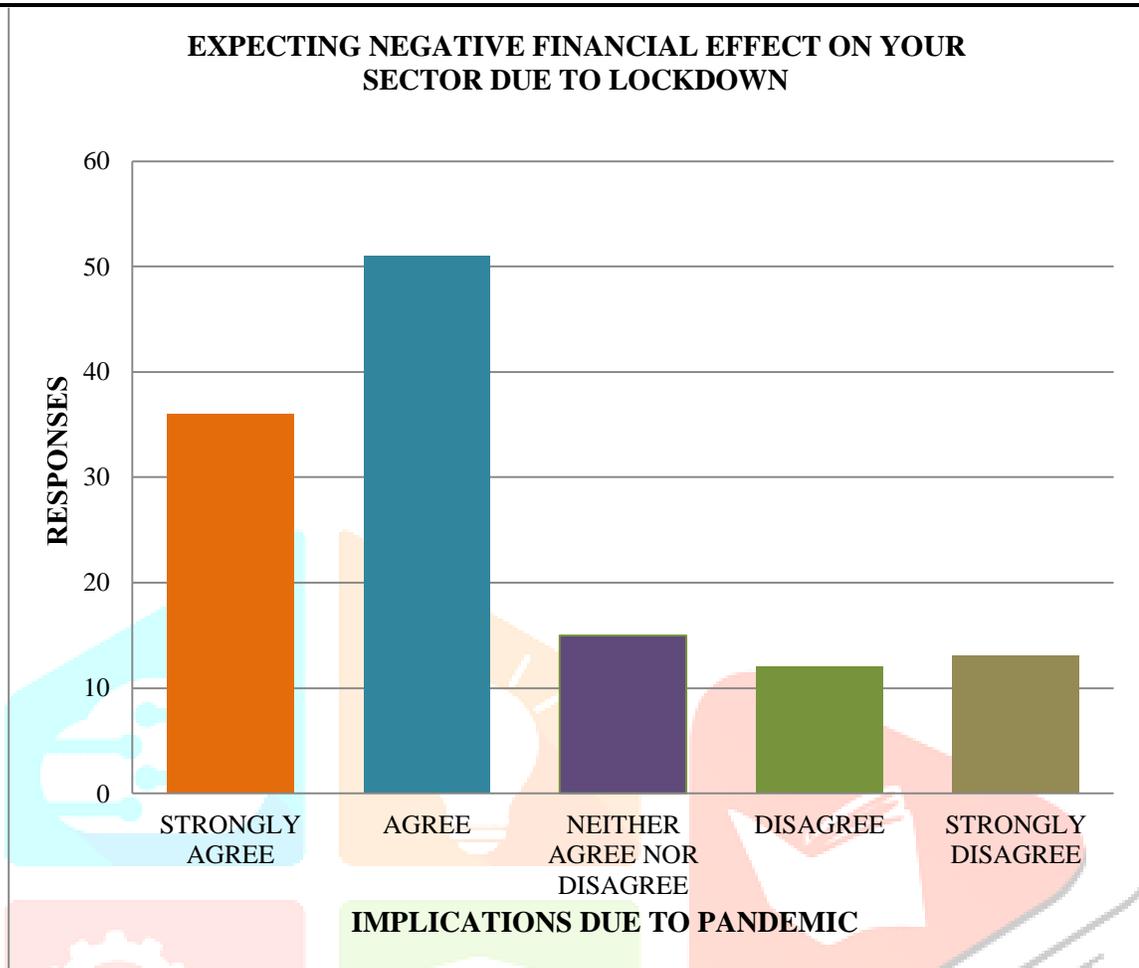


**Chart 4.38 Unforeseen events as an acceptable cause**

**Interpretation**

From the above Chart for the contracts of the company included the section for unforeseen events as an acceptable cause, 21 of the respondents strongly agreed, 52 of the respondents agreed, 20 of the respondents neither agreed nor disagreed, 15 of the respondents disagreed, 13 of the respondents strongly disagreed.

**Expecting negative financial effect on your sector due to lockdown**

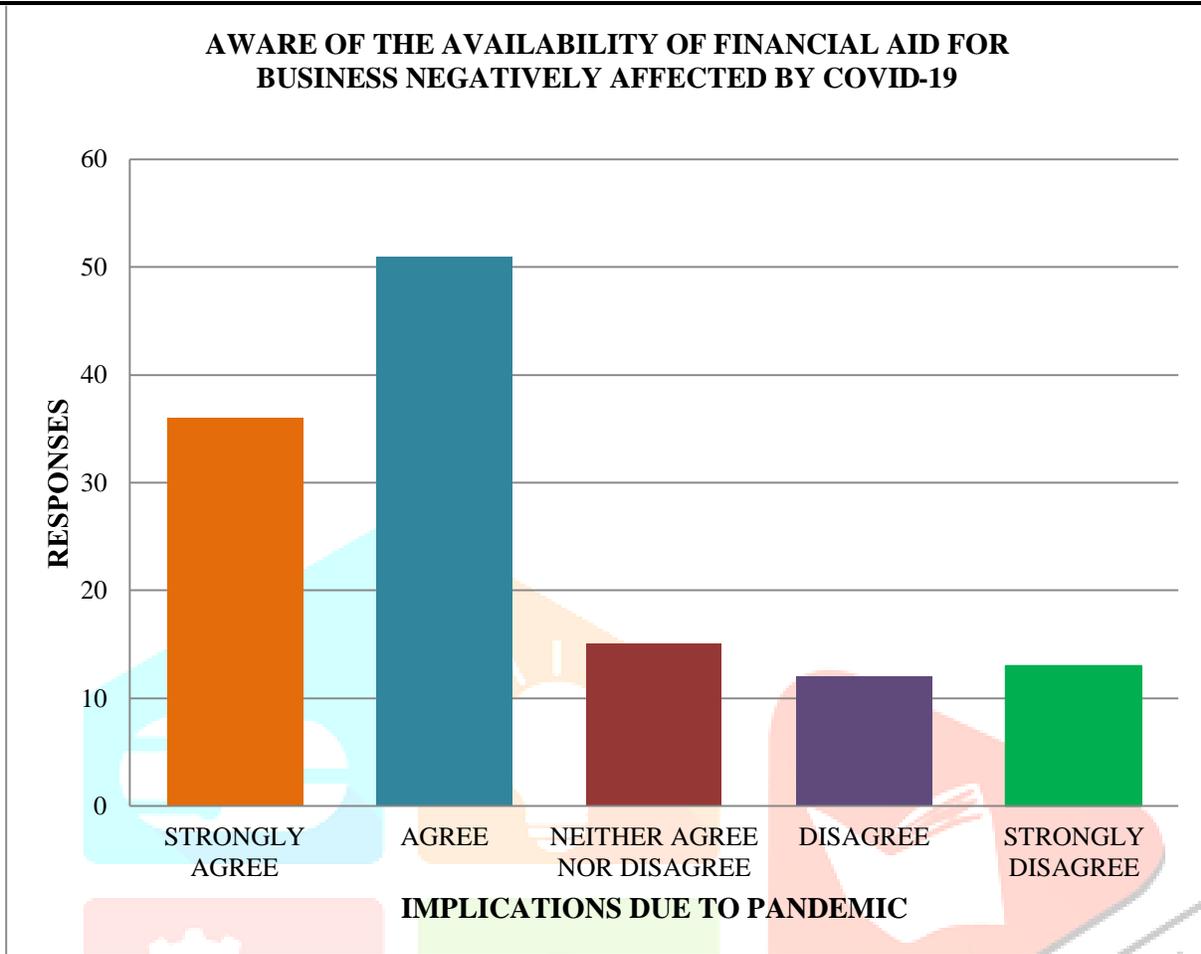


**Chart 4.39 Negative financial effect on your sector**

**Interpretation**

From the above Chart for expecting negative financial effect on your sector due to lockdown, 22 of the respondents strongly agreed, 52 of the respondents agreed, 19 of the respondents neither agreed nor disagreed, 16 of the respondents disagreed, 18 of the respondents strongly disagreed.

**Aware of the availability of financial aid for business negatively affected by COVID-19**



**Chart 4.40 Availability of financial aid for business negatively affected by COVID-19**

**Interpretation**

From the above Chart for aware of the availability of financial aid for business negatively affected by covid-19, 22 of the respondents strongly agreed, 52 of the respondents agreed, 19 of the respondents neither agreed nor disagreed, 16 of the respondents disagreed, 18 of the respondents strongly disagreed.

**4.3 ANNOVA TEST**

		ANOVA			
		Sum of Squares	df	Mean Square	F
Work affected during covid-19	Between Groups	2.635	2	1.318	1.401
	Within Groups	116.593	124	.940	
	Total	119.228	126		
Productivity during the pandemic	Between Groups	.576	2	.288	.435
	Within Groups	82.149	124	.662	
	Total	82.724	126		
Aware of the availability of financial aid for business negatively affected by Covid-19	Between Groups	1.186	2	.593	.366
	Within Groups	200.924	124	1.620	
	Total	202.110	126		

		ANOVA		Sig.
Work affected during covid-19	Between Groups			.250
	Within Groups			
	Total			
Productivity during the pandemic	Between Groups			.649
	Within Groups			
	Total			
Aware of the availability of financial aid for business negatively affected by Covid-19	Between Groups			.694
	Within Groups			
	Total			

**Post Hoc Tests**

**Homogeneous Subsets**

**Table 4.9 representing Work affected during covid-19**

Duncan<sup>a,b</sup>

Age	N	Subset for alpha = 0.05 1
3	7	1.29
2	45	1.91
1	75	1.92
Sig.		.075

Means for groups in homogeneous subsets are displayed.

- a. Uses Harmonic Mean sample size = 16.815
- b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type 1 error levels are not guaranteed.

**Interpretation:**

Since the significant value for work affected during COVID – 19 is 0.075 greater than 0.05, so there is no significant difference.

**Table 4.10 representing Productivity during the pandemic**

Duncan<sup>a,b</sup>

Age	N	Subset for alpha = 0.05 1
1	75	2.08
2	45	2.20
3	7	2.29
Sig.		.495

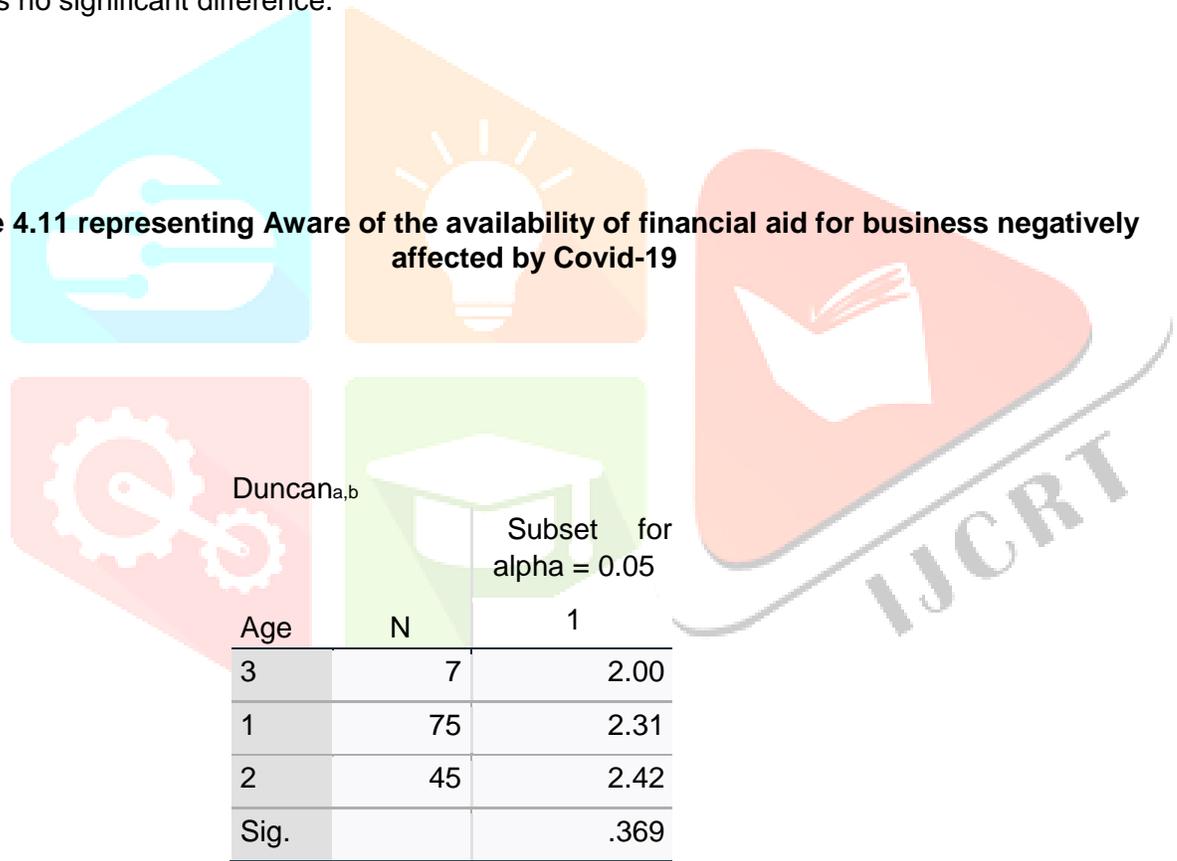
Means for groups in homogeneous subsets are displayed.

- a. Uses Harmonic Mean sample size = 16.815
- b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type 1 error levels are not guaranteed.

**Interpretation:**

Since the significant value for work affected during COVID – 19 is 0.495 greater than 0.05, so there is no significant difference.

**Table 4.11 representing Aware of the availability of financial aid for business negatively affected by Covid-19**



Age	N	Subset for alpha = 0.05
3	7	2.00
1	75	2.31
2	45	2.42
Sig.		.369

Duncan<sub>a,b</sub>

Means for groups in homogeneous subsets are displayed.

- a. Uses Harmonic Mean sample size = 16.815
- b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type 1 error levels are not guaranteed.

**Interpretation:**

Since the significant value for aware of the financial aid negatively affected during COVID – 19 is 0.369 greater than 0.05, so there is no significant difference.

**Table 4.12 representing correlation between work affected during COVID – 19 and Aware of the availability of financial aid for business negatively affected during COVID - 19**

		Work affected during covid-19	Aware of the availability of financial aid for business negatively affected by Covid-19
Work affected during covid-19	Pearson Correlation	1	.343**
	Sig. (2-tailed)		.000
	N	127	127
Aware of the availability of financial aid for business negatively affected by Covid-19	Pearson Correlation	.343**	1
	Sig. (2-tailed)	.000	
	N	127	127

\*\* . Correlation is significant at the 0.01 level (2-tailed).

**Interpretation:**

The correlation coefficient is 0.343, since there is relationship between work affected and aware of the availability of financial aid during COVID – 19.

## CHAPTER – 5 FINDINGS AND SUGGESTIONS

### 5.1 FINDINGS

- Majority (59.1%) of the respondents falls in category of 20-35 years of age.
- Majority (37%) of respondents are having income less than 20,000.
- Majority(84.3%) of the respondents are male. ○ Majority(61.4%) of respondents are on site work. ○ Majority(40.2%) of the productivity respondents are decreased.
- Majority (37%) of them are agreed that their firm adopted working at home during lockdown.
- Majority (36.2%) of them are agreed for believing working at home will substitute office work.
- Majority (47.2%) of them are agreed for materials are effectively transported to site on time.
- Majority(50.4%) of the respondents are agreed for other state workers returned to their state during pandemic.
- Majority (38.6%) of the respondents were agreed for local workers are available to substitute other state workers.
- Majority (51.2%) of the respondents are agreed that after lockdown the covid-19 infection control is fully implemented in working site.
- Majority (48%) of the respondents are agreed that applicability of social distancing in workplace.
- Majority (49.7%) of the respondents are agreed that applicability of social distancing in workplace.

- Majority (48%) of the respondents are agreed for concerned about safety of field work during the pandemic.
- Majority (40.9%) of the respondents are agreed for , believing there will be legal implications for delays in ongoing and planned projects.
- Majority (40.2%) of the respondents are agreed for the contracts of the company included the section for unforeseen events as an acceptable cause.
- Majority(40.9%) of the respondents are agreed for expecting financial effect on their sector due to lockdown.
- Majority (40.2%) of the respondents are agreed for , aware of the availability of financial aid for business negatively affected by covid-19.
- Majority (44.9%) of the respondents are agreed that work affected during covid-19.
- Majority (43.3%) of the respondents are agree for , lifestyle affected during covid-19.

## 5.2 SUGGESTIONS

There is no doubt that most civil engineers, contractors, supply chain workers and various construction professionals will continue to experience the impacts of COVID-19 pandemic on their sector. Even though most of their work affected due to the pandemic some workers were disagreed to the statement. Majority of them felt that the production gets decreased over in larger amount and they were faced serious financial issues regarding the sector.

The sanitary measures and other safety precautions were effectively handled over in the working sites and most of them followed it. The backups and other precautions over the financial side was also been effectively managed by construction companies and their way of handling the situation is controlled. But on the other side the lifestyle of engineers, supply chain workers and other construction professionals gets affected.

### 5.3 CONCLUSION

In conclusion, COVID – 19 pandemic may leads to some unwanted issues and affects the routine of many especially over the sectors which plays a crucial role in country's economy. The construction sector is one among them which would develops the country's GDP in an effective manner and millions of workers were depends upon the sector for their routine, so it's important for the entrepreneurs to handle the situation with effective plans and they are aware of the financial aid been created for the unavoidable situation.



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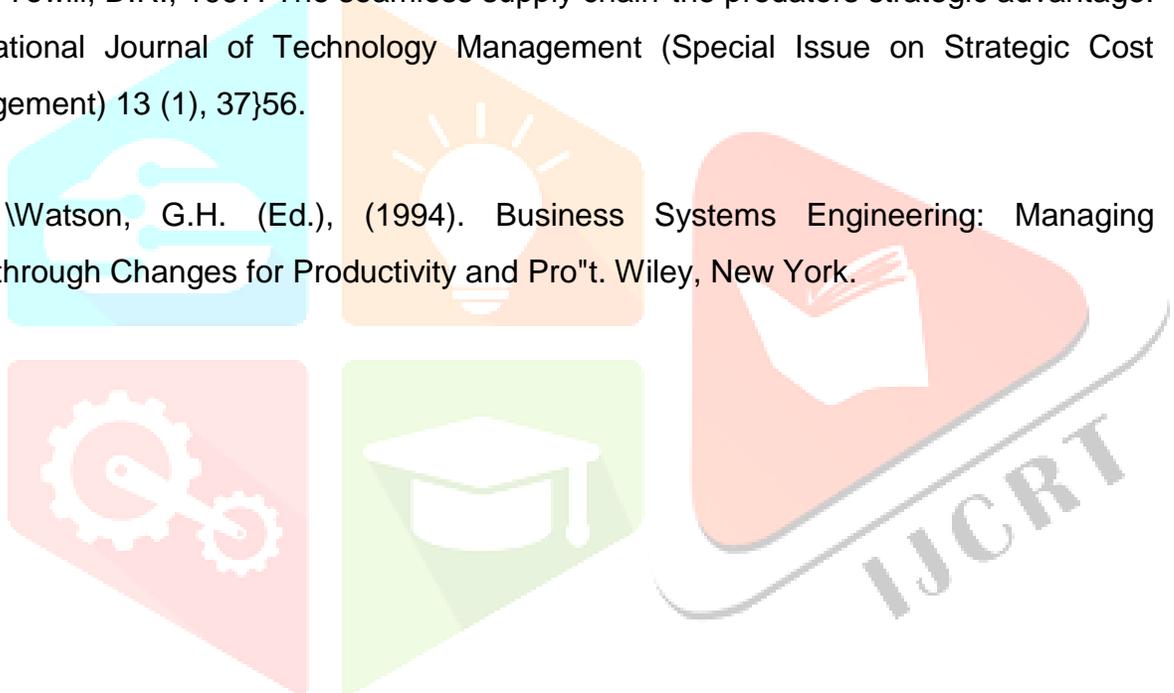
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## APPENDIX 1 (QUESTIONNAIRES)

## A STUDY ON SUPPLY CHAIN OPERATIONS IN CONSTRUCTION FIELD DURING COVID - 19

Age of respondents

Income of respondents

Gender of respondents

Work field (site work or office work) of respondents

The firm adopted working at home during lockdown

Believe working at home will substitute office work

Productivity during the pandemic

Materials are effectively transported to site on time

Other state workers returned to their state during pandemic

Local workers are available to substitute other state workers

Work affected during COVID - 19

Lifestyle affected during COVID – 19

After lockdown for COVID – 19, infection control is fully implemented in working site

Applicability of social distancing in workplace

Concerned about safety of field work

Believe there will be legal implications for delay in ongoing and planned projects

The contracts of the company included the section for unforeseen events as an acceptable cause

Expecting negative financial effect on your sector due to lockdown

I.

II.

III.

IV.

V. VI.

- VII.
- VIII.
- IX.
- X. XI.
- XII.
- XIII.
  
- XIV.
- XV.
- XVI.
- XVII.
- XVIII.

**APPENDIX – 2 (Article)**  
**A STUDY ON SUPPLY CHAIN OPERATIONS IN CONSTRUCTION  
FIELD DURING COVID-19**

**Dr.S.Uma Maheshwari    B. Sai Sankara Narayanan**

ASSISTANT PROFESSOR, SCHOOL OF MANAGEMENT STUDIES,  
SATHYABMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI  
– 600119

STUDENT, SCHOOL OF MANAGEMENT STUDIES, SATHYABMA  
INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI - 600119

**ABSTRACT**

COVID – 19 seriously cause severe damages to construction industry with lot of workers, professionals, engineers not able to work for their industry due to lockdown. It also cause serious economical issues with the clients not able to support the contractors for ongoing projects and planned money transaction were impossible due to pandemic. The huge loss blown to the industry created the impact of supply chain activities due to the pandemic. This paper reviews on supply chain operations that focusses on changes and innovation that connects the supply chain to other network, including transport, command and control. This paper results were mainly based the persons such as construction workers, contractors, engineers, entrepreneurs and various supply chain workers who involved in different supply chain activities in construction field. It also discuss about the challenges faced over by them during the pandemic. It mainly prescribes on the factors and effects of pandemic on their daily routine, the measures taken over by them to handle the situation, the safety precaution guidelines issued over

by the government and the implications done by them to overcome it. The main principle of this paper is that whether the construction workers are able to survive the pandemic and the change over to new normal are analyzed and discussed.

## I. INTRODUCTION

The COVID – 19 spread which occurred throughout the world in this year cause serious life threats, challenges to health and also tested our immunity level. This serious outbreak forced various governments to announce lockdown all over the country and enable people to stay at home. This has caused significant disruption in demand and supply around the world. Rather than the outbreak these kind of shutdowns were caused a serious economical threat issue for the country where the GDP also reduced than not seen before. We are now also seeing evidence of significant supply chain disruptions in building and construction industry which was the main source of the country's GDP. An unpredictable shutdown of the whole industry would be a huge loss that is been blown to various entrepreneurs, contractors and the clients who were in expectation over their planned activities. This article explains about the projects that are taken over by contractors and how they managed to give a solution to their clients and the time management, delays in projects are studied. The lifestyle of the workers and the new normal activities to be followed and the implications that are been done are also been analyzed. Overall, the main impact on the work and routine of the various construction professionals are been studied and the changes due to pandemic are adopted by them or caused serious challenges to them.

## II. METHODOLOGY

### i. Study design

This study is a cross-sectional investigation which was based on a self-administered online questionnaires circulated among civil engineers, contractors, supply chain workers and various construction professionals aging between 22 and 65 years, who are currently working either in an office job or a field job in a construction firm whose offices and projects are all located in the India. It also consists about the activities that are been followed up by them during their work and the questions were framed accordingly and circulated among the various civil engineers, contractors, supply chain workers, contractors and entrepreneurs.

### ii. Questionnaire design and data collection

The survey questionnaire was structured under the following subheadings of demography, impacts of covid-19, and other implications and safety measures that were done. To determine the general information about the nature of work, area of work, the complications that are handled and financial measures pre planned by the company. The data collection took place between February 1, 2021 to March 10, 2021 during which 127 professionals filled the questionnaire.

### III. STATISTICAL ANALYSIS

Microsoft excel has been used to analyze the collected data. The various charts are been represented to show the variations on how it works to detail them.

### IV. RESULTS

The obtained data from google form, are interpreted and analyzed. This form is been circulated among the top most construction firms and the workers across the country. 127 construction professionals were filled this form across India who were working in various departments around the construction industry. The differ in opinion among them were taken into account and the majority of it was declared as the result.

The questionnaire mainly consists of three parts, they are

- Demographic data of the Civil engineers, contractors, entrepreneurs and various supply chain workers.
- Effect of pandemic in their daily routine.
- Long term implications due to pandemic which acts as a new normal to their working behavior.

#### i. Demographic data

1) From the collected data it is observed that the no of respondents between 20-35 years of age is 59.1%, 35-50 years of age is 35.4%, 50-65 years of age is 5.5%.

2) From the collected data it is observed that no of respondents having income less than 20,000 are 37%, 20,000-50,000 are 36.2%, 50,000-1,00,000 are 22%, greater than 1,00,000 are 4.8%.

3) From the collected data it is observed that the no of male respondents are 84.3%, female respondents are 15.7%.

4) From the collected data it is observed that the no of respondents on site work are 61.4%, office work are 38.6%.

5) From the collected data it is observed that productivity during the pandemic increased is 26.8%, stayed the same is 33.1%, decreased is 40.2%.

#### ii. Effect of pandemic

**1)** From the above table the respondents for firm adopted working at home during lockdown (strongly agree (11.8%), agree (37%), neither agree nor disagree (12.6%), disagree (11.8%), strongly disagree (26.8%) ).

**2)** From the collected data it is observed that the respondents for believing working at home will substitute office work (strongly agree (9.4%), agree (36.2%), neither agree nor disagree (18.4%), disagree (17.3%), strongly disagree (31.5%) ).

**3)** From the collected data it is observed that the respondents for materials are effectively transported to site on time (strongly agree (11.8%), agree (47.2%), neither agree nor disagree (14.2%), disagree (20.5%), strongly disagree (6.3%) ).

**4)** From the collected data it is observed that the respondents for other state workers returned to their state during pandemic (strongly agree (18.1%), agree (50.4%), neither agree nor disagree (10.2%), disagree (11.8%), strongly disagree (9.4%) ).

**5)** From the collected data it is observed that the respondents for local workers are available to substitute other state workers (strongly agree (9.4%), agree (38.6%), neither agree nor disagree (18.9%), disagree (22%), strongly disagree (11%) ).

**6)** From the collected data it is observed that the respondents for, work affected during covid-19 (strongly agree (39.4%), agree (44.9%), neither agree nor disagree (6.2%), disagree (7%), strongly disagree (2.5%) ).

**7)** From the collected data it is observed that the respondents for, lifestyle affected during covid-19 (strongly agree (21.3%), agree (43.3%), neither agree nor disagree (10.2%), disagree (15.7%), strongly disagree (9.4%) ).

### iii. Long term implications due to pandemic

**1)** From the collected data it is observed that the respondents for, after lockdown the covid-19 infection control is fully implemented in working site (strongly agree (16.5%), agree (51.2%), neither agree nor disagree (13.4%), disagree (12.6%), strongly disagree (8%) ).

**2)** From the collected data it is observed that the respondents for, applicability of social distancing in workplace (strongly agree (18.1%), agree (48%), neither agree nor disagree (15%), disagree (15.7%), strongly disagree (2.9%) ).

**3)** From the collected data it is observed that the respondents for, concerned about safety of field work during the pandemic (strongly agree (22%), agree (48%), neither agree nor disagree (13.4%), disagree (8.7%), strongly disagree (7.9%) ).

**4)** From the collected data it is observed that the respondents for, believing there will be legal implications for delays in ongoing and planned projects (strongly agree (21.3%), agree (40.9%), neither agree nor disagree (16.5%), disagree (15.7%), strongly disagree (5.6%) ).

**5)** From the collected data it is observed that the respondents for, the contracts of the company included the section for unforeseen events as an acceptable cause (strongly agree (22%), agree (40.2%), neither agree nor disagree (15.7%), disagree (11.8%), strongly disagree (10.2%) ).

**6)** From the collected data it is observed that the respondents for, expecting financial effect on their sector due to lockdown (strongly agree (17.3%), agree (40.9%), neither agree nor disagree (15%), disagree (12.6%), strongly disagree (14.2%) ).

7) From the collected data it is observed that the respondents for, aware of the availability of financial aid for business negatively affected by covid-19 (strongly agree (28.3%), agree (40.2%), neither agree nor disagree (11.8%), disagree (9.4%), strongly disagree (10.2%) ).

**ANNOVA TEST**

		<b>ANOVA</b>			
		Sum of Squares	df	Mean Square	F
Work affected during covid-19	Between Groups	2.635	2	1.318	1.401
	Within Groups	116.593	124	.940	
	Total	119.228	126		
Productivity during the pandemic	Between Groups	.576	2	.288	.435
	Within Groups	82.149	124	.662	
	Total	82.724	126		
Aware of the availability of financial aid for	Between of Groups	1.186	2	.593	.366

		<b>ANOVA</b>				Sig.
Work affected during covid-19	Between Groups					.250
	Within Groups					
	Total					
Productivity during the pandemic	Between Groups					.649
	Within Groups					
	Total					
Aware of the availability of financial aid for Covid-19	Between Groups					.694
	Within Groups					
	Total					
business negatively affected by Covid-19	Within Groups	200.924	124	1.620	affected by Covid-19	Total 202.110
						126

**Post Hoc Tests**

**Homogeneous Subsets**

**Table representing Work affected during covid-19**

Duncan<sup>a,b</sup>

Age	N	Subset for alpha = 0.05 1
3	7	1.29
2	45	1.91
1	75	1.92
Sig.		.075

Means for groups in homogeneous subsets are displayed.

- c. Uses Harmonic Mean sample size = 16.815
- d. The group sizes are unequal. The harmonic mean of the group sizes is used. Type 1 error levels are not guaranteed.

**Interpretation:**

Since the significant value for work affected during COVID – 19 is 0.075 greater than 0.05, so there is no significant difference.

**Table representing Productivity during the pandemic**

Duncan<sup>a,b</sup>

Age	N	Subset for alpha = 0.05 1
1	75	2.08
2	45	2.20
3	7	2.29
Sig.		.495

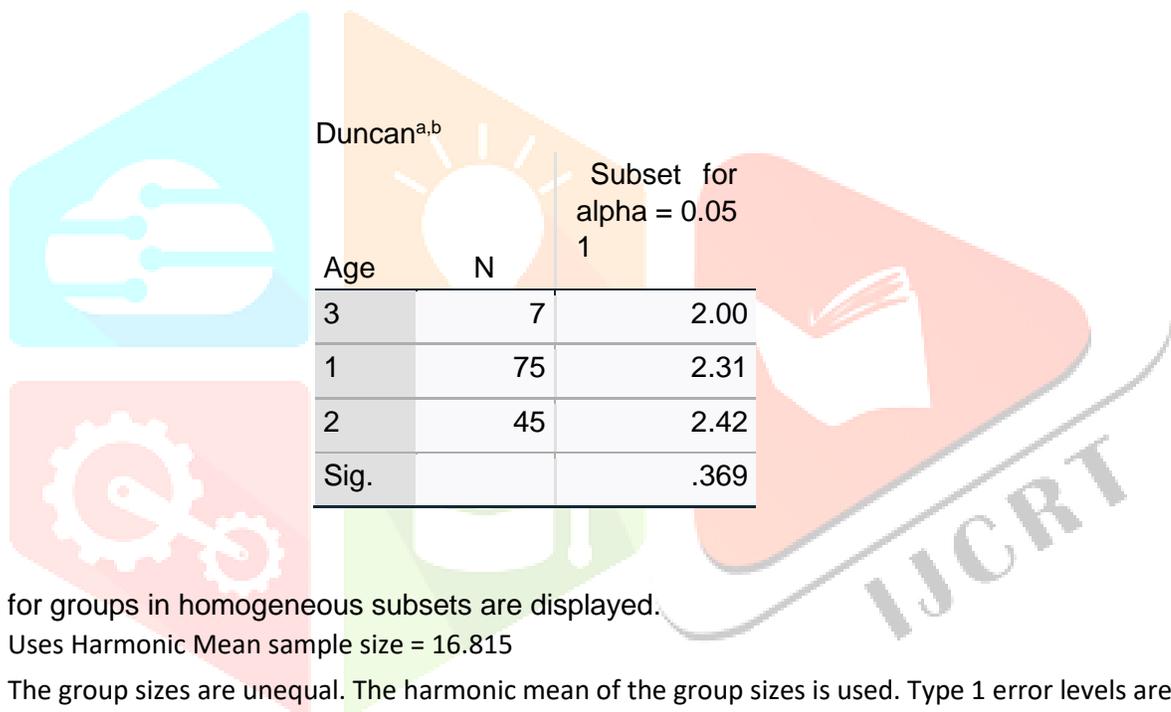
Means for groups in

- c. Uses Harmonic Mean sample size = 16.815
- d. The group sizes are unequal. The harmonic mean of the group sizes is used. Type 1 error levels are not guaranteed.

Interpretation:

Since the significant value for work affected during COVID – 19 is 0.495 greater than 0.05, so there is no significant difference.

**Table representing Aware of the availability of financial aid for business negatively affected by Covid-19**



Duncan <sup>a,b</sup>		Subset for alpha = 0.05	
Age	N	1	
3	7	2.00	
1	75	2.31	
2	45	2.42	
Sig.		.369	

Means for groups in homogeneous subsets are displayed.

- c. Uses Harmonic Mean sample size = 16.815
- d. The group sizes are unequal. The harmonic mean of the group sizes is used. Type 1 error levels are not guaranteed.

Interpretation:

Since the significant value for aware of the financial aid negatively affected during COVID – 19 is 0.369 greater than 0.05, so there is no significant difference.

**Table representing correlation between work affected during COVID – 19 and Aware of the availability of financial aid for business negatively affected during COVID - 19**

		Work affected during covid-19	Aware of the availability of financial aid for business negatively affected by Covid-19
Work affected during covid-19	Pearson Correlation	1	.343**
	Sig. (2-tailed)		.000
	N	127	127
Aware of the availability of financial aid for business negatively affected by Covid-19	Pearson Correlation	.343**	1
	Sig. (2-tailed)	.000	
	N	127	127

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Interpretation:

The correlation coefficient is 0.343, since there is relationship between work affected and aware of the availability of financial aid during COVID – 19.

## V. DISCUSSIONS AND CONCLUSIONS

From the results obtained, it is clearly known that the work and lifestyle of Civil engineers, contractors, entrepreneurs and various supply chain workers are been affected due to pandemic.

However most of the firms allowed their employees to work at home in this industry it has been practically not possible to do that but in office work such as drawing plan for building and Auto CADD works are been permitted to do at home.

The various safety measures and precautions prescribed by the government are mostly followed all over the site and lack of employees from other states are also been effectively substituted by the local workers. Several legal allowances were permitted by the government on the important works during lockdown so some felt that their work followed the routine but majority of them felt that their work routine and lifestyle gets affected due to pandemic.

The backup financial needs that are to be pre planned by the firm or industry face unavoidable situations are done by most the industries. The negative financial effect was also effectively managed. Finally the conclusion follows that the majority of the construction professionals felt that pandemic created a huge impact over their sector.

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