Gordon Institute of Business Science
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Understanding how service firms develop their systematic innovation processes

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ABSTRACT

The systematic process of innovation is how businesses may create and sustain their competitive advantage. This is accomplished through the application of new services or the improvement of existing services. The innovation process is regarded as a complex in nature and is difficult to conceptualise. When thinking about service innovation processes, the specific organizational setting is crucial. Understanding the nature of that industry can be aided by taking into account the characteristics of the firm and organizational environment. Technical engineering firms are knowledge based intensive firms who formulate solutions for their clients on a daily basis and are considered to be extremely innovative in nature.

The study has examined the way technical engineering consulting firms who provide building services formulate their innovation processes and why knowledge is important to these firms in the process. A set of semi structured interviews with 12 participants was conducted, which formed part of the data collection. The findings of the study have displayed six themes from the findings which aided in understanding two research questioned proposed in the study. The study revealed that firm's processes begin as result of events occurring randomly and their approach can be combination of both formal and informal processes when trying to achieve their goal of meeting market need and creating value at the same time. The results of the study further propose a model which describes the process and what aspects play role in these firms conducting successful innovation processes.

The research contributes towards the growing innovation processes research in service firms. This study has provided a view of what innovation processes consulting engineering service firms undertake in a South African emerging market context. The study is carried out at point where the current consulting engineering sector has been trying to recover from the impact of the COVID-19 pandemic and other political challenges in the country.

KEYWORDS

Service firms, Innovation process, open innovation practice, Knowledge based views, resource base views,

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Nabeel Mahomed, 01 November 2022

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1.1 INTRODUCTION

The following study examines how technical engineering consulting (TEC) firms which provide building services for clients formulate their innovative processes. This has been achieved through an exploratory, inductive case study approach. This process has been identified in a South African context taking an innovation process and knowledge-based view of the technical engineering consulting (TEC) firm.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

The directory of CESA (consulting engineers South Africa), indicates that there are 550 consulting engineering firms in South Africa. These firms have a total of approximately 19000 consultant engineers that have been registered with them. This information has suggested that the consulting engineering market in South Africa is saturated.

The BECS (Bi-annual economic and capacity survey), report released by CESA had indicated that the construction sector was the worst performing in the South African economy. Construction GDP was down 18.1% in last year's first quarter. Fee earnings for consultant engineers was down to 9.7% and consulting engineering companies or consultants are not expecting higher incomes going forward. It has described firms being in survival mode due to the current business environment which these firms are operating in. This generally applied to large to medium firms, however smaller firms remained optimistic (Industry Insight CC, 2021).

The recent pandemic, due to COVID-19 had caused disruption in industry. This has led to a chain reaction which has affected various avenues of core businesses and people's daily lives. Businesses therefore have shifted their focus to more innovative activities which has aided them in gaining success and survival in unstable market conditions (Wang et al., 2022). The literature in business innovation is quite large but most have focused on developed economies and reduced focus has been applied to emerging economies. In an economic downturn, a given sectors performance may not increase due to innovation, and this impacts the way firms ultimately innovate (Heredia Pérez et al., 2019).

Even though the pandemic influenced the downturn in performance of the construction sector, more recently in May 2022, Engineering news also suggested that the sector is further affected by the lack of development in the country (Hancock, 2022). Earlier in 2020, Engineering news reported that South Africa are losing engineers to foreign markets as result of the scarcity of public sector projects. State owned projects were vastly affected due to projects not being delivered within the prescribed time frame and budget associated with these types of projects. This had occurred as result of state failure to pre-plan correctly. This knock on effect has affected clients, consulting engineering firms and contractors as a whole (Parker, 2020). The impact of the pandemic has also created a skills deficit, loss of jobs and retrenchments for consulting firms (Nyathi, 2022)

As a result of the challenges the country faces the economic environment which these firms operate in is changing rapidly. With 550 firms listed in the country, engineering firms are forced to be more innovative as competition increases between them. These firms need to maintain their competitive advantage and sustain in order to remain relevant in the industry.

1.3 THE RESEARCH PROBLEM

There is a need to investigate innovation processes in emerging economies because research on innovation has mainly concentrated on developed countries, therefore this suggests that there is a gap that needs to be addressed. (Heredia Pérez et al., 2019). Service innovation as a topic in academia is still considered as a young avenue of research and is obtaining more interest from researchers (Chester Goduscheit & Faullant, 2018). These areas have involved professional firm service innovation and firm changes in processes. In the last few decades there has been an increase in the number of professional service firms (Pantic-dragisic, 2019). Prior research had focused primarily on mechanisms that affect institutions through the lens of classic professionalism (Cordasco et al., 2021). The nature of firms that provide services can be complex and can be looked at from differing perspectives (Anning-Dorson, 2018). There has been contribution towards literature in open innovation but, there is still a need for research on this topic (Arranz et al., 2019). The development of original, practical ideas and their transformation into useful services or goods are important components of innovation. The ability to increase revenue, create

business growth and interest new clientele can be formed from this innovation type (Xie et al., 2021). The focus of innovation in recent studies has predominantly been around the cutting-edge inventions that a firm might produce but has focused less on the organizational capital or inventors that play a significant role in the process itself (Vinokurova & Kapoor, 2020). These factors influence the process that are strategically implemented at a firm level (Heredia Pérez et al., 2019).

Firm process studies create an understanding of firm activity, the mechanisms involved provide theoretical experimentation of the process and not only in innovation studies (Van de Ven, 2017). Therefore, it is significant for a business to understand their innovation processes. They have greater focus for quality and production (Aliasghar et al., 2022b). Literature has also indicated that firm performance is linked to innovation in services (Anning-Dorson, 2018). In environments that are considered as highly competitive, Firms are challenged to improve and concentrate on their innovation processes. An effective process can improve market share for the firm. Firms need to be aware of the eco-systems which they operate in. This can help them formulate a plan of action that will ultimately benefit them in this context (Aliasghar et al., 2022).

Service orientated firms are playing a significant role in the business landscape (Xie et al., 2021). Many firms in industry are enhancing their innovation processes which leads to competitive advantage in their industry whilst at the same time creates shared value for customers and clients. Strategic change is required to meet these customers' needs and expectations (Morgan et al., 2021). Prior research has suggested many facets of innovation are included within the realm of service innovation. This can range from products, technologies, client or consumer involvement, internal and external firm mechanisms and firm performance. Internal mechanisms however still have received little scholarly attention (Xie et al., 2021).

When viewing an internal factor such as resources of a firm, they are included in three categories namely, human, organisational and physical. These three strategic categories have promoted towards competitiveness of a firm. Taking a resource-based view corresponds to organisational theory in learning. It integrates a series or pattern of behaviours in organisational routine (Pereira & Bamel, 2021). This is also substantiated in the article by Villani et al., (2021) that suggests that the combination of processes and resources creates innovation as an outcome (Villani et al., 2021).

Firm innovation mode has a significant relationship with the way it manages knowledge, the culture it creates, and the strategy taken to utilize the knowledge it has to develop innovation (Parrilli et al., 2020; Snihur & Wiklund, 2019). This is also substantiated against the study by Snihur & Wiklund (2019), as firms must find ways to implement new knowledge as it contributes towards firm innovation. (Snihur & Wiklund, 2019). Knowledge based networks, knowledge creation and its acquisition are significant factors that influence innovation (Villani et al., 2021).

The process of innovation itself involves activities have a combination of converging and diverging factors. This interleading process creates new avenues or triggers that create various influential factors and could be regarded as complex in nature. This process in various types of organisations is less understood (Van de Ven, 2017). Therefore, the setting of the study needs to be specific to the type of industry. For this reason, engineering consulting firms that provide services are the focus of the study. The study focuses on the innovation processes and knowledge-based views.

1.4 RESEARCH AIM

Technical engineering consulting firms (TEC's) rely on their engineers for individual know how. Therefore, these types of firms in this type of industry are considered to be rigorous with applications such as knowledge. It forms the foundation of the unique source of competitive advantage (Pantic-dragisic, 2019). Technical engineering consulting (TEC) firms are said to function in fast paced, high intensity environments. The consulting engineers that form part of this category have a good understanding of project based work (Pantic-Dragisic & Söderlund, 2020). Firms need to remain competitive and in order to achieve this , they rely on process innovation (Davids & Frenken, 2018). Engineers rely on a network of factors internally and externally to build capacity in the context of the profession (Pantic-dragisic, 2019).

Personnel who work for technical engineering firms or TEC's undertake complex work for various engineering projects in different locations. These engineers could be considered as knowledge workers that are project based or consultants with technical abilities whom possess an engineering qualification (Pantic-Dragisic & Söderlund, 2020; Sankowska & Söderlund, 2015). The study undertaken by Sankowska & Söderlund

(2015), describes mobile engineers as professionals who alternate between projects, move between firms, and accept different projects or tasks of a unique nature (Sankowska & Söderlund, 2015).

The work being carried out by these types of professionals differ from other types of service-based professionals. They have more independence which in turn creates freedom of expression which plays a role in the customer's ability to innovate in their own business environments. Clients ultimately have a need for services that offer differentiated approaches as opposed to traditional ones and where service improvements are evident (Chester Goduscheit & Faullant, 2018). One of the facets that apply to TEC firms such as functional flexibility also describes why clients would select organizations that can provide technical expertise which their own organizations would find to be extremely difficult for them to carry out (Pantic-Dragisic & Söderlund, 2020). The idea of a service-centered firm is to create value, these are progressive improvements which acts as a disrupter to which customer value is the ultimate outcome (Witell et al., 2017).

In a South African context, technical engineering service firms specifically firms that offer building services have been considered for the study. The building engineering service sector comprises of firms and engineers that specialise in mechanical HVAC (heating, ventilation and air conditioning) passive and active fire, plumbing, electronic, electrical and structural services. They are otherwise referred to as MEP services in an industry context (*Understanding Building Services*, n.d.). Therefore, the research aim is to study these firms and understand how they formulate their innovation processes and why knowledge is important in their processes.

1.5 SIGNIFICANCE OF THE RESEARCH

The environment of business is a fast changing sector and requires firms to be effective in maintaining their competitive advantage (Ovuakporie et al., 2021). Research into service firm innovation has recently received increasing consideration has become a priority as it is linked to financial growth (Chandler et al., 2019; Helkkula & Kowalkowski, 2018; Huarng et al., 2020). Scholars have interest in understanding how firms innovate in an organized manner (Chandler et al., 2019). Innovation in service firms is now seen as a primary driver of development amongst different scholars (Helkkula & Kowalkowski, 2018). There is a variety of disciplines that innovation research can focus on and because

this, literature in this respect is fragmented (Vargo et al., 2015).

The adoption of open innovation practices is one way which firms can enhance their advantage (Ovuakporie et al., 2021). One of the main areas of focus for open innovation research has been the way firms manage knowledge which ultimately leads to more innovative outcomes. These are potentially processes through which the innovation process is affected and can occur. Prior research suggested that the focus was primarily on service firms in a classical professional firm context. The technical engineering firm service industry today is characterised differently from standard firms and therefore, there exists a need to understand technical engineering consulting firms (Pantic-Dragisic & Söderlund, 2020).

1.6 CONCLUSION

Therefore, this study contributes towards the way technical engineering consultant (TEC) firms that specialise in building engineering services develop their systematic innovation processes and by taking a knowledge-based view this study can provide insight as to why knowledge is important in the process. From a resource point of view, these individuals are proposed to be studied in understanding their role of how they perceive the process and how it affects the firm. This process is required to be conceptualised using existing theory on this topic and what similarities exist for these types of service firms in industry.

Following on from this chapter, Chapter two illustrates the literature review, chapter three describes the research questions proposed for the study, chapter four displays the methodology utilised to undertake the data collection which forms part of the study, chapter five describes the in-depth findings of the interviews, chapter six addresses the analysis of the research questions and chapter seven concludes the study with recommendations.

2 CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The Literature review in this chapter outlines the themes of the study, which the proposal aims to build the research question on. The literature review highlights the importance of studying service firms briefly in the beginning of the review. The review then explores the aspects related innovation processes and then goes on to explore aspects that are related to the process. Lastly the literature focuses on open innovation practices, and which reveals why knowledge and resource-based views affect the process. The literature is developed from understanding what is known and what is not known about the innovation process.

2.2 SERVICE FIRMS

The service sector's significance in contemporary economies is expanding (Santos-vijande et al., 2021). Service industries in modern service firms involves developing services that can conform to market needs (Xie et al., 2021) . From a research perspective, technical engineering consulting firms or TEC firms have been identified as being significant role players in the market for innovation (Pantic-Dragisic & Söderlund, 2020). The goal of innovation research is to pinpoint the elements necessary for successful innovation (Xie et al., 2021). The service firm could be described as systems of resource-integrating agents that are comparatively self-sufficient, adaptable, and connected by common institutional structures and reciprocal value generation through the exchange of services (Vargo et al., 2020). Research on innovation in service firm is considered to be a priority. Service innovation research contributes towards the better understanding of their processes in a systematic manner (Chandler et al., 2019). The manner in which technical engineering consulting (TEC) firms perform re-iterates why it is important to pay closer attention to how these consulting businesses operate and comprehend their characteristics (Pantic-Dragisic & Söderlund, 2020).

2.3 INNOVATION IN THE CONTEXT OF THE STUDY

In literature, innovation has traditionally been defined as the creation of new goods or services. (Sørensen et al., 2010). The goals or objectives of an innovation process is to create financial gain to improve on a method by which products or services are created (Frishammar et al., 2012; Snihur & Wiklund, 2019). Frishammar et al. (2012), posited that there is said to be a close relationship between the facets of product innovation and service innovation (Frishammar et al., 2012).

The authors, Snihur & Wiklund (2019), defined innovation of products as an occurrence with a customer at the end of a process, but where service innovation is concerned, it can be regarded as a process that meets customer needs or coming up with solutions to customers challenges (Snihur & Wiklund, 2019; Troilo et al., 2017). Research in innovation primarily focused on how patterns of innovation are affected by R&D (research and development) aspects, the size of firms, firm age and the hierarchy of the firm from a managerial point of view at both an industry and at a firm level. Recently, research has moved its attention to figuring out why businesses are more adept at innovation in order to develop new processes (Ebersberger et al., 2021).

2.3.1 The Innovation Process

Innovation has been one of the significant elements by which firms have driven business growth and sustained their business (Francis et al., 2021). The journey of innovation can be described as a process model. The development, implementation, and ending phases of the process are separated by this model. (Oeij et al., 2019). Prior research also suggested a similar pattern where this process has been described by Sørensen et al., (2010), as a series of stages that begin with a selection and concludes with implementation (Sørensen et al., 2010). The purpose of an innovation process is to generate profit while enhancing a method for producing goods or services. (Frishammar et al., 2012; Snihur & Wiklund, 2019).This should lead to financial gain and benefit to customers based on the activities that have taken place (Snihur & Wiklund, 2019; Troilo et al., 2017).

The article by Van de Ven (2017), postulates that innovation follows a pattern when being created. This begins with a conceptual idea through to its execution phase (Van de

Ven, 2017). Taalbi (2017), also suggested that the forces that drive innovation create patterns of activity (Taalbi, 2017). The journey of an innovation process begins with events occurring at random which creates an opportunity of innovation to occur. A set of constraining factors and behaviour enabling elements work in a cycle. This journey has been described as a river that flows into various dimensions and branches (Van de Ven, 2017). Troilo et al. (2017), suggested that the process may involve multiple dimensions that could be impacted with change which would create an impact on other dimensions (Troilo et al., 2017).

The innovativeness associated with the innovation process is suggested to the way organisations engage in different activities that leads to new services or outcomes. Creativity is one of the precursors to innovation. In this regard, both people and groups need to get things moving (Ferreira et al., 2020). When analysing the concept of design, it is perceived as an outcome. In product terms it is described as the improvement of products, its function and its aesthetics. Design can also be conceptualized as an activity (Gemser & Barczak, 2020).

Previous research has explained that there are many factors that influence design and performance of products and services (Gemser & Barczak, 2020). Gemser & Barczak, (2020), proposed in their study a theoretical embedding for research in design innovation. figure 2-1 below explains what factors what is involved from a theoretical embedding of an innovation process.

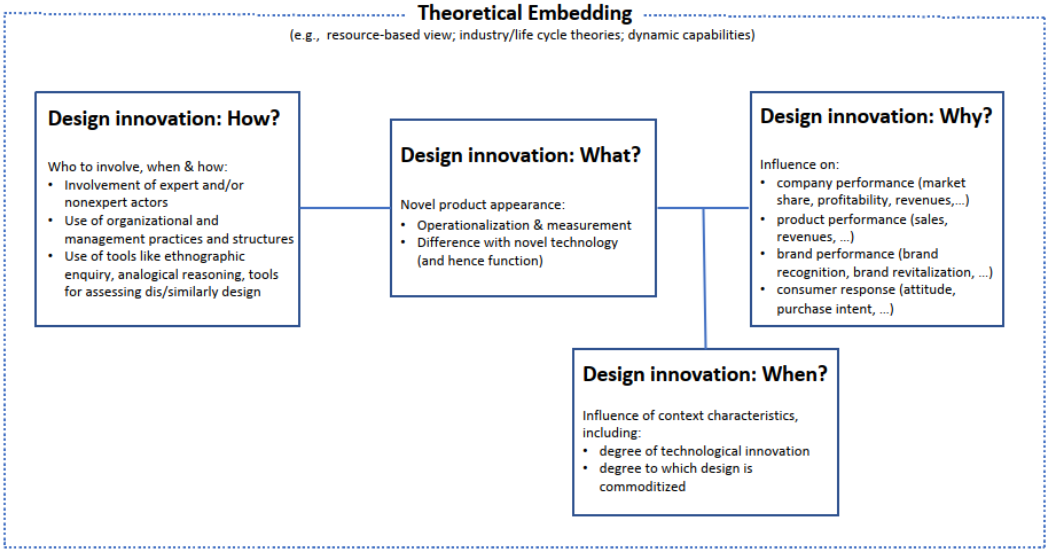

Figure 2-1 Displaying the theoretical embedding of an innovation process

This model provides some form of understanding what activities take place during the different stages of the process. This involves the actors during the process , practices and specific processes of organizations and tools which the organization may use as leverage (Gemser & Barczak, (2020).

Sørensen et al. (2010), initially posited that innovation experimentation can outline how processes are formed. Innovation experiments can create cause for new possibilities in research and most significantly identify new patterns, behavioral traits, and new observations (Sørensen et al., 2010). It cannot be simply broken up into stages due to its complexity. Every pathway may trigger a different one and this makes it difficult to conceptualize a process. This also is caused by internal and external factors that may present opportunity or obstacles. More studies that are associated with processes and its understanding should be explored which can contribute towards organizational change, structure, and adaptation (Van de Ven, 2017). Although the innovation process has been suggested to be complex, Witell et al. (2017), suggests when a process is formalised, then it creates benefits for the process itself. For this to occur, there should be plans to involve employees, clients and partners. Most organizations who are good at this can implement recent tasks easier and replicate it (Witell et al., 2017). Furthermore, Van de Ven, (2017) postulated that little is understood about how innovation process works in various organizational contexts (Van de Ven, 2017).

2.4 INNOVATION PROCESS ELEMENTS

2.4.1 Culture as an antecedent in the process

There are a number of facets that characterize a service firm from an innovation perspective. These are namely processes, roles of individuals, structure and culture (Troilo et al., 2017). Culture plays a significant role on innovation. This is due to innovation being a complex process. The culture of the organization is derived from the activities the individuals and groups foster. In combination with culture, the structure of an organization affects innovation, however the governance that are more efficiency focused will favour it (Kostis et al., 2018).

The cultural dynamic of service firms which is the responsiveness and the desire to absorb new ideas characterises how innovative a firm is. Several factors were suggested to help aid innovative practices in this study. Factors associated with firm success can be related to management of processes, communication practices, a firm's skill-set and resource-based elements. This directly contributed towards successful innovation projects (Santos-vijande et al., 2021). When examining a company's skill set at a deeper level their social capital plays a vital role influencing knowledge-based activities which was concerned around the creation of knowledge (Yan & Guan, 2018). The article further suggested that previous research could not conclude whether or not it had a direct impact on innovation but there were both positive and negative impacts (Yan & Guan, 2018).

Group culture according to Colovic & Williams, (2020), creates an environment for innovativeness. This type of culture nurtures collaboration, and knowledge sharing which is essential for innovation to occur (Colovic & Williams, 2020). The authors Arena et al. (2017), suggested that an organisations flow, its processes and enabled networks of people, form an adaptive space. This adaptive space is the foundation for innovation to occur. The nature of innovation within large firms are said to be formal structures because the enablement of innovation occurs through an organisation's personnel, whom use their networks to leverage off (Arena et al., 2017). Group culture influences trust between organisational members and has been outlined in research to contribute towards innovativeness (Colovic & Williams, 2020). Arena et al. (2017), also postulates that the lack of formal and informal influence prevents organisations from bringing their ideas to light (Arena et al., 2017). Colovic & Williams (2020), however describes an organisation where socialising is more apparent will build social cohesiveness and can be regarded as an informal group culture. It cannot accurately be confirmed to establish the extent of the impact that a culture might have on an organisations ability to innovate (Colovic & Williams, 2020).

2.4.2 Technology as an influencer in the process

It is essential for service firms to integrate technology into their processes. This largely due to the complexity of the process. Over a period, the constant application of technology will improve the innovation process and possibly revolutionise it to an extent (Homayounfard & Zaefarian, 2022). Older research suggested that the concept of technology affordance refers to what a purposeful organisation can accomplish with

technology. The use of technology can influence how users utilise it (Yoo et al., 2012). An opposing view suggests that the adoption of digital technologies may not influence the outcome of successful innovation directly. There might be a relationship formed between the technology of a firm and a firm's capabilities However, technology could be as a result of strategic suitability to the market environment (Usai et al., 2021).

Firms who provide services may also rely on sources external to their firm for their information on technology. A form of collaboration is created when these firms interact with outside sources (Homayounfard & Zaefarian, 2022). When firms utilise the available technology, they will exploit it to their advantage. From an innovation perspective, many studies can confirm that there are direct relationships between the adopted technology and its implementation by the firm which have yielded positive results. There is also however a degree to which the firm can be innovative when technologies are adopted in their processes (Usai et al., 2021).

The adoption of digital transformation is a major factor in the improvement of business operations, and it is related to the topic of technology in the organizational environment (Warner & Wäger, 2019). Parrilli et al. (2020), suggested that the business innovation system mode of a firm involves the distribution of technology within the firm and helps aid in building up the innovation capacity of the firm (Parrilli et al., 2020). A different view on the adoption of digital technology suggests that its more concerned around the strategy of its use in business and primarily involves the dynamic capability of the firm and the transformation of firms to be more digitised also creates relative complexity and uncertainty in the environment (Warner & Wäger, 2019).

2.4.3 Communication in the process

Communication in an organisation from an innovation process perspective can be associated with an activity such as voice practices (Shin et al., 2022). It has been established in prior research, that collaboration which impacts innovation and the performance of innovation are essential competitive advantage instruments for businesses in emerging markets (Kaya et al., 2020). As prior research reveals that there is a favourable association between voice practices and innovation, these practices allow the stimulation of innovation to occur inside an organization. (Shin et al., 2022). Voice practices in research has focused on the aspects of practices within the organisation can

affect the way the organisation conducts itself to promote change inside the organisation (Satterstrom et al., 2021; Shin et al., 2022). Shin et al. (2022), suggested that voice practices can be defined as a procedure or formal process which enables organisational members voices to be heard. Research on how these practices enable innovation has been under researched. These voice practices act a moderator to enhance organisation innovation (Shin et al., 2022).

An organization's important activity that supports the upkeep of its innovative culture is human resource management. (Seeck & Diehl, 2017). Behaviour and attitudes are two components of the process which have affected outcomes for the organisation, this requires a group of members to be collectively participating in similar behaviour to create change (Shin et al., 2022). Collaboration is a form of open innovation practice which lead to improved processes for an organisation. Formal and informal mechanisms in this regard are said to have influenced knowledge-based aspects of a workforce (Kaya et al., 2020).

Collaboration in theory has been suggested to improve not only knowledge-based elements of open innovation practices but also It can comprise of sharing knowledge both externally and internally (Kaya et al., 2020). According to Poocharoen & Ting (2015), the concept of collaboration influenced how an organisations internal network and arrangements may aid in coming up with solutions to problems (Poocharoen & Ting, 2015). Kaya et al. (2020), also posited that collaboration is impacted by how an organisations internal activities are structured. The outcome of this being managed correctly by a firm could improve productivity at group and individual levels (Kaya et al., 2020).

Tojeiro-rivero & Moreno, (2019), suggested that activities such as networking has been a significant contributor towards innovative performance. These involve technological collaboration which becomes an enabler for the transfer of knowledge The suggestion that it has had an extremely positive impact is also prevalent in most literature due to the fact the transfer of knowledge also benefits novel ideas (Tojeiro-rivero & Moreno, 2019). Innovation processes may be enhanced by collaboration but may rely on the open innovation activities, internal structure and voice practices can be revealed as a process itself (Kaya et al., 2020; Satterstrom et al., 2021). Where networking activities are concerned, the transfer of knowledge takes place between various actors externally

creates a synergy for performance. When collaboration externally with different firms, it contributes toward the formation of solutions which the industry may not have (Tojeiro-rivero & Moreno, 2019).

2.4.1 Response to market needs

Service firms drive their efforts towards consumer requirements through its activities. The modern view from an innovation process takes the perspective of the process from which solutions have emerged as result of value co creation of a firm's resource base (Vargo et al., 2020). Finding solutions for problems has been described in literature as a service strategy. The service strategy incorporated the members of an organisation and how they advanced their understanding of how they could best provide their service whilst creating benefit for themselves (Wieland et al., 2017). It's critical to comprehend how service providers innovate inside their ecosystem. (Vargo et al., 2020). Therefore, the creation of value in service firms has been reliant on the arrangement of the company's structure or arrangements they have in place (Wieland et al., 2017).

To comprehend the innovation processes better, Wieland et al. (2017) and Vargo et al. (2020), both suggested that when taking an institutional perspective of the service firm and the diffusion of activities must be considered (Vargo et al., 2020; Wieland et al., 2017). The diffusion of processes relies on the actors that are involved in the process. There interactions occur within an ecosystem of the firm. Innovation within the firm can take a knowledge-based view when associating actors involved influences both the process and the outcome (Chandler et al., 2019; Vargo et al., 2020; Wieland et al., 2017). When the perspective of diffusion process has been considered, the systematic view of the process needed to be understood from a broader structure (Vargo et al., 2020).

A process can involve multiple facets of innovation (Vargo et al., 2015). Vargo et al. (2015), suggested that the service eco system may act as a catalyst for innovations and technological advancements. This perspective provides a way of understanding how service firms create their processes and their value creation (Vargo et al., 2015). There are both divergent and convergent views when looking at innovation. Van de Ven (2017), discussed that an innovation process can expand into different directions but will converge as a result of the members within that cycle (Van de Ven, 2017). At a broad level, the divergent elements included elements of technology being diffused with the process and

convergent views included the actors and members diffused with collaboration. When considering converging elements from a market needs and solutions perspective, taking members of organisation into account, is that members in firm, form stronger relationships when they have shared the same sentiments about solutions (Chandler et al., 2019).

2.1 OPEN INNOVATION PRACTICES

Open innovation applications have been concerned with how businesses can build up their knowledge, achieve operational efficiency and deliver products and processes with the required quality (Arranz et al., 2019). Taalbi (2017), defined an open innovation practice as the management of knowledge flow between the boundaries of an organisation (Taalbi, 2017). Open innovation practices could form a relationship between exploratory and exploitative innovation. Researchers have disputed the key distinctions between exploratory and exploitative innovation. Finding, creating, and understanding new information are all components of exploratory innovation. Enhancing, utilizing, and expanding on the information that is currently available is the process of exploitative innovation. (Yan & Guan, 2018). An innovation process could be regarded as open innovation (Obradović et al., 2021). The goal of open innovation is to create new ideas by utilizing both internal and external ideas. (Bogers et al., 2019). Open innovation in the study of the literature has been considered to be fragmented and the internal and external factors which contribute to the creation of open innovation has been under researched (Arranz et al., 2019).

2.1.1 Resource based view

Process innovation occurs as a result of an organizations procedures that is related to its capability (Snihur & Wiklund, 2019). A firm's ability to create and reconstruct its competences to apply to surroundings is referred to as its "dynamic capabilities." This enables the business to get a competitive advantage. (Schilke et al., 2018; Teece et al., 1997). It can provide a firm with the capacity to customize its resources and how they define their resources (Kim & Mahoney, 2010; Schilke et al., 2018). In Service development, the formal process concentrated on the effectiveness, efficiency, and the outcome of a process with the use of resources (Witell et al., 2017). There are specific resources of the organization that specifically contributed towards forms of competitive

advantage. Professional based service firms cannot accept new projects or come up with solutions to challenges without these resources. Therefore, this implied that these resources are hard to find, non-substitutable and not very easy to replicate (Kim & Mahoney, 2010; Pantic-Dragisic & Söderlund, 2020).

Human resources which form part of the organisation's capital, is responsible for transforming knowledge derived from personnel experience. This is then developed into knowledge that can be shared expressively and relatively easily (Garcia Martinez et al., 2019). According to Witell et al., (2017), resource scarcity could create challenges for a firm. Capabilities might be limited and may end up being old-fashioned (Witell et al., 2017). It is crucial that an organisation manages the capabilities it has and the knowledge it possesses. When viewing knowledge as a capability, research has shown that this lens has been under researched from an open innovation point of view (Ovuakporie et al., 2021).

For a technical engineering consulting (TEC) firm to perform it requires an understanding of its capabilities and its nature (Pantic-Dragisic & Söderlund, 2020). Capabilities in a knowledge context could be identified as intangible resources acquired over a period which cannot be measured against a specific market (Garcia Martinez et al., 2019). Organizations should allow their resources to evolve in order to develop capabilities to deal with uncertainty. Knowledge management in firms is a process itself and could be identified as a capability (Garcia Martinez et al., 2019). Bogers et al. (2019), argues further that effective information flow management is essential for the success of open innovation. (Bogers et al., 2019).

The relationship that is formed by activities between individuals and organizations which creates dynamic capability is said to be complicated. They have many facets or elements that influence them and this has had an impact on researchers exploring this (Pantic-Dragisic & Söderlund, 2020). Furthermore, the study according to Qin et al. (2021), suggests that research is absent in areas that build on knowledge and resource-based views & innovation process and dynamic capability theory (Qin et al., 2021).

2.1.2 Knowledge based view

The research undertaken by Van de Ven (2017), suggested that the success of innovation occurred if managers improved the chances of developing skill-sets to overcome obstacles (Van de Ven, 2017). When taking a knowledge-based view innovation forms the foundation the development of business. Innovation is an outcome of knowledge and firms. Firms who adopt knowledge can create and develop innovation. The management of knowledge forms a relationship with business innovation (Huarng et al., 2020). Open innovation is thought to take the form of knowledge-based perspectives on innovation. This pertained to the knowledge exchange between an organization and its members. (Obradović et al., 2021). Knowledge can be recognized as the most significant resource of a firm that potentially creates competitive advantage and a unique source of innovation.(Gonzalez & de Melo, 2018; Messeni Petruzzelli et al., 2018; Obradović et al., 2021).

When taking a knowledge-based view through an innovation perspective, internal sources have played a significant role (Scaliza et al., 2022). Knowledge types are prevalent at different stages of the innovation process, but they differ from industry to industry (Davids & Frenken, 2018). Spillover effects of knowledge are a major contributor towards open innovation. There is however, an absence of understanding as to the problems with open innovation (Audretsch & Belitski, 2022).

To create a beneficial innovation process, it could rely on the transfer on access to tacit type knowledge. This requires significant collaboration and time between actors (Aliasghar et al., 2022b). Tacit knowledge however, is a complex facet to break down and is revealed through routines of the organization (Snihur & Wiklund, 2019). The research undertaken by Haneda & Ito (2018) suggests that the process of innovation or its methods should be researched empirically (Haneda & Ito, 2018). Prior research in open innovation also suggests that research does not have a common understanding of innovation processes as it includes many mechanisms (Dziallas & Blind, 2019). These mechanisms can influence others by means of change or triggers (Troilo et al., 2017). Although prior research has built on relationships between product innovation and external knowledge, the actual way processes are created by firms are still less understood (Aliasghar et al., 2022b).

Innovation processes are dependent on tacit knowledge and is associated with routines of the organization itself (Snihur & Wiklund, 2019). According to Pantic-Dragisic & Söderlund (2020), The type of TEC firm influences the way knowledge is transferred and developed. TEC firms are said to operate in skill containers. This creates a fast-paced environments for project-based work. This can create a perception of how the firm's capabilities can be analysed. There is link between the individuals in an organization and the activities they undertake which directly creates capability. Capabilities In this regard has been defined as processes that are learned through patterns of actions (Pantic-Dragisic & Söderlund, 2020). The process has been described as a sequence that included knowledge creation, how it was transferred, the integration of the knowledge and lastly, it's application (Dziallas & Blind, 2019).

Older research by Koskinen & Vanharanta (2002) suggested that tacit knowledge is a perspective of the experience that individuals have. This is not merely expressed by what people say but rather through their actions and tacit knowledge can be defined as the ability to know how to do things (Koskinen & Vanharanta, 2002). The article by Duan et al. (2022), proposed that the effectiveness of innovation relies on obtaining new knowledge-based resources. This quality necessitates efficient resource management and the knowledge they possess. The process of exchanging knowledge in a firm creates knowledge flow which affects the knowledge base of the firm (Duan et al., 2022). Explicit knowledge is another type that contributes towards the knowledge process. Both tacit and explicit contribute towards innovation in firms that are more well integrated rather than detached. Being well integrated means being more formal in its conduction (Bernal et al., 2022).

Frishammar et al., (2012) postulated in their study that capabilities were defined as a routine at the high level but should be considered as organizational capabilities rather than dynamic capabilities (Frishammar et al., 2012). They are developed through the knowledge which an organization has collected over a period. This is a critical element of the organization as it is fundamental in understanding how firms create, maintain, and develop their knowledge to change in the context of an environment (Pantic-Dragisic & Söderlund, 2020). When knowledge is transformed to become useful, it ensures effective use and utilization in the firm. This enhances the development and maintenance of expertise available (Dziallas & Blind, 2019).

Firms can improve their performance via means of knowledge widening and expertise based related to specific areas (Pantic-Dragisic & Söderlund, 2020). The study by Messeni Petruzzelli et al., (2018) postulated that activities in innovation contributes to knowledge at different points over time. These are considered as nascent inputs or inputs at an early stage which always is at the frontline ahead of mature inputs. The adoption of nascent input knowledge contributes towards valuable innovation as it could be argued that knowledge which has been previously developed will be considered to be less valuable over a certain period (Messeni Petruzzelli et al., 2018). Research undertaken previously has suggested that the value of innovations will increase with mature knowledge input because it can be adopted at a present stage of a process (Capaldo et al., 2017). The relationship between these two knowledge types signifies that firms must find a balance between mature knowledge input and the embracement of nascent type input (Messeni Petruzzelli et al., 2018). Messeni Petruzzelli et al., (2018) also argues that a firm's structural characteristics can affect a knowledge workers ability to concentrate on activities that contribute towards learning.

Although nascent inputs are required, mature knowledge allows firms to reduce uncertainty and cost of utilization, it therefore becomes more reliable over time (Capaldo et al., 2017; Messeni Petruzzelli et al., 2018). Because mature knowledge has been utilized previously, there is justification for its use. The functions of firms therefore do not need to be altered in the way it operates. Once knowledge has been accepted it becomes more valuable however, this type of knowledge would have undergone a validation process prior to it being implemented. therefore clients will be more accepting of solutions that correspond with their own values and beliefs (Messeni Petruzzelli et al., 2018).

Karrasch et al. (2022), postulated that there is a diversity of knowledge types. In order for it to have an impact, these types need to be understood in its entirety. This is called transdisciplinarity. Information, perspectives, and opinions needs to be exchanged between actors. This integration allows actors to actively produce solutions to challenges (Karrasch et al., 2022). Similarly, research undertaken by Sørensen et al. (2010), had previously described knowledge that exist in all industries. Two of these types directly apply to the context of a TEC firm. Analytical and Synthetic knowledge and are the two types which are necessary for empirical understanding and problem-solving capabilities (Sørensen et al., 2010).

This could be taken to a deeper level when compared against knowledge types for transdisciplinarity where the transformative and system types also allude towards the proficiency involved in understanding problems and how to solve them. It however includes an additional dimension that includes social eco systems (Karrasch et al., 2022). Mobile engineers are considered to undertake their work built on system knowledge. Integration contributes to an important aspect of an engineer's ability to work. The integration of knowledge between actors can contribute towards the effectiveness of a team (Sankowska & Söderlund, 2015).

In the transdisciplinarity context, the Transformative type is defined as knowledge which entails competency, solutions to problems and proficiency. The System knowledge type can be described as a facet which involves problem understanding, social eco-systems, mechanisms and the most recent type considered to be state of the art knowledge in literature. lastly target knowledge is described as a type which involves an actor's own purposes and the motives of others that is related to perception of how a system really is (Karrasch et al., 2022). Knowledge is built from within the organization and is a continuous process, however the outcomes of the process in literature is still relatively uncertain (Davids & Frenken, 2018).

2.1.3 Diversity and team dynamics

Innovation is encouraged by teams which have formal processes and by organisations who foster a group culture. Tacit knowledge can be passed from person to person through effective communication. This allows for new outcomes to be created (Colovic & Williams, 2020). Having teams in organisations that are well organized contributes towards coping with obstacles in eco system, however it is derived through experience and knowledge. Social structures and teams that are knowledge oriented is considered as unique in literature (Yul lee et al., 2021). In order for innovation to occur, it requires knowledge, expertise and learning amongst individuals who occupy different positions (Bouncken et al., 2021). Yul lee et al. (2021), postulated that the team's relationship with its leader influences how valuable the knowledge in the team is created. (Yul lee et al., 2021)

Yul lee et al. (2021), also postulated that when there are different business units, then it aids in building relationships and enables knowledge sharing. Mutual knowledge

leads to the creation of innovation, this ranges from processes that involve problem solving to principles (Yul lee et al., 2021). This exchange further allows individuals to identify where differences come to light between their alliances (Bouncken et al., 2021). With respect to resources recent views suggest that innovation from service point of view is an amalgamation of resources (Witell et al., 2017). Mutual knowledge also creates an overlap. This overlap amongst different firms could prevent firms from innovating to an extent (Bouncken et al., 2021).

Firms can improve their innovation by processing and understanding knowledge variations (Bouncken et al., 2021). Engineers are prone to solving problems for clients. However, engineers in the field are required to have built up a knowledge base which they can draw from to solve potential present problems that they may have. Experiences which encourage learning can become a basis for the solution to problems in another area (Kalogerakis et al., 2010).

2.2 CONCLUSION

The innovation process elements involved show that there can be overlap of factors when trying to describe the process and that a broader view may be selected when describing the process. As Van de Ven (2017), claimed that little was known about how innovation works in various organizational environments. (Van de Ven, 2017). and when overlap may occur it can create diffusion therefore the systematic view of the process must be realised from a broader structure Vargo et al. (2020), and Gemser & Barczak (2020), further postulated that in order to conceptualize a process an overview of the process must be outlined (Gemser & Barczak, 2020; Vargo et al., 2020). Figure 2-2 is diagrammatic summary of the literature that has been proposed to simplify how the process can be viewed.

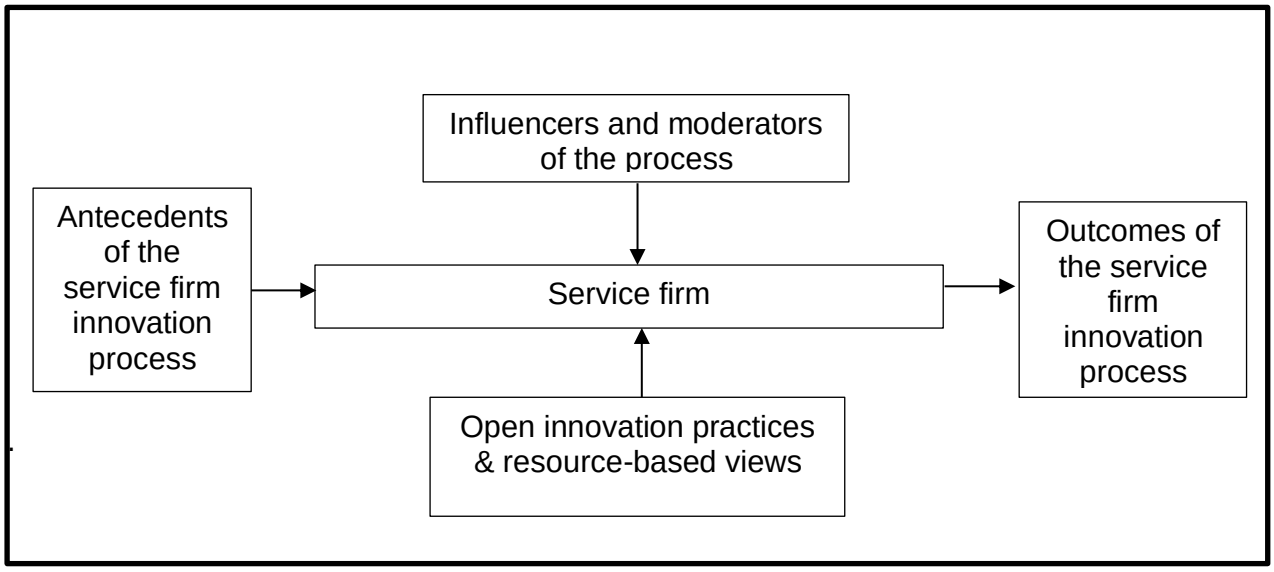

Figure 2-2 Describing a summary of the existing literature diagrammatically

3 CHAPTER 3: RESEARCH QUESTION

3.1 INTRODUCTION

The research questions in this chapter have been formulated on the basis of the literature review which has been outlined in chapter two. The literature has been formed from what is known and what is unknown on the topic of the innovation process in the context of the service firm innovation processes and what aspects might influence it. The following research questions have been outlined to provide insight into how service firms formulate their innovative processes in in a technical engineering consulting (TEC) firm context.

3.2 RESEARCH QUESTION 1

Sørensen et al. (2010), posited that experiments with innovation can describe how processes are formed and innovation processes are considered to be complex in nature (Sørensen et al., 2010). Gemser & Barczak (2020), postulated in their study, that in order to conceptualize a process an overview of it process must be outlined. Design innovation research has also shown that there are some significant key themes that present themselves in covering innovation. Simply put, it consists of what, why, when, and how (Gemser & Barczak, 2020). Therefore, in attempt to understand innovation processes in a specific organizational setting, the proposed research question is to develop an understanding of:

How do technical engineering consulting (TEC) firms formulate their systemic innovation processes and what may affect it?

3.3 RESEARCH QUESTION 2

Economic advancement is a key output as a result of innovation. Consumer demands in the modern professional service firm world has creates challenges for firms to continuously innovate. (Villani et al., 2021). Gemser & Barczak, (2020), postulated in their study that the “why” refers to a theme from which the innovation process has been derived from systems research. This point of view is required as it involves activities and processes that become an enabler for innovation required. Therefore, the second

proposed research question is to develop an understanding of:

why knowledge is important in this process?

3.4 CONCLUSION

The research contributes towards building a framework for innovation processes for service firms in a South African context. This can contribute towards the gap that exists in understanding processes that exist in emerging economies (Heredia Pérez et al., 2019). The research also contributes towards literature on innovation process studies in an engineering consulting service firm context.

4 CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

The following chapter describes the type of research design which has been adopted to the analyse the proposed research questions in chapter 3. The study has utilised the use of the qualitative approach to research innovation processes. The sample firms and actors involved had the relevant experience in order to give meaning to the findings. The sample set of firms included one large firm and three small firms. The raw data was collected in form of semi-structured interviews it was transcribed and analysed in ATLAS ti. Codes were generated from the analysis which gave insight into the emerging themes of the study which is related to the literature review in chapter two. The researcher took into account code saturation, limitations and quality controls. These aspects also involved ethical considerations, validity and reliability.

4.2 CHOICE OF RESEARCH DESIGN

The research design selected was qualitative and exploratory (Saunders & Lewis, 2018). According to the study undertaken by Sørensen et al. (2010) case studies in process innovation has been used to understand the phenomena. The nature of the research questions require perspectives to be understood (Sørensen et al., 2010).

The philosophy for the study was guided by the literature. The insight into innovation processes has been provided by the actors involved. The study has adopted a philosophy of interpretivism (Kumar, 2011). This definition has been defined how we can make sense of something (O'Reilly, 2012). The aim of the study was therefore to explore an innovation process and how it can be conceptualised.

The inductive approach was adopted for the research. This approach allowed the phenomena to be identified and that may occur repetitively to draw conclusions from the observations (Saunders & Lewis, 2018). This approach may be defined as a flexible approach (Kumar, 2011). The study explores innovation from a process perspective and the process taking a knowledge-based view. Researching this phenomenon allowed the

researcher to formulate a theory to understand the themes which had emerged (Saunders & Lewis, 2018).

A mono method was selected as the methodological choice. A set of semi-structured face to face interviews, analysis of secondary data and observations was implemented. (Saunders & Lewis, 2018). Phenomena such as open innovation comes from the users itself (Sørensen et al., 2010). Qualitative research allowed individuals voice to illuminate their perspective (Chhabra, 2021). Studies by Karrasch et al., (2022) used face to face interviews for their systems understanding approach (Karrasch et al., 2022). The interviews identified the facts involved which provided insight into innovation processes and where possible, substantiated it against examples or descriptions identified (Troilo et al., 2017). Earlier research on methods in innovation suggested that that qualitative research can provide clarity on certain complex criteria which quantitative research would not be able to provide solely from surveys (Sørensen et al., 2010). Lastly Interviews provided perspective for exploration between individuals and organisations (Pantic-Dragisic & Söderlund, 2020).

A case study strategy was implemented for the study. Researching Phenomena such as innovation processes have been justified using this approach (Davids & Frenken, 2018; Pantic-Dragisic & Söderlund, 2020). Older research also suggested that case studies have contributed towards prescriptive models in process innovation (Sørensen et al., 2010). The cross-sectional strategy had been utilised for the collection of data and information from technical engineering consultants who have considerable experience in the building services industry. This was carried out until levels of saturation had been achieved. Time was therefore an important factor which was considered as data was collected over a limited period (Saunders & Lewis, 2018).

The research first investigated the understanding of how innovation processes are formed. The second step was to use the semi-structured interviews to identify the relevant themes and concepts and how it forms a link with the model for a process perspective. This idea was formulated from the study by (Troilo et al., 2017). This was a similar process undertaken by Troilo et al., (2017), which created a theoretical road map for managers in a service innovation process. Although this study addresses TEC based firms, they ultimately provide a product which is used by the end user in the form of an engineered

solution on a project. The process involves the actors which have been described in the literature, managerial practices and various tools (Gemser & Barczak, 2020).

4.3 POPULATION

The sampling frame of the population was limited (Saunders & Lewis, 2018).The population only considered TEC firms or consulting engineering firms.

4.4 UNIT OF ANALYSIS

More than one TEC firm which specialise consulting services was selected from a qualitative point of view for this study. The department which had been selected within the firm carried out similar operations in a project context in relations to the other firms. The firms which provide building services was selected from the total population. These were a combination of large firms that have multiple departments that contain the department similar to the small to medium enterprises which only specialised in building services only. This was not limited to a specific consulting engineering discipline. The case study by Pantic-Dragisic & Söderlund (2020), had proposed that in order validate conceptual models, more than one service firm must be examined. They also examined various types of managers and consultants (Pantic-Dragisic & Söderlund, 2020). The individuals considered for the study will be required to have knowledge of the firm's processes. The population being considered remained flexible during the study as the study is exploratory and qualitative in nature. The age, role and experience of the participants plays a role in the study (Kumar, 2011). This case study required the participants selected to be screened so that their back grounds could be understood to confirm the criteria explained in the sampling methods and size. Therefore, the level of analysis shall be the innovation process and the participants with the relevant experience is comprised of the departments that offer building services.

4.5 SAMPLING METHOD AND SIZE

The researcher will not know the exact number of individuals that will be required to reach a point of saturation as the sample itself is not predetermined. Therefore the size of the sample is not important (Kumar, 2011). A form of purposive non-probability sampling

was adopted for the study. This was judging the best candidates to obtain information based on the research questions (Saunders & Lewis, 2018). These individuals were considered to be “elite informants” or “interpreters” (Aguinis & Solarino, 2019; Gemser & Barczak, 2020). They ranged from Senior directors to experienced engineers. Case study type research relies on multiple sources that can provide data (Creswell et al., 2007). These individuals had access to confidential information, they make decisions and had the capacity to form outcomes (Gemser & Barczak, 2020). Aguinis & Solarino (2019) argue that Replicability can be utilised when the selection of the sample set of the case studies are similar. (Aguinis & Solarino, 2019). Pantic-Dragisic & Söderlund (2020) interviewed fifty individuals in their study and Davids & Frenken (2018) study indicated that they collected information from sixteen individuals. The study shall include large, medium and small firms where access is possible. The type of participants involved all had a minimum of 5 years of experience in their respected building services field. According to Given (2008b), more effort is being made in qualitative research to have inclusion and diversity in the sample set (Given, 2008b). For this reason, more than one TEC firm was selected in the study which included one large firm and three smaller firms in comparison. The sample set includes both men and women and was a combination of different ethnicities as well.

The following candidates are considered based on the following criteria and research objective for this typical case study approach (Guest et al., 2006):

Table 4-1 Describing criteria for selecting candidates for the proposed case study

Firm type	Type of individual	Reason for use	Underlying premise
Engineering firm	Manager of department or owner or shareholder or partner of an organisation in building services (More than 6 years’ experience)	They are responsible for operations, processes, making decisions, managing relationships, client interfacing and have substantial experience in various projects.	Gaining perception on specific elements of processes and practices

Engineering firm	Consultant engineer: expertise in building services specifically (More than 3 years of experience)	They are responsible for project management, activities on different projects, manage relationships, necessary expertise to deliver projects.	Gaining perception on specific elements of processes and practices

4.6 MEASUREMENT INSTRUMENT

The measurement instrument is the interview guide which has been depicted in Appendix. The interview guide highlights the topics and the discussions that was addressed during the interview (Kumar, 2011). The guide has been developed based on the topic of process innovation and the major themes that have become prevalent in the research outlined in the literature review. The interview schedule can be found in Appendix 2 of this document which has been presented in a table. The face-to-face interview shall reveal prevalent themes and concepts which are required to be identified, analysed and understood. Each interview lasted between 20 minutes and 50 minutes.

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The interview guide addresses the following domains:

- The process created before, during and after projects;
- Understanding interaction of actors involved;
- Barriers which may occur during the process;
- Triggers for different stages in the process;
- Unique source of advantage;
- Similarity of processes, methods and practices; and
- Knowledge based views.

4.7 DATA GATHERING PROCESS

Firstly, ethical clearance was obtained and secondly the individuals being approached for the interviews will be requested to sign a consent form to provide information should they agree to part take in the study. The masters committee of the

Gordon institute of business provided the necessary information and guidance for the ethical clearance. Ethical clearance was achieved on the 7th of August 2022. This evidence of this is provided in Appendix The data gathering process involved collection of primary data in the form of the interviews and some secondary sources that are applicable to the chapters five and six (Kumar, 2011). This comprised of documentation such as stage information, observations, physical articles or objects, prior records and lastly the information retrieved from an interview (Creswell et al., 2007; Kumar, 2011).

The use of a semi-structured open ended interview was used as the interview method (Kumar, 2011). This method was also used in the studies by Pantic-Dragisic & Söderlund (2020) and Davids & Frenken (2018). The semi-structured interview allows for flexibility (Kumar, 2011). The process of allowing narrative to occur during the interview can provided insight and focus on the occurrences or actions that have taken place, this gave meaning to the involvements (Creswell et al., 2007). The objective of the interviews in relation to this study was to conceptualise the process involved and attribute the key themes that emerge from the discussions. This information was required to elevate the status of the argument being presented. The proposed semi-structured interviews were considered to be online interviews over the Microsoft Teams application. All of the participants opted for this method due to time constraints in their personnel schedules

4.8 DATA ANALYSIS APPROACH

Technology was used to collect information from the personnel interviewed (Kumar, 2011). Thereafter transcriptions were created to transform the interviews into text by a transcriber. Software such as Microsoft word online dictate functions and Microsoft teams transcribing was used initially and then the data was cleaned by a transcriber to provide uniformity. This was one of the measures used to ensure the strength of the data which it character (Saunders & Lewis, 2018). The transcriptions from the interviews were then placed in ATLAS TI. This can be described with the use of the conventional content analysis review of the raw data which eventually leads to codes or themes that have revealed themselves from the text (Hsieh & Shannon, 2005). When beginning to analyse the raw data some factors were considered such as length of the interview. The longest interviews were coded first and thereafter the shorter interviews were coded.

The data analysis approach required transcribed data to be assigned to different groups within different codes. This systematic approach allowed the researcher to undertake a repeated process of creating codes and modifying them (Flick, 2014). Prior studies in innovation suggested that there has been a broad spectrum of themes or concepts in innovation processes but more recently a theme of knowledge has occurred more frequently (Frishammar et al., 2012; Obradović et al., 2021). The coding was therefore based on the two overarching research questions based on innovation processes and the other taking the knowledge-based view (Flick, 2014).

These codes were then categorised and placed into clusters, a relationship between the overarching research questions were established with the codes. A total of 169 codes from all of the transcribed were found in the first process of coding. These codes were then placed in sub-categories and then main categories(Flick, 2014). A second and third processes of breaking down these codes into better clusters was then undertaken and a total of 101 final codes were created. These codes were then extracted and placed into a code book which is found in Appendix 3. Lastly the remaining codes were refined again in the main categories which formed part of the analysis.

A relationship was identified between them and lastly placed in a diagram to provide a visual description which is depicted in findings chapter. This technique allowed the researcher to establish antecedents or outcomes of the phenomena being studied (Hsieh & Shannon, 2005). A verification process was adopted ensure that the data collected is both reliable and valid. This contributes to the rigidity of the case study. It ensured that the analysis of the data collection and literature review remains consistent and systematic. This process allowed errors to be identified and contributed toward the identification of relationships and development of the phenomena In the study (Morse et al., 2002).

4.9 SATURATION

When there is no longer any newly discovered information influencing the study endeavour, this is known as saturation. (Given, 2008a). Theoretical saturation in qualitative research alludes towards the research in investigation coming to an end. Theoretical saturation and data saturation are both different. Data saturation involves the researcher identifying patterns of information which re-occur which makes the researcher anticipate it (Given, 2008c). Data saturation also involves the identification of no new

phenomena in the study being introduced therefore trying to continually look for new emerging trends in the data may lead towards weakening return. (Given, 2008a). For this reason, the data saturation was observed when new codes presented themselves in the findings until new no codes were observed. Figure 4-1 displays the number of new codes generated per interview.

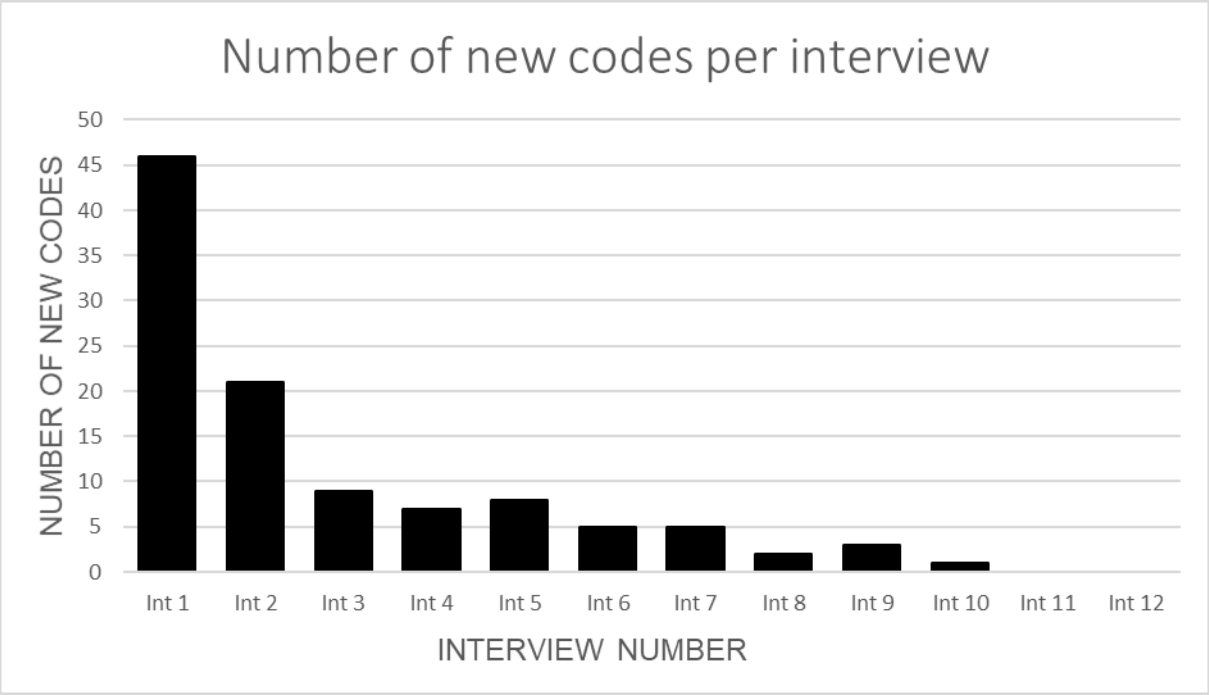


Figure 4-1 Displaying number of new codes generated per interview

4.10 QUALITY CONTROLS

Secondary data such as documentation needed to be analysed prior to it being used in the study as it may be subject to bias Kumar (2011). A checklist such as the high-quality research tool was adopted to ensure the study is relevant, rigorous and responsive. This process allowed the researcher to address questions that may arise during the research period. This model also encourages service-related case studies to be explored. This could be seen as a verification process to ensure that all information in process is validated and reliable. The framework for the measures of developing an analytical approach towards gaining a rigorous study for the has been included in figure 4-2 below (Epp & Otnes, 2021).

Table 1. Road Trip Checklist for HQQR.

	Vehicle	Route	Travel Companions	Safety Kit
Relevant	✓ Does the theoretical approach illuminate relevant phenomena? (Tuncay, Otnes, and Fischer 2015)	✓ Is your "road map"—your coherent narrative—consistent and transparent throughout the paper? (Ordenes et al. 2014) ✓ Is the research question relevant and clearly stated? (Moisio, Arnould, and Gentry 2013)	✓ Who are your key informants? How do their experiences help you develop relevant insights? (Arnould and Price 1993)	✓ What preparations have you completed to enable you to assess the quality and accessibility of the context? (Jaakkola and Alexander 2014)
Rigorous	✓ Are your method selection, data collection, and analysis aligned with your theoretical lens? ✓ Are you up to date on the literature related to your theoretical perspective? (Kozinets et al. 2004)	✓ Do you articulate your "methodology wheel" (who, what, when, where, and why), making your research procedures transparent? Can readers re-trace your process? (Berry and Bendapudi 2007)	✓ What relative expertise (e.g., substantive, theoretical, methodological) do your coauthors bring to the project? (Diamond et al. 2009)	✓ Do your data excerpts advance your theory? (Weijo, Martin, and Arnould 2018) ✓ Is the use of extant literature in your findings interpretive rather than contextual? (Higgins and Hamilton 2019)
Responsive	✓ Does your analysis evidence flexibility in incorporating emergent findings? (Husemann and Eckhardt 2019)	✓ Does your paper offer adequate conceptual and rhetorical signposts for the reader? ✓ Are the side trips you incorporate productive to your analysis, or distracting? ✓ Do you demonstrate that your road trip evolved to accommodate emergent themes and negative cases? (Tsarenko, Strizhakova, and Otnes 2017)	✓ Do participants' diverse experiences with the phenomenon extend and challenge your emerging framework? (Thomas and Epp 2019)	✓ Does your visual depiction (framework) help readers quickly understand your findings? (Giesler 2012)

Figure 4-2 displaying the quality control road map (Epp & Otnes, 2021).

The first approach to ensure validity involved the instrument being used to be pressure tested before the actual interviews took place. This pilot study had been used to check if the schedule contains any leading questions. The second approach was to adopt the face type of validity. This is the extent of ensuring the questions naturally make sense. This allowed the researcher to test responses from interviews undertaken in the interviews following them (Guest et al., 2014). With respect to reliability of the data, (Guest et al., 2014), suggests that validity is more important than reliability in qualitative research, however to ensure reliability an approach to ask the questions displayed in the interview guide in the same order in each interview was undertaken which allowed for inductive probing to occur.(Guest et al., 2014). Lastly Data had to be stored electronically and was only accessed using a password.

4.11 LIMITATIONS

In study by Aliasghar et al. (2022), proposed that the size of the company could affect the innovation process.. This is mainly due to the resources that larger firms have. This element was therefore controlled as a parameter (Aliasghar et al., 2022b). This argument is further postulated by Snihur & Wiklund (2019), that innovation processes are more prevalent in larger firms (Snihur & Wiklund, 2019). Even though the firm may be larger, the size of departments undertaking similar work can be directly affected by the size of the greater firm. From an innovation process perspective. The sample set of firms which agreed to be studied were not willing to provide data that was considered to be extremely sensitive which was also observed in the study by Haneda & Ito, (2018).

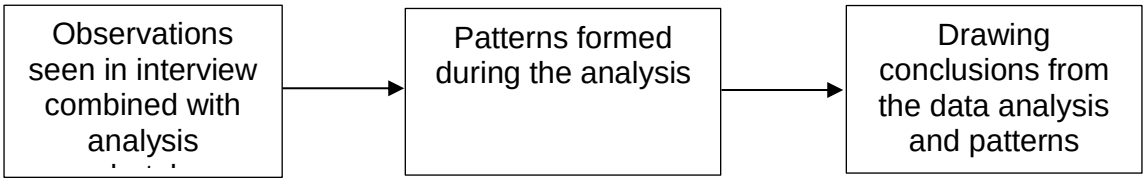
The secondary data provided took a significant amount of time to review (Saunders & Lewis, 2018)**.** One of the limitations of the data analysis is that the content analysis method can create confusion with a different form of qualitative research method (Hsieh & Shannon, 2005). The process models or frameworks in innovation processes that currently exist may possibly be only conceptual (Frishammar et al., 2012). Lastly, recent research suggests that some organisations may be reluctant to provide information or answer questions about their innovation processes (Dziallas & Bin, 2019).

5 CHAPTER 5: FINDINGS AND RESULTS

5.1 INTRODUCTION

The inductive approach has been adopted for the data analysis. This approach involves a series of observations made, the patterns which have been formed in the responses and drawing conclusions from these observations. If a series of responses from the data is considered to occur frequently then there is a sense of reliability in the data (Flick, 2014). The process of discovering elements from observations which allows generalised finding to be expressed. This creates consistency with the adoption a interpretivism approach described in the previous chapter (Kumar, 2011).

The process has been described below using a flow chart:



The following sections describe the participants and the analysis of the research questions.

5.2 DESCRIPTION OF PARTICIPANTS

The following table describes the participants and organisations that formed part of the data collection:

Table 5-1 Displaying characteristics of the participants

Designation	Gender	Age	Position	Qualifications	Years of experience	Type of organisation (Large/small)	Name of the organisation
PTP1	Male	34	Senior electronic engineer	BEng in electrical and electronic engineering	9 years	Large	PRO
PTP2	Male	40	Shareholder & Director	BEng Civil engineering	17 years	Small	STC
PTP3	Male	37	Senior engineer	BTech in mechanical engineering	12 years	Large	PRO
PTP4	Male	36	Head of department	National Diploma in mechanical engineering	15 years	Large	PRO

Designation	**Gender**	**Age**	**Position**	**Qualifications**	**Years of experience**	**Type of organisation (Large/small)**	**Name of the organisation**
PTP5	Male	42	Head of mechanical and with services	Master's degree in mechanical engineering	17 years	Small	WTR
PTP6	Male	28	Head of department & Regional director for mechanical services	MDip in mechanical engineering and a BTech in mechanical engineering and BSc in engineering and technology management.	9 years	Large	PRO
PTP7	Male	68	Member and Partner	BSc Mechanical engineering, master's in environmental engineering & an MBA	45 years	Small	MCH
PTP8	Male	39	Associate director	BSc in civil engineering, GDE from Wits university & Others	15 years	Large	PRO
PTP9	Male	48	Head of department & Regional director	National diploma and a BTech degree in fire technology	14 years as a consultant	Large	PRO
PTP10	Female		Regional director in the Properties and Buildings division.	BAC in Technology Management, BTech in project management and a National Certificate in electronic engineering	20 years	Large	PRO
PTP11	Female	36	Mechanical Engineer & Healthcare Lead (Principal Associate)	BSc in mechanical engineering and an MBA	12 years	Large	PRO
PTP12	Male	55	Principal member	BEng Mechanical	30 years	Small	MCH

The names of the sample set of firms and participants that have taken part in the study have been removed and exchanged with codes such as PTP or other three letter substitutes. This has been carried out to ensure anonymity of the firms and participants is maintained. The individuals that have taken part in the study were taken from different hierarchical positions in their organisations. All the participants provide engineering services in the building services sector with respect to the built environment in engineering.

All of the interviews were carried out over the Microsoft Team's application. This was the preferred method from each participant due to their availability, schedule and implications of COVID-19. Each interview was recorded, transcribed and coded. This was done to ensure the interview was conducted as planned. All of the participants from the firms that were interviewed were from Johannesburg, South Africa. For the purposes of the study an organisation size is determined by the following:

Table 5-2 Displaying the description of a small, medium, and large firms

Description	Number of employees
Small	1 to 99 employees
Medium	100 to 499 employees
Large	500 employees

The questions put forward in the interview allowed the researcher to get a general overview of the structural processes that building services departments undertake. The questions were focused on the innovative process, knowledge and resources. The scale of the firms that were researched mainly were either large or small. No medium sized firms participated in the study. 8 out of the 12 interviewees were from a large firm and the remaining 4 participants were from small firms. Both firms provided insight into a general process being formed subject to building services projects that they undertake. The perception of the large and small firms is analysed based on the responses to specific questions in the following sections. The quotations that have been shown in following sections are obtained from the word for word verbatim transcripts.

The combined experience that all of the interviewees have is a total close to 180 years in industry. Each consultant is experienced in a particular area of building services. From the data this included mechanical HVAC (heating and ventilation), medical gas, electrical and electronic, wet services, fire services and structural engineering disciplines. These services combined provide service to clients in various building projects. These mostly included shopping malls, office buildings, basements. hospitals, warehouses and data centres.

The researcher has outlined the categories and the first order codes that influenced each category in each question. The themes that have originated from the categories is displayed in each summary of the research questions.

5.3 RESEARCH QUESTION 1 FINDINGS

How do technical engineering consulting (TEC) firms formulate their systemic innovation processes and what may affect it?

5.3.1 Introduction

The findings of the interviews are described in the following sections to provide insight into the findings which influence how firms undertake their innovation process. Each section displays a diagram which describes the category formulated from the coding process. This section also describes the findings relevant to the research question and is supported with evidence in the form of quotations from the interviews. The quotations are as a result of the codes built in ATLAS TI.

5.3.2 Stages of importance

The network below indicates which stages were considered to be more prevalent in the interviews.

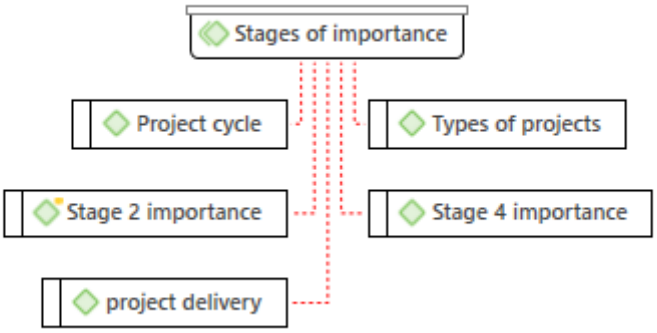


Figure 5-1 Displaying the stages in the project process of importance category for research question one

The participants explained how the project cycle usually begins. This is usually by a client request as described below. Thereafter there would be a fee agreement between the client and the engineer.

PTP4: "So we would normally get a project sometimes via an RFQ or directly approached from a client, a developer and we would essentially submit a bid or a fee proposal essentially, and either that would be rejected or approved or negotiated."

PTP12: "Well, typically they would be an inquiry from a client or from the fellow professional, you know, architects, quantity surveyors, project managers, followed by a client brief."

This responses describe how external parties will request the services which puts emphasis on relationships external to the organization.

From the findings of the interviews, emphasis was made to the manner in which delivery is associated with projects and the cycle of projects. TEC firms follow a very similar process irrespective of the firm size which is largely dependent on the projects which they undertake. The perception of most of the respondents have suggested the process of delivering a project is usually based on the project life cycle depicted by Consulting engineers of South Africa. Building service firms are reliant on developers, clients and other external parties for appointment for projects.

PTP5: "Okay so look I mean typically we follow the Engineering Council or the PROCSA Project cycle which, which starts with project exception. Then, sort of conceptual design, then more detailed design, and production of kinda documentation. Uh, then uh procurement and tenders. And then construction and finally close out. So I mean, I think we followed typically, very typically the consulting engineers of South Africa Projects life-cycle really."

PTP6: "If you look at the six PROCSA stages, which is the professional stages and the agreement, that us as consultants would engage within our clients, it's broken up into six portions, one being inception, 2 being concept design, 3 being detailed design, 4 being documentation and procurement, 5 being construction and 6 being close out."

Only in one case did the participant state that they do not follow the stages extremely accurately.

PTP12 "Essentially, yes. Well, no, nobody ever follows the PROCSA stages correctly because I don't think it suits anybody, but in principle, you know, yes, but not to the letter."

During the interviews, the discussion around which stage in the process of delivery is considered to be the most important. Whilst all the participants have different views concerning this. Two specific stages had been outlined to show up. These are considered to be stage 2 and stage 4 of the PROCSA process. The conceptual design being the initial plan to implement on the project at a specific cost. Of course, one can argue that without the client appointing an engineer at stage one of the processes, the engineers would not have a project. The perception is that once the concept has been finalised then the remaining stages would follow.

PTP2: "So basically, as I've been taught by those older and wiser than me is if it's conceptually done well, the design of the building at concept stage, you can deliver it averagely and you can still make it work, but if you have a bad concept, you can engineer it perfectly and you'll battle to make it work. So, in other words, 99.9% of our effort goes into delivering a good concept of a job."

PTP 9: "You know, to specifically point out one stage, it might be a stage 2 for me where your concept is actually done, and it's been agreed with the client. You know if that's done properly and it's clear to the client and to all the other consultants what is

expected from them, your management, all that will become easier. You know, if you do your designs properly, it's just a matter of going to site and make sure that it's installed according to your designs."

PTP11: "The process gets highly rushed and what ends up happening is people just can end up duplicating what they've done on other projects and just putting it in place. So, it's really important that proper time, especially at those early stages."

This stage seems important because at this stage there shouldn't be any errors as it might be a challenge later in the cycle. Although another stage became prevalent. The stage before construction therefore the design at this stage still seems to be in progress. The perception of stage 4 from some participants is equally as being important is as result of the stage being before construction and just after the detailed design phase. It allows engineers to pick up if there are elements that are incorrect in their documentation.

PTP5: "The most important in terms of de-risking from a technical perspective I then obviously say Stage 4 which is detailed design and bordering on tender documentation because. That to a large effect determines, (A), how accurate, Firstly, your tenders that you're gonna get back are. It also determines how much of time you're gonna spend, you know, over and above your general construction meetings and construction site walks, but it's really gonna, you know, the better your stage 4 documentation the less time you're going to spend on site fielding queries."

PTP6: "We probably have the most innovation with stages four and five."

5.3.2.1 SUMMARY OF SECTION

In summary of this section the interviews reveal when consultants of firms are appointed on projects, there is agreement between the client and consultant firm which is agreed. The consultants then follow the PROCSA stages to deliver their project. Stages 2 and 4 seem to be the most important this being the concept stage and the stage before construction.

5.3.3 Way of working

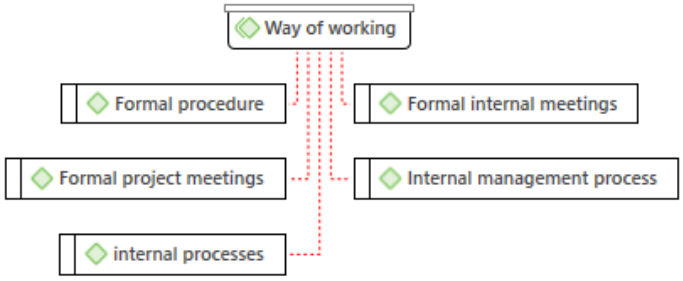


Figure 5-2 Displaying the way of working category for research question one

The Participants in most of the interviews discussed their day-to-day activities. The type of day-to-day activities which the consultants take part in irrespective of the building service type involves internal formal and informal procedures. From the interviews, these activities included internal team meetings, external design meetings, client meetings, site meetings, managing projects, responses to emails, informal discussions with team members, allocation of work to resources, marking up of drawings, project control. Some participants activities based on what on priorities which they need to undertake for a specific time frame or day.

PTP 2: "The only thing that gets into the way is how many tasks you have to do in a day and what you have to prioritize and what's best for your business. So, they'll always be someone who's left unhappy by the end of the day but as long as you do what you feel is best for your business on any given day, that's all you can do."

PTP 9: "let's say a Monday, Wednesday, and a Friday. In the mornings I have meetings with my staff, go through the plan of action."

PTP 9: "you've got numerous meetings that goes from MS Teams meetings to actually physical face to face meetings, site meetings then you do; it all depends on your emails and all of that."

PTP 12: "Well, our collaboration office is essentially face-to-face. I don't think there's any other means. You know, there would be swapping of information between

people via e-mail, but you know, we talk about things, and we discuss things eye to eye. Externally, it's mostly via e-mail and lately via online meetings, Teams, Zoom, that kind of thing. And obviously when outside in face-to-face meetings with some clients and project teams. So, in internally to summarize internally face to face and externally, you know via probably via e-mail, online meetings and face-to-face meetings."

All of the participants attend different meetings for their projects. This both includes digital and physical meetings. The meetings are a form of collaboration which the participants use to either discuss their projects with clients in formal forums or discuss plans for their week internally. This can give the impression that formal procedures are used as mitigation of risk procedures or to ensure that project criteria are planned for and met.

All of the engineers in the interviews came across as extremely passionate about what they do and how they do it. The status of the firm also seems to have impacted the way they view their profession. All of the participants from PRO were proud of the way undertake their daily activities and the fact that they have the leverage of global outreach at their disposal. The culture of working together in all the firms also came across quite strong. No disciplines work in silos of each other as many projects involve building services from other companies and not limited to the ones who participated. Being solution driven at all costs requires more than just the engineers. PTP 2 from STC gave the impression of what it takes.

PTP 2: "It takes everyone, even the tea lady, who stays till 8:00, o'clock to make us a cup of coffee every now and then. It literally takes everyone."

Being solution driven which is what seems to be the behaviour of engineers, there must be a balance between how far the engineer must go to achieve the solution and the cost at which the consultant achieves the solution. Having a continuous loop of communication both informally and formally shapes the behaviour of these engineers. Internal processes in this regard is important.

PTP 4: "So, I think it's a cultural thing within that at least in my ability we've tried to put it into our daily operation. It's like celebrating failure, for example. So, our individuals mustn't be scared to fail. If they're faced with a problem, they must attempt it, you know,

and without being afraid of being reprimanded. So as long as you've given it a good opportunity and you've shared your ideas, then we constructively discussed whatever the matter is."

PTP 10: "We have a multidisciplinary culture in our company."

The perception of the responses received indicate that there is an amalgamation of processes that all occur at once if the need arises. Some participants indicated the way their organisations are structured but the perception of formality and informality comes across in the interviews.

PTP 2: "Yes, because we are a small organization, we don't necessarily have an HR division. So, all of the shareholders, and directors deal directly with staff-related problems, technical matters, you name it. We do it all."

PTP 2: "We don't have any managers and our hierarchy is fairly flat. So, on a daily basis, yes, we deal with everything from phone calls, from builders, staff-related matters, designs of buildings, dealing with clients, all in one day".

The type of projects which the participants work on which influence day to day activities is outlined below in terms of their responses.

PTP 5: "From health care hospitals, clinics, medical legal laboratories, but that's sort of specialized in uhm institutions and then we've done lots and lots of commercial office blocks, so high-end office blocks with green star certification, done some residential but we've got a lot of low cost residential conversions. So, you know apartments, used to be historically apartment blocks two are now either low cost resi or student accommodation, uhm multi apartment buildings, we've done some hotels. You know 177 empire, Radisson, that type of stuff."

PTP 7: "Yes, but it's mostly offices and uhm warehousing."

PTP 9: "You know, all types of occupancies that you can think of if you just drive down the road and we actually doing each and every individual development we can be part of."

The larger firms tend to work on as many projects as they can but so do the smaller firms. PTP 7 however had only two types which they had mentioned in the interview.

5.3.3.1 Summary of section

The way of working reveals where there can potentially be challenges that the consultants need to tackle. This comes up in their planning meetings. There is culture in which firms work which could play role in how they can carry out their activities or what the consultants do every day. The large firm like PRO has a multi-disciplinary culture and the smaller firms are more informal but display a socially cohesive group structure. The type of projects which influence their day-to-day activities in project delivery for the sample set of firms work on are similar. Some participants were more specific than others.

5.3.4 Challenges in the project process

The following Challenges or obstacles has been observed in the interviews and has been shown in the network below:

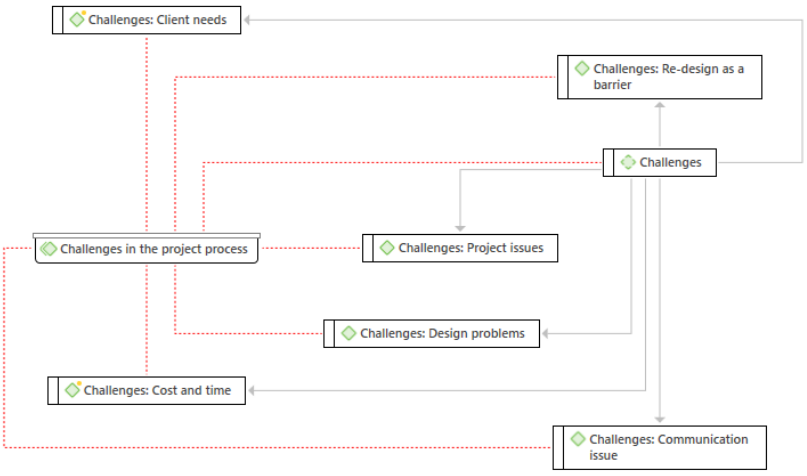


Figure 5-3 Displaying the challenges in the project process category for research question one

The perception from the interviews reflects that these challenges are often a result of a design challenge or a project. These can be based on client needs or the type of project, but the engineers seem to welcome the challenge.

PTP11: "Even today there's projects I come across where it's exciting, it's brand new and as long as it's a bigger challenge."

PTP9: "The challenge comes in if you slip on your designs and you only realize later that listen, I've missed this or I've missed that; to go back to the client and then ask for additional fees or additional costs."

There are also different constraints that each of the participants had experienced. Some of these included but were not limited to issues with local partners which resulted in redesigning, delays, resourcing, site clashes, miscommunication or even information. These challenges seem to come up at random for the firms and influence their costs and time. The costs and time would have direct impact the fee of the projects.

PTP 6: "We had an issue with a supplier in Cape Town on one of our projects where it was quite a complex issue. We had a miscommunication between the engineer between the client and between the supplier where it actually resulted in everybody in three different versions of the same message that came across and the product was procured based on three different ideas, should we say, or three different expert expectations of how this product should perform and once the product was then installed on-site there were three parties which were not obviously happy about how the product was performing."

PTP 9: "The challenge comes in if you slip on your designs and you only realize later that listen, I've missed this or I've missed that; to go back to the client and then ask for additional fees or additional costs."

PTP 9: "Well, it's barriers, it's redesigning the whole time."

PTP11: "Sometimes lack of information, so you need to get certain deliverables out, but there's not enough information to get it out. Or sometimes it can happen lack of resources, if suddenly a whole lot of projects have been kickstarted, you can come into a situation where you don't have the resources you need to deliver on their project."

The challenges that participants have spoken about vary from participant to participant. Each challenge can vary with degree of difficulty and varies from service to

service. No participant mentioned the same challenge and possibly have spoken about the challenge that may have found significant in their experience or a more recent one that may have experienced. Internally however having challenge can affect the processes during projects depending on the severity or degree of the challenge.

Two participants however also suggested that they create their own challenges by making the same mistakes and mistakes made by other consultants which affect them

PTP 1: "You know, if you're busy with quite a few projects at the same time, it's Difficult to give each project the focus it deserves, and in some instances, you could make mistakes or overlook something."

PTP 7: "And uhm mistakes. Mistakes made internally, mistakes made by other parties that you gotta work around and find solutions. I'd say those 3".

The perception of these responses suggests that working on multiple projects or human error creates challenges for the firm internally.

5.3.4.1 Summary of section

The challenges discussed during the interviews seem to come up at any time during the cycle. Each challenge may come with a varying degree of difficulty. The challenges are not bound to only one project. These challenges seem to come up on any project and more than one challenge may arise at the same time. The challenges can be a combination of both internal and external. Challenges created by the firm itself or challenges as result of external parties or clients. The participants however embrace challenge.

5.3.5 Responses to challenges

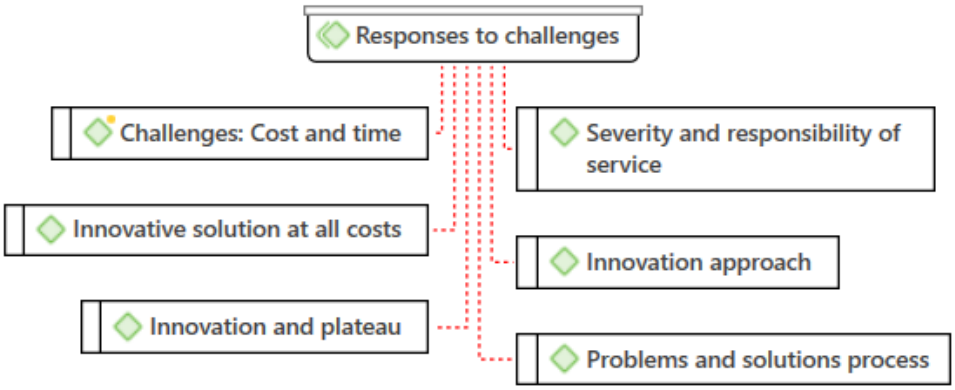


Figure 5-4 Displaying the responses to challenges in the project process category for research question one

The participants had suggested what the key factors are, that influence how they come up with solutions and what processes they may follow. Time and cost aspects regarding solutions came up frequently with most of the participants.

PTP4: "So, one aspect is cost. So, the client, wants the Rolls Royce most of the time and they give you a budget for, what would be a good example? A Ford car, you know, the client is expecting that. I think a way of overcoming that is expertise and value engineering and workshopping it with the client, giving them options to say you know you can look at something like this. That is a different solution, maybe not a Rolls Royce, but it will give you what you want and still be able to perform the duty or job."

PTP 6: "So, one of the biggest influences I would say is cost and time. I think in order to develop innovative solutions, you need to spend money to save money."

PTP 9: "We wanna get the balance between the best solution and the best cost."

PTP 12: "I think we are possibly more cost-conscious than other people and maybe that sort of half answers the previous question. I think it's a question of cost consciousness and we tend to design not too conservatively. So, we don't double up everything and we try to come up with solutions that are shaped around a specific purpose and not deviate too much from that, not build all sorts of other things into it at the same time that we don't

particularly need. So, it's its focused design. That's what it's supposed to do and tries to do it within a reasonable amount of money."

The perception of these responses implies that perhaps not the most expensive solution would benefit the client. The clients and their projects seem to be largely cost dependent. Spending money for the solution would impact the organization in terms of time and impact the client in terms of the solution. It however also seems that the impression of satisfying client needs, and they are accepting of it, if it is reasonable.

There is also the perception from the interviews that the process of formulating novel ideas for projects often puts the engineers and personnel involved at risk with their client's projects and therefore the solution is forced at all costs. This could be due to the contractual obligations of agreement between the clients and organisation, reputation. When the engineers are faced with this sort of situation, they will risk their own and time and revenue to find a reliable outcome for their clients and for the project. This may also come down to the severity of the issue at stake. It is difficult to rationalise how severe an issue can be.

PTP 9 "You need to be man enough to stand up, face the music, put your hand up and say Okay, we did slip up or we didn't but at the end of the day, you wanna show that client you're dedicated, that you're committed to project success"

PTP9: "It doesn't matter what, even if you need to take a knock on the chin, you know you drop your multiplier. Spend extra hours on it and not be profitable. But at the end of the day, that client will come back to you, and instead of going to someone else because he knows that you are committed, you're dedicated to him as a client."

Therefore, finding the right balance between costs and time may be affected by the actual responsibility of the engineer. There is also an intuition and urgency involved when coming up solutions as PTP7 and PTP8 suggests.

PTP7: "We don't go around looking for innovation, it's just if it occurs to us, then we consider it."

PTP 8: "Our team, we're quite cohesive and I feel like we do deal with a lot of

challenges pretty well. If there are crises, we tend to pull together and get the job done. I would say our team is good in that like we don't have this panic attitude of, you know, if something is critical"

The participants provided insight into their process of implementing a solution based on their service and expertise when asked if they had a particular method in coming up with solutions. The start of the analysis of the problem begins with understanding why it has occurred and what is the root cause of it. This may involve intrinsic investigation such as the stage in which the project it is in, finding previous communication that may involve the problem, whether the problem is due to the project itself or an error on the part of the engineer. Various options are then considered and then implemented.

PTP 4: "I think that process will stay the same you know looking at a problem rationally from fundamental and that's how you become innovative."

PTP 6: "What I would look at is obviously areas where there are problems first. I don't believe in creating solutions where they aren't problems. So, we'll have a look at where there is an element for improvements. Then once that area has been identified, we'll analyse all the different inputs that task needs, what the inputs are that would essentially drive this problematic or this inefficient task. Once we've identified all the inputs of that, we then take it to the next stage to have a look at incremental changes to the inputs or incremental changes to the processes of how we get to the outcome and we would then obviously see where the different stakeholders would sit within that, identify the root cause of the problem. It's often not what you think the issue is, there are often root causes or underlying issues and really looking at the bigger picture of this complex solution, having a look at all the inputs and stakeholders for it, identifying incremental changes within those and the outcome essentially then would fix."

PTP 9: "Go and work through the history of the project. Was there proper communication? Were you informed about it? And then you know, what happened, happened. We can't go back. We can't turn back time. We will workshop it internally and come up with a solution and not only one solution. I truly believe that the best option is to have two or three proposals on the table to a problem and discuss that with the client."

PTP 12: "Well, you, first have to formulate what the problem is obviously to

understand what it is that you need to achieve and then you have to start thinking creatively about possible solutions to achieve that. And then you have to weigh up these possibilities against each other and which one you think is more appropriate and understand what it is you're working with, dream up some alternatives and then gravitate towards what do you think is the best solution."

The process seems to be the same for most participants in respect to how they come up with solutions. The solutions process is followed in systematic manner where root cause identification is first aspect. The problem might require to be work-shopped internally and lastly think creatively about how the problem can be solved and then options may be presented. Some of the respondents also mentioned that processes to be more innovative when coming up with solutions is still being implemented and possibly is a grey area. PTP 10 makes an interesting point with regard to incremental improvements. This suggests that the solution might be something that involves aspects which the consultants already have knowledge about but involves incremental improvement to enhance the solution. This might be due to the fast-paced environment which they are working in.

PTP 8: "I think we as a company should really think about that though. I know we've got a lot allocated for training and development but yeah, I'm not really so much allocated for innovation."

PTP 10: "I think the challenge we are having at the moment is that the resources that have to put this in place and drive the prices and so forth have too much other stuff that needs their attention and it results in it not moving as fast as it should, but the processes are there. It's getting developed, but it still needs a lot of work."

This led to questions in the interview's regarding whether or not the participants thought they had reached a plateau with respect to coming up with innovative solutions. Interestingly 8 participants said no, one participant said yes and no, and 3 participants said yes

PTP4: "Sometimes I think in the moment you do feel like you've reached a plateau but as my personnel experience in our business, technology just manages to find a way to develop, and industry finds a way to develop."

PTP 8: "Yeah. I think the most innovative we actually get is…so if we are doing a new project, the client will say what's the thinnest you can get your slabs and then we'd go into column grid spacing and types of slabs to use but it doesn't go too much further than that."

PTP 12: "Well, yes and no in the sense that you know, over time, if you can't have exhaust, what's there to do and you know, new ways, of doing things. There's any possibly so many of them but at the same time, you know, the industry changes, and what we work with also changes. There is always new scope for new things."

The structural services engineers both had the same opinion in saying no, the engineers who provide HVAC services had mixed opinions and the remaining services said no. The perception of these responses gives the impression that the external environment influences how the engineers can innovate. For example, participant 4 mentions that technology improves externally and aids in the engineers using that as leverage to provide better solutions. Participant 12 also refers to industry change externally and can adapt to changes easily if it benefits them.

Another interesting aspect that forms from the interviews is that participants involved in services that involve critical life safety aspects, although bounded by limitations from a financial or time perspective, they will find a solution at all costs.

PTP 2: "The answer to that question is they don't. Once we agree the fee, we know the fee. We don't cut the cloth to suit the fee. We do the best we can every day to deliver the job. Whether that makes us money or loses us money, I can't answer that question. A can't answer that question, but you only have one reputation. Irrespective of the fee or how big or how small the job you have to do, the best you can every day."

PTP 2: "If we need to hit it with a big hammer, we hit it with a big hammer. We don't cut the cloth to suit the fee."

PTP 2: "if it made a big difference in someone else on the professional team's life, yours, for example, anyone else's, we don't see ourselves as an island within a team. So, we would quite often go the extra mile for someone else on the professional team in order to make the building a better solution. So, we quite often do that."

PTP 9: "You still need to comply. You, as a competent person, still need to sign off and take liability and responsibility for it so. From a fire point of view and I might be repeating myself, we're working with people's life, property, and business continuity. You can only be that innovative before you're just stepping over the line and being irresponsible and obviously, we're not trying to be cowboys. We do have innovative solutions, but obviously within limits."

Although solution may come at all costs irrespective of obtaining review, it has to work, or the problem still exists, and it can lead to more challenges internally and externally. Internally, processes can be impacted as result of the challenges from other projects that resources are working on and externally, it could impact an organisations reputation and may put pressure on the relationship between the client and the organisation. Although firm impact is one aspect of not implementing solutions that can work, individual reputation can also be at risk. Two participants highlighted the severity and responsibility aspects of their service as it may involve life safety. The perception received in the interviews also suggests that participants are also very passionate about their work and also have a personnel responsibility to fulfil their duty.

5.3.5.1 Summary of section

The responses to challenges involve understanding the problem and what plan of action needs to be taken. The solution is largely dependent on costs and time for both the client and consultant engineers. There isn't a particular method that each engineer follows in order to come up with solutions and is dependent on the individual and service they provide. The solutions approach is similar for the participants. Understanding root causes, what may have created the problem, creative thinking in the process and lastly providing input to create a potential solution. With respect to whether the consultants have reached a plateau in being innovative, it seemed to be dependent on the service offering and what is happening in the external environment with respect to technology and the industry. Lastly when services that carry more risk in terms of life safety need to find a solution to their challenges at any cost and implement it.

5.3.6 Collaboration between firms and consultants

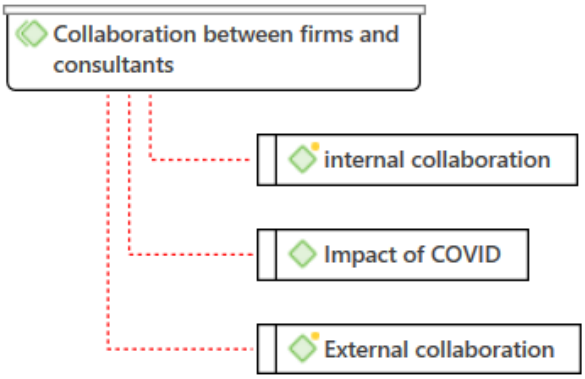


Figure 5-5 Displaying the collaboration between firms and consultants for research question one

All of the participants were asked whether they would call anyone outside of their organisations if they couldn't find a solution to their challenge whatever that challenge may be. The participants mentioned that during the process aspects involving a solution or obtaining an opinion from personnel such as contractors or other engineers whom they have relationships with aid assisting with the solution-oriented outcome. All the participants except PTP7 had expressed any need to contact personnel outside their firm.

PTP1: "Definitely yeah, in in some instances there's certain new technology that comes out that I might not completely understand, so I'll go directly to the supplier or in some instances I might even speak to a contractor that has experience with that type of technology."

PTP 5: "Speaking to other engineers in the industry or even what I'm saying is sometimes a contractor or a or a specialist supplier, something like that would give you a different take on a different outlook, a different approach to the problem and that as I find that If nothing else it makes you think about something that you hadn't considered before or considered it in a different way. So yes, we do, certainly."

PTP 6: "Yeah, definitely. I think where we are quite transparent is that even though our competitors are essentially competitors within our industry, I think we're all striving towards the same goal and that would be to develop good infrastructure products to our country essentially and to our clients and I think that's a common goal throughout our consulting industry."

PTP11: "So yes, I think definitely when engaging to colleagues and other professionals in the same space there are ways that you can, you know, collaboratively sort of getting ideas from other professionals."

The interviews suggest that the engineers also do this because there is chance that, these professionals might have come across a similar problem and dealt with a client who was accepting of a solution. Many of these engineers and their teams use formal and informal approaches to dealing with problems. Often, it's a conversation internally that leads to a formal discussion or meeting. In the formal approach its often brought up in structured weekly meetings that take place between the head of departments or directors and their teams. This suggests interactivity and internal collaboration and digital collaboration during cycles.

PTP 5: "Interaction with each other is very flexible, very informal. You know, in a sense that there are obviously design checks and design sign off's, but I mean yeah, I would certainly not send a mail or expect a engineer to send a mail to me asking me a question about a design. I'd expect him to walk into my office and say this is my issue."

PTP 8: "I would probably say it starts off informal but does get formal. If I have an issue in a project it will probably be over coffee that I ask one of the directors, what do you think about this and then they would give the initial thoughts, but once we get into the detail, we need to sit down and have formal meetings to finalize."

PTP11: "We're having a team meeting; someone might raise that I'm having a problem with this particular project. This is the challenge. Has anyone seen anything like this before? Or on Microsoft Teams, just a quick Teams message to the team and someone will be able to respond that oh yes, I've seen this on another project."

The communication that is created is governed by the internal management processes. This aids in contributing towards solutions or has an element of risk mitigation.

PTP9: "Yeah, now and then we slip. We are a company that's got strategies in place."

Most of the participants made reference to the COVID-19 pandemic when discussing communication. COVID-19 changed the way people communicate projects previously. It would usually be a formal meeting with their clients at offices and it would be a normal day at the office for these engineers. The digital push enabled the use of

communication enablers such as Microsoft teams or zoom. This introduced a new way of working for the firms. The impact of COVID-19 also had an impact on the projects and their progress. This created many challenges internally and externally. It may have impacted how a project was also being developed. It led to new client needs but also has contributed massively towards a digital way of working and collaborating.

PTP2: "What I mean by that is well buildings have changed since the onset of COVID, so we're not doing the really big ones like we used to anymore. But in the past, I'm gonna say really big office building 15 to 20,000 square meters would take you three years from start to finish. Nowadays we do sort of the seven and a half to 10,000 square meter projects."

PTP6: "So, communication portals, especially through the COVID period, have enhanced over the last three years."

PTP10: "internally, the prices have changed quite a lot since COVID happened. It used to be quite a collaborative environment where we were all in the office, we had regular face-to-face meetings. It was easier to just go to a person and ask what the progress is on a certain item. Currently, we are sort of doing a hybrid situation where some of these interactions or online, some of them are face to face."

The pandemic created challenges for firms internally from a project point of view and from a communication point of view. A once very face to face collaborative environment had shifted the industry to a more hybrid way of communicating, but the perception is that it that these firms have adapted quite easily as they are still on hybrid models.

5.3.6.1 Summary of section

Collaboration is form of communication in the process undertaken by these sample firms. It is one of the key factors which seems to have influence on innovative solutions. The networking and relationships with external sources contribute towards valuable information sharing. Other communication aspects such as interaction during formal and informal approaches to discussions is a contributor towards kick starting the innovative process in dealing with challenges. The impact of COVID-19 has also changed the way the sample set of firms work. They have hybrid models where they work from home and from the office. This has created more digital spaces for people to collaborate. Internal communication currently is quite flexible and informal in most cases but there are

strategies in place for the larger firm PRO which have structured meetings which enhances their communication between individuals. These type of formal or structured meetings can identify risks early. The smaller firms of the sample set in this regard are more informal in their inter-activities concerning collaboration.

5.3.7 Technology enhancement

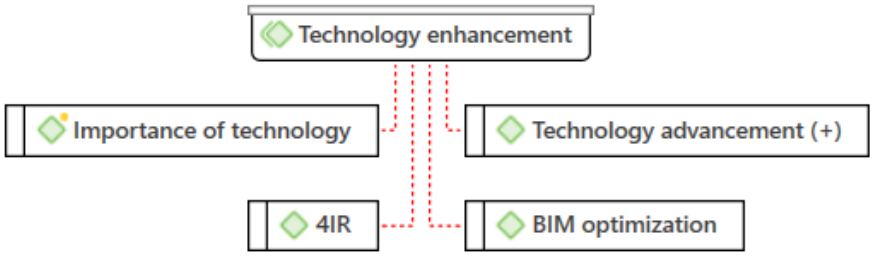


Figure 5-6 displaying the Technology enhancement category for research question one

The technology in the industry is only effective for these organisations if used to its full potential.

PTP 6: "We can use that same BIM 360 documentation process for our internal checks, our internal reviews, and our internal optimization. So not only use it for product delivery to the end user, but we've also actually adapted that on our internal way of working, regardless of who's using that platform and which client we're servicing."

The participants give the impression that technology aids in the process in straying away from using first principles and onerous exercises and essentially speeds up the process of delivery. Costs and time are essential for the firms to generate revenue. Once the technology has aided a project-based activity, it can also allow replicability to occur in project-based activities and solutions.

PTP 6: "In one of the hospitals that we did, it was about 350 pages worth of bills of quantities, which would take an engineer roughly about four to five weeks to do if it was measured correctly and through the use of automated BOQs on Autodesk, Revit, for example, we were able to do that exercise in nearly two days."

PTP 12*: "If you had to do manual heat load modelling with a calculator and a piece of paper, it would take you a week. So, you know, we can typically do it with an Excel application. You can do a week's work in an hour or so and quite detailed in such a way that it can be reused in the future. So, it's not the piece of paper that's written once for a specific project. It's something that can be used later."*

The types of software packages that the participants had mentioned were BIM (Building information modelling) optimization and REVIT. These software packages are used as a tool in project engineering tool for design, calculations, document control and formal communication practices. The participants referred to BIM as part of the project process and seems to have affected all disciplines in the industry. Software which allows real time feedback and creates communication streams between different services on projects. The same process on BIM is used for internal project delivery at PRO. BIM optimization came up in the majority of the interviews and seems to be an enabler for project success.

5.3.7.1 **Summary of section**

The participants discussed technology and its positive aspects that it can help project processes with. Both small and large firms from the sample set utilise it. Specific software or technology for the consultants are developed externally and these sample set of firms rely on it to aid them in their solutions and processes.

5.3.8 Technology challenges create

Figure 5-7 Displaying the technology challenges category for question one

The participants alluded towards the fact that technology can also create potential challenges for consultants. When resources do not utilise it to its full potential. The

importance of technology has been highlighted to suggest that its use is based on the knowledge of the software. It requires the use to be experienced in the type of software that is unique to each discipline. “This can result in design and calculation errors, and this has a knock-on effect which creates challenges and problems later in the project process. This directly creates a challenge for the engineers and the client. This forces the engineer to come up with solutions at that point.

*PTP12: “You know you can draw ******** electronically. Sorry for the word. But if you understand what I mean, yeah, you know, the fact that you are using an electronic means of doing something technologically advanced doesn't save you from producing nonsense. You could still make big mistakes and typically with these things the mistakes are big.”*

PTP 5: “I think technology pushes us or pulls us into the into the future, I think engineers. By nature, are somewhat, I Wouldn’t say averse, but they need a push to embrace new ways of doing things or new technologies, you know they seem to want to stay with the tried and tested it for obvious reasons. you know If something goes wrong with, we're directly accountable.”

The perception from the responses received suggest that smaller firms are more inclined to use existing technology or technology that drives industry. the participants from PRO put a lot of emphasis on the use of technology and how it has set a benchmark for projects and delivery in this in construction building services industry.

PTP 2: “So, we think technology is a big, big, big, big winner in our organization, and whatever technology we need to invest in in order to get better efficiency out of our stuff, we do that.”

Possible Redesign affects time, management and costs to the organisation, there seems to be relationship building between the innovation an engineer can produce depending on the time frame he/she has to come up with a solution. The design time of a challenge or solution is dependent on the stage the project and the costs associated with the solution.

As also suggested in the communication section, the external environment influences the manner in which firms can innovate. It is dependent on their technology and their limitations. The technologies that engineers are required to know about can help them provide information to clients looking for cost effective solutions. This can however be seen as a limitation form a solution perspective. The engineer can propose solutions but to an extent. The possibility of drastic changes in practical solutions may be minimalistic as they also need to comply to standards.

PTP 11: "What can I do to make this more energy efficient? What can I do to develop a better solution for the client. Is there new technology out there? So I found that working during those particular projects, I've had more time to think broadly about those concepts instead of always fussing about the details and that's sort of given me space to be more innovative in delivering those particular projects."

5.3.8.1 Summary of section

Technology can have a negative impact on the process if it is not used in the correct manner, it can create potential challenges. The consultants are still accountable for how they come up with solutions and if it involves technology being used then it needs to be correct. The following diagram has been shown below which outlines the theme created for technology. The technology can also be a limiting factor in how they innovate as the external market technology associated with consultant design also has a relationship.

5.4 RESEARCH QUESTION 2 FINDINGS

why knowledge is important in the process?

5.4.1 Why is knowledge important in the process?

The main categories developed from the findings reveal that capabilities, building knowledge & expertise and resource management contribute towards why knowledge is important to technical engineering firms in the innovation process.

5.4.2 Capabilities

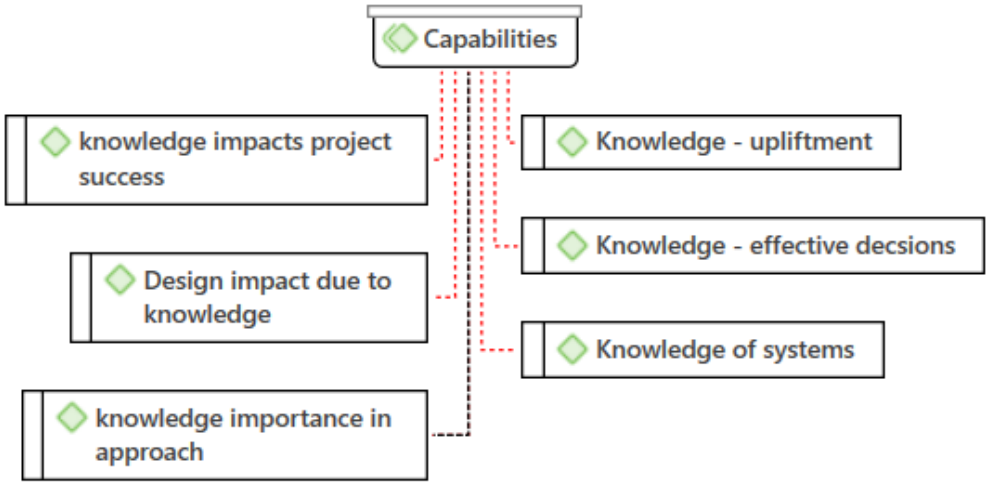


Figure 5-8 Displaying the capabilities category for research question 2

Capabilities from knowledge perspective has been highlighted as a critical element that influences capabilities of the consultants. Consulting firms are considered as knowledge based intensive firms and relies on their expertise to deliver projects which effectively generates revenue for the firm. The first order codes that have been generated for this category have been shown in figure.

With regard to knowledge, the overall perception is that knowledge is role player in the consultant's capability in numerous aspects. The respondents had varying opinions but alluded towards the capability of achieving success. Having knowledge of systems influences project success. The capabilities of an individual can determine this depending on how knowledgeable they are about the actual knowledge of things and systems in a project cycle. The participants outlined the following with respect to this.

PTP 5: "So I Think knowledge is very important, especially for an engineer you know, obviously you have to be technically knowledgeable, you have to understand the physical principles that Impacts whatever we designing and that, but that that to me is knowledge. So knowledge is important and it doesn't matter."

PTP 10: "So from a knowledge base point of view, we need to make sure on a daily basis that we keep in touch with all the manufacturers and the sales department of these

different divisions so that you know when we do specify something that it is new and that we are also informed and educated whenever there's something new on the market so that we don't end up in a situation where the client is telling us about this being available and we don't even know about it."

The participants highlight the importance of being knowledgeable of their systems and the expertise they are providing. In order to be delivering expertise required and successfully, the consultants are required to have certain degree of capability. The need to be cognizant of the impacts their delivery and what their knowledge might have on the greater external environment and their own organization.

Two senior participants from the sample set highlighted that upliftment of consultant's aids in actively contributing towards the uplift of capability towards their colleagues helps save time and allows individuals to grow which can actively also aid in achieving a company's goals.

PTP 2: "Knowledge is everything because the more you are able to upskill your staff with the knowledge that you have acquired over a period of time, the more they can do without you."

PTP 9: "If you wanna keep all your knowledge to yourself you're not actually developing your colleagues, you're not contributing positively to the company's goals to make every employee a better person. You know we are all here to develop ourselves, to develop our colleagues, to work better. So, it also saves a lot of time if you've got knowledge about stuff."

Another two senior participants highlighted knowledge can also influence how approaches are made to challenges and projects.

PTP 12: "So, knowledge, I would say is quite important and this applies to knowledge of things and systems and all the rest of it, and also knowledge on how to approach a problem. So, you know, it's one thing understanding stuff. Stuff is what we work with. It gets built eventually, and then it's there and we must make it work. But what's also important is to understand how you can approach a problem. How do you solve stuff and how do you get to a solution."

PTP4: "So as a junior engineer, you're either attending meetings or carrying out site inspections or doing calculations. Whatever the case may be, you don't have the right experience, i.e knowledge really to be able to do it so."

The perception of the response gives insight into the fact that as a junior engineer, their capabilities to do carry out tasks during a project process may be difficult in carrying out elements that affect a project. As seen from previous sections of these findings there are many factors on projects that can be considered.

The last two elements of this category could be related. This is the way knowledge affects design impact and project success.

PTP3: "Knowledge is very important. It is very important. So, it's one of the first tick boxes for the process itself, because if you're not knowledgeable about the subject line and the process then you enter at risk of not delivering what is required to be delivered at the end of the process. So, knowledge is a key aspect of it. So, one has to try and get as much knowledge as they can on the subject matter for them to succeed, for the process to be completed."

PTP8: "Extremely important. I say in construction there's no guess what, so it's always you have to know what you're doing. You have to know your constraints. You have to know the impact that your designs are having both cost-wise, on the environment, to your client, and to the public. It's such a fine line between thinking you know how to do something and actually knowing how to do it correctly."

PTP 11: "You can only deliver as far as you know. What you don't know, you don't know, especially when it comes to design. Knowledge and experience is very key in our industry and that can only be built up over time through exposure to different projects and environments etcetera. So, I think, we sell knowledge, we sell expertise as a business. We're not selling anything. We're not selling a commodity. We're not selling, you know, soap for example. Our trading commodity is knowledge and skill so yes, it's very important in the consulting space that we are in."

These responses describe that knowledge I order for projects to be successful, the consultants have to know what they are doing. They are selling their knowledge of expertise to end clients in trying to achieve needs and providing solutions to their challenges. This requires the capability of the consultant working on required projects be knowledgeable about all aspects. These aspects also involve the external environment and the process.

5.4.2.1 Summary

The perception of the discussions from all of the participants is the significance knowledge plays for the firms but describes that it can aid the sample set of firm's capabilities in achieving project success. If the firm's capability from a knowledge-based view do not meet the criteria for projects, then consultants may be in need of assistance. There was consensus from two senior participants which highlighted that uplift of their colleagues contributes positively and this can increase capability faster as it allows the colleagues, they work with to increases their capacity to deliver. The perception of the responses also emphasizes that if you don't have knowledge of project delivery, the aspects involved with processes and the external environment can impact the sample firms negatively. The knowledge capability of the firms influence how they provide services to their market.

5.4.3 Building knowledge and expertise

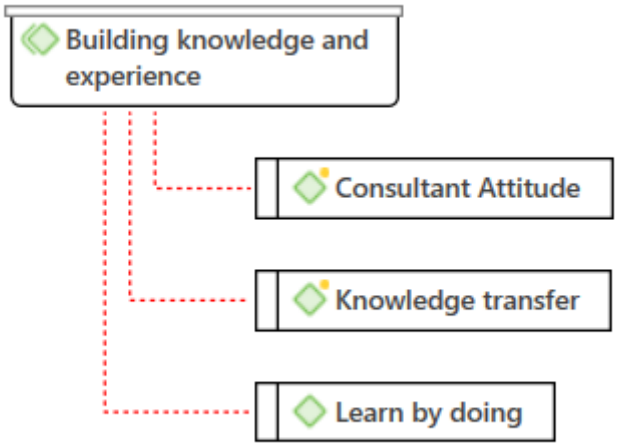


Figure 5-9 Displaying the building knowledge and expertise category for research question 2

The second category in describing the findings for research 2 is Building knowledge and experience. This category includes three aspects namely knowledge transfer, learning by doing and consultant attitude.

The participants seemed to have provided both positive and negative perceptions about knowledge transfer. The perception from the positive responses from the participants suggest that Knowledge transfer can be built from experience They can obtain knowledge and apply it from one industry to another. But this is also dependent on experience working on previous projects.

The knowledge built up on projects can be re-used. The participants as seen in the previous question all work on similar project types in their respected fields. They could even work on the same project together. Therefore, when going from one project to the next, the knowledge and experience applied can create replicability.

PTP 1: "You can take the knowledge from one industry and sometimes apply it to the next you know and especially, for example, I picked up on hotels, they, they're reluctant to change, you know, they have a standard that was developed, say 10 to 15 years ago and since then technology has improved. You know, things need to be done, definitely and you can advise the client Listen here, I know you're saying Standard, but we've experienced this and it works. Would it be something you to consider?"

PTP7: "Try to make things more repetitive so that you can reuse things."

PTP9: "Yes, I think so. You know, some of the projects that we're doing are similar, some are not and you can actually take that knowledge and transfer it from one project to the other"

The similarity of projects plays a role in how the knowledge is re-used. The degree to which information is re-used is not explained in the in the interviews. The knowledge transfer that they can apply can contribute positively due to the consultant's obtaining knowledge from different industries. PTP 7 stated that things should be tried to be re-used. This could be due to the similar project types which the consultants work on. This effectively saves time for the consultant as well. PTP12 and PTP9 suggested some

negative aspects about transfer of knowledge from project to project.

PTP 12: "Yes. There generally is and it's a basic principle of applying what you know in the sense that you know your knowledge is only as good as the previous job you did. Your experience is only as good as the previous job you did, so you know. You can't do every job as a completely new thing; the risk would just be too high."

PTP 9: "You know, some of the projects that we're doing are similar, some are not, and you can actually take that knowledge and transfer it from one project to the other; not all of them and obviously within certain barriers and conditions."

The perception of this response suggested that there is risk in re-using the knowledge on all projects. There are also limitations in the sense that these consultants are bounded by project requirements or regulations. Delivery of projects to occur according to two participants are a result of on the job learning rather than just being knowledgeable but without a good foundation it might not be easy.

PTP7: "What I think people need to deliver here is learned on the job, I don't think anybody has learnt what they need to do to deliver output in an academic environment."

PTP8: "that experience influences knowledge and I say that because you have your knowledge base which is your university or your Technikon courses, and then when you get into industry, you start developing your experience and you the knowledge base is 100% important, but as you gain your experience, you work on different projects, you meet different people, that's when you build on that knowledge and you sort of expand and become more flexible. That foundation, that knowledge foundation is extremely important. I don't believe that you can learn engineering on the go. So, I don't believe that you can start designing and going to the site without your fundamentals being in there."

The perception of these responses also describe why experience on projects is important. Experience builds knowledge and contributes towards being flexible in approach. Academic knowledge may assist but consultants need experience to build practical knowledge. But the aspect of consultant attitude is then highlighted. The perception from the interviews indicated consultants should build up their knowledge and expertise in terms of personnel upliftment and fulfilment which can create success for

them and their firms.

PTP 6: "I think the best way to explain it would be if you have the right people in the business with the right experience and the right attitude."

PTP3: "It's that I'm willing to learn. For the organization itself, I will say also the willingness to work with the new systems and the ability to support their staff on that. So that's what's unique about both. So, for my side, it's the willingness to learn and that doesn't close out any suggestion from anyone because I believe that everyone has a little bit of something that they can contribute towards your project."

the consultants need the right attitude to learn which aids I personnel upliftment and benefit for the firms. There must be willingness on the consultant's side to build up his or her own knowledge from projects.

There seems to be relationship between the amount of knowledge one has and how it may affect experience. PTP4 and PTP 12 highlighted why experiences influences knowledge build up.

PTP4: "Whatever the case may be, you don't have the right experience, i.e., knowledge really to be able to do it so. For example, you get challenged in meetings and challenged by external parties to be able to carry out the tasks. But as you gain the experience and gain the knowledge as a direct result, you start to gain power at that age-old saying knowledge is power."

PTP12: "Yes. Experience has got a kind of a stagnating effect if you don't watch out in the sense that you what you think you know is possibly outdated and you know if you if you have vast experience, it sometimes makes you resistant against new solutions and the knowledge that you think you have is often not applicable, so there is a bit of interaction between those two things. With great experience normally comes great knowledge or with greater experience comes greater knowledge but it's not necessary that any of that is still applicable. So new experience is also important and all the experience, so you know, new experience tests knowledge. and it tests its relevance."

With more project experience, the more knowledge can be created. As PTP4 mentions that you may not have the correct experience, but a challenge can be created and with that you build up the knowledge to tackle the challenge which leads to greater knowledge. PTP12 however mentions that you may build-up enough knowledge and your experience can become stagnant, therefore a consultant must be able to adapt to learn new things so that challenges can be overcome and become accepting of new solutions.

5.4.3.1 summary of section

The findings in this category reveals that there is a degree of experience and knowledge that is built up on project-based work and how it can be applied. Knowledge can be recycled on projects but to a certain degree. A push and pull relationship seem to exit between the two variables. It depends on the consultant attitude to approach projects with an open mind and gain knowledge so that they can be more flexible in their approaches. There are both positive and negative aspects when replicating knowledge in the process.

5.4.4 Resource management

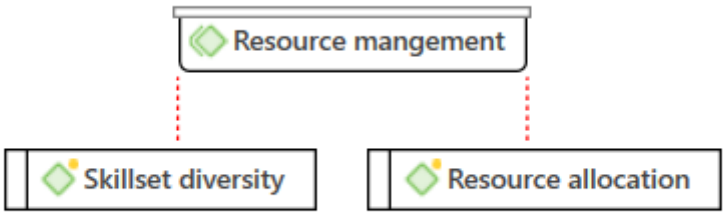


Figure 5-10 Displaying the resource management category for research question 2

The third category developed from first order codes is resource management. All of the participants in the interviews made emphasis on resources and how they are managed. This displays the significance of resources and how their level of expertise is important to all of the sample firms. Resources in the context of the interview are considered to be junior and senior engineers which are managed by a senior director or head of department in PRO's case and a partner, shareholder or owner at the smaller firms. The selection of specific resources that influence projects are based directly on experience rather than knowledge, but this was more specific to the PRO firm rather than

the smaller firms.

PTP6: “Who has experience in delivering these sorts of projects? Who's done this type of work in the past and we would allocate to that resource to that project?"

PTP11: "So I generally would look at the complexity of the project and then you look at the skills of the team, various skills of the team. So, if someone is more experienced in hospitals, for example, you know that person would more than likely be placed on a lead role for that particular project, and then whoever is supporting is for people who are sort of learning about that type of facility or expertise. So, what we generally do is to understand the complexity of the projects if there are special skills required, identify within the team who has that particular skill and do your resourcing based on that.”

In comparison to some of the smaller firms the responses were orientated around project delivery and projects that take priorities.

PTP 12: “It's a tough one, you know it. Essentially in a small company there's, you know, limited resources so whatever needs to be done needs to be fitted into what's available, you know. There's not an endless supply of capability so timewise, it needs to be managed and prioritized. I think prioritizing what needs done and when is probably the main thing that we do to manage that resourcing.”

PTP5: “Because we're a small organization, you'll find that we've got a lot of diversity, you know, in that one engineer doesn't simply, just, specialize in, say, drainage and another one says water, another one in HVAC. So essentially what we try and do is allocate a resource per project rather than a resource per specialty.”

The smaller firm WTR due to their size manages their resources around skill set diversity if they provide more than one type of service and a smaller firm like MCH will allocate resources as they need it depending on what takes priority.

The responses of the interviews gave the perception that skill-set diversity was more prevalent in the smaller firms of the sample set then the large firm of the sample set. It requires a better understanding of people in their team rather than just allocating a resource to a project based on their expertise.

PTP2: “Others are one-trick ponies. They can only do one thing at a time otherwise if you ask them to do too many things, they don't ever even get to complete one of them. So that's very much about how you get to know your staff, their strengths, their weaknesses, and then use those in order to deliver what you need to deliver.”

PTP10: “Not all of the resources are good or specialists at all of them. So, we tend to be three or four resources working on a single project and then those different ones specialize in their specialty.”

PTP10 displayed proof of this and was pretty much the consensus with the other participants from the PRO firm. But skill-set diversity at the PRO firm in terms of expanding their knowledge base involved other aspects such as having qualifications and on the job knowledge expansions which may influence their skill set range.

PTP 3: "You need project management skills, and you need also to have a qualification whether you have an engineering qualification. OK, you need an engineering qualification, I'll say, whether it's electrical, mechanical, civil, but to execute the work that I'm doing you need to have a qualification. Also, you need to be registered with the Council of someone that is relevant to that field it's within ECSA or some other councils applicable in your field or some PMP or something, but you need to be registered with councils. You need to have your project management skills and you also need to human relations skills in a way.”

PTP 10: "knowledgeable on different standards in different countries, how they do things differently, how their technology is different, how their specification levels are different. So, knowledge on not only technical portions of the projects like I mentioned earlier but also knowledge of that country, knowledge of the contract is in that country, even knowledge about the local engineers that do what we do. I think it's very, very important and the success of a project depends on that."

5.4.4.1 Summary of section

One of the processes that PRO undertakes due to their size is based on the scope of the project, the size of the project, the expertise of the resource available, the delivery

time and would allocate the engineer accordingly. Although this would also apply to the smaller firms, it can be argued that the number of people per department at the bigger could be similar in number. Smaller firm however might take on work where they do not have all the right resources and make it work in order to still generate a revenue.

5.5 SUMMARY OF CHAPTER 5

In summary for research question one, there were five categories derived from the findings in the interviews which were namely Stages in the project process of importance, way of working, challenges in the project process, response to challenges, collaboration between firms and consultants and technology enhancement. These categories have been formulated in contribution to understanding how TEC firms formulate their innovation processes and what may affect it. From the categories and perception of responses it was found that culture as an antecedent in the process, response to market needs, communication in the process and technology as key influencer are all factors. In summary of research question two, there were three categories namely capabilities. These categories have been formulated in understanding why knowledge is important in the process.

Table 5-3 Displaying the total number of categories and themes that have been formulated for both research questions

Category	Theme
Stages of importance	Culture as antecedent in the process
Way of working	
Challenges in the project process	Response to market needs
Responses to challenges	
Collaboration between firms and consultants	Communication in the process
Technology enhancement	Technology as a key influencer in the process
Technology challenges	
Capabilities	Service delivery
Building knowledge and expertise	
Resource management	Operational efficiencies

6 CHAPTER 6: DISCUSSION OF RESULTS

6.1 INTRODUCTION

This chapter shall outline and discuss how the analysis of results in chapter 5. The discussion shall provide an analysis of each question proposed in chapter 3. This will include how the service firm process of innovation can be conceptualised and how knowledge plays a role in the innovation process. The description shall be compared with the available literature which has been described in Chapter 2. This chapter shall also aim to contribute towards literature on service firms, specifically on technical engineering consulting (TEC) firms and existing literature of service innovation processes.

In order to analyse the questions, firstly context shall be provided then themes of each section will be discussed in the analysis as well as its relationships with the themes that emerged from question two of the research questions and lastly a conclusion to the question which will contribute towards buildings a model at the end of the chapter.

6.2 ANALYSIS OF RESEARCH QUESTION 1

Research question 1 sets out to analyse how the systematic innovation process is formulated and developing an understanding of the process. The literature suggests that in order to conceptualise a process an overview must be created (Gemser & Barczak, 2020). In order to achieve this the themes that have merged will be analysed after context from the findings is outlined.

6.3 CONTEXT IN TERMS OF THE FINDINGS

Firstly, the analysis shall aim to describe the foundation on which the project cycle is built on from the findings and appropriate secondary data. the service delivery utilises the PROCSA stages of the CESA guidelines which was outlined in most of the findings. These stages are broken up into 6 different stages namely as per figure 6-1 below.

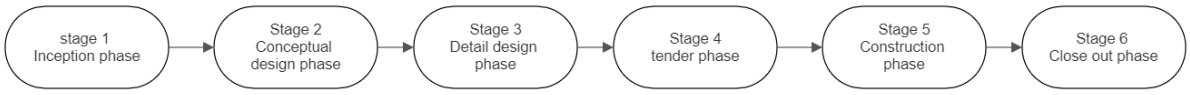


Figure 6-1 Describing the stages of the project process from the PROCSA stages

Secondary data findings reveal that the PROCSA (Professional services agreement) stages for project delivery is concerned with the contract between engineers and their clients. It contains a set of annexures outlining terms and conditions, schedule for special conditions, fly sheets and duty of care undertaking forms (*PROCSA*, 2022).

The secondary data findings also describe the agreements included in this agreement which, apply to mechanical, structural, fire, mechanical, electrical, electronic, civil, wet services, project managers, development managers, quantity surveyors, landscaping and the architectural disciplines. It is important to note that only the engineering disciplines that form part of building services in property were part of the study. The type of projects that most participants have been involved in include office buildings, basements, hospitals, apartments, hotels and data centres. In some cases, the participants mentioned occupancies that not everyone included in their lists. The type of projects that most participants have been involved in include office buildings, basements, hospitals, apartments, hotels and data centres. In some cases, the participants mentioned occupancies that not everyone included in their lists.

Therefore, an important consideration in the analysis is the context of the project delivery eco-system. The sample set of firms are service firms that are required to provide services for clients that will appoint them in a South African context with the use of the PROCSA agreement. the types of services in the MEP sector of services are applied to all types of occupancies which are classified in the national building regulations (NBR) which is further comprised of the South African National Standards (SANS) documents. The most recent type is referred to as SANS 10400. These where the documents which the participants outline as the rules and regulations which they are governed by in terms of their daily activities regarding design.

The following elements from the findings are consolidated into a summary to describe the similarities and what is important to the firms based on the interviews during the project process. This table is important to analyse patterns that have been formulated

from the findings.

Table 6-1 Displaying similarities or differences between the large firm of the sample set and the smaller firms of the sample set from the findings

Description	**Large firm- similarities or difference**	**Smaller firms – similarities or difference**
Services	Multi-disciplinary – offers all services	May offer more than one service but in the case of the sample set, only two firms offered one service
Project types	They work on multiple different occupancies	They work on multiple different occupancies in most cases
Way of working	Appears to be formal	Appears to be more informal
Day to day activities	Appears to be similar	Appears to be similar
Challenges	Can occur at any point in a project cycle – can be external or internal challenges	Can occur at any point in a project cycle – can be external or internal challenges
Response to challenges	Intrinsic investigation – understand-gather information–formulate solution	Intrinsic investigation- understand– gather information- formulate solution
Challenge Degree of difficulty	Cannot accurately determine which challenge is more severe	Cannot accurately determine which challenge is more severe
Response to challenges	Cost and time implications – extremely important	Cost and time implications – extremely important
Response to challenges	Solutions may come at any cost and depends on severity and responsibility	Solutions may come at any cost and depends on severity and responsibility
Cost and time	Critical factor for the firm	Critical factor for the firm
Capabilities	Having the correct	Having the correct

	knowledge to deliver project is important. Believe in upliftment of colleagues	knowledge to deliver project is important. Believe in upliftment of colleagues
Description	**Large firm- similarities or difference**	**Smaller firms – similarities or difference**
Building knowledge and experience	Learn by doing & knowledge transfer	Learn by doing & knowledge transfer
Resources	Can allocate based on expertise and level	Will allocate based on priority but skill-set diversity is important

The above table is also used as quality control mechanism based on the existing research articles regarding small and large firm contexts.

6.3.1 Culture as an antecedent in the process

Two categories which form part of this theme are the way of working and the stages of importance in the process. Both large and small firms from the sample set suggest that that they carry out similar daily operations. The larger firm from the sample set displayed more structure in terms of their activities which they undertake daily. The larger firm gave the perception of being more formal in their approaches to how they conduct business processes, whilst the smaller firms gave the perception of being more informal in their approach to how they conduct business processes. Participants of the larger firm often referred to being a global franchise and that gives them leverage in terms of how they conduct business. They have portrayed being a multi-disciplinary culture with formal strategies in place for undertaking of works. The smaller firm's processes, and activities seem to have been encouraged towards priority in terms of how they conduct their processes.

Although project-based activities remain similar for both firms, there was consensus that all participants follow the same processes when being appointed on a project from a contractual point of view. The way of working suggests how projects could are handled. The perception of stage importance for most participants was the concept

design whilst others alluded towards stage 4 importance. This may indicate the significance of having an innovative way of approaching problems from a process point of view. It is important to note that the smaller firms like STC and MCH only offer one specific service in building services environment where a firm like PRO offers a multi-disciplinary service in terms of building services. The only firm which was considered to be a small firm which offered multiple services was WTR. This can suggest a different dynamic in how the consultants interact and how they operate. The theme of culture as antecedent in the process forms a relationship with service delivery from a knowledge point of view, operational efficiency and responses to market needs as depicted in figure 6-2 below:

Culture as antecedent in the process	Forms a relationship with	Responses to market needs
		Service delivery
		Operational efficiency

Figure 6-2 Displaying the relationships with Culture as an antecedent in the process with other themes

Consultants can work on multiple projects at a time along with their teams in the process and therefore seem to operate at high intensity. this therefore describes the nature of the consulting business. Projects which the organisations undertake can last anywhere between three months to three years and multiple projects with different timelines would be running simultaneously. Therefore, aspects like operational efficiency and service delivery in this context of this study are key themes that forms a relationship with the culture of the sample set of the firms. From an operational efficiency and service delivery perspective the processes of the firm would play a massive role in how they manage their projects and resources. The diversity of the work force would encourage innovation in workplace practices and flexibility on how innovative they can be in their respected spaces or departments. The processes at larger firms are governed by formalised structured and processes in how they respond to market needs. The processes at the smaller firm are formal in their approach from a process perspective when undertaking formal projects but are more informal in their processes internally.

6.3.1.1 Comparison with the literature

The cultural dynamic of a service firm from an innovation perspective should be a representation of their goals to absorb new ideas(Santos-vijande et al., 2021). The culture of the organisation is result of the activities the individuals and groups foster (Kostis et al., 2018). The sample set of firms in the study displayed very similar processes in terms of how they work from a process point of view when carrying out projects. TEC firm service culture seems to be defined by their adaptive space. The adaptive space is defined as the organisations flow, processes and enabled networks (Arena et al., 2017). As depicted in the literature the factors associated with firm success can be related to management of processes, communication practices, a firm's skill-set and resource-based elements. This can directly contribute towards successful innovation on projects (Santos-vijande et al., 2021).

Two themes which were identified was service delivery and operational efficiency form a relationship with culture as antecedent in the process in the findings. This is consistent with the literature. These components are related to management of resources and their capabilities in terms of the findings. Governance that are more efficiency focused within the firm will favor innovation. Kostis et al. (2018), and Arena et al. (2017), postulates that the lack of formal and informal influence prevents organisations from bringing their ideas to light (Arena et al., 2017; Kostis et al., 2018). The larger firm are deemed to have more formal processes and the smaller firms displayed to have more informal processes and both firms portrayed similar processes when undertaking projects. This suggests that formality and informality of processes is a factor in terms of the sample set of firms from culture and process point of view. One interesting aspect highlighted in the study by Arena et al. (2017), which was prevalent in the interviews is with regard to creating good concepts of prototypes early on during the innovation process. The findings suggest that producing a good concept design early on in the process is a key element in a project cycle as it mitigates potential issues later on during the project cycle.

6.3.1.2 Summary of section

Most of the literature is consistent with the findings, however literature considered formality in processes in firms to be more innovative. If smaller firms work on similar projects and conduct very similar processes, then informality of processes should also be considered as a factor for innovation in smaller firms in the TEC firm space from culture

point of view. Forming concept designs in the way of working should also be a key process mechanism which should be formalised. Therefore, formal and informal processes are a factor in the culture of a technical engineering consulting firm.

6.3.2 Response to market needs

The response to challenges as theme has been built from two categories namely challenges and the response to challenges. Various challenges may present themselves at any point in a project process. There is varying degree of challenges that the participants outlined in the findings. It would be hard to assess the degree of the challenges that the participants outlined. The sample set of participants highlighted that the way innovation occurs is often based on a challenge in a project or client need. The solutions or response to these challenges are heavily influenced by costs, time and in some cases the severity and responsibility of a particular service in the building services space. The cost of the solution has two implications mainly on the firm itself in terms of time they take to generate solution and the actual cost of the solution for the end user.

Being solution driven which is what seems to be the behaviour of consultants from the sample set, there must be a balance between how far the consultant must go to achieve the solution and the cost at which he achieves the solution. The participants were also asked if they had a specific method when coming up with solutions most of them identified that they need to understand the problems intrinsically and identify what aspects are involved with the problem. When a problem presents itself, the start of the analysis of the problem begins with understanding why it has occurred and what is the root cause of the problem. This may involve intrinsic investigation such as the stage in which the project it is in, finding previous communication and whether the problem is due to the project itself or an error on the part if the engineer or actor within the firm involved on that project. This can be considered to be a formal approach to the solution seemed to be similar for the respondents in terms of the challenges that may present itself for both the large and small firms of the sample set. Response to market needs forms a relationship with communication, service delivery and operational efficiency which has been depicted in figure 6-3.

Response to market needs	Forms a relationship with	Communication in the process
		Serviced delivery
		Operational efficiency

Figure 6-3 Displaying the relationships for response to market need with other themes

When the sample set of firms find challenges, they have both formal and informal procedures to start the process of responding to challenges. Identifying problems that the sample set of firms may start with formal or informal communication procedures. The sample set of firms can seek to find solutions internally and externally. This has direct influence on collaboration between individuals both internally and externally. When solutions require externally the sample set of firms may try to find them outside of the organisation if it is orientated around systems that external suppliers may offer. They may also look internally at how they can come up with solutions based on their own expertise and analysis. The communication and approach for the larger firm is combination of both formal and informal approaches. The communication aspect will also involve discussions internally, these are formal and informal, but the process moves to formal even if it did initially start as an informal process.

The response to market needs also influences the service delivery point of view from knowledge and expertise perspective. Improving on current capabilities, knowledge and expertise can improve the way the sample set of service firms address their problems. Lastly the size of the firm influences how the market needs influences operational efficiency especially from a resource-based view. The sample set of the larger firm can allocate easier than the sample set of the smaller firms and smaller firms work on a basis of priority unless they possess more diverse skill-sets. The idea of the response to the market need is to create mutual benefit for both firm and for a client or project.

6.3.2.1 Comparison with the literature

The overall response to market needs is the value that co-created with creates mutual benefit for the service firm and the client or project need they are satisfying considered (Vargo et al., 2020; Wieland et al., 2017). The solutions-based approach for the sample set of firms can be described as combination of other themes as well and their

relationships that all operate in a network simultaneously but relates more the themes which the response to the market needs has been outlined to have relationship with the previous section. Communication within the sample set of firms defines how the approach to the problem begins. The value co-creation in the literature starts with how the firm is structured and what the firms have in place as strategies for delivery (Vargo et al., 2020). The innovation required might be dependent on internal or external sources. From internal view point it might be reliant on resources who possess the knowledge of systems or externally it might rely on the innovation that the environment or eco system the sample set of firms are working in. This element is also substantiated by Wieland et al. (2017), where he suggested service firm will innovate in according to their eco system.

When considering resources and knowledge-based view perspectives in this context. The process of responding to the need which entails coming up with the solution is reliant on the actors involved. They need to have the same sentiments about the solutions which they provide so the cycle of problem solving will converge to the same outcomes each time and value is created (Chandler et al., 2019; Vargo et al., 2020). The processes that occur as a result of an identified challenge whether the process begins with a formal or informal approach affects the knowledge base of the resources or actors involved in the process (Chandler et al., 2019).

6.3.2.2 Summary of section

The literature agrees with the findings in most cases and outlines the fact the innovation process when conceptualizing the manner in which firms come up with their solutions needs to take a broader perspective as there are simultaneous processes that occurring at the same time. Formality and informality are also factors that need to be considered for the consultant's approach at the beginning of the process, but the process would tend towards being formal even if it started off informally.

6.3.3 Communication in the process

The theme communication in the process has been formulated from one category which is collaboration between firms and consultants. Internal and external collaboration aspects are associated with this category. The firms to large extent were impacted by the

COVID- 19 pandemic which changed their way of working from a collaboration aspect. An industry that was primarily orientated around face-to-face interaction now moved toward being a hybrid system. The participants highlighted that external collaboration amongst other engineers, suppliers or people they trust can influence solutions on projects and is essential especially where outside solutions are necessary based on the existing technology that might allow them to implement it in addressing the consultant's needs. In this theme there was the case of formality and informality with respect to how communication internally and externally may occur. The larger firm of the sample set seemed to have provided the perception that they had more formal processes whereas the smaller firms in the sample set seemed to have had a more informal approach to how they communicate. Communication therefore forms a relationship with response to market needs and operational efficiency as depicted in figure 6-4

Communication in the process	Forms a relationship with	Response to market needs
		Operational efficiency

Figure 6-4 Displaying the relationships for communication in the process with other themes

From a response to market needs perspective, the formal procedures can highlight potential issues before they arise thus eliminating potential challenges that may present itself or it can be a kick starter to finding a solution to the risk that has been identified. This would therefore allow the cycle of responding to the market needs to occur. The smaller sample set of firms have adopted a more informal approach to their communication methods. From an operational efficiency perspective, the hybrid workspaces requires that processes that can facilitate interaction between members of firm is carried out efficiently, therefore informal and formal virtual communication practices can also take place. Since hybrid workspaces would not allow direct face to face interaction constantly, therefore it would be vital that in smaller firms, resources keep communication channels open as the small firms from the sample set have more informal approaches to communication as well.

6.3.3.1 Comparison with literature

As suggested in the literature, voice practices and collaboration in service firms can contribute towards being more innovative, maintaining innovation and sustain competitive advantage (Kaya et al., 2020; Shin et al., 2022). As an important aspect in an emerging market context, collaboration is key for these firms to ensure that processes

allow it and to be flexible in the approach (Kaya et al., 2020). Shin et al. (2022), suggested that voice practices can be defined as a procedure or formal process which enables organisational members voices to be heard and Collaboration is form of open innovation practice which leads to improved processes for the organisation (Shin et al., 2022). Formal and informal mechanisms in this regard are said to influence knowledge-based aspects of the of the workforce (Kaya et al., 2020). Therefore, the importance of formality and informality in the processes is highlighted in the literature. The literature however suggests that formal processes are more favourable for innovation to occur. networking activities is a key influencing factor the innovative performance of a firm (Tojeiro-rivero & Moreno, 2019).

The impact of COVID allowed the firms to become more technologically advanced from a networking perspective. The implementation of using Applications such as Microsoft teams applications may have impacted these firms to be more innovative in their approaches to challenges and day to day activities. This possibly allowed consultants to save time on their projects but encouraged new ways of working and ways of finding solutions where collaborating face to face informally would have been challenge. Parrilli et al. (2020), postulated that when interaction can occur between firms, then it also contributes to be more innovative (Parrilli et al., 2020). These consultants work on projects where they are collaborating most of the time in formal project meetings where projects are concerned. This is where multiple firms or multiple departments from a large firm can work together.

6.3.3.1 Summary of section

Collaboration is highlighted in the literature as a key element for innovation to occur in service firms therefore the literature therefore the findings agree with the literature. Formality and informality have also been highlighted in the themes and in the literature where formal processes are deemed to be an important element of the communication factor. The smaller firms from the sample set are more prone to informal processes therefore, informality from a communication perspective should be considered as well for TEC service firms in an innovation context. Therefore, formal and informal communication practices is a factor for a technical engineering consulting firm.

6.3.4 Technology as a key influencer in the process

Two categories developed for research question aided in forming the overall theme of technology as an enabler in the process. There were both positive and negative aspects associated with the use of technology from both sample sets of firms. Both the large firm and smaller firms from the sample set suggested the use of the same technology in a building services industry context. The use of technology can enable firms to be innovative. As displayed in the summary sections of the findings, technology plays a significant role in how the firm carries out their processes and can affect the way a firm innovates. From an innovation perspective, the focus is largely based on understanding what technologies are being developed in the market in order for firms to be more innovative in their solutions. An industry context or regional context of South Africa, as seen from the findings, most of the participants referred to about BIM or REVIT applications and its usage.

Perhaps the use of these technologies by the consultants in a South African context is the innovation mode of the industry. In the findings it was noted that professions such as the architectural firms that play a role on design projects were responsible for changing the way consultants worked on developing 2D capabilities to 3D capabilities. This then required more information to be stored on platforms to make information more accessible to end users during a project cycle. Technology aids in the process in straying away from using first principles and onerous exercises and essentially speeds up the process of delivery. Costs and time are essential for the firms to generate revenue, but the actual technology does not seem to influence how the firm innovates per say but rather influences it. Figure 6-3 illustrates which themes technology as a key influencer forms a relationship with.

Technology as key influencer in the process	Forms a relationship with	Response to market needs
		Communication in the process

Figure 6-5 Displaying the relationships for technology as a key influencer with other themes

Technology as a key influencer in the process forms a relationship with responses to market needs and communication in the process. For the sample set of TEC firms, technology seemed to have influenced and forms a relationship with the response to market need. As seen previously. The response to market needs is associated with solutions that involve technology. The sample set of firms are reliant on what new technology is being implemented where they can use in their designs. These could be considered as improvements to existing technology available to the consultants and the services they provide. This use of the technology can aid the consultants in providing solutions for clients that did not previously know about it. Criteria for sustainability can also be accomplished with new technology as emerging economies move towards better and more sustainable solutions. Technology also aids the sample sets of firms in terms of time and costs. The faster they can implement solutions the more time and revenue is saved on their projects. As seen from the previous theme description costs and time influence the manner in which solutions are implemented unless the solution has a degree of severity and responsibility attached to it. Technology used in the service firms has an impact on the how these firms are communicating. Uses of BIM tools encourage internal and external collaboration. These can be considered to be cloud based technologies influencing the communication process.

6.3.4.1 Comparison with literature

The sample set of firm's process involves technology but seem to be orientated around processes rather than being idea based to influence the market need. Therefore, taking the opposing view to what Usai et al. (2021), suggested in their research where technology is used as strategic fit in the process rather than influence the innovative process (Usai et al., 2021). Parrilli et al. (2020), suggested that the business innovation system mode of a firm involves the distribution of technology within the firm and helps aid in building up the innovation capacity of the firm (Parrilli et al., 2020). The business innovation mode is elaborated to be in terms of the South African context. Both the large firm and smaller firms from the sample set suggested the use of the same technology in a building services industry context. Both REVIT and BIM software tools are essential for the Sample set of firms. This distribution of this type of technology can influence innovativeness for the firm to an extent.

A form of collaboration is created when these firms interact with outside sources (Homayounfard & Zaefarian, 2022). When firms utilise the available technology, they will

exploit it to their advantage. All of the sample set of firms can look externally for technological solutions for them to implement in their solutions. It is important to note that firms who compete are also likely to use the similar solutions in an industry context. Therefore, technology is a key influencer in the process as it aids in solution development. This is consistent with the view from Usai et al. (2021), which suggested that technology is a result of strategic suitability.

6.3.4.1 Summary of section

The findings are consistent with the literature in terms of the findings and agrees with the literature. Cloud based and design-based technologies such as BIM & REVIT are important for the innovation process but utilisation of it in the correct manner must be applied in order for the processes the technical engineering firm undertakes is effective.

6.4 ANALYSIS OF RESEARCH QUESTION 2

6.4.1 Service delivery

Service delivery (KBV) is built from the categories of capability (KBV) and building of knowledge and expertise. This theme takes a knowledge-based view of service delivery. In general, both sets of the smaller firms and large firm could agree that knowledge forms an important part of the process in different scenarios. The participants suggested that knowledge may be built up and influences capabilities of the firm. The capabilities of the firm improve their processes and allows them to deliver projects that does not impact the environment in a negative manner. A simultaneous process of building knowledge and experience forms a relationship with capabilities. Building up more experience leads to building up greater knowledge, but the sample set of firms also made emphasis on the fact the consultants of the sample firms have to have the right attitude to develop themselves too. Having the right balance of knowledge and experience influences flexibility in approach. Figure 6-5 displays the relationships that service delivery forms relationships with.

Service delivery (KBV)	Forms a relationship with	Response to market needs
		Technology as a key influencer in the process

		Communication in the process

Figure 6-6 Displaying the relationships for service delivery with other themes

Service delivery (KBV) forms a relationship with three themes namely response to market needs, technology as an influencer in the process and communication in the process. A knowledge-based outcome for the improvements influences the capabilities and the manner in which the sample set of firms can respond to market needs. Improvement of service delivery aspects also enables experience of the firm when responding to the need. Service delivery improves the usage of technology in the process. Having knowledge of the technologies that aid the firm in successfully achieving requirements on projects influences time and revenue. Service delivery (KBV) forms a relationship with communication in the process by means of the improvement of knowledge when interaction occurs internally and externally between firms and participants. Having a good understanding of the process and what objectives must be achieved is important to the sample set of firms that actively take part in projects. Lastly from a knowledge-based view, the seniority level of the participant plays a role. Consultants who are not considered to be experienced enough need to be a part of the process involving communication, respond to challenges and market requirements, be familiar with technology in the process and adopt a learn by doing strategy to build up experience in order to build capabilities and provide the required service delivery from a perspective of knowledge and experience.

6.4.1.1 Comparison with literature

Bouncken et al. (2021), suggested that firms can improve their innovation via means of processes and understanding of knowledge variations (Bouncken et al., 2021). Kalogerakis et al. (2010), further postulated that engineers in an industry context exposed to situations where they are required to solve problems for clients. Experiences will encourage better understanding and improvement of knowledge where it can then be applied in other areas (Kalogerakis et al., 2010). All of the sample set of firms have given the perception that these elements are key factors in the business. This type of innovation in the industry context could be described as combination of both exploratory and exploitative practices which the firms undertake in their processes.

When firms tend to seek knowledge externally or internally which aids them in providing solutions, there is a process of knowledge transfer which will occur. This is confirmed in the study by Yul lee et al. (2021), which suggested that knowledge that is considered as mutual can lead to innovation and this includes rage of processes that would involve problem solving capability (Yul lee et al., 2021). However, another view may suggest that mutual knowledge overlap may prevent innovation from occurring (Bouncken et al., 2021). The general findings suggest that for technical engineering firms, external sources can be an advantage in most cases.

Having different business units can aid in the development of mutual knowledge as well (Yul lee et al., 2021). The larger firm from the sample set of firms have various disciplines which creates the perception that they have an advantage. This may be true however, service firms are said to be knowledge intensive based, therefore irrespective of firm size knowledge will always be the foundation of the business whether the firm possesses other departments or not.

The smaller firms work on similar projects as the larger firms, therefore there is a possibility that the knowledge base of the firms is similar. Tacit knowledge and routines for the sample set of firms are important are important (Snihur & Wiklund, 2019). From the findings the main perception is that there is a knowledge cycle occurring that leads towards learning, understanding and replicating. This however based on the improvement to their already existing knowledge base which the consultants are applying. From the knowledge types that have been explained in the literature Tacit, analytical, synthetic and mature knowledge types are evident in the findings (Sørensen et al., 2010). The knowledge transfer aspects can be associated with learning by doing and upliftment, but it leads towards replicability.

6.4.1.2 Summary of section

The literature agrees with the findings. Knowledge transfer and building up knowledge-based skills for the sample set of the firm is an important open innovation practice which the sample set of firms must manage. This is key contributor towards the effectiveness of being innovative in the technical engineering service firm context.

6.4.2 Operational efficiencies

The theme of operational efficiencies is built up from the categories of resource management. This theme involves the management of resources at different levels. All of the sample set of firms had given insight into how to they manage their resources that operate in their firms. The larger firm sample set made emphasis on management of resources based in their skill level, type of previous projects they worked on, and the overall complexity involved in the project before allocation. The larger firm seemed to have possessed more resources that have expertise in each of their specific services with less diversity. Although this was the general perception, it can be different for each department based on the consultant's skill level. The smaller sample set of firms emphasised that priority is a key element when managing resources. This is because they are much smaller operations will be prioritised around what is more important in terms of completing project processes more successfully. The management of resources in larger forms seemed to be more formally oriented with respect that this corresponds to internal management processes whereas the smaller sample set of firms didn't have much emphasis on management of resources with respect to internal management processes in the findings. Figure 6-6 describes the themes that operational efficiency forms a relationship with.

Operational efficiency	Forms a relationship with	Response to market need
		Service delivery (KBV)
		Technology as a key influencer

Figure 6-7 Displaying the relationships for operational efficiency with other themes

Operational efficiency forms a relationship with responses to market needs, service delivery (KBV) and technology as a key influencer. Response to market needs may involve more than one resource in trying to achieve project requirements. Resources play a massive role in how the sample set of firms can achieve their goals of coming up with solutions to challenges. For the larger firm, projects with specific complexity can only be managed by an individual or individuals who possess the necessary skills, experience and knowledge to manage the complexity.

The relationships between the three themes have a significant amount of overlap. When resources build more knowledge and experience, it impacts how they may be managed by management of the sample set of firms. Therefore, these two themes have a directly proportional relationship based on the general perception of the findings. A combination of the categories also impacts the individuals themselves whilst management needs to maintain uplifting their resources and ensure knowledge is transferred efficiently, they need to uplift themselves and develop an attitude to embrace challenges so that they must carry out tasks to the required level. The use of technology can have both positive and negative aspects as seen from the general perception of the findings. From the resource-based view, individuals who carry out task using technology must be able to do it efficiently and be knowledgeable about the products at the same time. Resources in this case are not only considered to be engineers but modellers or BIM operators. If these resources are not managed efficiently then it may result in creating challenges for the firms and the consultants who are responsible for meeting their goals.

6.4.2.1 Comparison with the literature

Duan et al. (2022), suggested that having formal processes which enable effective management of resources can affect the knowledge base of the firm (Duan et al., 2022). This open innovation practice allows the firms to recognise their most knowledgeable individuals and exploit them to their advantage in order to maintain competitive advantage (Gonzalez & de Melo, 2018; Messeni Petruzzelli et al., 2018; Obradović et al., 2021). When a firm is integrated in this manner then they are more formal in conduction (Bernal et al., 2022). The findings suggest that the larger firm of the sample set are more formal in how they manage their resources as they are managed based on their expertise level and can allocate to projects depending on the complexity of the project. This can be an indicator that in terms of open innovation practice their conduction is formal and this helps them maintain competitive advantage.

The smaller firms as the findings suggest are more informal and will manage resources based on priority and skill set level. This suggests that they are informal in their approach and possibly due to their size. Witell et al. (2017), postulated that a formal process concentrates on effectiveness and efficiency (Witell et al., 2017). From the smaller sample set of firms, the management may seem informal, but priority project-based management still enables their resources to deliver their tasks. The sample set of firms

did not address acquiring of resources as general perception in the findings. This could have alluded towards a resource deficit that exists potentially in the industry. Kim & Mahoney (2010) and Pantic-Dragisic & Söderlund (2020), had also suggested that resources can be hard to find and are not easy to replicate (Kim & Mahoney, 2010; Pantic-Dragisic & Söderlund, 2020).

6.4.2.2 Summary of section

The literature is consistent with the findings in many respects however literature in this case also suggests that formalized processes lead to efficiency, effectiveness sustained competitive advantage. Informality here for the smaller firms of the sample set needs to be considered as result of their management style. Therefore, both formal and informal processes operational efficiency must be considered.

6.5 SUMMARY OF CHAPTER 6

The following table is a summary of the analysis which has been displayed in the previous two sections. Figure 2-2 described in chapter two will be used as a basis for the analysis and what should be considered from the findings and analysis. The contribution towards the model is described in the following the tabulated summary:

Table 6-2 Displaying the tabulated summary from the analysis in combination with the literature

Category	Theme	Agrees with the literature	Considerations from the findings to add to the literature	Contribution towards model
Stages of importance	Culture as antecedent in the process	Yes	Formal and informal processes	In conjunction with Culture as antecedent in the process
Way of working				
Challenges in the project process	Response to market needs	Yes	Combination of Formal and informal approaches & moving from informal to formal	In conjunction with the service innovation process
Responses to challenges				
Collaboration	Communication in the	Yes	Combination of	In conjunction

between firms and consultants	process		Formal and informal approaches	with moderators and influences
Technology enhancement	Technology as a key influencer in the process	Yes	Findings as per literature	In conjunction with moderators and influences
Technology challenges				
Category	**Theme**	**Agrees with the literature**	**Considerations from the findings to add to the literature**	**Contribution towards model**
Capabilities	Service delivery (KBV)	Yes	Findings as per literature – service delivery & knowledge management	In conjunction with open innovation practices
Building knowledge and expertise				
Resource management	Operational efficiencies	Yes	Formal and informal management of resources	In conjunction with moderators and influences

As described in the introduction, technical engineering consulting (TEC) firms will innovate in a project context. The innovation process is kick started when challenges present themselves. Van de Ven (2017), postulated that there are converging and diverging factors that is associated with the process to achieve an outcome (Van de Ven, 2017). Vargo et al. (2020) and Gemser & Barczak (2020), further postulated that in order to conceptualize a process an overview of the process must be outlined (Gemser & Barczak, 2020; Vargo et al., 2020). As described in above in table 6-2, the themes all form relationships with each other in a simultaneous process that occurs when dealing with challenges. Tis effectively allows the process to occur. The participants involved are the actors which allow convergence to occur at arriving at a solution for the challenge. Chandler et al. (2019), postulated stronger relationships are formed when members of an organisation share the same sentiment of what a solution is. This where the themes that aid solutions come into effect and creates a cycle. When actors share the same sentiment, they will use all of their means necessary to achieve the solution. Costs and time are extremely important, and the firms will try to address the solution required in the fastest time. Irrespective of the challenge, the process seems to be the same but the approach or simultaneous processes that are occurring at the same time will either be formal or informal.

7 CHAPTER 7: CONCLUSION AND RECCOMENDATIONS

7.1 INTRODUCTION

The purpose of the research was to explore service firm innovation, its process and elements that may affect the process. The study has been undertaken in the context of technical engineering consulting firms who provide building services which included mechanical heating and ventilation (HVAC), medical gas, electrical and electronic, wet services, fire services and structural engineering disciplines. As recent literature suggests, service firm innovation research is relatively young, and scholars have given this topic enhanced awareness. This is because innovation in service firms leads towards them gaining competitive advantage in the fast-changing environments which they currently operate in (Chandler et al., 2019; Helkkula & Kowalkowski, 2018; Ovuakporie et al., 2021). The research problem had identified that processes can create multiple dimensions and can be regarded as complex in different organizational contexts (Van de Ven, 2017). Therefore, the study involved technical engineering consulting (TEC) firms. This was because TEC's operate differently to traditional service firms and TEC's are considered to be uniquely characterized. Therefore, the understanding of the TEC's firms' nature is relevant to service innovation processes in a research context (Pantic-Dragisic & Söderlund, 2020). Chapter seven aims to describe the summary of the of findings of the research study, how it has contributed towards business studies, describing the limitations experienced during the study and future recommendations for research.

7.2 SUMMARY OF FINDINGS FOR RESEARCH QUESTION ONE

Research question one of this study was proposed in an attempt to develop an understanding of How technical engineering consulting (TEC) firms formulate their systemic innovation processes and what may affect it.

Van de Ven (2017), postulated that the journey of the process reveals different facets and dimensions that flow like a river (Van de Ven, 2017). During the project cycle each stage may develop different challenges based relatively on the stage of the project. Therefore, it could occur anywhere between the concept stage and close out of the project. There are various types of challenges that the sample set of firm's experience. The degree of the challenges experienced by these firms may vary with difficulty along the way. There

may also be multiple challenges that may be realised because the sample set of firms work on multiple projects at a time. The type projects that the sample set of firms work on in the context of the findings is not critical to the development of the solutions however the type of service may need to consider severity and responsibility in terms of the service itself. For example, the consultants providing fire and structural services were inclined to mention this in the findings.

When challenges on projects present themselves, it is up to the consultants to initiate the process of coming up with solutions. Taalbi (2017), Suggested the journey of an innovation process begins with events occurring at random and this allows the process of innovation to occur. In this case the random events which occur can be considered as challenge in the project process. The challenges created can be both as result of internal or external elements. Sørensen et al. (2010) and Oeij et al. (2019), suggested that the innovation process follows a pattern. Table 6-1 in chapter six highlighted similarities and differences for the sample set of firms to at a broad level to identify patterns. Patterns in terms of the theory can be conceptualized with stages of the processes (Oeij et al., 2019; Sørensen et al., 2010).

At broad level the sequence of events that occur when dealing with challenges is simply broken down to intrinsic investigation, understand, gather information, implement solution. Both sample sets have similar approaches when looking at how they deal with challenges but there is an amalgamation of processes that occur in combination with this process. This amalgamation or combination of processes in highlighted chapter two and chapter six where processes might require a diffusion of activities to occur in tandem with the innovation required to meet market needs or solutions. Diffusion of processes is considered when taking an institutional or firm perspective (Vargo et al., 2020; Wieland et al., 2017).

The diffusion of processes that occur for research questions one involves the themes that have been identified which play a major role in how the firm meets their requirements on projects., come up with solutions and carry out required processes in order to achieve the solution or in this respect meet the market need. These themes have been outlined in chapter six in table 6-2. As suggested, this lens can provide insight into how the value creation is actually achieved (Vargo et al., 2015). There are also patterns that are formed when considering the diffusion of processes. These themes and their

relationships have been discussed in chapter 6. The innovation process is suggested to be complex in nature but when the processes is presented in formalised manner, then it creates benefit for process, but in order to view It systematically it must be viewed from a broader perspective especially where overlap occurs (Vargo et al., 2020; Witell et al., 2017). The themes in this case create overlap. Talking into consideration the summary above, the findings in chapter five and the discussion of chapter six. the following model is proposed for to view the process systematically.

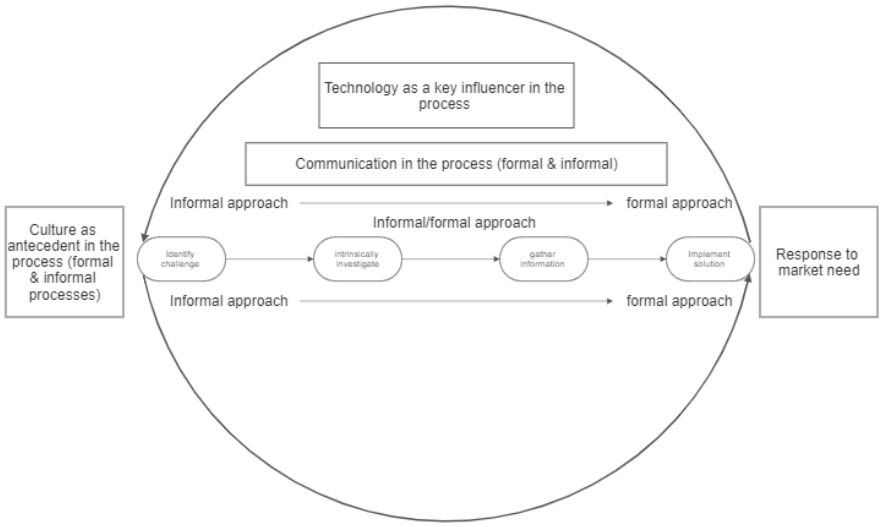


Figure 7-1 Displaying the proposed model of the innovation process as a cycle for research question one

The model can be described as almost a cycle of repetition that occurs every time a challenge presents itself. The culture of the firm and the processes will decide how the challenge is identified. The process of identification can occur both informally and formally. This is both a combination of the processes that occur from culture and communication perspective. The approach to the challenge also can also be a combination but if it started informally it would move towards being formal. Technology aids the process but may also create challenges. Cloud based technologies and engineering-based software said to improve innovation, but if all of the firms are using it, it would depend then on the effective use of it. This model applies to the first part of the research question.

7.3 SUMMARY OF FINDINGS FOR RESEARCH QUESTION TWO

Research question two of this study was proposed to understand why knowledge is important in the innovation process. This question was proposed in conjunction with question one.

Research question two adopts the knowledge-based view and why knowledge is important in the process. The findings in chapter five and six incorporated two aspects which were the prevalent themes in the findings. Operational efficiency which involves resources and service delivery (KBV) which incorporates knowledge and experience.

Aliasghar et al. (2022), suggests that for the innovation process to be beneficial to the firm then it relies of tacit knowledge and Snihur & Wiklund (2019), suggested that tacit knowledge is related with how the organisation conducts its business and routines (Aliasghar et al., 2022; Snihur & Wiklund, 2019). Knowledge transfer and learn by doing strategies were prevalent in all the sample set of firms. They also put emphasis on why knowledge is critical for them to deliver projects. Essentially the firms are selling their expertise, and this can be a differentiator for the firms.

Pantic-Dragisic & Söderlund (2020), suggested that the type of technical engineering consulting (TEC) firm influences the way knowledge is transferred and developed (Pantic-Dragisic & Söderlund, 2020). The study had representation from one large firm and three small firms. There was overall consensus that the sample set of firms believe in learn by doing and knowledge upliftment of their colleagues in a key contributor towards knowledge of the consultants internally. Externally Knowledge bases are improved by the transfer of knowledge from suppliers of technology and other consultants whom the sample sets interact with, in the event that they do. Aliasghar et al. (2022), suggested that the actual way processes from a knowledge-based view are created by firms are still less understood (Aliasghar et al., 2022). The knowledge processes observed also forms diffusion processes with the themes that have emerged from question one. The relationships if these themes were discussed in chapter six. Therefore, knowledge-based process or these open innovation activities can be applied to the current model as it forms part of the process when responding to a market need.

When considering the resource-based view, the manner in which the sample set of firms manage and allocate resources in important. Effective management of resources is

a key a factor which enables competitive advantage according to Duan et al. (2022).As outlined I chapter five and six the primary differences were the location of resources based on expertise for the larger firm and skill set diversity or priority in the smaller sample set of the firms .Resources and their capabilities possibly form a direct relationship with the knowledge based view. Their knowledge is built from experience and their experience is also toed to knowledge. This allows them to carry out replicability on projects and transfer or improve their knowledge from project to project. Therefore, the resource-based view can be applied to the current model as depicted in the final model consideration in figure 7-2.

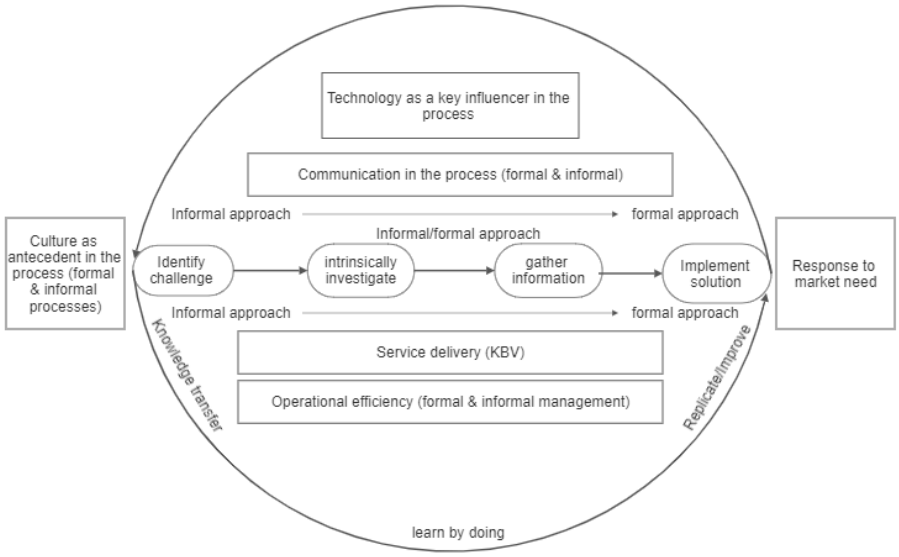


Figure 7-2 Displaying the proposed model for the innovation process as cycle incorporating research question 2

the research has identified how technical engineering firms formulate their innovation processes. The process cannot be looked at isolation as the themes which have emerged from the findings influence it. Two aspects were deliberately left out of the model in the summaries of but research questions but will now be addresses to bring the research study to a close in terms of the research questions. Costs and time are major influences in respect of the solution. The findings therefore propose the final aspect of the model to include costs and time and degree of challenge as two variables which the model can operate with. Irrespective of the degree of challenge, the process remains the same. If where solutions take more time, it costs the firms more revenue and where it takes less

time it will cost the firm less revenue, but the process remains the same. Therefore, improving processes can enhance how the firm generates its revenue.

Therefore, the final proposed model is indicated below in figure 7-3

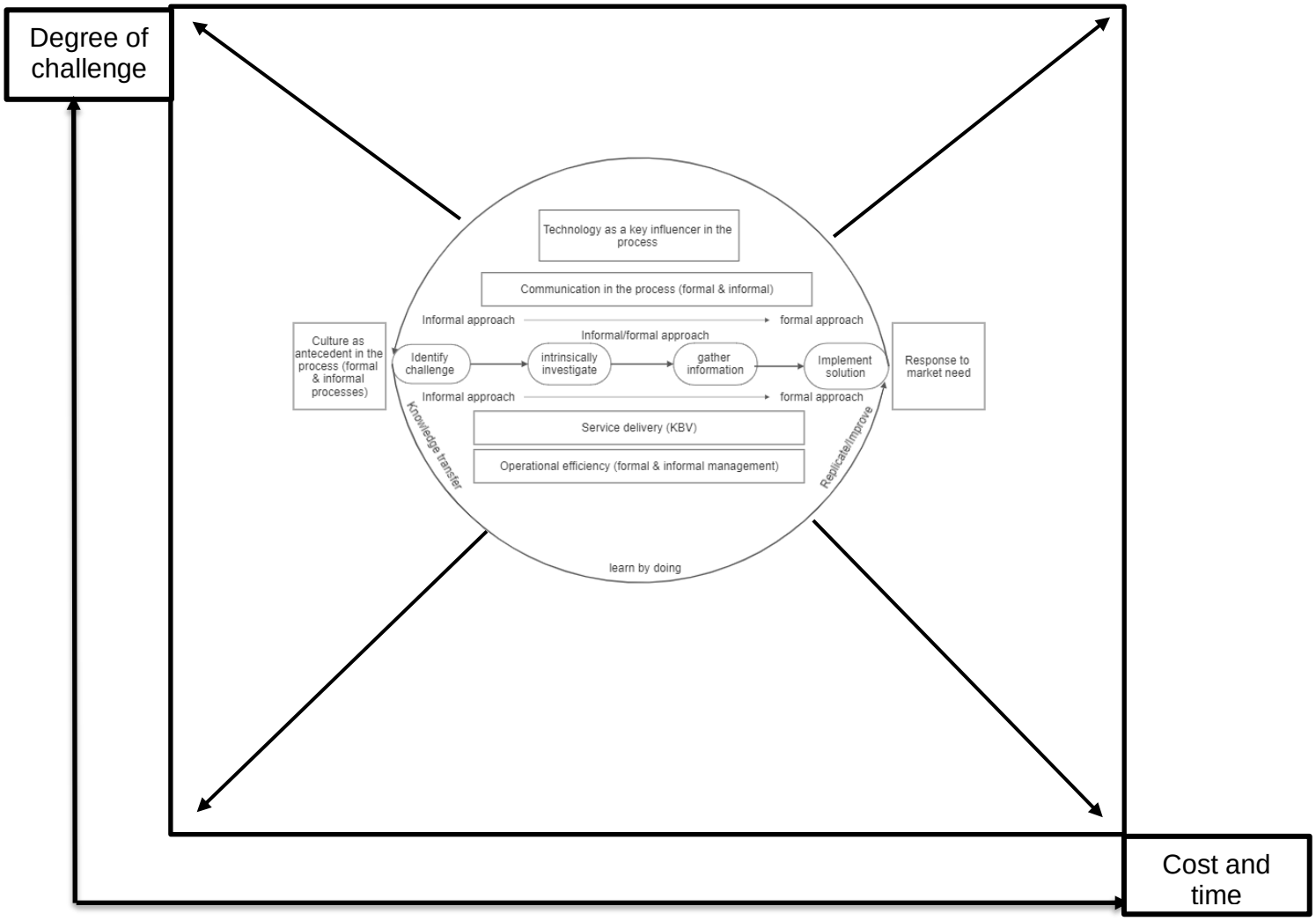


Figure 7-3 Displaying the process model application between cost, time and degree of challenges

7.4 CONTRIBUTIONS

The research contributes towards how technical engineering firms in the South African emerging market context formulate their innovation processes. The literature suggests that firm innovation is linked to financial growth and how they innovate in an organised manner is a consideration (Chandler et al., 2019; Helkkula & Kowalkowski, 2018; Huarng et al., 2020). Pantic-Dragisic & Söderlund (2020), suggested that there is a need to study technical engineering firms and this study extends towards this call for

research. Due to the fragmented and complex nature of innovation process research, the innovation that service firms provide is a key development (Helkkula & Kowalkowski, 2018; Vargo et al., 2015). Lastly Heredia Pérez et al. (2019), postulated that innovation processes should be studied in emerging markets. This study has attempted to contribute towards studying and simplifying a complex process within this gap that exists with respect to consulting engineering firms who operate in the building services sector.

7.5 LIMITATIONS

There were some limitations which were encountered during the study. Some of the firms which were approached consisted of both large and small firms. They declined to participate in the study as result of privacy regarding there processes, information and available time due to commitments. A limitation experienced with the sample sets that did participate included the release of company documents and financials. Most respondents before signing the consent forms had stipulated that they would not release financial information. The final limitation was scheduling of interviews during the planned time that researcher had proposed initially. Three interviews had to be shifted multiple times to accommodate the respondents. This was a result of commitments that had presented itself during the initial allocated time frame.

7.6 RECOMMENDATIONS FOR FUTURE RESEARCH

The recommendations for future research in a South African context should include more large firms in the sample set. A possible study with only small firms in the sample set can also give insight as to whether all small sample firms adopt similar processes. More participants from different category could be included such as the consultants modelling/designing teams which the consultants work with. A further element for consideration would be to interview the clients which these consultants undertake projects for. This can give insight into what clients appreciate about the consultants they work with.

7.7 CONCLUSIONS

In conclusion the, the aim of the study was to understand how TEC firms formulate their innovative processes and why knowledge is important in the process. A qualitative, exploratory approach was adopted for the study and number of semi structured interviews with participants had taken place. The interviews provided insight into what processes

these firms undertake, what challenges they face and what aspects are important for consideration with regards to innovation processes, knowledge-based views and resources. The innovation process observed from the findings of technical engineering consulting firms is a diffusion or combination of elements that has been conceptualized to provide an overview of the process. This process illustrates a cycle that will continue to occur when challenges arise as many facets of the process will occur simultaneously with the process to converge towards a solution which is a representation of the market need.

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9 APPENDIX 1 – INTERVIEW GUIDE

The following interview guide in tabulated format addressing the focus and the question relating to the focus. It has been created to address the criteria articulated in the measurement section of this document:

Table 9-1 Displaying the interview schedule

Question	Focus /objective	• Interview question /statement
0	Individual	• Please state you name, age, gender, and role at this organization
1	Individual	• Please tell me how many years of experience you have and what qualifications do you possess?
2	Firm & individual	• Would you consider this to be a small, medium, or large organization/enterprise?
3	Individual	• Do you manage personnel at this organization?
4	Innovation process	• Can you explain some day-to-day activities that you undertake at this organization?
5	Innovation process	• What type of projects does this department undertake and can you tell me a summary of the service you are offering?
6	Innovation process	• Please explain the cycle of service delivery at this firm. • Basically, the process of achieving a project and the stages that are involved in delivering a project?
7	Innovation process and resources	• How do resources affect the project delivery?
	Innovation process and resources	• How does Technology affect resources and projects?
8	Innovation process/ resources/knowledge	• What expertise do resources need to deliver on projects at this firm?
9	resources/knowledge	• How many projects do resources work on at the same time? Does this vary and what factors influence this
10		• How long does a project typically last

11	Innovation process/ resources/knowledge	• How do resources that are involved during the project cycle collaborate with other individuals of this organisation and similarly with external individuals or other organizations?
12	Knowledge	• How does expertise play a role in service delivery?
13	Knowledge	• Do you speak to others about solutions not in your organization
14	Innovation process & knowledge	• How does your team deal with challenges – client and organization
15	Innovation process & knowledge	• What barriers have you come across during the project cycle and what do you do to overcome these?
16	Innovation process & knowledge	• How do you formulate a solution of a problem or challenge
17	Knowledge	• How do you identify resources for different projects?
18	Innovation process & knowledge	• What impacts service delivery and processes
19	Innovation process & knowledge	• How important is knowledge in the process
20	Innovation process & knowledge	• What influences coming up with innovative solutions on projects
21	Innovation process & knowledge	• Do you feel you have reached a plateau in coming up with solutions to problems on typical projects
22	Innovation process & knowledge	• Do you have a particular method you implement during projects
23	Organisation	• If you had to identify your unique source of advantage, what would it be?
24	Organisation	• Why do clients select you as their ideal consultant
25	Client	• How many years of experience do you have and what type of projects do you undertake?
26	Client	• What primary services are you looking for

		industry?
27	Client	• Do you select firms based on their expertise or their reputation?
28	Client	• What do you look for in a consultant engineer when working them?
29	Client	• What experiences can you share with me when working with these types of engineers? These can be good and bad
30	Client /Innovation process	• How do you perceive the innovation process and the knowledge base of the firms you work with?

10 APPENDIX 2 CODE BOOK

Table 10-1 Displaying the code book

Code
○ 4IR
○ Appreciation
○ BIM optimization
○ Challenges
○ Client needs
○ Communication issue
○ Cost and time
○ Design problems
○ Project issues
○ Re-design as a barrier
○ Client relationships
○ Consultant Attitude
○ Continuous professional development
○ Correctness of knowledge
○ Culture
○ Culture driven towards solution
○ Day to day activities
○ Design impact due to knowledge
○ Detailed design stage 3
○ Digital collaboration
○ Digital engineering
○ Early adoption technology
○ Experience
○ Expertise
○ External collaboration
○ External communication
○ External eco system
○ External environment
○ Fast-paced projects
○ Feedback analysis on training
○ Formal internal meetings
○ Formal procedure
○ Formal project meetings
○ Handover Stage 6
○ How knowledge affects time
○ Impact of COVID
○ importance of solution
○ Importance of technology
○ Inception stage 1
○ Informal management

○ Informal method
○ Innovation and plateau
○ Innovation approach
○ Innovation evolution
○ Innovation limitations
○ Innovation motivation to client
○ Innovative solution at all costs
○ Innovation vs problem solving
○ Internal collaboration
○ Internal management process
○ Internal processes
○ Interpersonal skills
○ Knowledge - effective decisions
○ Knowledge - not making the same mistake
○ Knowledge - upliftment
○ Knowledge enablers
○ knowledge impacts project success
○ knowledge importance in approach
○ Knowledge of systems
○ Knowledge transfer
○ Large organisation advantage
○ Learn by doing
○ market saturation
○ Mistakes and lessons learned
○ Number of projects
○ Number of solutions to challenges
○ Occupancy work
○ Outcome
○ Passion and commitment
○ Planning
○ Problem identification in projects
○ Problems and solutions process
○ PROCSA stages
○ Professional registration
○ Project based activities
○ Project control
○ Project costs and financials
○ project delivery
○ project diversity and resource management
○ Project meetings
○ Push and pull relationship between knowledge and experience
○ Relationship building
○ Relationships
○ Research
○ Resource allocation
○ Responsibilities
○ Revit based technology

○ Risk management
○ Risk perception of innovation
○ Severity and responsibility of service
○ Skillset diversity
○ Stage 2 importance
○ Stage 4 importance
○ Sustainability
○ Technology advancement (+)
○ Technology challenges create
○ Time as a factor in the process
○ Training and education
○ Type of networks
○ Understanding root cause