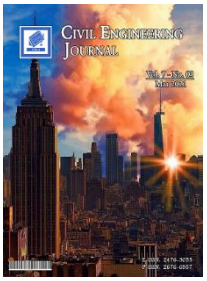
Available online at www.CivileJournal.org

Civil Engineering Journal

(E-ISSN: 2476-3055; ISSN: 2676-6957)

Vol. 7, No. 03, March, 2021



Investigation of Innovation during Bid Evaluation Process in the Road Construction Industry

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Received 19 November 2020; Revised 17 February 2021; Accepted 24 February 2021; Published 01 March 2021

Abstract

Tender evaluation is the procedure of choosing the best contractor for a particular project from many applicants. Although rational and logical methods can be used for bidding strategies, bid evaluation remains a skill for which an engineer's verdict is crucial. Contractors commonly witness that tender selection is not an easy job, and the lowest bid does not necessarily win the contract. The tender decision mainly depends on quantifiable measures such as financial costs and paybacks, and qualitative or invisible factors like administrative security accountability, aptitude, and the proficiency of the contractors. Moreover, Bid evaluation is a decision-making procedure that incorporates an extensive criteria range for which the information is not accordingly. Hence, ambiguity linked to such information is not appropriate for this study. This paper aims to evaluate innovation during the bid evaluation process in the road industry. The research results indicate that the private and public sectors in Australia offer innovative products and work methods, given the chance. Therefore, innovation during the bid evaluation process is welcomed and sometimes strongly encouraged. Further, it is important to have strong research in to how to effectively determine value for money in the context of developing suitable and quality roads. Therefore, this research is useful in the context of evaluating factors that help to understand value for money in the road sector in context of bid evaluation process.

Keywords: Innovation; Bid Evaluation; Road Industry; Tender Evaluation; Innovation Factors.

1. Introduction

It is widely accepted that projects related to road construction should be managed effectively. The literature indicates that demands from customers in terms of value for expenditure have been increasing rapidly [1, 2]. Therefore, a rigorous evaluation of tenders to ensure an effective return on investment is essential. A failure to accurately assess tenders can lead to complications for the whole project and the road construction company. The selection of a suitable construction contractor increases the likelihood of the successful completion of a road construction project [1, 3]. This may also ensure the customer/ owner goals are achieved and the project is completed on time, within budget and delivers high quality project outputs. As innovation has a place in road construction, it will be useful to include innovation as one of the indicators in the evaluation of tenders as part of competitive tendering.

The quality of roads also suffers badly due to global warming resulting in changes in the earth and environment [1, 4-6]. Therefore, in this context, previously used methods of road construction are not suitable and cannot be applied in

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http://dx.doi.org/10.28991/cej-2021-03091676

this rapidly changing environment. Hence, there is a need to evaluate the level of innovation during the bid evaluation process in the road construction industry [1, 4-6], which could be of great benefit to the community in terms of identifying quality contractors, finding what new materials they plan to use, how they will be time efficient etc [7, 8]. This could also help both developers and government bodies save time and effort in designing and developing sustainable roads, as it is particularly challenging to build durable roads in countries which are most impacted by global warming using traditional methods. This is why governments need to ensure that contractors will utilize new and sustainable materials to address the challenges in today's environment.

The term innovation in the road industry refers to several factors: the use of sustainable materials and resources for road construction such as recycled materials and foamed bitumen, and utilizing technological innovation that comprises the use of suitable technologies to incorporate effective innovation in the road sector [2, 4] Innovative technology includes the use of automatic and computerised information systems for traffic signs, the use of solar technology in road construction to improve road quality and efficiency, including the use of best practice in engineering, more harmony between the public and private sectors, and enhanced quality control in processes by the use of different methods and techniques [1, 4, 9, 10]. The literature indicates that governments spend a large portion of their budget on road construction as well as road maintenance, therefore, there using new and innovation methods and techniques in road construction would be highly beneficial. The assessment of factors related to innovation during the bid evaluation process could help in reducing the production of greenhouse gasses, decreasing contamination and ensuring the adoption of environmentally friendly methods in road construction and maintenance [1, 9, 10].

There are several methods to assess the comparative tender assessment using factors that include proposed cost, bidder management system, resources, their performance in the market, and their related work experience. However, the literature shows that many projects related to road and bridge construction fail due to a lack of awareness of innovation when assessing the tenders [1, 11, 12]. Innovation is an important factor, as this allows the owner to assess the bidder's capacity to use new technology and ideas. The aim of this paper is to evaluate the proposed factors of innovation in the bidding process for the assessment of innovation in comparative tender assessment qualitatively. The article comprises of the following sections. Background of bid valuation and related work, importance of innovation in bid evaluation, research design, result and discussion and conclusion.

2. Background and Related Work

In the road construction industry, awarding road construction projects to the most suitable and affordable bidder with the lowest cost tender is the common standard over the world. However, the widespread acceptance of bids based on a low cost is why many road constructions companies and other individual participants in this field are unsatisfied with the present system [2, 12]. Company CEOs and road construction managers frequently find that assigning and awarding a road project to the lowest bidder might not guarantee that the project aims, and objectives are achieved in terms of road quality, completion timeliness and the total cost of the project. Numerous road contractors are also dissatisfied with how road projects are awarded, where low cost is the sole criteria for awarding a project [2]. The obligation to ensure high quality in road construction projects might preclude the lowest bidder from being awarded the project.

The competitive bidding process occurs all over the world since its early stages. For instance, in United States of America, competitive bidding verdicts are cited back to the laws known as "Canal Law", which was passed in in 1847. In fact, the modern and competitive bidding idea in road construction appears to have originated in America, Australia and United Kingdom due to their belief in a free innovativeness structure [2, 13]. The first purpose was to guard against dishonesty in construction development and negligence by community administrators. The aim of bidding on road construction projects was theoretically to deliver the taxpayer a developed road for the minimum cost possible over the competition. Today, the strategy of accepting the lowest bid remains fundamentally untouched. Guarding against dishonesty and conspiracy are still valid purposes.

This is why, in Australia, the present process of selecting a low-cost bid is not a viable strategy. First and foremost, accepting a bid based on the lowest cost could result in quality control issues. Requiring a high quality road for the lowest cost are contradictory terms. Accepting a tender based on the lowest cost also usually means timeliness difficulties. Lastly, accepting the lowest cost tender could lead to prerogative circumstances that, somewhat are actually produced through an original bid evaluation. A bid which is based on the lowest cost has quality concerns and may not be completed on time. In the road construction industry, low bidders are often not able to produce the necessary mix of road contract duration, road quality and road cost [2, 13, 14]. Preferably, award principles must comprise an evaluation of the bidder's ability, commitment, background, skills, past experience, cost and how innovative they are in terms of road development. It is clear that numerous problems arise when adjusting award criteria to comprises aspects of road quality other than the lowest bidding cost. The choice of sustainable standards and equality are key problems.

In the context of project duration, the task of determining a suitable project bid duration is significant for evaluating bids. Precise approximations of the required building time are important. Impractical project bid times could result in a higher project price and an increase in the likelihood of arguments between the contracting authorities and road contractors. Likewise, many researchers have highlighted the status of sensible time approximations with respect to entitlements supervision [1, 6, 10]. However, in relation to identifying suitable project time, cost and calculating the exact actual time could be difficult for the road development authority. The time needed for road construction varies greatly from one construction company to another. As the literature shows, only a few companies or individual road contractors know which resources are required to develop a road on time and within budget. During the pre-bid determination of project completion time, the road contractor can only make an overall estimate regarding completion time, based on which the specialist awards the contract, however the contractor's expectations could be valid or invalid.

Another point which needs to be examined in relation to contact duration is the direct impact on the overall cost of the project. The bidder's bid cost is only a part of the project cost in general. In this context, two other project price-related categories contribute meaningfully to the final cost of the road construction project [1, 14]. First, the road construction company managing the contract and the administration cost, and second, the road user cost must also be taken into account. The road user cost is incurred by the community as a result of the road construction. The road user cost characteristically comprises project administration cost, delay cost, additional gasoline cost and other indirect project costs, as a final road development cost. Both the road user cost and administrative cost from the road development company depend on the project duration period.

3. Innovation

The term innovation is one of the key concerns in the bidding process for the road construction industry and the topic has been listed as a hot concern in recent years. The issue was first discussed indirectly in public firms and commercial firms. However, many firms especially those in road construction in the context of the bidding process have not come to grips with this. Therefore, assessing innovation during the bid evaluation process in the road construction industry is important.

Many companies and individual contractors in the road construction industry, both private and public firms, have long called for increased innovative ideas and productivity [15, 16], however, there are key difficulties associated with this. When a road construction contractor signs a contract with the government, the contract is based on a particular project and the innovations to be used are incremental, depending on the company's experience and knowledge in the road industry field and occur within exact road development projects [16-18]. Also, some researchers point out that only a short-term economic viewpoint is usually espoused, though innovation-based economic strategies are long-term [18, 19]. A road consultant is often regionalized in impermanent project administrations [20-22], and innovations produced from imaginative or inspired problem-solving at the site location do not typically move to other construction-related projects, which could hamper their dissemination. Dissemination of innovations among projects related to road and builders is likewise vulnerable [23, 24].

Nonetheless, innovation has been proposed and implemented in many fields such as lean construction and building information modelling [22, 25]. Road contractors have also documented the underlying of industrialized house-building which is based on the platform used to progress efficiency by reducing difficulty and cumulative standardization [26-28]. In this context, building type like modular building [29, 30], is a costly offsite road construction approach [30, 31] and current frames-of-reference have been challenged through the use of building systems [23, 30]. Tactically concentrating beyond single construction projects and the integration of knowledge in different organizations also fundamentally varies from building in separate projects [11, 30]. However, in order to realise the possible advantages offered through those platforms is itself is a big challenge, partially due to problems in merging a standardized in the industry providing with non-standardized demands of consumers [11, 30, 32]. Further, no benefits are gained through innovations until they are broadly designed, implemented and deployed [16, 33], which is not up-front. This is because road construction includes a compound societal system [34, 35], in which characteristics that can quicken innovation, for example pressures among changing construction project tasks and comparatively stable, homogeneous company processes, might also smother the dispersal of practices and new technologies [36, 37].

Therefore, implementing and deploying innovations in medium- and large-sized road construction companies is extremely complex for evaluation [38-40], which is strongly influenced through ingrained contextual fundamentals stanching from numerous complicated systems which do not examine the association among these types of systems [6, 10]. Henceforth, the sub-systems related to social groups showed an impact on the dissemination of innovation in predominant social systems which involves considerable additional consideration. Likewise, Akmam Syed Zakaria, Gajendran [38] suggested in their review that different influences affect industrial building projects and they documented the structural, circumstantial and behavioural aspects that affect industrial building projects decisions.

Shibeika and Harty [40] suggested that the contextualist approach in the context of innovation in engineering projects has several phases: innovation over time, iterative process of innovation and complex, and altering situations in an examination of the dissemination of innovation called digital an engineering organization. Finally, innovation in the bidding process in the road industry is still at a very early stage and a lot of work is required from both public and private firms.

4. Research Design

The literature indicates that many different types of interview templates for qualitative research have been used in different areas such as engineering, education, science etc. [41]. For this research, we used an interview technique called the semi-structured interview to collect data from the study participants and the techniques are more effective compared to the other data collection techniques. Therefore, for this study, face to face and online interviews with road building consultants and road builders from different building companies in Australia and interview cards were used to conduct the interviews. An interview card denotes to the speedy interview which comprise a brief level of information about the research topic being explained during interview and other related information that helps to advise interviewee in an efficient and effective way [42]. During the interviews with the road building consultants and the road builders, these interview cards were used to train interviewee and for the importance of the interview in order to measure the factors in practice. The interview cards also encompass the list of the bidding process included factors such as cost, contract time, contractor background, skills, innovation etc.

There were four different interview cards explaining the complete interview process: card one welcomes the study participants, card two is used to collect the study participants' background experience and education, card three is used to gather the study participants' knowledge of the process of bidding evaluation in the context of road construction in Australia, card four is used to conduct interview in the road development sector. Thus, qualitative data might be examined with the purpose of exposing hidden and new factors in the bidding process in the road construction industry [43].

Furthermore, Cassell and Symon [44] suggested in their research that qualitative data researchers should follow the method of semi-structured interviews, which begins with a welcome message to the study participants and short information on the study questions. The interview starts with general questions about the study. Semi-structured interviews allow researchers to plan the interview process and start the interview with open-ended study questions about the proposed research theme. Consequently, the technique of semi-structured for qualitative data is appropriate to gather data for this study. The researcher adopts preparatory reasoning to understand the point of view of the study participants about the planned research. The technique is appropriate to explore and distinguish how, when, why, what and with what in relation to the bidding process in road development in the context of the evaluation of innovation in the road development process.

4.1. Data Sampling Technique for Qualitative Study

Data sampling is a statistical analysis technique which can be categorised into two groups: first, the data sampling techniques which are employed to answer and understand numerous styles of study questions, including probability sampling and the judgemental sampling technique. Second, both the non-random data sampling technique and non-probability technique of data samples are used to pinpoint the data sample which is based on the study aims [42, 43]. In this research, for the quantitative study, the data was collected using a random sampling technique, however, for the qualitative phase of this study, the sampling data collection technique is able to select the exact data from the study participants that might help to obtain detailed information to answer the research questions. According to Oates [45], the aim for the qualitative study is to explore issues related to this research in detail, therefore, in the qualitative study phase, we find that a random data sampling technique is not suitable.

A data sampling technique called non-probability is possible in practice and is more appropriate to examine the detail information about the proposed study. The data sampling techniques are founded on the following important information: the study objectives and aims, the research questions and based on the relevant research strategy, the data sample may provide researchers with detailed information on the planned study which might allow the investigators to explore the research questions for the study and obtain theoretical perceptions [42].

Moreover, in the context of the study questions in the data sampling technique known as non-probability, the main issue is that the size of the study data is not clear, because in this technique, there are no proper rules for data collection. Somewhat, the connection between the objectives of the research, study purposes and technique of sample for data collection is imperative. Henceforth, the sample size of the data depends on the aims and objectives of the research and the questions belonging to the study, such as why the proposed research is important, is the proposed research reliable, is the proposed research methodology suitable for the planned study, what can be achieved from the research, what are the study findings and what is the size of the data sample [45].

In this planned study, we spent around 4 months locating and approaching suitable study participants to interview. A total of 21 road construction experts and consultants from different building companies in Australia were approached and 9 agreed to participate in this proposed study, with six participants being interviewed face to face and three being interviewed online, each interview taking approximately 1 hour to complete.

For this qualitative research, an interview template is developed to answer the first three research questions of this study. There are two key sections in the template, section one comprises 20 questions and section two obtains feedback from the study participants. Question 1 asks the participants about their business organization activity. Question 2 asks the participants what they know about the bid evaluation process in the road construction industry. Question 3 asks the participants approximately how much it costs to prepare a tender. Question 4 asks the participants about the management of the tender process in their organization. Question 5 asks the participants about what information the participant's organization needs to gather when preparing a tender. Question 6 asks the participants about who typically introduces innovation in process/product/management in the road industry and who assesses new ideas in their organization. Question 7 asks the participants whether they think Australia should update their old methods of developing roads as old methods are not suitable these days. Question 8 asks the participants if they think the road builder's experience in testing new material could impact the performance of a newly developed road project.

Question 9 asks the participants if they think the assessment of innovation is an important factor during the bid evaluation process in the road industry. Question 10 asks the participants what type of innovation factors they would like to see in the bid evaluation process. Question 11 asks the participants which area they think requires continued research in the bids assessment process in the road construction industry. Question 12 asks the participants who (manufacturer, contractors, subcontractors, distributors, client or head distributor) generally introduces innovative ideas to road construction projects?

Question 13 asks participants what (cost effectiveness, sustainability, client demands, time constraints, technology) are the main drivers of innovation in the road construction industry. Question 14 asks the participants where in Australia they believe most innovation is taking place. Question 15 asks participants what they think are the main drivers (awards, grants, government scheme, access to new technologies) of innovation in the road construction industry.

Question 16 asks the participants if their organisation encourages creative problem solving to improve innovation. Question 17 asks the participants what attracted their organisation (project costs, project location, project time, or scope of the project) to participate in the bid? Question 18 asks the participants if the government investigated their organisation's financial capacity, performance, resources, related experience and project management skills when they evaluate the bidders' bid. Question 19 asks the participants if the Government investigated the organisation's environmental policy and occupational health and safety procedures when they evaluated the bidders' bid. Question 20 asks the participants if the government investigated the innovation offered by the organization when they evaluated the bidders' bid?

Three academics and two experts from the bidding process in the road industry and innovation in the construction sector were contacted to review the interview template, the cards used to conduct the interview and the research questions. Later, the research questions and interview cards were sent to three experts in the road industry for the purpose of pilot testing. The pilot testing results suggested that two study questions required further improvement in terms of simplicity and efficiency. Moreover, after early feedback from the university academics, the study question template format changed slightly and only seven study questions were reshaped with the aim of improving the readability and understanding of the interview cards.

4.2. Interview Process

Before conducting the interviews, the Human Research Ethics Advisory Team at Queensland University of Technology was approached to obtain ethical approval. The ethics approval reference number is (87461_Oad_Kajewski_Assessing innovation in comparative tender assessment in the road sector). The ethical standards and principles in relation to research anonymity, privacy and confidentiality, consent forms, and question template developed by Landsheer and Boeije [46] were followed. The qualitative stage (the interview process) took around one year from January 2019 to January 2020. Prior to conducting the interviews or asking the participants any questions, the study aims, and objectives were explained and discussed with the participants and they were asked to sign the consent form. All the interviews were recorded to ensure any bias was reduced by obtaining confirmation from the participant which increased the reliability, readability and validity of the study.

The privacy and confidentiality of the participants were guaranteed. The researchers approached the participants via email and over the phone and during the conversation the researcher explained the research to the participants and obtained their consent. To ensure the time of the interview was suitable, the researcher allowed the participants to select the time and to choose their preferred interview method, either face to face, Zoom or online. On average, each

interview took one hour to complete however, however, the participants were welcome to continue their discussions until they had shared all their information. At the end of every interview, the researcher asked every participant if they wanted to participate in the study in the future and if they wanted to be informed of the study findings. Finally, the researcher thanked the participant for their contribution and their time.

Table 1. Demographic data

Participant role	Years of experience	Industry sector	Date interview conducted
Discipline technical director and lead transport modeller	16	Public and private sector	2nd February, 2019
Road supervisor	15	Private firm	23rd January, 2019
Project planner and manager	25	Local Government and private industry	26th March 2019
Executive director for major projects	10	Private firm	30th May, 2019
Senior executive	24	Local Government and private industry	9th July, 2019
Project leader	12	Local Government, international and private industry	12th October, 2019
Roads advisor	14	State and private firms	14th December, 2019
Project manager	13	Local Government, international and private industry	13th January, 2020
Supervisor	11	Private company	10th November, 2019

In this research, to collect data from the experts in the area of innovation, bidding and the road construction industry in Australia, a purposeful sampling technique was used. We first approached experts in the area of innovation, the bidding process and the road construction industry in Australia and invited them to participate in the study. Upon their agreement, the researcher forwarded to them information on the research, the consent form and the interview questions. To collect data from the road construction experts, a qualitative study was conducted. A total of 21 experts in road innovation, the bidding process and road construction in Australia were contacted and nine agreed to participate. The interview questionnaire was divided into two sections. In section one, the participants were asked 20 questions about the factors which impact the road construction industry, innovation in road construction and the bidding process in the road construction industry. In section 2, the participants were asked to give feedback on the study or if they felt there were any missing factors. Information on the study participants' role in the construction industry, their work experience, the date the interview was conducted, and the type of industry in which they work is summarised in Table 1.

4.3. Thematic Analysis Method and Qualitative Data Analysis

This paper qualitatively examines tender assessment-related factors and their influence on the tender evaluation and bidding process in the road construction industry in Australia. The qualitative method of data collection and analysis is considered to be a suitable research method for the following reasons: first, the qualitative research method enables researchers to evaluate and test research for further development; second, the research method helps the researcher understand the viewpoint of experts in the area of innovation in the road construction industry and the tender assessment process; third, the method helps researchers to discover missing factors in relation to tender assessment.

This paper details how the interviews were conducted and discusses the usefulness of the sampling technique for this research. The paper also discusses the research method adopted for this research. The research method used in this research investigates the key factors relating to tender assessment, namely: company experience, innovation, performance ranking, management skills, resources, management system and project cost. Every key factor relating to tender assessment is further categorized into numerous sub-factors, as shown in Figure 1. The fit model is used to identify how the selected factors are linked to each other and their loading on the research hypothesis. This type of alignment fit is found in the information systems literature.

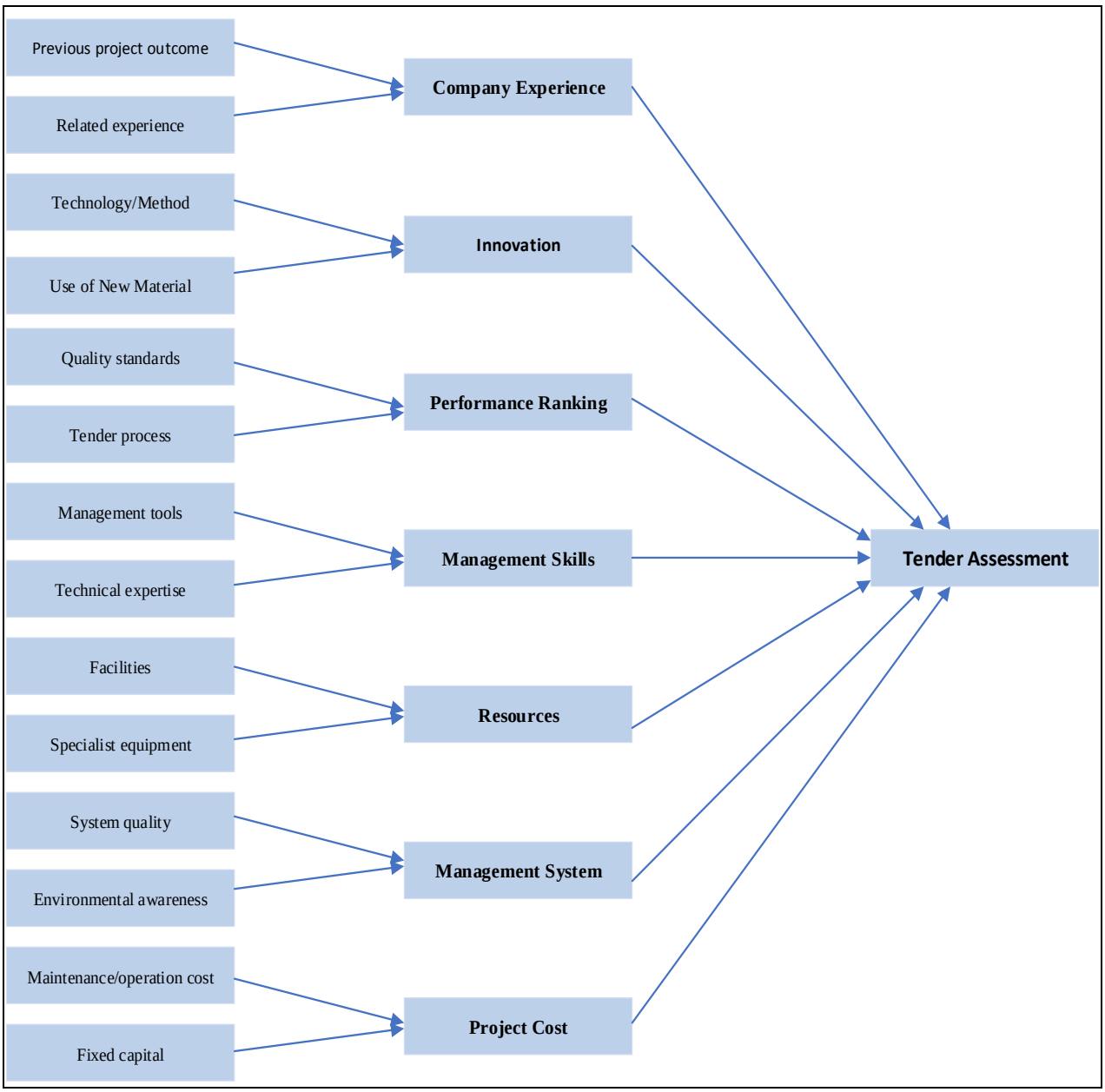

Figure 1. Key assessment factors in the bid evaluation process

For the data analysis, an early literature review in the context of bid evaluation and innovation in the road construction industry was completed so that the research scope can be examined, understood and distributed [47]. For this, a thematic analysis technique was selected to identify the factors that impact bid assessment and the evaluation process in the context of the road construction industry in Australia. The thematic analysis technique also helps to link the factors loaded with the study questions. As the thematic analysis technique is a theoretically flexible method to research like qualitative or study that aims to categorize and designate factors of bid evaluation in the road industry [47, 48]. Moreover, numerous factors have been identified under each key factor of bid evaluation using the thematic analysis technique. For example, the factors "previous project outcome" and "related experience" are identified under the key factor of "company experience", the factors "technology/method" and "use of new material" are identified under key factor of "innovation", the factors "quality standards" and "tender process" are identified under the key factor of "performance ranking", the factors "management of tools" and "technical expertise" are identified under the key factor of "management skills", the factors "facilities" and "specialist equipment" are identified under the key factor of "resources", the factors "system quality" and "environmental awareness" are identified under the key factor of "management of system" and the factors "maintenance/operation cost" and "fixed capital" are identified under the key factor of "project cost".

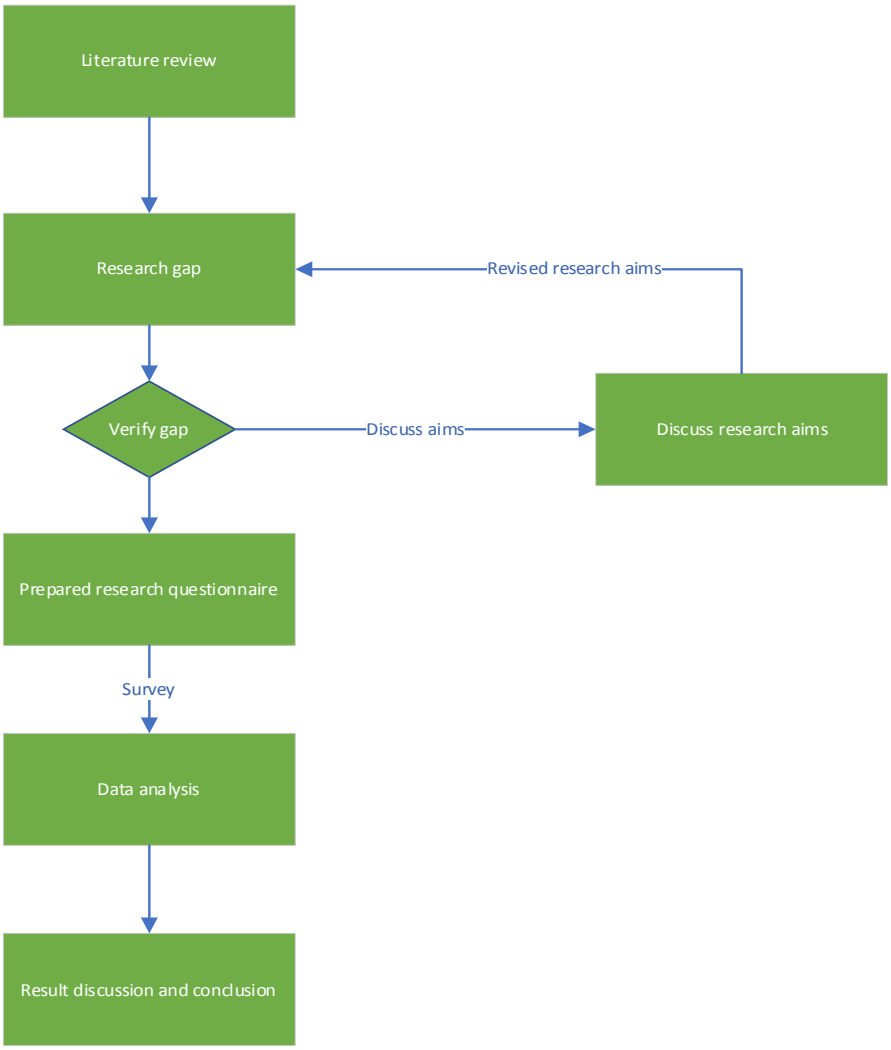

Figure 2. Paper plan

As shown in Figure 1, each sub-factor is grouped with the key factor of bid assessment and evaluation. For each factor of bid assessment and evaluation, a statistical formula of Cronbach's alpha is applied to measure and understand the factors' consistency and the internal reliability between the sub-factors and their parents' factors. A reliability coefficient of 0.70 or higher is considered to indicate a suitable relationship in the field of scientific research and the construction industry [49]. The structure of the article presented in Figure 2.

4.4. Thematic Analysis Technique

The thematic analysis technique is used to classify the study themes by examining the study data and re-reading of study data [50]. According to Braun and Clarke [48], the thematic analysis technique is very useful to capture the key thoughts of the study and to link the study theme with the research questions. Moreover, according to Patton [51], the logical process of the thematic analysis technique supports the study theme based on the data result. Also, the technique covers the study implications and explains the study factors and suggestions.

In the qualitative study in this research, data is collected in the context of semi-structured interviews, therefore, the collected data requires additional cleaning and analysis. This is why a suitable approach for data analysis is required. In this study, the research is divided into five phases using the thematic analysis technique, as shown in Figure 3. Phase 1 shown in Figure 3 is the initial cleaning and data reading phase: once the study data has been received in the form of script and audio files, we then carefully read the interview transcript and listen to the interview audio. Phase 2 Coding: in this phase, the bid evaluation sub-factors are placed under their parent factors. Phase 3 Group Key/parent factors: once we identified the sub-factors of each parent factor of bid evaluation, we then grouped the sub-factors with their parent factor of bid evaluation in the road construction industry. Phase 4 bid evaluation factor ranking: once the sub-factors are identified and placed with their parent factors, we then ranked every sub-factor of bid evaluation on a five-point Likert scale. Phase 5 analysis of the study data and result discussion: this phase identifies the relationship between every factor of bid evaluation using a reliability test.

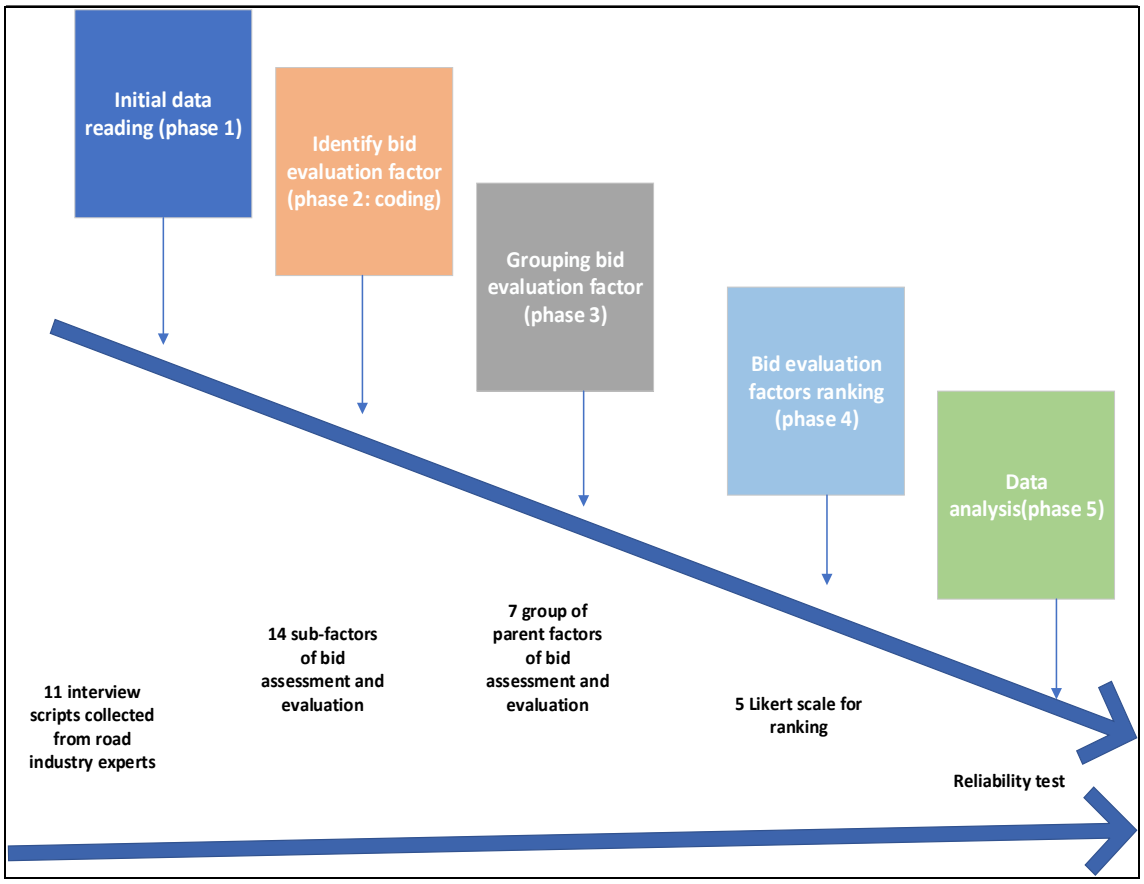

Figure 3. Thematic analysis process

In order to analyse the study data, we applied the thematic technique using the NVivo software application. The NVivo application is developed to analyse the qualitative study data and the data which is collected through the mixed method. In particular, the NVivo application is used for the inspection of dissimilar study data types, for example data in the form of text, audio, video, and in the form of images. The application is valuable for this research for the following reasons: it enables un-normalized qualitative study data to be examined and analysed, it enables data of different types to be uploaded as audio files so the researcher can analyse these using the thematic analysis technique.

The audio file of each interview was listened to carefully and imported into the NVivo application so that the data can be coded and analysed. Figure 4 shows how we imported the data into the NVivo application. After this, the interview scripts that were in the form of word documents were imported in the NVivo application and the data was read thoroughly. Figure 3 shows the method we used for the qualitative study and the technique we applied for the data analysis [52, 53]. The study data analysis used thematic analysis that allow bid evaluation and innovation factors in the road industry in Australia so that the coding of study data can be started on the study data sample and to authorize current themes obtained from the study scripts.

The coding phase in this study is divided into three steps, as shown in Figure 3: step 1, identifying and setting the proposed research themes, for instance What is research and what is the purpose of this research? What is the research aims and objectives? and why are the research themes important in the designated topic. Step 2 clarify in order to identify the association between the sub-factors of bid evaluation and the parent factors of bid evaluation and innovation in the road construction industry in Australia. Step 3 obtain bid evaluation and innovation factors for every parent factor. This process is founded on this research data analysis of all nine interview scripts and the frequency rate of bid evaluation terminologies. Furthermore, to ensure coding reliability, the data at the phase of coding has been discussed in thematic analysis and qualitative research techniques. After the coding phase has been completed, the research themes and their associated sub-factors are removed from the study interview scripts.

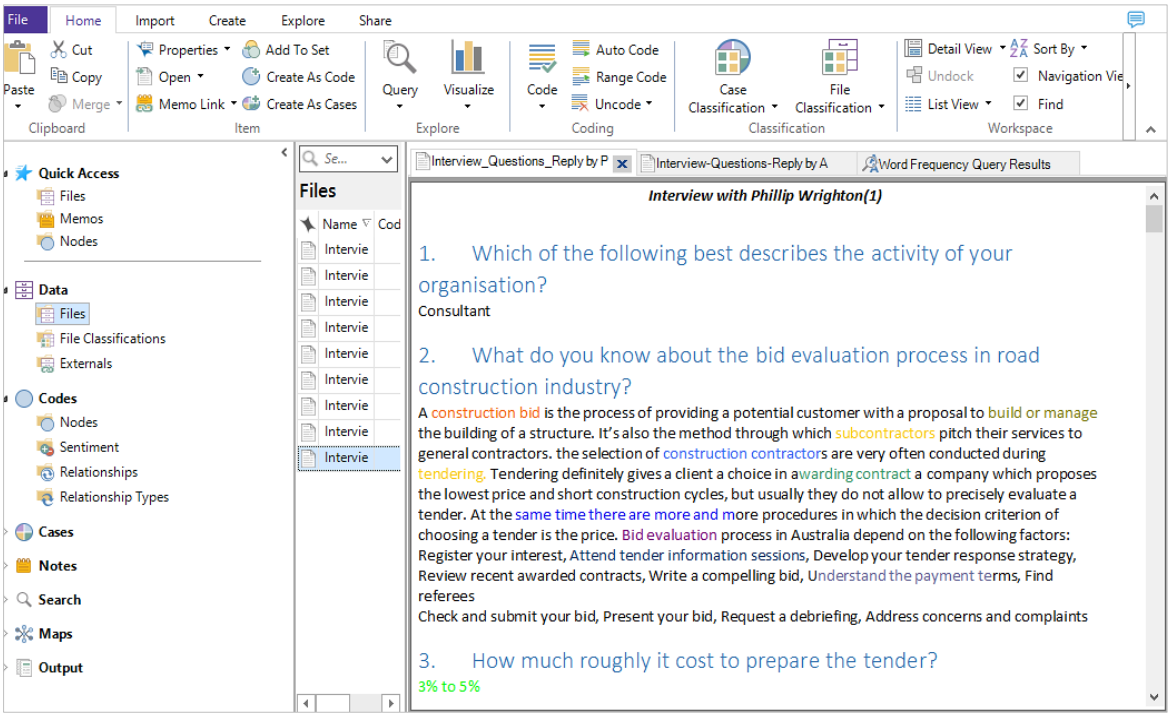

Figure 4. Interview scripts in NVivo

5. Data Analysis, Results and Discussion

The foremost challenge in the execution of a construction project is to select an appropriate contractor. Selecting a contractor entails bid evaluations, which is a critical task performed in the public and private sectors by the client company and consultants. To do this, several objectives have been set to assess the ability of the contractors to help in the efficient management of the commercial aspects of construction projects. However, some models and agendas have also been developed to evaluate every contractor's bid and to decide on the best proposal [17, 32].

The measures of the seven key factors for bid evaluation and innovation in the road construction industry were taken from the bidding and road construction industry literature [29, 34, 35]. The idea of fit is employed to classify the associations among the factors comprised in every parent factor of bid evaluation and the loading of every factor of bid evaluation for the effective assessment of each bid. This investigation refers to the correlation among the following seven factors of bid evaluation: company experience, innovation, performance in ranking, management skills, resources, management system and project cost.

5.1. Company Experience and the Bid Evaluation Process

A company's previous experience of tender requirements needs to be evaluated and assessed to determine whether the company has the right expertise to achieve the outcomes of the construction project. Current and past experience is more valuable than significant company experience. The construction company's prior experience in practical areas is analogous to the tendered construction project, the measure of the company's past project experience and the role it played in these road construction projects must be considered. To assess the company's past experience in the road construction industry, it is important to evaluate the following two factors: previous project outcomes and related experience.

Figure 5 shows the thematic analysis results of previous project outcomes and related experience in the context of company experience evaluation in relation to the bid evaluation. The study data results indicate that two sub-factors (previous project outcomes and related experience) loaded on the company's past experience factor, which qualitatively validates the proposed factors of innovation in the bidding process. All the selected sub-factors of bid evaluation are equally vital for understanding and evaluating a company's past experience in the context of bid evaluation and innovation in the road industry.

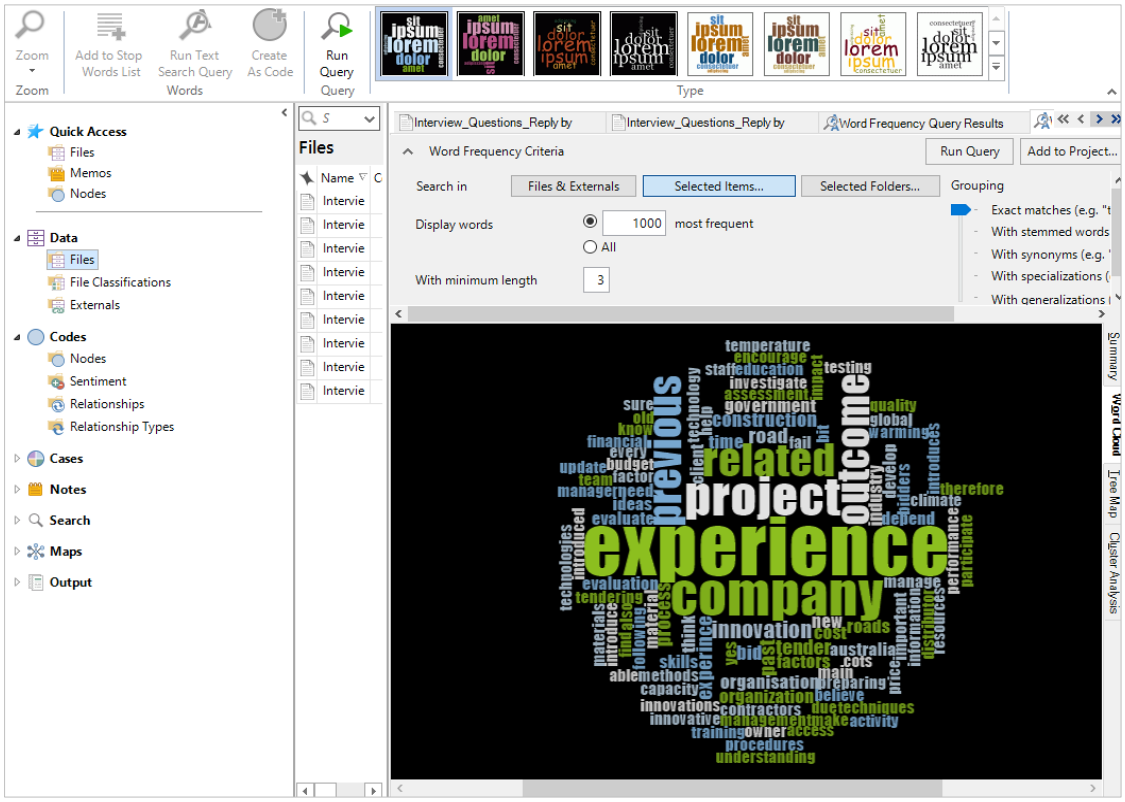

Figure 5. Evaluation of company's past experience in road construction

5.2. Innovation and Bid Evaluation Process

The process of improvement and innovation in the field of road construction and bid evaluation offers vital industrial and community advantages by making a significant contribution to financial growth and improving the quality of roads. However, implementing better innovative standard practices in order to advance the existing processes of construction and to increase attractiveness of product, have progressively become a challenge for bid evaluation and the road construction industry. The use of innovation in the field of the bid evaluation process refers to the use of latest technology, such as solar roads and the use of new materials such as recycled material. To assess innovation in the road construction industry, it is important to evaluate the following two factors: the latest technology and the use of new material in the road construction industry.

Figure 6 shows the thematic analysis results for how innovative the company is in the context of developing suitable and sustainable roads in relation to bid evaluation. The study data results indicate that two sub-factors (latest technology and use of new material in road construction) are loaded on the company innovation factor, which qualitatively validates the proposed factor of innovation in the bidding process. All the selected sub-factors of bid evaluation are equally important to understand and evaluate innovation in the company in the context of bid evaluation and innovation in the road construction industry.

5.3. Performance Ranking and Bid Evaluation Process

The tenderer's performance in road construction industry varies of based on different factors. The past performance of the tenderer in relation to related road construction projects should be evaluated in terms of budget, time performance, quality standards, product value and project management. The company's performance capability depends on the project completion date. To assess the past performance of the company in relation to road construction projects, it is important to evaluate the following two factors: quality standards and the tender process.

Figure 7 shows the thematic analysis results for how the company performed in past related projects in the context of developing suitable and sustainable roads in relation to bid evaluation. The study data results indicate that two sub-factors (quality standards and tender process) loaded on the company performance ranking factor, qualitatively validates the proposed factor of innovation in the bidding process. All the selected sub-factors of bid evaluation are equally important to understand and evaluate company performance in past projects in the context of bid evaluation and innovation in the road construction industry.

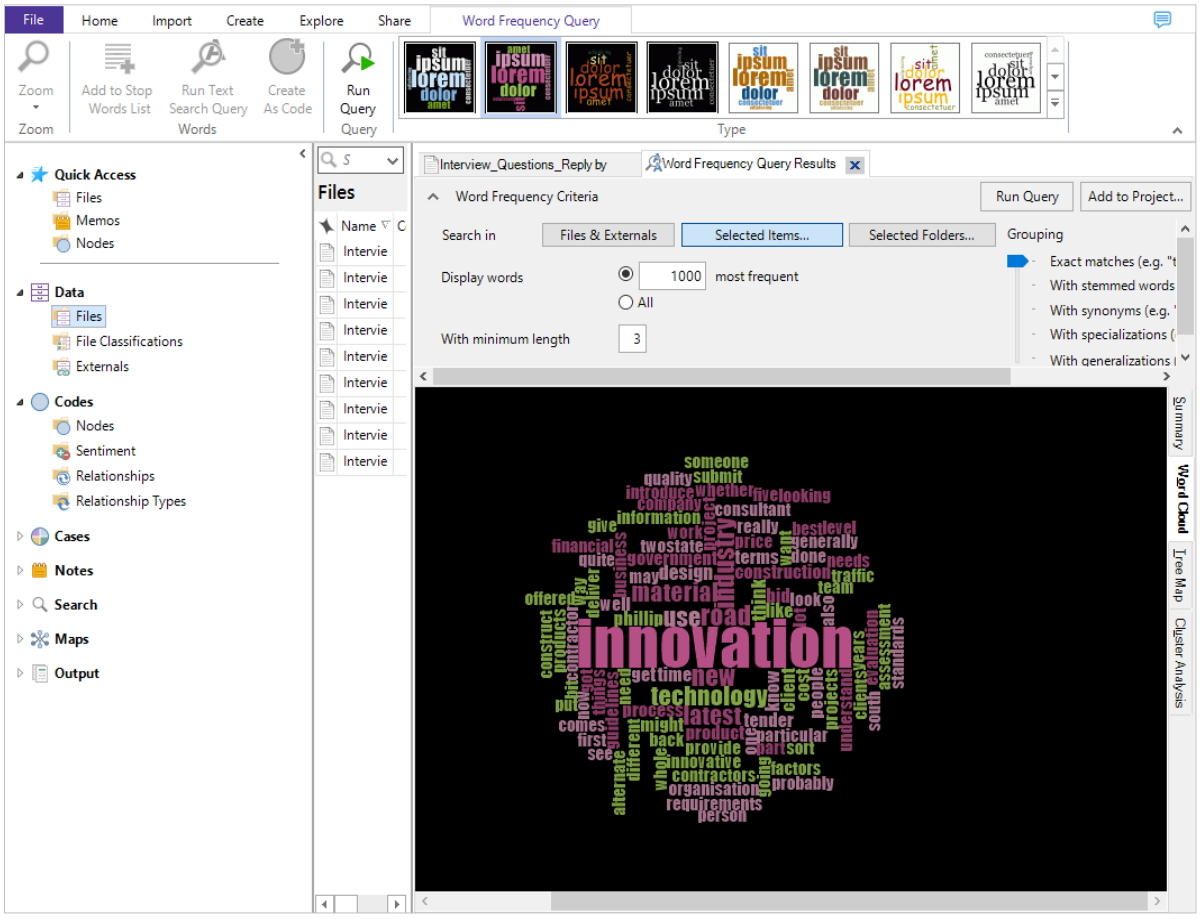

Figure 6. Evaluation of innovation in road construction

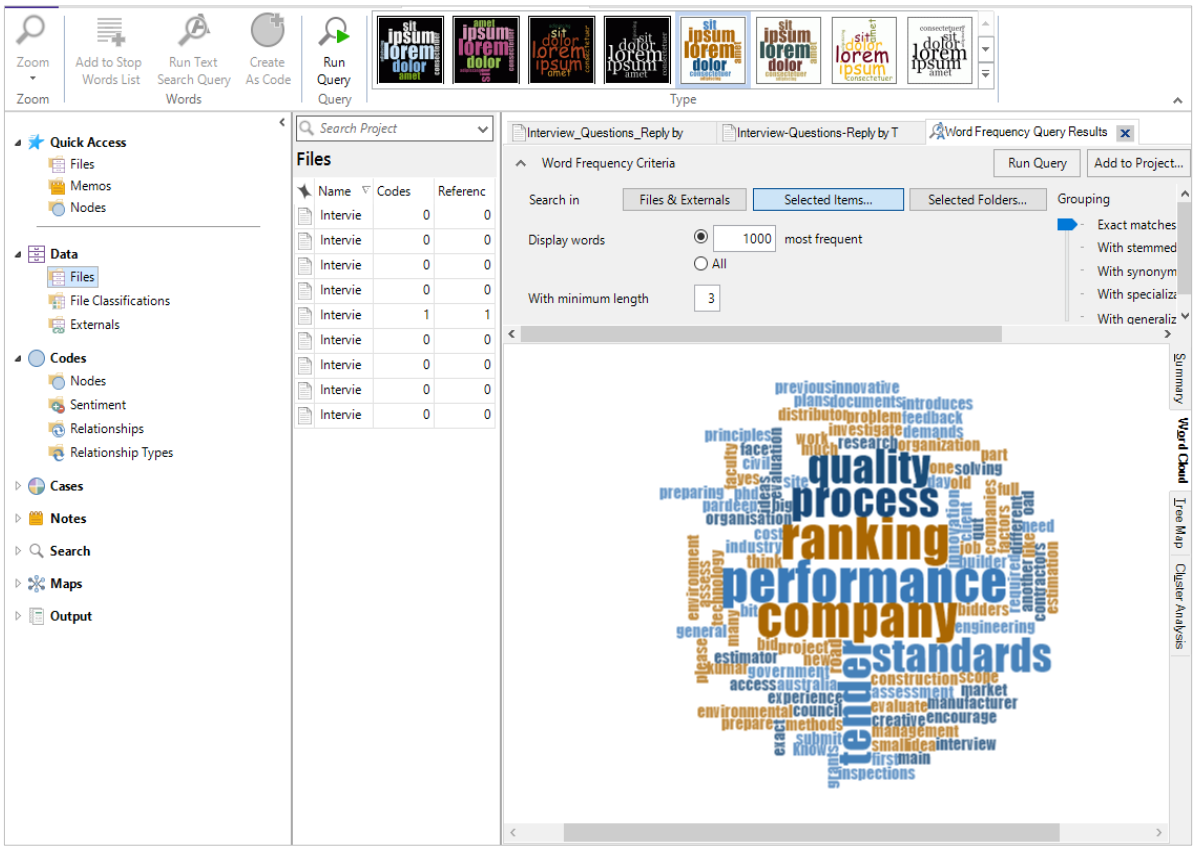

Figure 7. Evaluation of company performance in terms of road construction

5.4. Management Skills and Bid Evaluation Process

It is important to evaluate the bidder's capabilities to manage staff skills to assess the quality of the bid for the road construction project, the staff training program, and the procedures and policies for safety and wellbeing. To assess the management skills of the company in relation to past and current projects in road construction, it is important to evaluate the following two factors: the management of management of tools and the company's technical experience.

Figure 8 shows the thematic analysis results for the company's performance in current and past related projects and the management of staff skills in the context of developing suitable and sustainable roads in relation to bid evaluation. The study data results indicate that two sub-factors (management of construction tools and company technical experience) loaded on the company performance ranking factor qualitatively validates the proposed factors of innovation in the bidding process. All the selected sub-factors of bid evaluation are equally important to understand and evaluate the company's management skills in relation to past and current projects in the context of bid evaluation and innovation in the road construction industry.

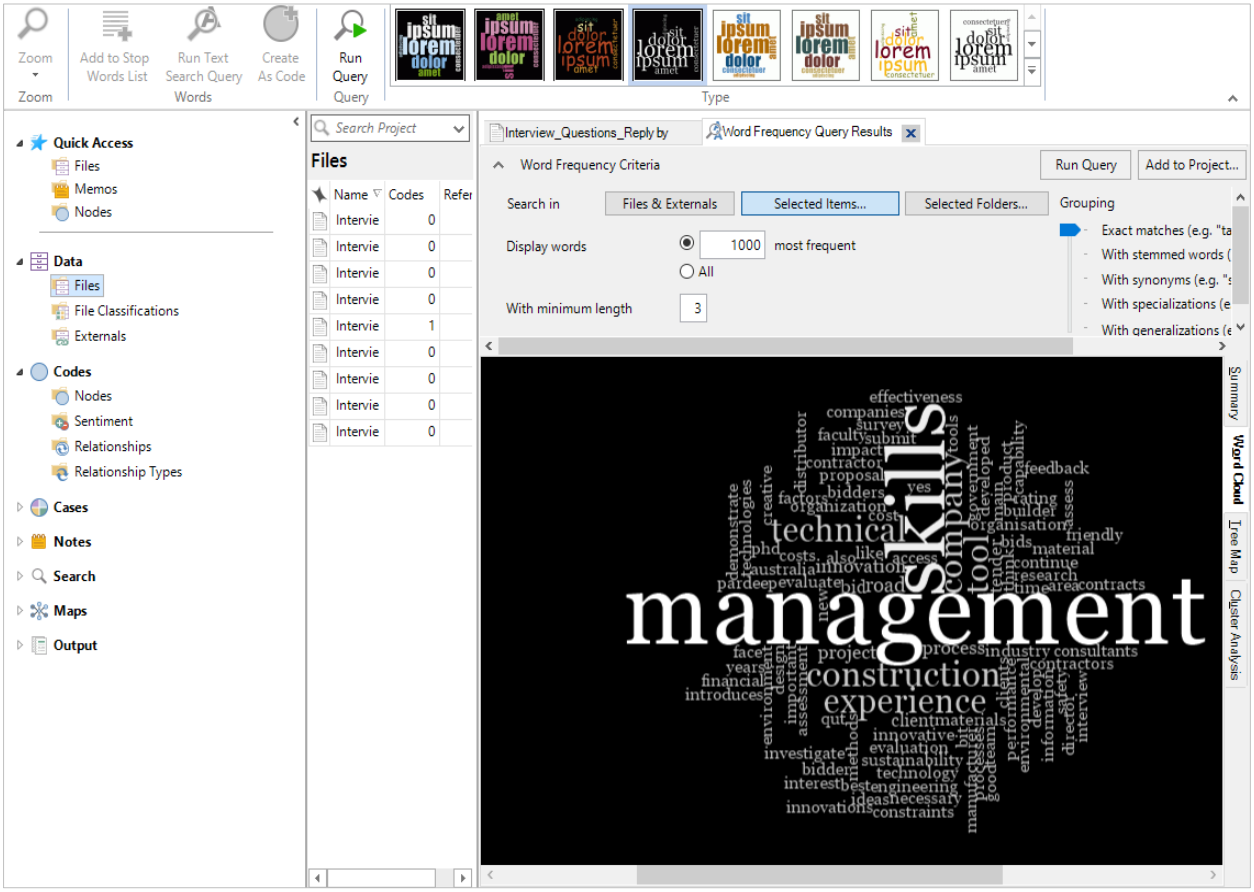

Figure 8. Evaluation of management skills in terms of road construction

5.5. Resources and Bid Evaluation Process

It is important to evaluate the bidder's capabilities in relation to the equipment, and intellectual property that the bidders use in the construction of roads. This information is also important to assess in the context of the bid evaluation process. To assess the resources of a company in construction projects, it is important to evaluate the following two factors: facilities for the company's staff member and specialist equipment.

Figure 9 shows the thematic analysis results for the company's capability in the utilization of resources in the context of developing suitable and sustainable roads in relation to the bid evaluation. The study data results indicate that two sub-factors (facilities for the company's staff member and specialist equipment) are loaded on company capability in resources factor, which qualitatively validates the factor of innovation in the bidding process. All the selected sub-factors of bid evaluation are equally important to understand and evaluate the company's resources in the context of bid evaluation and innovation in the road construction industry.

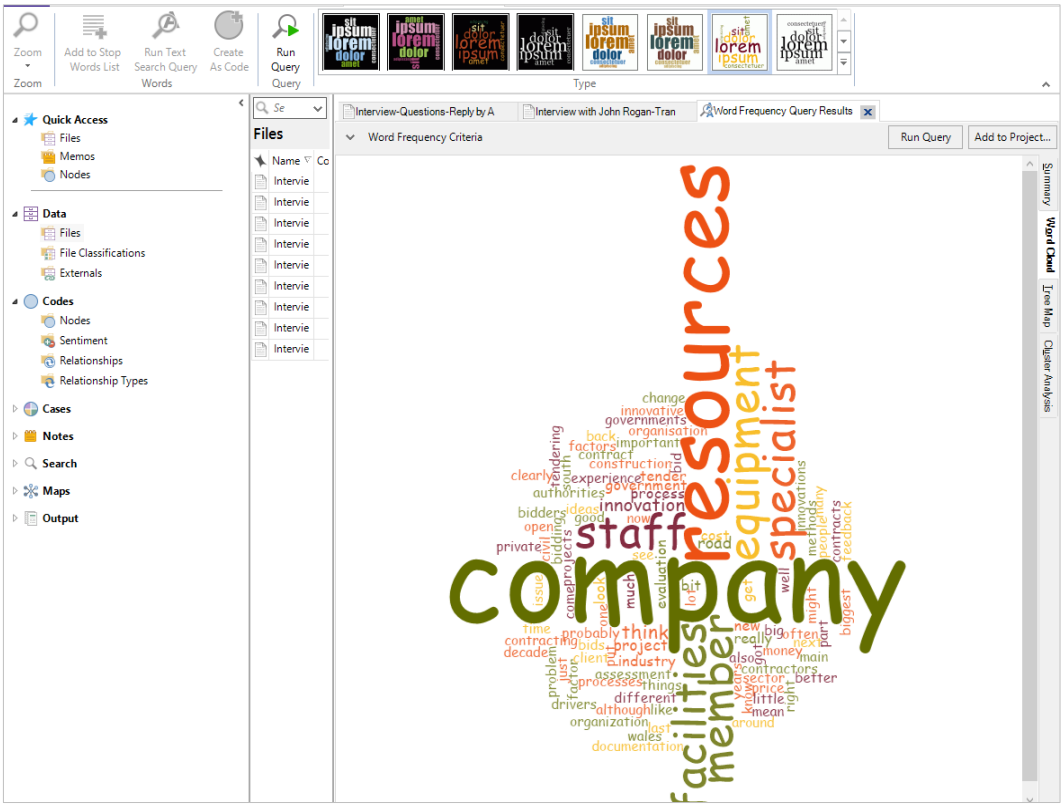

Figure 9. Evaluation of company resources in relation to road construction

5.6. Management System and Bid Evaluation Process

It is important to evaluate the bidder's system quality when assessing the quality of the bid in the context of road construction, the tools the company uses to manage the project, the environmental management system and program software. To assess the company's management system in the context of a road construction project, it is important to evaluate the following two factors: system quality and environmental awareness.

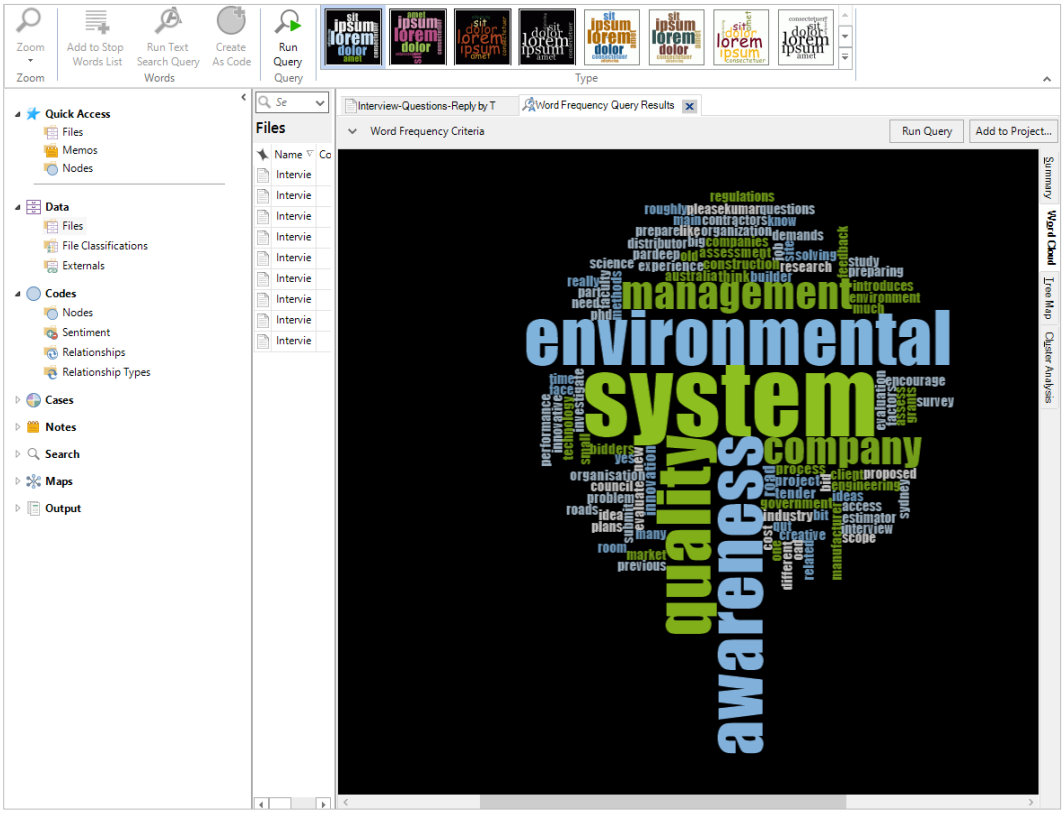

Figure 10. Evaluation of the company's management system in relation to road construction

Figure 10 shows the thematic analysis results for the company's capability in the management of the company's systems in the context of developing suitable and sustainable roads in relation to the bid evaluation. The study data results indicate that two sub-factors (system quality and environmental awareness) loaded on company capability in the management system factor qualitatively validates the factor of innovation in the bidding process. All the selected sub-factors of bid evaluation are equally important to understand and evaluate the company's system in the context of bid evaluation and innovation in the road construction industry.

5.7. Project Cost and Bid Evaluation Process

It is widely accepted that in the majority of cases, a bid is successful based on cost and time to deliver. A bid with a low cost has a very good chance of being the winning bid. To assess the project cost in developing suitable roads, it is important to evaluate the following two factors: cost of maintenance and fixed capital.

Figure 11 shows the thematic analysis results of project cost in the context of developing suitable and sustainable roads in relation to the bid evaluation. The study data results indicate that two sub-factors (cost of maintenance and fixed capital) loaded on the project cost factor qualitatively validate the factor of innovation in the bidding process. All the selected sub-factors of bid evaluation are equally important to understand and evaluate the project cost in the context of bid evaluation and innovation in the road construction industry.

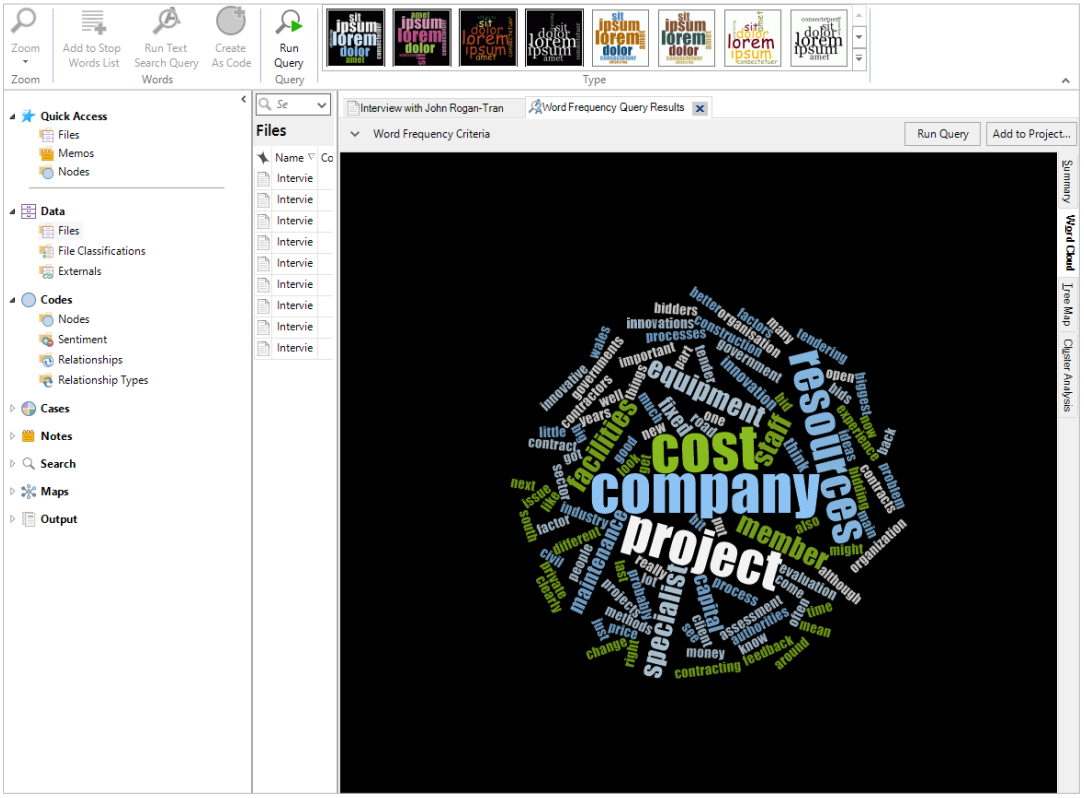

Figure 11. Evaluation of project cost in relation to road construction

5.8. Bid Evaluation Factor Fit

When evaluating contractors' bids, the main factor to consider is the cost of the project. This factor significantly impacts the choice of a suitable contractor for a construction project. Even though the lowermost bidder system protects the public from certain traditional practices, it could result in unforeseen complications. Unreasonably low bids are usually put forward by incompetent or unqualified contractors and may involve extensive delays, cost swarming, quality issues, and major disagreements. In past years, several key changes have been made to the lowest bidder system which includes reasonable auction-goer, public interest, and a pre-qualification list. These changes have opened avenues to new evaluation methods that can be implemented to replace the single criterion lowest bidder system.

In order to identify and examine the relations between all these sub-factors and their related parent factors and their impact on the bid evaluation process, it is important that every selected factor must fit together. The literature defines numerous types of methods as a fit such as gestalts; mediation; moderation; co-variation; reliability and matching as a fit [54-56]. For this research, reliability as a fit has been designated to examine the reliability scale and classify the relations among nominated factors in the scale. Moreover, people who perform different roles in the construction

industry were asked to indicate using a five-point Likert scale how they felt their organization performed against every selected factor of bid evaluation. Table 2 shows the importance of every chosen factor of bid evaluation and how the results of these bid evaluation factor vary from one another, shown in Table 2.

Table 2. Descriptive data analysis of bid evaluation factor

Bid evaluation factor	Minimum	Maximum	Mean	Std. Deviation
Company experience				
Previous project outcome	4	5	4.15	0.571
Related experience	4	5	4.50	0.570
Innovation				
Latest technology	3	5	4.60	0.698
Use of new material in the road industry	4	5	4.75	0.586
Performance in ranking				
Quality standards	3	5	4.90	0.570
Tender process	3	5	4.55	0.544
Management skills				
Management of construction tool	4	5	4.35	0.610
Company technical experience	3	5	4.40	0.581
Resources				
Facilities for the company staff member	3	5	4.60	0.603
Specialist equipment	3	5	4.65	0.505
Management system				
System quality	3	5	4.70	0.416
Environmental awareness	3	5	4.60	0.698
Project cost				
Cost of maintenance	2	5	4.60	0.825
Fixed capital	2	5	4.35	0.775

5.9. Loading of Sub-factors on Their Parent Factor in Bid Evaluation

Once all the factors of bid evaluation have been extracted from the interview scripts, we then ranked each factor based on the number of times it occurred in the manuscripts. The five-point Likert scale was used to rank the factors, where 1 represents “very unsatisfied”, 2 means “unsatisfied”, 3 means “neutral”, 4 means “satisfied”, and 5 means “very satisfied”. The data results indicate that construction companies with an advanced relationship capacity are more likely to ‘introduce’ or ‘facilitate the launch’ of new products than others. Correspondingly, the visionaries, whether ‘originators’ or ‘implementers’, were more likely to have a relationship contract experience.

Only 1% of the total factors with no relationship capacity had either introduced or facilitated the launch of new products, while 56% had an understanding that relationship-based contracts had done so. This percentage increased to 80% and 73% respectively for highly experienced individuals in road industry. Hence, the possibility of introducing or facilitating the launch of a new product increases when the respondent’s relationship capacity is enhanced. Thus, there is an evident difference in the revolutionary activity between the ones with and without relationship contract expertise. Almost 85% of the survey participants with relationship contract expertise had either introduced or facilitated the launch of new products. Hence, the study data results demonstrate a positive relationship between innovation and relationship capacity.

The study findings also recommend that individuals with greater experience of collaborative project relationships are more mindful of the impediments that emerge when introducing or facilitating the launch of new products. Each construction product system type entails some major challenges which are associated with the implementation of pioneering technologies and can be addressed by developing strong industry relations [4]. The construction management literature advises that repetitive interactions between the project team members within a complementary relation-focused contractual method enhance the worth of examining shared goals, encourages learning from affiliation, promotes trust, and augments the teams’ capacity to distinguish and address impediments that may appear when achieving shared goals [57, 58].

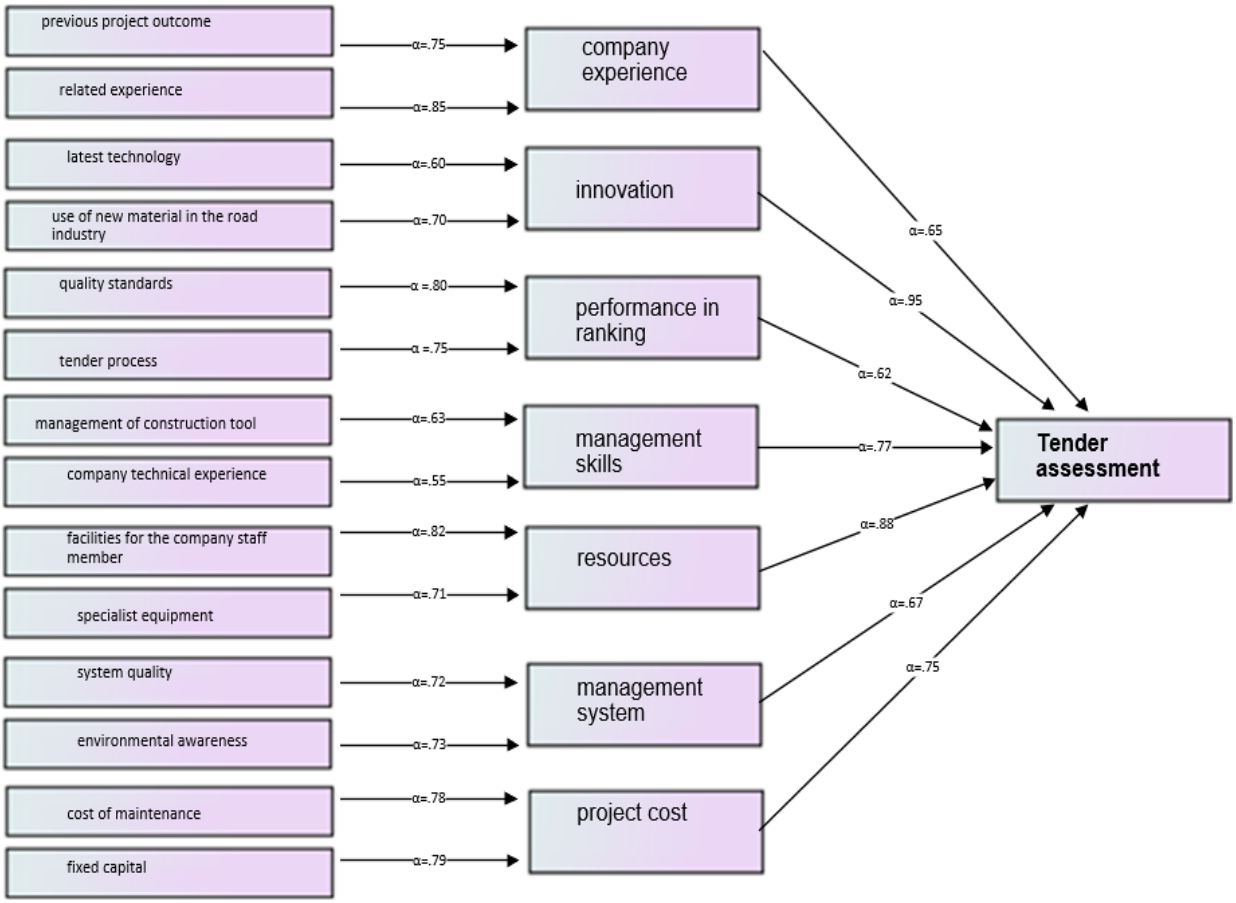

Figure 12. Tender assessment evaluation

A notable difference was observed between organizations that possess relationship capacity expertise and those that have no expertise in the road development and uses of new material. The descriptive statistics generated consistent results, illustrating that 84% of non-experienced construction companies found novelty 'very difficult', 'difficult', or 'somewhat difficult', while only 73% of experienced construction companies had the same scale. So, these results point to a probable relationship between innovation difficulty and relationship capacity as shown in Figure 12. The presence of 'facilitators' as pacesetters (only pacesetters responded to the difficulty question) had a minute impact on the probable relationship. Relationship capacity is needed by organizations that introduce new products, and those that envision themselves as facilitating the launch of new products.

6. Conclusion

The literature indicates that choosing a contractor for a construction project can be highly challenging, particularly in the context of evaluating innovation in the road construction industry. Bid assessment is one of the major trials that project owners and experts may face in both the public and private sectors. On the contrary, there are unbiased means to measure the ability of a contractor to appropriately manage the business facets of a construction project. A few numbers of guidelines have been established to assess contractors' bids and choose the best one.

In the road construction industry, innovation is a continue process in a multiparty atmosphere and is constrained by the requirements of the project. Therefore, the analysis and evaluation of innovation with other factors of bid evaluation is important. In order to ensure the quality of project contractors, the evaluation of innovation can be undertaken prior to bid submission using the contractor qualification approach. The government or contract owner's examination regarding a contractor's ability to tackle the business aspects of the process during prequalification enables the contractor to focus on the details of the projects after the contractor has passed the pre-tendering process.

This paper qualitatively examined the proposed factors of innovation in the bidding process. The results indicate that construction product modernization can have a positive impact over the project and industry performance; however, effectual construction modernization requires close partnership across an intricate cluster of project organizations. The study findings are as follows: first, during the analysis of the qualitative data, we find that developed and developing countries are aware of the need for the implementation of new and innovative methods to develop roads. Second, the research results show that the techniques and methods of developing roads in Australia are

constantly evolving to react to stakeholder expectations and new challenges. Thirds, public and private firms are willing to offer innovative methods when given the opportunity, and in this context, innovation should be encouraged during the bid evaluation process in the road construction industry. Fourth, the results show that it is important to assess value for money in the road construction sector, for example, Treasuries around Australia have methods to assess value for money, however, it may be useful to review these to ensure they are acceptable.

7. Declarations

7.1. Author Contributions

Conceptualization, P.O., S.K. and A.K.; methodology, P.O., S.K. and A.K.; software, P.O., S.K. and A.K.; validation, P.O., S.K. and A.K.; formal analysis, P.O., S.K. and A.K.; investigation, P.O., S.K. and A.K.; writing—original draft preparation, P.O., S.K. and A.K.; writing—review and editing, P.O., S.K., A.K. and B.X.; visualization, P.O., S.K. and A.K.; supervision, S.K. and A.K.; funding acquisition S.K. and A.K. All authors have read and agreed to the published version of the manuscript

7.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to confidentiality and privacy

7.3. Funding

This research funded by the Queensland University of Technology (QUT) and ethic approval to collect the study data has been obtained from the University ethics commenter.

7.4. Conflicts of Interest

The authors declare no conflict of interest.

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