



Bid Evaluation and Assessment of Innovation in Road Construction Industry: A Systematic Literature Review

Pardeep Kumar Oad ^{1*}, Stephen Kajewski ¹, Arun Kumar ², Bo Xia ¹

¹ Queensland University of Technology, 2 George St, Brisbane City QLD 4000, Australia.

² RMIT University, 124 La Trobe St, Melbourne VIC 3000, Australia.

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Abstract

Objectives: This paper present a thorough understanding of bid evaluation process and assessment of innovation in road construction industry. **Methods/Analysis:** The research articles reviewed are based on topics of bid evaluation process, evaluation of bids in road construction industry, the indicators and techniques of bids evaluation, process of Bid evaluation in countries, innovation in road industry, and indicators of innovation in the context of road construction industry. **Findings:** It is widely accepted that projects related to the road construction must be accomplished in an organized manner. Literature indicates that the road constructing demands from customers and competition of assessing and evaluating tenders have been increasing rapidly. **Novelty /Improvement:** Challenges in developing suitable roads contribute to the inconsistency in the industry and directly demands towards physical work on a road construction project, nevertheless, a failure to accurately assessment of tenders can lead to complications for the whole project and road Construction Company. The selection of a suitable construction contractor's surges likelihoods of successful achievement of a road construction project. This may also achieve the customer goals, and retain the project schedule on time, within the budget and achieve high quality project.

Keywords: Road Construction; Innovation; Indicators of Innovation; Bid Evaluation; Case Studies; Indicators of Bid.

1. Introduction

It is widely accepted that Government agencies in the road construction and management industry sector aim to achieve value for their investment as they procure road construction industry services. As Government announces any road construction project and seeks procurement for services, several contractors apply, and it is complex to assess innovation in these proposals on a comparative basis. This requires several factors such as: clear project definition, what is new (innovation), previous experience for the proposed project. However, it is not easy to assess innovation on a comparative tender assessment basis.

The quality of roads also suffered badly due to the global warming and lot of changes in the earth and environment happening these days. Therefore, in this context many other old methods of developing roads are not suitable and cannot be applied in this rapidly changes environment. [1] This raised a need to evaluate and have a new factor called innovation to assess during the bid evaluation process in road construction industry. This required to evaluate the bidders in relation to how they are innovative in this environment. This evaluation of factors related to innovation

* Corresponding author: pardeep.oad@hdr.qut.edu.au

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during the process of bid evaluation could offer benefits to community for example: innovation can help the organization and government bodies to evaluate how effective are they in terms of cost saving bidders are and what new material they are going to use, how they will save your time [2]. This could also help to save time and effort of both developers and Government bodied in designing and developing sustainable roads, as world building roads for many years based on using traditional methods and tradition material but because of the global warming our roads are not really sustainable. This is why we need to make sure that builders are going to build the road with using new material which is sustainable to this current environment

The term innovation in road industry refers to several factors such as: the use of improved materials for the persistence of road building roads for example recycled materials, solar roads, foamed bitumen; information technology innovation that comprises the practice of improved technologies for the incorporation of fruitful innovation in this area [1-3]. Progressive technology comprises the automated computerized information systems of traffic indicators, having improved system databases, usage of solar road information technology or procedure innovation that could be developed this area, including the usage of improved engineering practices, more synchronization among the public and the private sectors and paying better quality control in procedures by the usage of different approaches and methods [1, 2, 4]. Also, there is huge government expenditure in road building as well as protection, so there is a requirement for the usage of innovation to find techniques that will be cost efficient. Innovation to address conservation concerns around decrease in the emission of greenhouse gasses and decrease in pollution promote the adoption of greener methods of road construction as well as safeguarding [5-7].

Therefore, the road building industry is looking for a better efficiency and productivity in its methods and techniques. However, this quick change in the construction industry and its environment is not incorporated as quickly by the industry and this compromises innovation performance, and impacts customer, product and industry goals [4, 7, 8]. Moreover, this rapid change in the construction industry needs to accelerate the process of innovation in the road industry and relationships with the market, product and technology. This influences the process of constructing fast, reliable, secure and low budget roads [44-46]. This paper presents a systematic literature review on the process of bid evaluation in road construction industry and assessment of innovation in the road sector during bidding process.

The paper is structured as follows: in Section 2, presents planning of literature review process, which consist of five questions and their answers: What is evaluation of bids in road construction industry? What are the indicators and methods of bids evaluation? How the process of Bid evaluation varies in different countries? What is innovation in road construction industry? And What are the indicators of innovation in road construction industry? Section 3 discusses conclusion, limitations, and future research directions.

2. Literature Review Planning

To perform this systematic review in the field of bid evaluation and innovation in road industry, we used the guidelines developed by Kitchenham (2004) for reviewing and examining the available research articles relevant to our topic. According Kitchenham (2004) a literature should be answered in the form of research questions; therefore, reader can easy understand the topic from different perspectives [47]. This research divided the bid evaluation process and innovation into five questions which are as follow. Figure 1 shows literature review plan.

1. What is evaluation of bids in road construction industry (RQ1)?
2. What are the indicators and methods of bids evaluation (RQ2)?
3. How the process of Bid evaluation varies in different countries (RQ3)?
4. What is innovation in road construction industry (RQ4)?
5. What are the indicators of innovation in road construction industry (RQ5)?

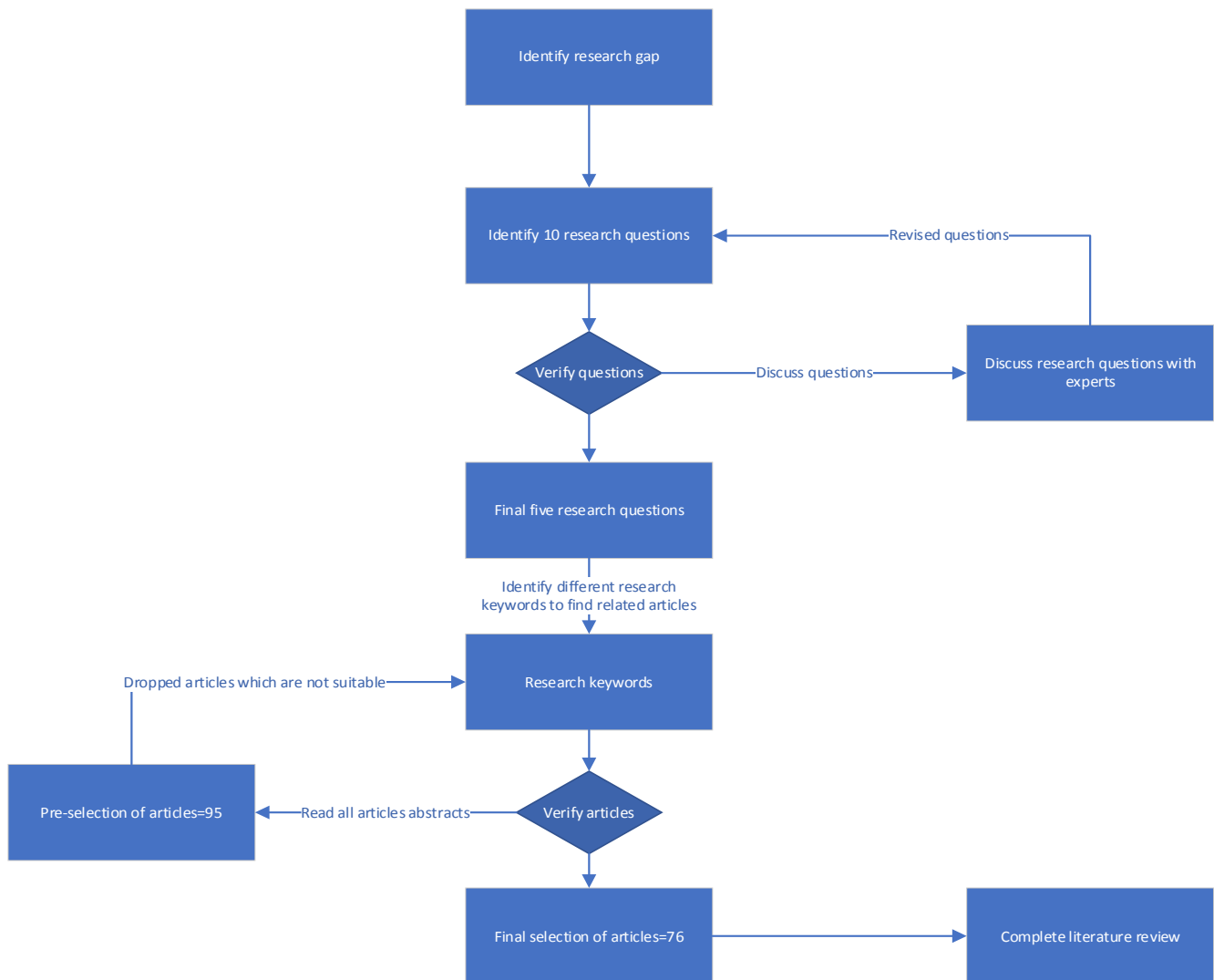


Figure 1. Literature review plan

2.1. Evaluation of Bids in Road Construction Industry (RQ1)

Evaluating bid is the process, in which submitted tenders are examined and evaluated in order to reach at the selection of an ideal bidder. The road construction bids are normally assessed first on the bases of pass and fail selection criteria before any particular single bidder is finalized or accepted [9-11, 49]. For instance, even if the bid evaluation rank is not based on a practical assessment, a determination should be made that the practical solution projected by a tender bidder is practical, suitable, feasible, robust and deliverable, that it is based on secure, maintainable and reliable technologies [9-11, 50]. A technology that meets all minimum safety requirements set by the authorities and that the financial structure and cost are reliable with a practical solution [12]. It is very important to look at the anticipated road construction project administration: the bidding association should come across as a consistent entity instead of just a collection of construction companies put together for the process of bidding.

There are two key issues is the choice of the assessment criteria for the process evaluation bids [13, 14, 51]. First, rarely, only one constructor or bidder will submit a constructing tender notwithstanding the specialist having issued the invite to tender to numerous nominated road constructor candidates. If it looks that bidder response was low due to the absences or inefficiency in the tender supporting documentation then these can be remedied. Second, it is possible that a contactor made a bid with a belief that there would be a high level of competition. In that case the approach may be to continue with the procurement and choose the individual road bidder (if it meets criteria) and announce a winner. In this way authorities confirm that the tender is fully acquiescent and meets the evaluation criteria.

Other bid evaluation strategy, according to Herbsman and Ellis (1992), include: time, quality and cost as measured through the bid quality based on contractor's previous work, amount and time of criteria execution, and quality [15]. This suggests that the winning bid is in accordance with the agreement and the bidding contractor is competent to accept the contract [16]. The process of bid evaluation is employed to designate the method for strategic assessment and evaluation to tender bids submitted by registered and pre-qualified road contractors. The bid evaluation strategy employed that would reflect the consumer's objectives [16].

Moreover, Herbsman and Ellis (1992) has also additional construction project precise criteria, including maintenance, security, durability and safety [15]. Moselhi and Martinelli (1990) proposed a more objective methods of bid evaluation through means of multi-attribute usefulness techniques for merging selection criteria of contract and the bid price. The bids evaluation in context of multi-attribute methods might tackle some difficulties and issues when matching and comparing different bids evaluation criteria measured through different scales [17]. Henceforth numerous ways have been recommended for merging criterion values and standards into a single scale.

On the other side of the debate Herbsman and Ellis (1992), proposed a bid evaluation approach based on cost and time in order to determine and evaluate the winning bid in the council level streets and highway construction contracts. Through converting the construction contract cost to time, a straightforward assessment would be made on an individual criterion [15]. Lastly, Holt et al. (1993) combine their pre-qualification and post-qualification bids assessment score into a simple index by allocating 60% weighting for the pre-qualification assessment score and 40% to the post-qualification assessment score [18]. Henceforth, it might be concluded that there is no agreement as yet on a general set of evaluation selection criteria for road contractor selection. Selection criteria might vary in strength according to the features of the project development such as cost, selection of construction contractors, Topsis and Saw-G Grey techniques, pre-qualification and evaluation of bid criteria. However, literature shows there is document study that discuss innovation in the context of bids from contractor's evaluation and assessment. Thus, there is an urgent need of research in the field of innovation and bids evaluation so that this process can be fast, reliable and fair.

2.2. Indicators and Methods of Bids Evaluation (RQ2)

This section discusses the factors or indicators that often consider during the assessment of tenders in road construction industry.

2.2.1. Road Construction Budget

In the field of road construction industry, Government contractor pre-qualification and tender evaluation principles and procedures are currently employed in numerous countries, and it involves the development and extensive attention of essential and adequate decision criteria to assess and evaluate the overall appropriateness of contractors [19-21]. Most of the developed countries spend huge amount on the development of suitable and reliable roads [5, 52]. In this context authorities are very careful when selecting and assessing tenders. For example, in Australia, the state and the local government are responsible for the construction and maintenance of roads.

According to Australian Bureau of Statistics (ABS). (2017), the demands for constructing quality roads increasing on daily basis. Figures 2 and 3 show Kilometres and lane Kilometres of roads in Australia. This rapid grow in road demands can lead to spend a Government a huge budget. For example, according to the same report from ABS (2017) Australia in 2014 about \$15.8 billion is allocated for road renewal and maintenance. The spending on the core road maintenance program by the Road Traffic Authority (RTA), NSW, Australia in the year 2010/2011 was \$1billion. This makes a supportable and economical innovative road development strategy important and beneficial for Australia and internationally, both in terms of ecological and economic benefits.

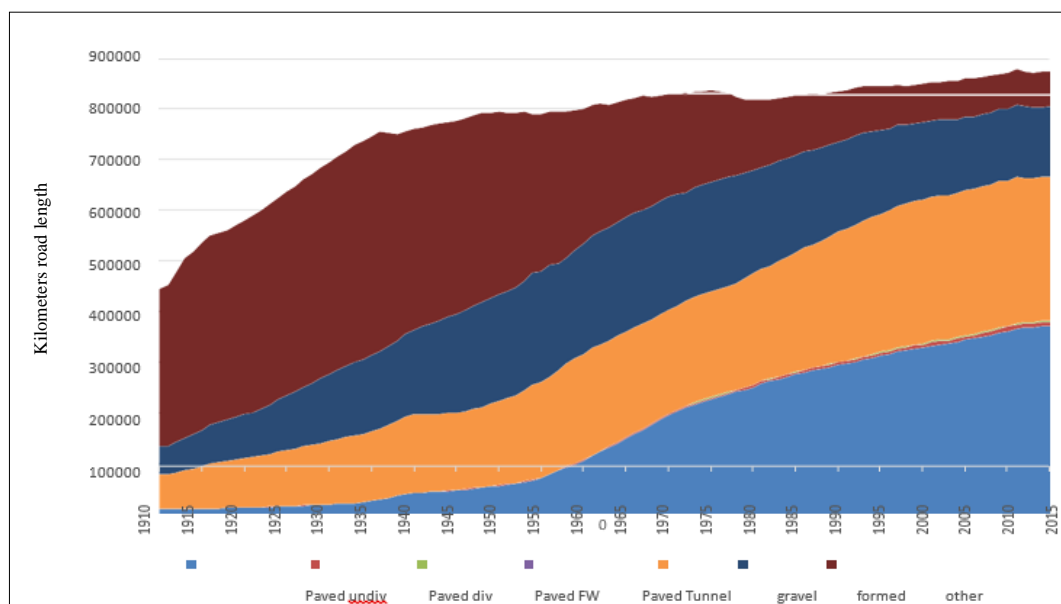


Figure 2. Kilometres of Road Length in Australia [22]

According to Australian gadget 2017-2018, Government spending billions of dollars every year on infrastructure across Australia as shown in Figure 4. South Australia, spending \$3.1 billion, Western Australia spending \$7.7 billion, Queensland spending \$13.6 billion, Northern territories spending \$1 billion, New south wales spending \$18 billion, Victoria spending \$10.4 billion, Tasmania spending \$1.1 billion and Australian capital territory spending \$440 million.

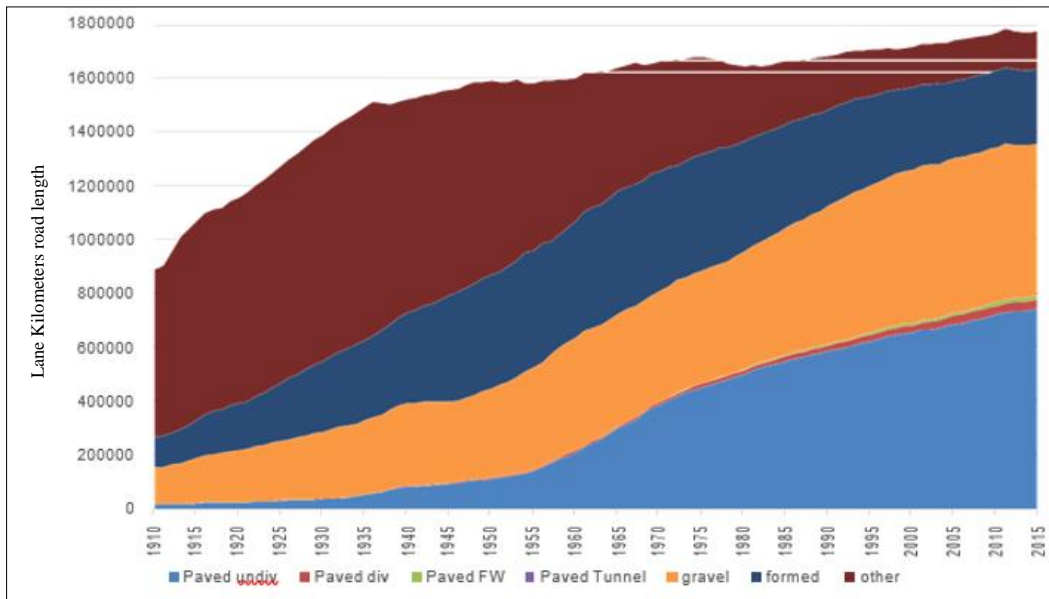


Figure 3. Lane Kilometres of Road Length in Australia [22]

Moreover, Australia has adopted a competitive contracting approach for road maintenance. This strategy has resulted in around 10-40% cost savings. It has also stimulated the integration of innovation and improved services. Figure 5 showing since 2008 to 2009 Government spend \$15.8 billion on roads expenditures. The transport sector contributes to over 23% of the total emission of carbon dioxide from the combustion of fossil fuels. This sector also contributes to a total of 15% emission of greenhouse gases (Australian Bureau of Statistics, 2013). There is a prediction that these emissions will increase by a level of almost 2/3 in the coming thirty years that makes the adoption of innovative strategies to reduce the levels of emissions from the road construction sector imperative. In this context, Australian government is very conscious in constructing better roads and for this they also spend huge amount of time, and cost in assessing contractor’s bids. In this process government makes sure selected contractors have suitable knowledge, skills and an experienced team, and advanced resources etc.

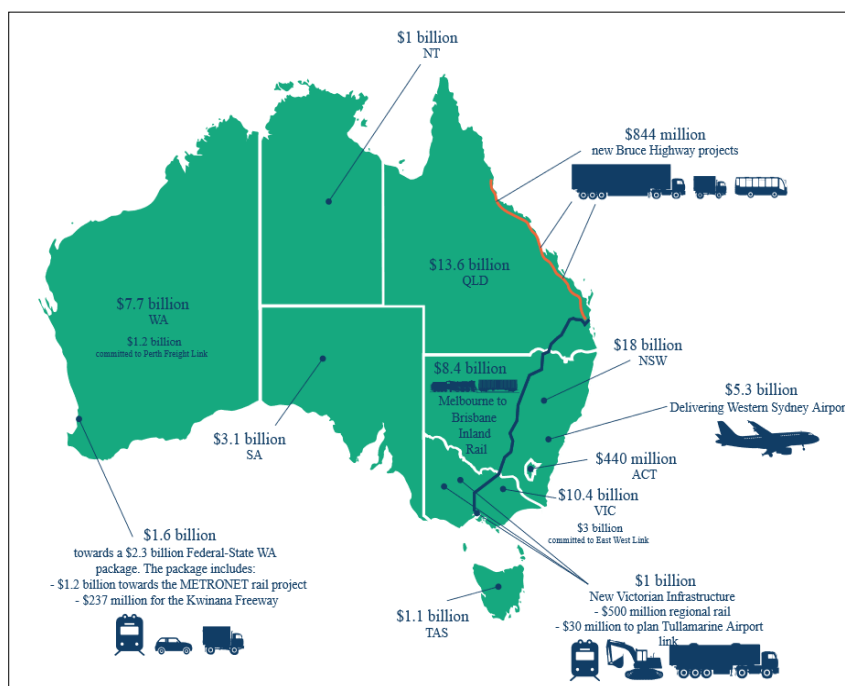


Figure 4. Australian infrastructure budget 2017-2018 [23]

Russel and Skibiniewski (1988) explained bid assessment and evaluation as a decision-making procedure that involves the implementation and wide consideration of essential and adequate decision criteria employed to evaluate the contractors' competences [6]. It needs construction manager with extensive experience and knowledge in order to use a suitable criteria to assure the selection of the most appropriate contractor theoretically and financially for the company [6, 11, 53].

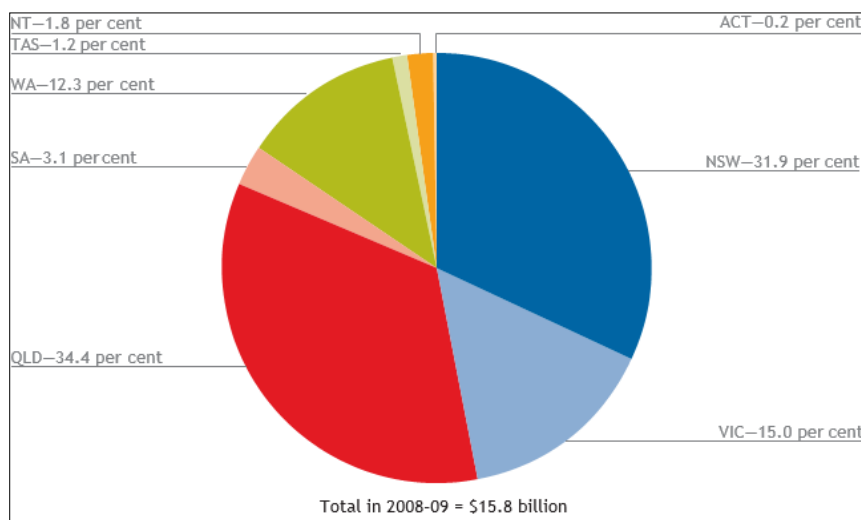


Figure 5. Proportions of total state and territory expenditure on roads

2.2.2. The Cost or Price Consideration

Literature showed many for evaluation bid criteria and all factors the key evaluation factor is construction price or cost consideration that might affect the construction contractor's selection [11, 13]. While the lowermost bidder mechanism or system protects the community from improper practices, it has certain disadvantages. These include arbitrary low-cost bids from road construction contractors either intentionally or unintentionally or unqualified road construction contractor that cause wide delay in construction, quality issues, cost over budget and augmented number of disputes. Over the past many decades some modification to the lowermost bidder mechanism were made, for example, community interest, reasonable bidder and pre-qualification contractors list that welcome many other doors for the evaluation methods to be accepted in its place of the single criterion mechanism lowest bidder mechanism.

2.2.3. Road Construction Contractor's Selection

Many researchers pointed out that it is very difficult to select a suitable and reliable contractor. In the context of road construction bid evaluation is one of the key challenges that face proprietors and advisors in the private and public sectors [24-26]. On the other side hand, there are objective means to measure the ability and strength of a road construction contractor to appropriately manage the business characteristics of the road construction project. Literature also show numerous frameworks and models have been created and developed to assess contractors' bids and select the appropriate and suitable contractor.

2.2.4. Information about Contractors

It is compulsory for the government to investigate, collect and assess information to calculate objectively the evaluation criteria against the bidders for bid evaluation. Literature shows lot of information in this section, I presented only the most used information, which includes [5, 12]: first, competency of firms equipment and plant to do the work appropriately and expeditiously; second, construction contractor's permanent place or location of business; third the present position of the construction contractor to complete the agreement well; fourth, firm fitness of financial competence to meet requirements required by the government or work; fifth, suitability of firm technical experience and ability; sixth, firm satisfactory experience in past similar construction projects in context of their size and type. In total, the information employed for the evaluation of criteria for bid and pre-qualification assessment falls into five main sets: the general information which is employed mostly for managerial purposes, firm's technical information, firm financial information, firm administrative information, and firm information safety [27].

2.2.5. Contractors Performance

Selecting a potential contractor for a specified project is a critical component in the project management's selection and evaluation processes; careful consideration needs to be made to establish what contractor performance is to help in establishing a framework that can be used to help decision-makers in selecting the most appropriate

potential contractor for a project. Researchers defined overall contractor performance thus: "Overall contractor performance is defined to embrace construction cost, construction time, construction quality and sustainable development, the philosophy being that the achievement of one aspect of performance should not be at the expense of another." [28]

Regarding contractor selection processes, the literature identifies several methods and techniques that can be used in such a process; the most common procedure used is based on prequalification, negotiation and open tender [29].

2.2.6. Pre-qualification and Bids Assessment

The information regarding to the assessment of pre-qualification and bids can be measured in numerous ways. This may be completed through assigning highest value for every used criterion of bid and pre-qualification [6, 8]. These values are then ranked to their qualified importance on the strategy that is related the delivery of the overall project completion. When criterion of pre-qualification and bids is made up of further sub criteria, the actual value scores of the sub criteria are comprised to compute the whole value for the group. In order to avoid biases, it is suggested that at least of three [28] assessors is mandatory for every scoring action. Holt et al. (1993) studied an improved quantitative method for choosing construction contractors. The method encompasses a three-level process demanding the calculation of pre-qualification contractor's documents, further assessment of contractors in the light of particular bidders and compare the bid cost amongst the invited bidders [18].

2.2.7. Management of Construction and Risk Method

The idea of management of construction and risk method was introduced in the 1980s. Management of construction and risk method as a project delivery method was shaped to deliver input to the designer to rise reliability [26, 30, 31] and constructability of designs and to minimize schedule time by overlapping of the method design [5, 19, 21]. According to Holt et al. (1993) the contractor typically has an important input in the process of design. In general, management of construction and risk method generates a cooperative environment that uses the perception, experience, and development of the designer and the management of construction [18]. Management of construction and risk method is gaining acceptance, particularly in the construction of the big construction projects, for example, construction of Government schools, airports and sports supports stadiums. The management of construction and risk method aims to decrease the risk of price over budget and timetable creep and to accelerate the road construction process without negotiating quality. In this case the road construction administrator works with the road designer as a team member throughout the design phase of the project.

2.2.8. Methods of bid evaluation

There are different methods that can be used to choose which road contractor would be awarded a road tender, however research indicates that Governments and private companies most commonly use the following methods:

Bespoke approaches: these approaches used widely in industry and selection of procedures that developed by the individual business organizations thus there are numerous differences and relies only on true/false or yes/no principles and the judgement of decision maker's. The process is more suitable to the biases of the business decision maker [32, 33].

Multi-criteria selection methods: these types of methods used to weighted price factors as well non-price factors in single stage or two different stages. The approach is useful in order to minimize the influence of the biases of the business decision maker via defining the weighting of every criterion before to inspecting any suggestions or submissions. In this research we used multi criteria selection method, which is mixed method approach [32, 33].

2.3. Bid Evaluation Process in Different Countries (RQ3)

One of the key challenge of evaluating bids in road construction industry is to identify the best method of evaluating bids. For this we have identified two countries that published how they evaluate contractors bids.

2.3.1. Bidding Process in U.S

In the United States, the selection of bids in road construction industry based on the bidder price. The bidder who proposed the lowermost bid price has awarded or win the bid under the sealed bidding system. However, this process at Government level is fair, highly transparent and appropriate for the standard of competition. Under this bidding system, though, the bid price where the only factor for awarding a construction contract, this lead the failure of large and medium road construction projects. It was because the bidder who won the contract proposed a very low bid price with the intent of rising the cost after they effectively concluded an agreement [9, 34]. In these following circumstances, the U.S government came to understand the exiting tendering system has negative

impact on the project success, quality and the Government budget, therefore, they suggested new tendering system, where they consider number of factors, as shown in Table 1.

2.3.2. Bidding process in France

France discontinued its old-style tendering bidding system for large or public projects. At this stage Government, replacing the old bidding system, which was based on the price with the selection of bidders, where the bid based on the economically advantageous. However, in road construction industry, government usually had officials who are experts in the area to choose suitable bid. In current years, reforms in the bidding process have been evaluated to improve the quality of the road and life [9, 34]. Therefore, Government suggested several other factors to include in the bidding process, which are shown in Table 1.

Table 1. Bidding process in different countries [9, 34]

Bidding process factors/criteria	Bidding process in different countries				
	U.S	France	Germany	Australia	Middle East
Bid Price	✓	✓	✓	✓	✓
Bidder details	✓	✓	✓	✓	✓
Scope of work	✓	✓	✓	✓	✓
Bidder experience	✓	✓	✓	✓	✓
Technical resources	✓	✓	✓	✓	✓
Reference or related work quality	✓	✓	✓	✓	✓
Health and safety	✓	✓	✓	✓	✓
Taxation details	✓	✓	✓	✓	×
Financial information	✓	✓	✓	✓	✓
Infrastructure	✓	✓	✓	✓	×
Team skills	✓	✓	✓	✓	×
Plant and tools	✓	✓	✓	✓	
Innovation	×	×	×	×	×

2.3.3. Bidding Process in Germany

In Germany, bids are evaluated and bidders are awarded contract based on, how the bid is economically advantageous to the Government. However, bidders from Germany are mainly small and medium sized organization, the bidders are not capable to develop high quality roads and roads which fulfil the EU rules and regulations. Therefore, Germany Government announced that any company from EU can participate in the bid, so that the roads quality can be improved by having highly skilled and large infrastructure organizations on board [9, 34]. The Government new bidding system based on the many factors, which shown in Table 1.

2.3.4. Bid Evaluation Process in Australia

Victoria's, Australia the road construction and maintenance industry has an important influence on the state budget, development of important commercial and infrastructure and commercial and on the provision of jobs. The civil construction and maintenance industry in Victoria is dedicated to shadowing excellence in the building road and maintenance of other Victoria's infrastructure, with the consideration of environment and the people's social purposes. Important to meeting this obligation, is the advancement of best practice in managing road construction related contract and tendering. For this Victoria government has set some minimum standards of accepting tenders for public roads maintenance and construction [35].

Victoria follows various procedures of tendering the most commonly used are: Open Tenders, Selected Tenders and Preregistered (Selective) Tenders. Open Tendering involves the rules and regulations to promote the "Invitation to Tender" in a related newspaper, deliver relevant project details information, invite the contractors and inform the closing date of tender. Selected Tendering follows the same rules and regulations as "Open Tendering" with the exclusion that contractors can apply for the tenders only if they have prior competence in the similar projects. Pre-registered (Selective) Tendering based on two key levels: advertisement of tenders and seeking expression of interest from the contractors [35].

- For the three procedures of tendering Victoria apply the following principles;
- Value for money – Government accepted services and goods at optimal cost and focus on the performance standards.

- Open and fair competition – maximising the chance for companies and individual contractor to participate for business.
- Accountability – assigning accountability for obedience with policy and acceptance of best practice.
- Risk Management – accepting management policies to reduce risk in contract management and tendering.
- Probity and transparency – guaranteeing fairness, independence, reliability and transparency in all levels of the tendering process.
- Local Industry Participation – using native suppliers as long as they offer best price.
- Minimisation of tendering costs – guaranteeing that lowest cost tenders will also give the consideration as long as they ensure the quality services.

Moreover, Victoria follow the following principles in order to evaluate tenders form the contractors [35].

- Project total cost
- Contractor's ability to meet the desires of Government
- Project delivery time offered in the tender
- How contractors ensure project quality
- Contractor's previous performance on similar projects
- Contractors experience overall
- Contactor's capabilities
- Contactor's health and safety measures
- Contractor's workplace and industrial relationships management practices and performance
- Contractor's environmental supervision practices and performance
- Contactors public relations practices and performance
- Contractor's wealth
- Contractor's skills

2.3.5. Bid evaluation process in Middle East

The Saudi Arabian development industry has extended pointedly lately, primarily as a result of the popularity in the Saudi development advertise; this has been driven by the administration's system to re-fabricate the Kingdom's framework. These development ventures incorporate the working of new streets, spans, sports offices, private lodging and government workplaces. By far most of these tasks are financed by the administration and can be sorted as real activities. There are additionally huge requests on the private development segment and the primary drivers of this request are to a great extent a result of changes in social and monetary parts of Saudi society. These viewpoints incorporate the ways of life of Saudis who are tending to move from country to urban regions, increments in openings for work, and increments in yearly salaries [36-38].

The administration's procedure and changes in the socio-financial matters of Saudi society have accordingly made countless in the Kingdom and, therefore, this huge number of open activities has pulled in a similarly expansive number of national, provincial and worldwide temporary workers to enter the Saudi development industry. A key challenge, in this way, for Saudi open task proprietors is the temporary worker choice process because of the effect of the undertakings' prosperity on open enthusiasm, and also with fulfilling the experts [28].

The contractual worker pre-determination process in Saudi principally relies upon a bland rundown of criteria, made by the administration; this is filled in by the temporary workers themselves. This frame neglects to satisfy the necessities of the undertaking's customers and has ended up being in powerful the same number of temporary workers have neglected to meet the venture's prerequisites and have neglected to meet their execution guarantees. The main phase of the present preselection process is that the temporary worker fills in the appraisal shape yet understanding of the Saudi development industry has shown that the contractual workers are untrustworthy as far as surveying their own execution, the quantity of undertakings they have finished, or their own money related execution as an association. There is absence of certainty with respect to the temporary workers' assessment of their own execution [29].

An examination of the writing recognized a few criteria that should be considered in building up a more proper structure that could be embraced in the pre-determination process in the Saudi Arabian open development part. Some of these criteria were investigated and affirmed in the underlying subjective information. The primary criteria and the sub-criteria are [9, 16]:

Specialized Capability of the Contractor

- Previous encounter on a comparable sort and size of undertaking
- Appropriate capabilities and experience of specialized staff
- Plant and gear: accessibility, condition and appropriateness of the hardware
- Quality control
- Specialized information of the predefined venture

Money related Capability of the Contractor

- Financial soundness
- Positive FICO assessment
- Banking course of action
- Working capital
- Current and settled resources

Wellbeing and Safety Record

- OSHA rate
- Management wellbeing responsibility
- Experience in dealing with hazardous substances
- Experience in clamor control
- Safety record
- Company security approach

Notoriety

- Past venture disappointment
- Length of time in business
- Past customer connections
- Other connections
- Number of comparative finished undertakings
- Reputation of the sub-temporary workers to be utilized for the undertaking
- Percentage of past works finished on plan
- Relationship with providers
- Claims and legally binding debate

Administration Ability

- Past administration execution
- Qualification and experience level of venture administrator
- Qualification and experience of administration staff
- Present workload and capacity to help the new venture
- Number of direct laborers accessible for the undertaking

Association's Culture

- Familiarity with nearby working society
- Contractor nature with nearby providers
- Familiarity with controlling specialist
- Experience in the area

- Relationship with sub-contractual workers
- Contractor's nature with climate conditions.

2.4. Innovation in Road Industry (RQ4)

In early days road construction and bid evaluation was done without detail planning. As roads were constructed according to cumulative needs, following the ways that were made bullock carts. For instance, the first road in Australia was built by the Dawes Battery. After the reimbursement of the Parramatta region, a road from the region to Sydney was built. The year 1792 noticeable in the construction of roads to linkage the settlements of the Windsor region to Parramatta and city of Sydney. This road rapidly expanded, but there was no guideline in the early road system in Australia [22], 54. Hashemian et al. 2020, explores the salt gradation requirements implemented through numerous regional or national highway units in US and Canada for the season of winter road development and maintenance processes. This research indicates that salt degree requirements are conceded due to the available of material locally [48].

More in context of innovation in road construction and bid evaluation. For example, according to Caerteling et al., 2011, the road construction commerce in Australia is being researched from the viewpoint of innovation and use of progressive technology [1]. There is an increasing requirement for the road building area to get due attention to achieve improved and accept innovation owing to the fact that the road building sector in Australia is the key contributor of engagement in the nation. According to Kaare and Koppel, 2012, the road infrastructure is very significant, as it is the foundation of transport of consignment and ensures business and individual travel mobility [3]. The asset required in road building is much advanced in contrast to other small construction projects, so with substantial stakes, there is a requirement to involve planning and investigation in this commerce in order to endorse innovation in a proper way. There is a rising requirement to adopt innovation in construction industry as the adoption of innovation in road construction can help to set a good example in the market.

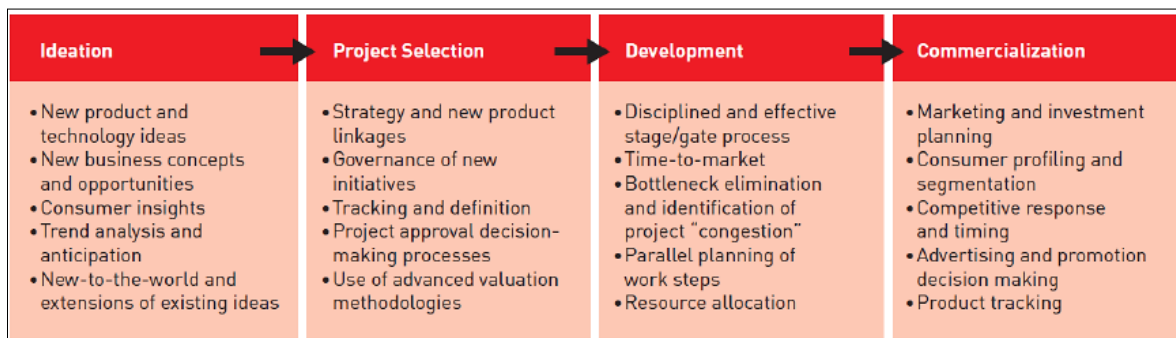


Figure 6. Innovation Value Chain [39]

According to Liu et al, 2017, there was a rapid deterioration in the road conditions all over the world in 18th century. In many developed countries around the world, the methods of building roads were improved with the passage of time and innovative tools and technologies were used. For instance, in the United Kingdom, there was a shortage of trained engineers and inspectors. The landscape of the United Kingdom was not very supportive of construction roads effortlessly, but the Romans looked to have little struggle in construction very traditional early roads. The year 1890 noticeable in the context of using innovation or innovating ideas in construction the roads when asphalt was employed as a supernumerary for road building [14].

The term innovation can be defined as a way of implementing new things effectively. Innovation could have two key types: product innovation, that includes the creation of improved services and products, or innovation in process, which comprises implementing suitable methods and ways of the production of products or delivering services. Innovation can also include the improvement or adoption of a new way of how the company and the dealers interact for the distribution of services and products. There is an incremental innovation that comprises minor changes to the current services and products. There can be fundamental innovations too, that comprise a key change in the company processes and working of the products. The construction manufacturing can be subjected to all of these types of innovation.

Selecting and prioritizing potential road construction bids is one of the key challenges in construction industry, which is one of the important axes of administration models of private and public business organizations included in development, innovation and research activities [17, 55]. For this reason, there is a great amount of literature devoted to the bids selection problem. Graves and Ringuest (2003) suggested a mathematical programming model in order to evaluation projects in the field of information technology [40]. Pinto (2010) studied many quantitative and qualitative project and bids selection and evaluation models [41]. Sokmen (2014) planned a list of the numerous criteria and methods employed until 2013 [42].

In the context of innovation and bids evaluation in road industry, literature shows that there is a common belief that higher research and development spending interprets into advanced economic presentation and many studies demonstrations that there is no association between research and development expenditure and company success [13, 14]. According to Kandybin and Kihn (2004), for corporations to maximize invest of return on innovation in evaluating bids, an efficient innovation value chain is essential as shown in Figure 6. The innovation value chain consists of four critical types of capabilities namely: commercialization, ideation, development and project selection [39, 56].

2.5. Indicators of Innovation (RQ5)

According to innovation and science Australia, people in Australia now a day live much longer, physical healthier, as country has some of the highest values of living in the world thanks to the new technological innovations. The advantages that innovation has transported to community’s lives are in the quality of life that people enjoy inn Australians and the expressive work Australian undertake. That is the reason innovation continues to be serious for the future of Australian people, and to inspire other countries Australian need to focus on the following indicators of innovation: Education, industry, Government, Research and development and culture and ambition.

2.5.1. Education

In order to response to the changing nature of workplaces by preparing all people in Australian must be educate and trained by 2030. Therefore, it is important to teach people desire skills such as science, engineering, technology and mathematics so that their skills can be improved through the development of high skilled training to our teachers. Also, Government make sure that vocational education and training system is available to the new priorities offered by innovation [43]. Figure 7, presents how much Government spend on schools and its outcomes. After the analysis of data and its result team from Innovation and Science Australia, recommend the following:

- Reinforce training for pre- service and during the service school teachers;
- Must prepare students for post-school technology, engineering, science, and mathematics professions;
- Increase student determination and achievement in learning and proficiency;
- Examination the training and vocational education system;
- Continue and reinforce reforms to the training and vocational education system.

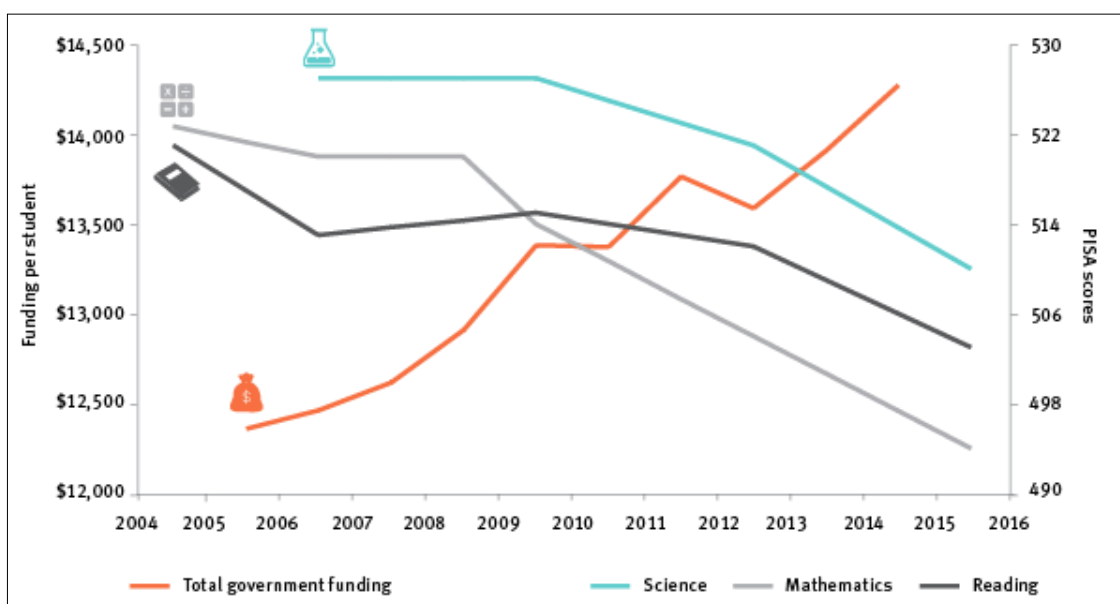


Figure 7. School education funding and outcomes, 2004-05 to 2015-16 [43]

2.5.2. Industry

For Australia situation, Government should ensure Australia’s continuing success by inspiring high-performance organizations and improving production. According to the report result, Australia’s innovation investment and talent could be supported by cultivating access to worldwide talent pools and development better diversity [43]. Figure 8, presents how much business and government on development and research from 1992 to 2016. Government spend on schools and its outcomes. After the analysis of data and its result team from Innovation and Science Australia,

recommend the following:

- Through improving the Government support, the business expenditure can be reverse;
- To promote innovation Government should enhance efforts to support small and freshly started businesses;
- The first thing Australia business can do, is to priorities spending in machine learning and artificial intelligence;
- Guarantee strong competition in knowledge rigorous commerce sectors.

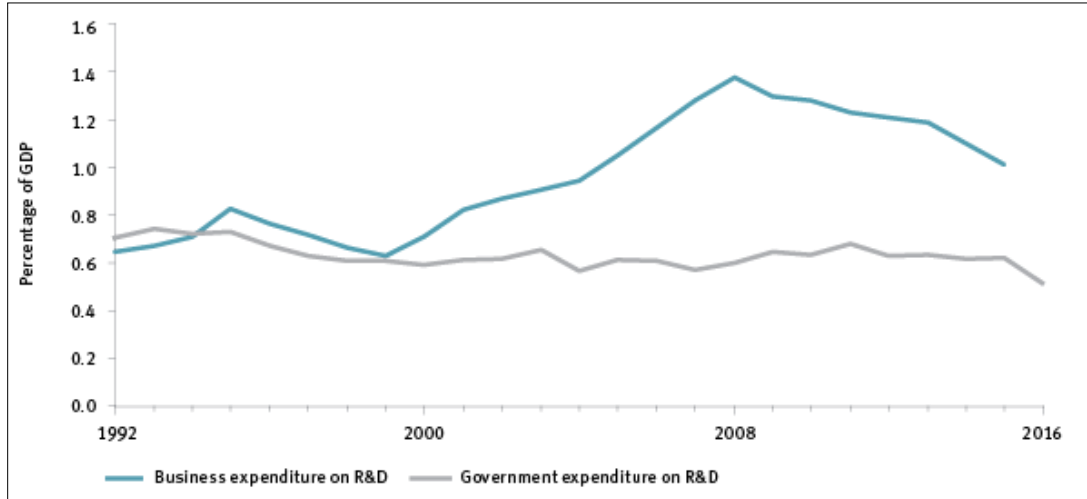


Figure 8. Expenditure of Australian business and government research and development, 1992–2016 [43]

2.5.3. Government

The Government and its related agencies should be motivated for innovation and be recognized as a worldwide leader in advanced service distribution. Therefore, a flexible supervisory atmosphere that supports advancement and innovation may be attained through partnership between Australian governments and customers [43]. In this way Australia Government procurement as a strategic control in order to bring innovation in the country. Figure 8, presents Government expenditure on procurement contract from 2008 to 2016. After the analysis of data and its result team from Innovation and Science Australia, recommend the following:

- Form a more flexible monitoring atmosphere that adopts innovation;
- Reassure social innovation sending all over Australia;
- Expand delivery and use of open administration information;
- Upsurge the employ of innovative procurement plans.

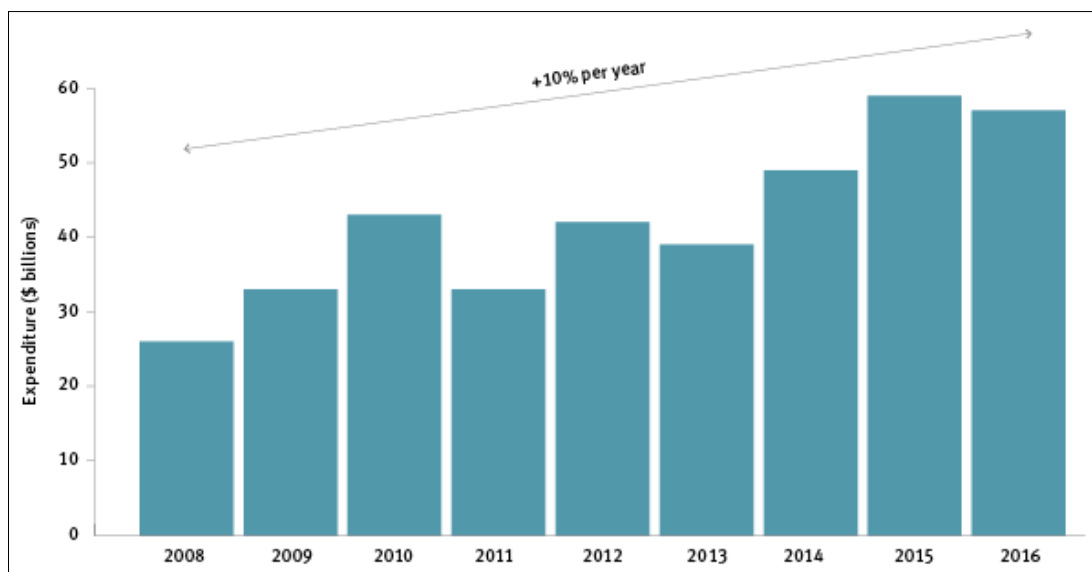


Figure 9. Government expenditure on procurement contract from 2008 to 2016 [43]

2.5.4. Research and Development

Another way to improve innovation in the country is the improvement of research and development efficiency by increasing transformation and commercialization of investigation. The strategy for the implement of innovation in research and development by maintaining Australia's excellent quality research and continually improve investment in national research structure, commencing with the country's high performance information systems and computing facilities [43]. Figure 10, presents Government expenditure on research and development from 1992 to 2014. After the analysis of data and its result team from Innovation and Science Australia, recommend the following:

- Familiarize a partnership premium on tax balance to incentivize teamwork;
- Appraise scaling-up business higher grade by investigation placement plans;
- Appraise the influence of current changes to incentivized partnership in 2022.

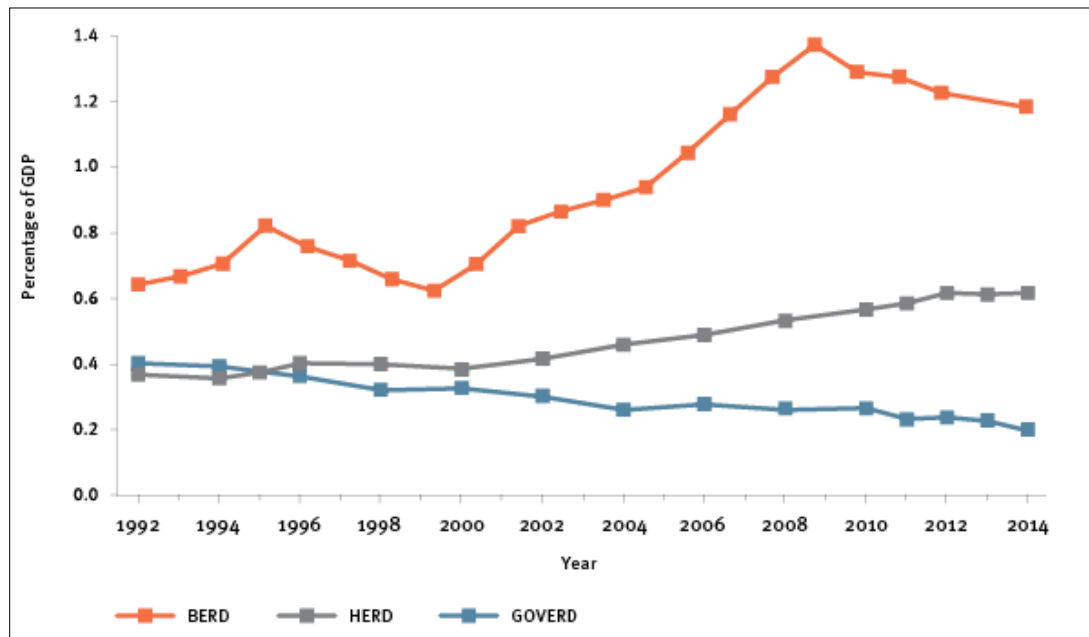


Figure 10. Government expenditure on research and development from 1992 to 2014 [43]

2.5.5. Culture and Ambition

Another innovation indicator is culture and ambition, in which Government should improve the nationwide culture of innovation by initiation of ambitious national agendas. The strategy is that Government should ensure National Missions are suitable and can be attained through the implementation of a robust method to implement and identify missions [43]. Figure 11, presents health and life expectancy expenditure per person in different countries. This indicates that innovation in people health can improve the progress of people at workplace. After the analysis of data and its result team from Innovation and Science Australia, recommend the following:

- The ideal health system mission, delivery and innovation assistances for all Australians;
- Guaranteeing Australia's National Missions are active might be attained through the implementation of a robust method to implement and identify missions.

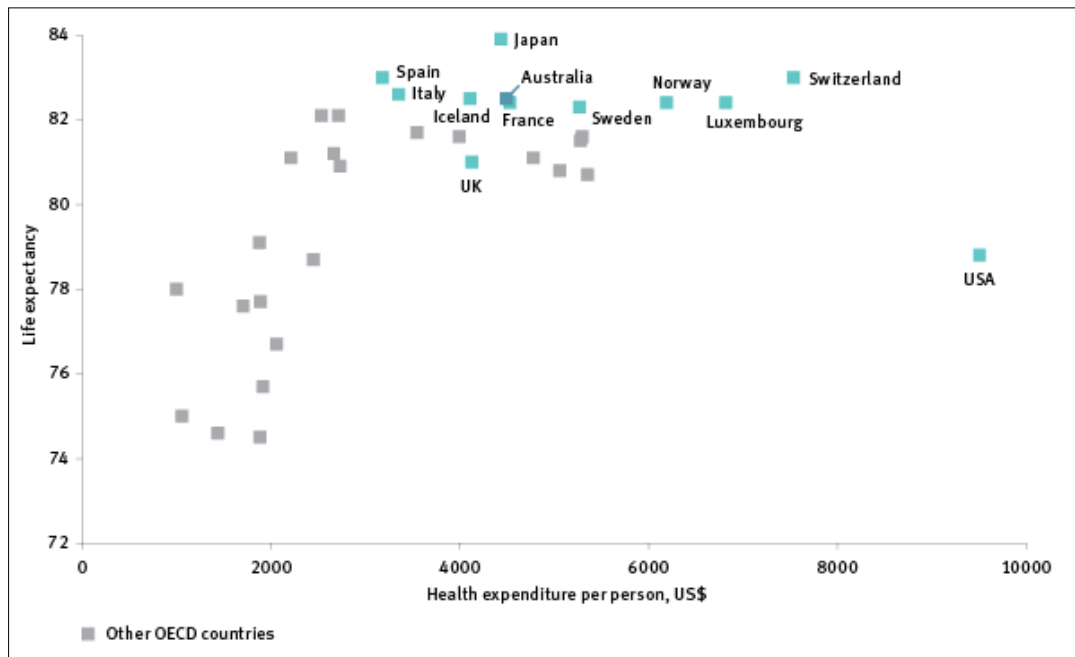


Figure 11. Health and life expectancy expenditure per person in different countries [43]

3. Conclusion and Recommendations for Future

The selection of road contractors is most of the times conducted at the tendering stage. Tendering at early stage certainly gives a customer an option in accepting contract from a contractor which offers construction in short time and the lowest cost, nevertheless generally they do not permit to exactly assess and evaluate a tender. While, there are many procedures in which the decision on the standard of selecting a road tender is the cost. In recent years, maximum road construction customer made use of these types of a method. Moreover, literature indicates that the low-priced tenderers frequently have difficulties with accomplishing the project. Selecting the cheapest price is the basic reason of challenges in the project completion as most to the time low-priced means lowering the project quality. Therefore, this situation makes it particularly significant to appropriately assess the road contractor's competences.

Literature presents several methods to assess the comparative tender assessment by using the following factors: proposed cost, bidder management system, resources, their performance in the market, and their related work experience. However, literature shows that still many projects related to road and bridges construction failed due to lack of awareness innovation when assessing tenders. Innovation is a key factor, as this allow government to assess the bidder's capacity of using new technology and ideas, as due to global warming we need new ideas to contrast roads. Aim of this paper is to present a systematic review of bid evaluation process and assessment of innovation in road construction industry.

During research review number of real-world case studies on the road sectors in the context of bid evaluation were examined. The findings indicate that there is an emergent need of innovation in the bid evaluation in the road construction industry. This led to further examine the research in regard to identify the factors that contribute to the evaluation of bids. Also, the result indicates that most developed countries are aware of the need for innovation as the key to sustainable and environment-friendly, cost-effective methods of road construction as well as maintenance. However, still many developing and developed countries are ignoring innovation the road industry, which could lead to the numerous research and practical implications can be obtained from this study, which are as follows:

- Academics and researchers interested in the research area of bid evaluation and assessment of innovation in the road industry. This article presented detail information on factors included in bid evaluation process, how to assess innovation in the process of bid evaluation, exiting bid evaluation techniques and methods, motivation behind bid evaluation and assessment of innovation in road industry, and evaluation of different innovative cases in road construction industries.
- Practitioners who are interested in how to evaluate and assessment bid from different bidders. This research proposed a comparison on bid evaluation process and assessment of innovation and discussed several innovative projects in the area.

4. Declarations

4.1. Author Contributions

Pardeep Kumar Oad, Stephen Kajewski, Arun Kumar, and Bo Xia contributed to the design and implementation of the present review, to the analysis of the results and to the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

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4.3. Conflicts of Interest

The authors declare no conflict of interest.

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