Value for Money in Infrastructure Projects: A comparison between budget techniques used in Ireland and elsewhere

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Abstract

The focus of this research was to examine the current budgeting techniques used in infrastructure projects in Ireland, and to compare these to those used elsewhere. Its aim was to analyse how such methods are utilised, and how this contributes to a project being considered 'Value for Money'. The research was also deemed necessary, to investigate if the same methodologies and techniques were used in Ireland as were globally.

A sample of industry professionals were surveyed to gauge their response on questions on both budgeting techniques used and also value for money on projects. This sample covered areas such as Ireland, UK, Australia and the Middle East to ensure an appropriate comparison.

The main findings of the research are that there are relatively few tried and tested budgeting techniques and that such techniques that are used only demonstrate a project is 'better' Value for Money than competing projects, rather than suggesting it is value for money on its own merits. The findings of this research confirm the most commonly used budgeting techniques are Cost Benefit Analysis and Net Present Value methods.

The main conclusions and recommendations of this research therefore, are that Value for Money needs to be clearly measurable on a project thorough out the entire life cycle of a project and the project success factors clearly aligned to this concept. There are processes in place to achieve this at project selection stage, but such requirements need to be made part of the project completion process.

Key Words: *Budgeting Techniques; Value for Money; Infrastructure*

Introduction

This study sought to examine which budgeting techniques are used in infrastructure projects, both in Ireland and globally, to theorise what are the most advantageous of such techniques to use. For example, what part can and does reference class forecasting play in the selection of projects to undertake? Or is Net Present Value the most utilized method in cost analysis, and comparison of competing projects?

Previous research in this subject internationally has been conducted by authors, such as Espinoza (2014), Fridgeirsson (2009) and Flyvberg (2008). This research examined

what were international best practice in budgeting for infrastructure projects, and Ireland in particular was the focus of research by Gühnemann and others (2012). Some of this research conducted also examined the cost and benefits of project selection, whereas this study will only address the cost impact of a project.

The study will also investigate the particular budget techniques which inform the criteria established to decide if particular projects are accepted as being 'value for money' in the initial stages of project development. Also, if certain budgeting techniques are favoured over others, and if so why?

The methodology used to conduct the research was to undertake a questionnaire based study, as this was deemed the most beneficial way to illicit responses from those working in the relevant industries. As there was minimal research into the topic in Ireland, the questionnaires were sent to respondents globally, to compare with the responses in Ireland.

What are the techniques available for Practitioners?

Previous research identified some of the available techniques used in the industry for budgeting of projects. Iluah (2014) lists out three such methods in existence:

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Benefit Cost Ratio (BCR)

The Net Present Value method discounts back all of the costs (and benefits) of projects to a single time to allow comparisons to be made of similar projects to see which will be the better option for investment. For example, by discounting back a project which will say take five years to build and one which will take three years to build, a comparison of sorts can be made to assess which is better. This is a rather simple example, and to put into context, the assumptions that are made in such budgeting techniques being used in large scale infrastructure pose a multitude of assumptions being made and pushed forward. According to Trigeorgis (1996), 'it should be noted that in the absence of risk, the NPV method is indeed a valuable tool as it provides a consistent financial measure of the value of an investment'. Benefits of using the NPV method to evaluate projects include 'emphasising the importance of liquidity' and assisting the ease of comparison of different projects, 'and to reject projects that do not have an acceptable NPV' (Dyson, 2007).

The IRR method is quite similar to NPV in that it discounts back the future costs and benefits of a project back to a common time frame. The difference being, the IRR method seeks to discover the rate (as in percentage rate) at which the NPV of a project will equal zero. It aims to calculate the rate rather than defining it as in the case of NPV. The advantage of this method is that 'it gives a clear percentage on return on an investment' (Dyson, 2007). The IRR method likewise, to NPV, suffers from the over simplistic approach to development costing of a project with the use of assumptions

which can on occasion be arbitrary figures. This is especially true of large scale development projects, which could be programmed to occur in different phases, with different risks and assumptions used.

The application of Benefit Cost Ratio (BCR) is one of the more common appraisal tools in infrastructure projects. In the UK, for instance, it is deemed an appropriate tool by HM Treasury for such infrastructure projects funded from the exchequer. BCR is where the benefits are monetised on one side, and a ratio is created for the expected costs of the project. Berechman (2010) defines it as 'the present value of the projects total benefits divided by the present value of its total costs'. It is a useful tool, used in conjunction with NPV, can compare like for like projects. The problem arises when issues in Infrastructure projects such as Environmental and Social considerations have to be monetised as part of the process.

As can be determined from the above three budgeting techniques, they are all broadly similar tools for appraising projects. The three methods recognise the time value of money, but the main difference between the three is the output received at the completion of the procedure – NPV give a monetary sum, IRR a percentage rate and BCR a ratio of costs: benefits. They are useful for comparing projects, as long as similar techniques are used to compare the projects, and also that the assumptions used are consistent.

The research into the above techniques has also highlighted the need to not just assess the cost an estimate factors when discussing budget. There are a number of other tools and techniques to be aware of which are useful for infrastructure projects, such as Cost Benefit Analysis (CBA) and Multi Criteria Analysis (MCA) which take into account not just the costs, but also the benefits. Cost Benefit Analysis is a tool to look at the costs and benefits of a particular project. It has its origins in Infrastructure, notably on the utility of public works in 1884 (Ashworth, 2004). It lists out the determinants to cost, such as construction estimate, cost of acquiring land, cost to business, etc. and measures those against the benefits such as shorter commuting time (in the case of Infrastructure) and employment during construction. This will of course indicate if and where value for money can be achieved in a project.

Multi Criteria Analysis, similar to CBA, is used to define and measure the characteristics which will the effect the overall success of the project, as far as they are foreseeable at the project selection stage. According to Ward et al (2016) 'MCA concerns the making of choices using multiple, and often conflicting, criteria, in efforts to arrive at pre-considered desired outcomes'.

Unfortunately, the above methods of estimating a cost of a project (infrastructure or otherwise), and then making assumption of present values of future costs is fraught with assumptions and 'best guess'. According to Kahnemann (2011), this is undertaken with an optimistic rather than realistic slant on costs and benefits. Flyvberg (2006) goes on to stress the existence of 'strategic misrepresentation' in cost forecasts. This he explains is an underestimation of 'costs in order to increase the likelihood that it is their

own projects and not the competitions that gain approval and funding'. A method to allow for this has been developed, known as Reference Class Forecasting (RCF). It involves the development of a large scale database of projects with actual costs to develop a reference class for estimates for similar projects, to arrive at the most likely cost of a project. The RCF method was used on the Edinburgh tram project which had a massive cost overrun (costing more than twice its original estimate) with a reduced scale of the development. The reason given for the incorrect baseline estimate given by the RCF method was that the uplift for optimism bias was underestimated, despite the fact that the forecasters were using government figures for the uplift (Flyvberg, 2008). As RCF is in its infancy, only being accepted in the last ten years or so, its use will become more substantial as more refined databases are developed to estimate costs.

Definition of Value for Money with respect to Project Success Factors in a construction / infrastructure project

Value for money in projects can have a very different meaning to each of the parties involved depending on their assigned risks and interests in the project. Indeed, to achieve project success many stakeholders in the project will look to transfer risk to ensure they meet their own goals. In the UK, HM Treasury (2000) defined value for money on public projects as 'the optimum combination of whole life cost and quality (or fitness for purpose) to meet the user's requirement'. Therefore, value for money does not only take into account the final cost of delivering the project, but also the cost in use of the deliverables and also the fact that it meets the specifications as set out.

Value for money at the procurement stage of the project process, is undoubtedly one of its main key drivers. As this research is focussing on the pre-selection stage it is important to be aware of the differences in goals of the teams involved. In project selection, the developers of the budget wish to get the correct project approved, possibly in competition with other projects which is seeking funds; those involved in the procurement process have a budget approved, so need to get the best value for money from the procurement process itself – usually by utilising competitive tendering between a number of parties. According to the European PPP Expertise Centre (2016), "A necessary condition for a project to represent value for money, irrespective of the procurement option chosen to deliver it, is that the benefits to be derived from the project outweigh the costs". The opportunity to achieve this is at its most pivotal at the project selection stage, and diminishes the further the project is developed.

Reeves (2013) listed out the following drivers of Value for Money in Infrastructure projects in no particular order of relevance:

- Competition
- Risk Transfer
- Output Specification

The same author also outlined obstacles to value for money, namely (a) the cost of borrowing, and (b) transaction costs.

Research by Ball et al (2003) on Private Finance Initiative (PFI) projects listed Risk Transfer as having the greatest significance on achieving value for money. As many infrastructure projects globally are funded in this way it is important to remember this fact. The importance of risk transfer is also outlined in the Irish government report Public-Private Advisory Group on PPPs (2001). Here it is stated the idea is not about risk avoidance but 'optimal allocation of risk, for example, by exploiting private sector competencies (managerial, technical, financial and innovation) over the project's lifetime and by promoting the cross-transfer of skills between the public and private partners'.

International Methods for VFM Approaches to Project Selection

Research has been undertaken on Budgeting techniques in project management elsewhere, such as the use of MCA by Asian Development Bank (ADB) for road and transport projects, and also by the European Investment Bank in urban project appraisal (Ward et al, 2016). It is important to remember that, as part of the EU, much of the funding for infrastructure in Ireland comes from European sources. There is research being conducted into how best to fit such accountability in the techniques used in budgeting for healthy project performance. The OMEGA Centre for Mega Projects in Transport and Development, based in University College London (UCL) is an 'international network of researchers and professionals engaged in various aspects of the planning, appraisal and delivery of mega transport projects (MTPs) world-wide' (OMEGA Centre, 2016). The researchers carried out a 'five-year international research programme of 30 case studies of decision making in the planning, appraisal and delivery of Mega Transport Projects (MTP's) in ten developed economies in Europe, USA and Asia Pacific' (Dimitriou et al, 2013). Their research did not take into account the budgeting techniques used in appraisal of such MTP's, but declared that budgeting is not necessarily one of the critical success factors of project success. In this respect, they concluded that other requirements can also have an effect on value for money, such as the fact that the project added value to the national economy of the country concerned, the project was sustainable in the future and that the correct specifications were used to complete the project.

The OMEGA Researchers also concluded that government bodies such as Infrastructure Australia has been initiated to advise the government on 'investment priorities for critical national infrastructure developments' (Dimitriou, 2013). In this respect, value for money is a requirement of Infrastructure Australia's Urban Transport Strategy, when it was stated 'Australia needs an urban transport strategy to ensure that our community gets the best value for money in terms of infrastructure spending' (Infrastructure Australia, 2014).

Research by Mackie et al (2014) revisited the known appraisal techniques in transport projects up to that point, in the various locales worldwide. It included a summation of the budgeting techniques used in such locations, the most common of which were NPV, BCR and IRR. This research is of benefit as it considers locations as diverse as the UK,

Europe, Australasia and North America. It confirms the use of NPV and BCR in both the USA and Australia. It also considers the use of First Year Rate of Return (FYRR) as an investment appraisal tool, in both Australia and New Zealand. FYRR 'is computed by dividing the first year's net benefits by the PV of the cost of the investment, A low FYRR may indicate a poor investment (Berechman, 2010).

Data Collection – Survey of industry professionals

The survey was forwarded to 121 industry professionals worldwide. Of those, 28 replies were received, indicating a response rate of 23%. The vast majority of the respondents were from cost and commercial roles, with a suitable geographical spread (Ireland 21% - Africa 21% - Middle East 25% - Australia 18% - Others 15%).

To ascertain the relevance of Value for Money, the sample audience were tasked with scoring what were considered main drivers of value in the context of projects, over and above those defined by HM Treasury as discussed previously. The sample scored what were considered additional parameters that should be included in a definition of value for money. The respondents to this survey regarded the Economic Added value of a project to be of paramount importance of the options given (44% of respondents put this as their first choice). Of the other options, the weighted scoring put Schedule and Programme second in respect to a project being value for money ahead of Sustainability. Interestingly Sustainability was the most popular second choice response, ahead of schedule and programme.

One has to wonder why sustainability is lower in such a survey, it can only be surmised that the sample only considered VFM in the context of a project rather than the perspective of the whole life cycle of a venture. Sustainability is key to the full cost and benefit of a project, which once the life cycle of a development is complete can be assessed properly. Also, there was also very narrow margin between both, and a minimum number of different answers could have altered the survey either way. The 'Environmental' consideration was placed at the least likely to affect Value for Money, which would be expected, but open to challenge, as infrastructure projects especially can have a lasting effect on their surrounding areas, but again may not necessarily have a monetary value.

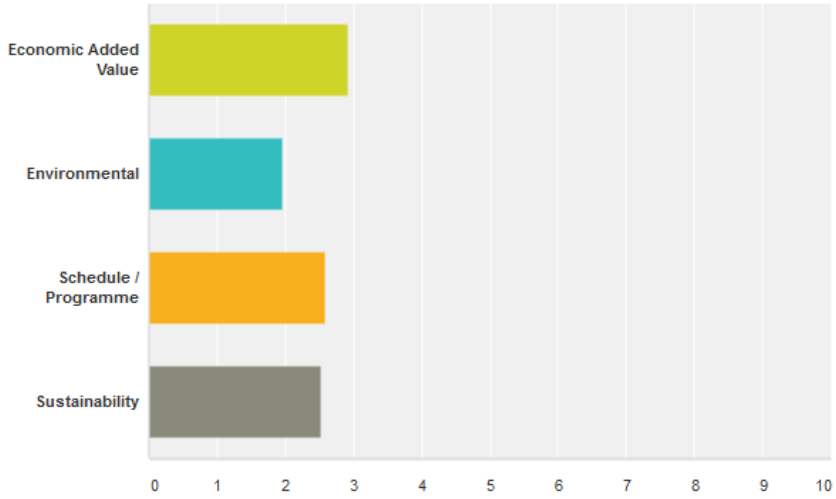


Table 1: Value for Money in infrastructure projects is defined as 'the optimum combination of whole life cost and quality to meet the user's requirements' by HM Treasury in the UK. On a scale of 1-4 please rate the following as you would include in the above description of Value for Money

The samples were also asked whether a Value for Money assessment is undertaken as part of the project approval process, in their experience. This will determine whether Value for Money is an integral part of the respondent's project management processes, which were it not considered important would not form part of the approval of projects to commence. The overwhelming response to this was to the positive (89% Yes), leading to the indication that Value for Money is a requirement of Project Approval regardless of location. Whether this is integral to project approval or just another box to be ticked as part of the process will be investigated further in this research.

The following question looked at the requirement of a Value for Money exercise once a project has been completed and handed over to the operators (see Table 2). Interestingly, despite the fact that it is easier to judge whether an infrastructure project has been value for money once the project phase has been complete, less than half of those surveyed are required to complete a Value for Money exercise at this stage to add to the learning from project completion. Of those surveyed, Australia and the Middle East respondents were the only to have a majority whose projects actually undertake Value for Money exercises upon project completion.

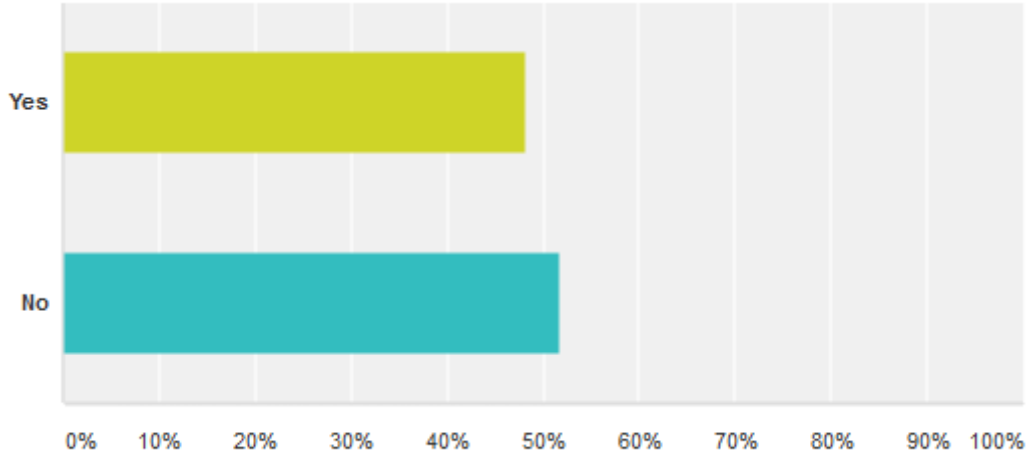


Table 2: Upon Project Completion, does your company complete Value for Money exercises as part of the project close out?

The next section of the questionnaire dealt with which budgeting techniques were used in projects of those contacted. The first question was a multiple choice, multiple answer question. The respondents were given a number of budgeting techniques, and those they used in projects were to be selected. The most popular answers in this section was the Cost Benefit Analysis and Net Present Value (NPV). This suggests when determining budget costs for an infrastructure project, the sample of cost professionals surveyed used the most common methods. Of the other choices, BCR is used in the Middle East and the United States; MCA is used in Africa and the Middle East; and the most recent technique, RCF, is gaining use in Australia, the United Kingdom, the Middle East and Africa, according to this sample (see Table 3). This ties in with the sources above, where CBA is still the most common specified in public infrastructure works, but both MCA and RCF are getting attention for the appropriate budgeting of projects. The next question follows up on this question, with a query on procedures for correct budgeting on such infrastructure projects, and the majority (73%) agreed that their company had specific procedures in place as to how to conduct the above budgeting techniques in an infrastructure project (see Table 4). This suggests that the lead is taken by the employers / sponsors on a project, and the respondents to this survey engage in the use of such techniques to correctly implement the budget strategy. Therefore, if. for example, MCA was specified by their company those surveyed would be tasked with implementing the budget technique as part of the budget strategy.

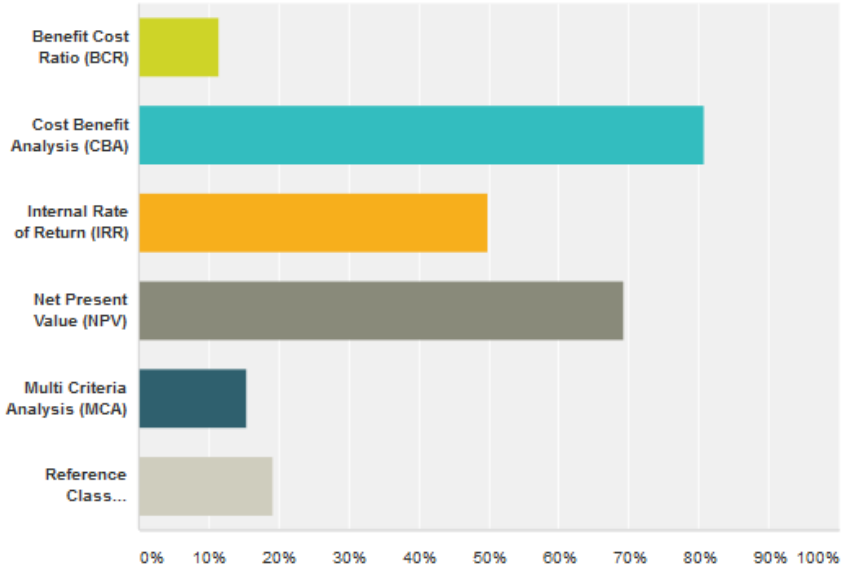


Table 3: Which, if any, of the following are used for budgeting of a Project?

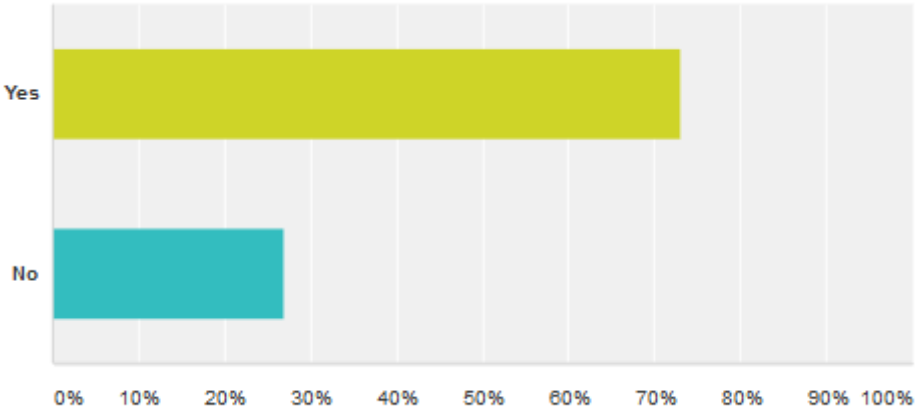


Table 4: If yes, are there standardized procedures in your company how to conduct the above techniques?

Table 5 demonstrates the responses on the subject of the budget review process of infrastructure projects. The most common methods used to review budget process, are Value Engineering exercises (92% of respondents) and Risk Review sessions (77%). Almost all respondents chose one budget evaluation method, with over 80% choosing at least two methods for inclusion with the budget review process. It can be assumed from this, that there is a rigorous review of budgets to ensure robustness of the budget. Team workshops are also a popular method of budget review (54%), as they can include all members of the team (including project managers, planners, design, architecture, etc.) to ensure any and all risks to the project have been considered. Less

widespread budget review methods were Brainstorming Sessions (45%) and the Delphi Method (12%). No alternatives to those listed were proffered by the respondents.

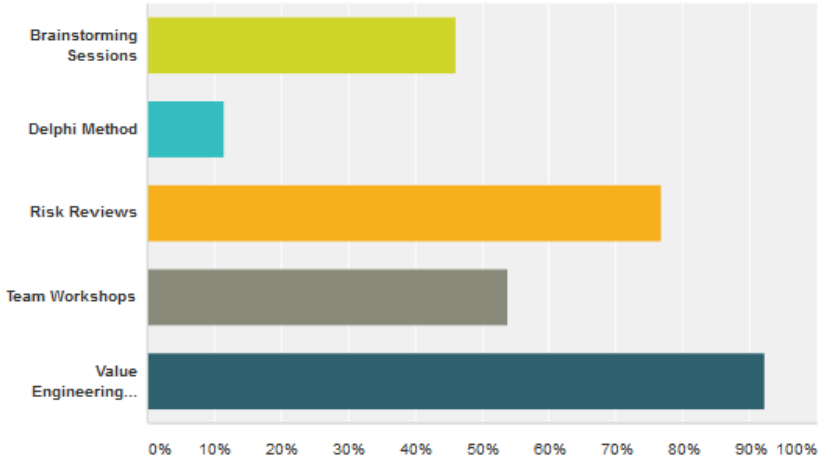


Table 5: Which, if any, of the following are completed as part of the company's budget review process?

The following questioned the sample on their opinion of the project budget; do they consider the contingency allowance in projects (in their experience) to be Optimistic, Pessimistic or Realistic. Most agreed that the budget contingency of their project experience was realistic. One respondent stated that the budget contingency is 'Quantitatively determined by an integrated cost-schedule risk analysis to an agreed level of confidence' (Anon, 2016). This would suggest that the contingency is rigorously checked to ensure that it is realistic. Again, it is important to remember from the previous discussion of RCF, that a robust contingency or uplift for risks contains a certain level of confidence, so that the risks can be tracked against any contingency allowed for. This could likewise tie into a Value for Money exercise upon project completion, hence the reasoning behind this question.

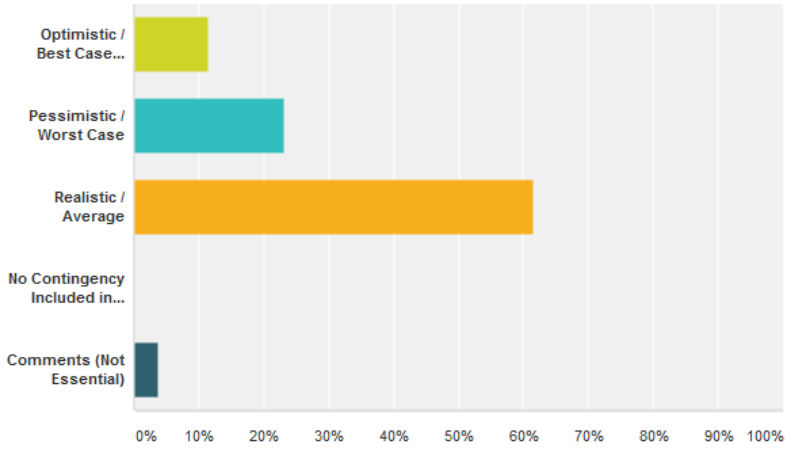
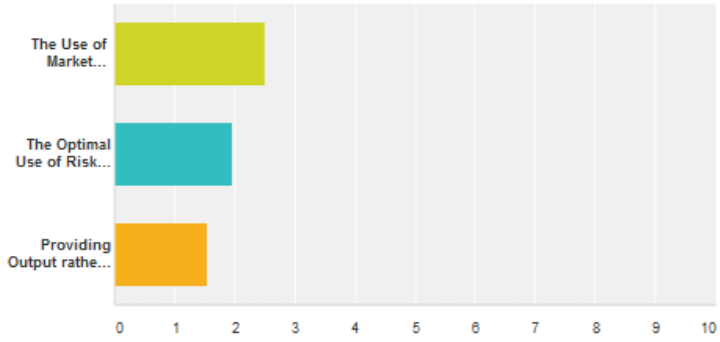


Table 6: When Including Contingency on a Project, do you consider the allowance

Table 7 follows up on the previous research by Reeves in 2013 on the main drivers for Value for Money. As this research only listed out such drivers, this question focussed on which order the sample audience would place such drivers within the context of their experience. The main driver as the sample saw it for Value for Money is by leveraging the tendering process to get the best Value for Money from the tendering contractors. Obviously once a contractor is on site for an infrastructure project, their main interest is to make the venture as profitable as possible for their company. This may not necessarily be in agreement with the goals of the sponsoring agency, so at the tendering stage is the most optimum time to leverage this position to achieve Value for Money. Less considered by the sample audience as a driver of Value for money is the use of output specification rather than input as to what the project should include as part of its specification. This may again involve risk transfer, as it would then be the contractors remit to achieve an output, by which ever means they deem necessary, as long as they meet the required standards.

Interestingly, 39% of respondents gave the three drivers in the order they were given, i.e. 1,2,3. This would lead to the possibility that some of the respondents may have been influenced by the order in which they were given and this sample may not necessarily be of use for this question. Therefore, caution must be exercised when making recommendations and conclusions using this data.



	1	2	3	Total	Score
The Use of Market Competition to get better value for money (Tendering)	61.54% 16	26.92% 7	11.54% 3	26	2.50
The Optimal Use of Risk Transfer as part of the Contract Negotiations	23.08% 6	50.00% 13	26.92% 7	26	1.96
Providing Output rather than Input Specifications to Tendering Contractors	15.38% 4	23.08% 6	61.54% 16	26	1.54

Table 7: According to previous research, the three below options are the main drivers of Value for Money on infrastructure projects. On a scale of 1-3, please rate them in order of relevance you deem them to be

The remaining question in the survey focussed on the opinions of the sample with a straightforward 'Yes' or 'No' response. The first requests the opinion of the respondents on the question of whether there is a robust process for reviewing budgets prior to project approval. In the majority of replies (81%) this is the case. This would indicate those involved in the cost management of projects are satisfied that project budgets are sufficiently reviewed. Two of the respondents commented on this question, the first declaring that the budget review process 'is very strict' (Anon, 2016), while the second respondent stated that budget costs are obtained from 'established contractors for various elements' of the project (Anon, 2016). While this may be easier to achieve, it is also important, for the accuracy of the budget, to ensure that the assumptions of the established contractor are fully stipulated before being included in any overall budget.

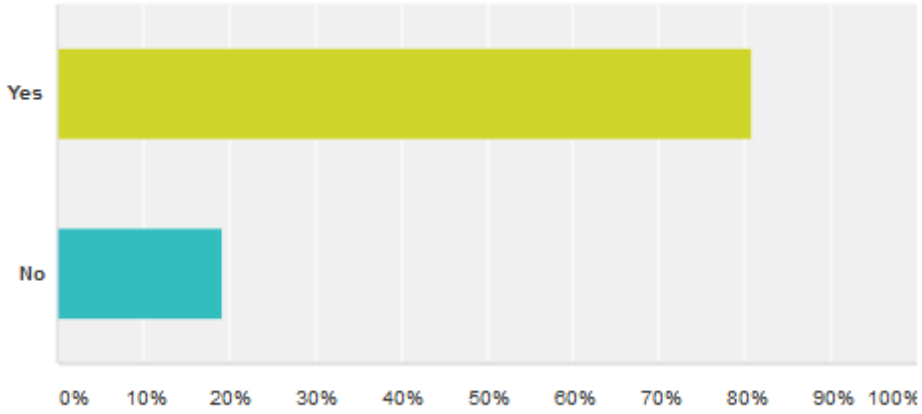


Table 8: In your opinion, is there a robust process for reviewing budgets prior to project selection?

CONCLUSIONS

In conclusion, the survey did for the most part answer some interesting questions on the subjects of budgeting techniques and value for money in infrastructure projects. One of the main findings from analysis is that while most budgeting techniques are common across the jurisdiction, there are relatively few techniques available for use. Such techniques also only show a project as 'better' Value for Money than competing projects, rather than suggesting it is value for money on its own merits.

Also, while value for money exercises are almost always carried out at the evaluation stage of project development, at the project completion stage they are generally not. Also, while the main budgeting techniques used are traditional CBA, MCA and RCF are gaining traction in the industry. This can only be a positive, as this will allow professionals to make more accurate assumptions by having a greater array of tools available to estimate and budget for such infrastructure projects, which are generally unique.

The original research sought to consider how the techniques played a part in the selection of certain projects. According to this research, this is generally achieved through the use of the use of standardized metrics and procedures across the board to ensure like for like comparisons were made for projects. Such learnings were to be expected, but the depth of knowledge available was another interesting learning. The analysis also revealed that, according to cost management professionals, Schedule, Cost and Quality are the most significant critical success factors to have an influence on the success of a project, in that order. It also revealed that CBA was the most common budgeting technique used by those surveyed, and also the fact that Value Engineering is the most common technique used in the budget review process.

Bibliography & References

AACE. 2016. *Cost Estimate Classification System - As Applied in Engineering, Procurement and construction for the Process Industries*. [ONLINE] Available at: http://www.aacei.org/toc/toc_18R-97.pdf. [Accessed 27 September 2016].

Amos, S.J. ed., 2004. *Skills & knowledge of cost engineering, 5th Edition*. AACE International.

Anderson, G. and Anderson, G.J., 1998. *Fundamentals of educational research*. Psychology Press.

Armstrong, J.S. ed., 2001. *Principles of forecasting: a handbook for researchers and practitioners* (Vol. 30). Springer Science & Business Media.

Ashworth, A., 2004. *Cost Studies of Buildings*. Pearson Education.

Ball, R., Heafey, M. and King, D., 2003. Risk transfer and value for money in PFI projects. *Public Management Review*, *5*(2), pp.279-290.

Berechman, J., 2010. *The evaluation of transportation investment projects*. Routledge.

Biggam, J., 2008. *Succeeding with you Master's Dissertation.*

Cohen, L., Manion, L., & Morrison, K. (2007) *Research Methods in Education.*

Department of Transport, Tourism and Sport. 2016. *Common Appraisal Framework for Transport Projects and Programmes*. [ONLINE] Available at: http://www.transport.ie/sites/default/files/publications/corporate/english/common-appraisal-framework-2016-complete-document/common-appraisal-framework.pdf. [Accessed 28 September 2016].

Dimitriou, H.T., Ward, E.J. and Wright, P.G., 2013. Mega transport projects—Beyond the 'iron triangle': Findings from the OMEGA research programme. *Progress in planning*, *86*, pp.1-43.

Dyson, J.R., 2007. *Accounting for non-accounting students*. Pearson Education.

Eliasson, J. and Fosgerau, M., 2013. Cost overruns and demand shortfalls–deception or selection?. *Transportation Research Part B: Methodological*, *57*, pp.105-113.

European Union. 2010. *Buying Social: A Guide to Taking Account of Social Considerations in Public Procurement*. [ONLINE] Available at: https://procurement.ie/sites/default/files/migr/Buying%20Social_SocConsidPubProcu_101210.pdf. [Accessed 26 September 2016].

European PPP Expertise Centre. 2016. *Phase 1 - Project Identification*. [ONLINE] Available at: http://www.eib.org/epec/g2g/i-project-identification/11/index.htm. [Accessed 26 September 2016].

Espinoza, D. and Morris, J.W., 2013. Decoupled NPV: a simple, improved method to value infrastructure investments. *Construction Management and Economics*, *31*(5), pp.471-496.

Espinoza, R.D., 2014. Separating project risk from the time value of money: A step toward integration of risk management and valuation of infrastructure investments. *International Journal of Project Management*, *32*(6), pp.1056-1072.

Eyþórsdóttir, E.Ö., 2013. Reference class forecasting method used in Icelandic transportation infrastructure projects.

Flyvbjerg, B., Glenting, C. and Rønnest, A.K., 2004. Procedures for dealing with optimism bias in transport planning. *London: The British Department for Transport, Guidance Document*.

Flyvbjerg, B., 2006. From Nobel Prize to project management: getting risks right. *Project management journal*, *37*(3), pp.5-15.

Flyvbjerg, B., 2008. Curbing optimism bias and strategic misrepresentation in planning: Reference class forecasting in practice. *European planning studies*, *16*(1), pp.3-21.

Flyvbjerg, B., 2008. Curbing optimism bias and strategic misrepresentation in planning: Reference class forecasting in practice. *European planning studies*, *16*(1), pp.3-21.

Fridgiersson, T.V., 2009. The Use of Reference Classes to forecast risk and uncertainty in Icelandic projects. *IProceedings of the 5th Nordic Conference on Construction Economics and Organization,* Vol 2 pp-118-225.

Gühnemann, A., Laird, J.J. and Pearman, A.D., 2012. Combining cost-benefit and multi-criteria analysis to prioritise a national road infrastructure programme. *Transport Policy*, *23*, pp.15-24.

HM Treasury, Government Accounting, Annex 22.1, 2000.

Ihuah, P.W., 2014. Appraisal Methods in Mutually Exclusive Development Projects: A Pragmatic Analysis of Alternative Technique. *International Journal of Applied and Natural Sciences*, *3*(4), pp.1-14.

Infrastructure Australia. 2014. *Infrastructure Australia Recommends a Strategy for Australia's Urban Transport*. [ONLINE] Available at: http://infrastructureaustralia.gov.au/news-media/media-releases/2014/2014_02_07.aspx. [Accessed 4 October 2016].

Institute of Engineers Ireland. 2003. *Project and Cost Estimation and Control: An IEI Submission to the Minister for the Environment & Local Government*. [ONLINE] Available at: https://www.engineersireland.ie/EngineersIreland/media/SiteMedia/communications/publications/June-2003-Project-Cost-Estimation-and-Control.pdf?ext=.pdf. [Accessed 28 September 2016].

Kahneman, D., 2011. *Thinking, fast and slow*. Macmillan. Page 250

Lohan, G., 2012. *Extending Agile Systems Development: An Application of the Beyond Budgeting Model* (Doctoral dissertation)

Mackie, P., Worsley, T. and Eliasson, J., 2014. Transport appraisal revisited. *Research in Transportation Economics*, *47*, pp.3-18.

Merrow, E.W., 2011. *Industrial megaprojects: concepts, strategies, and practices for success*. John Wiley & Sons. Page 75

Naoum, S.G., 2007. *Dissertation research and writing for construction students*. Routledge.

National Roads Authority. 2012. *Project Appraisal Guidelines: Unit 14.0 Non Major Schemes*. [ONLINE] Available at: http://www.tii.ie/tii-library/strategic-planning/project-appraisal-guidelines/Unit-14-Non-Major-Schemes.pdf. [Accessed 28 September 2016].

National Roads Authority. 2010. *2010 Project Management Guidelines*. [ONLINE] Available at: http://www.tii.ie/tii-library/strategic-planning/project-appraisal-guidelines/Project%20Mangement%20Guidelines%202010. [Accessed 28 September 2016].

Office of Government Procurement. 2015. *Public Service Spend and Tendering Analysis for 2013*. [ONLINE] Available at: https://procurement.ie/sites/default/files/migr/ogp-public-service-spend-tendering-analysis-2013-1.pdf. [Accessed 26 September 2016].

OMEGA Centre. 2016. *About OMEGA Centre*. [ONLINE] Available at: http://www.omegacentre.bartlett.ucl.ac.uk/about-omega/. [Accessed 4 October 2016].

Priemus, H. and van Wee, B. eds., 2013. *International handbook on mega-projects*. Edward Elgar Publishing.

Public-Private Advisory Group on PPPs. 2001. *Framework for Public Private Partnerships "Working Together for Quality Public Services"*. [ONLINE] Available at: http://webcache.googleusercontent.com/search?q=cache:8R-ogRku7jIJ:www.housing.gov.ie/sites/default/files/migrated-files/en/Publications/DevelopmentandHousing/PPP/FileDownLoad,1752,en.doc+&cd=2&hl=en&ct=clnk&gl=ie&client=firefox-b-ab. [Accessed 26 September 2016].

Reeves, E., 2013. Public-Private Partnerships in Ireland: A Review of the Experience. In *Paper presented to the Nevin Economic Research Institute*.

Stevenson, W.J. and Sum, C.C., 2002. *Operations management* (Vol. 8). New York, NY: McGraw-Hill/Irwin.

Treasury, H.M.S., 2003. The green book: appraisal and evaluation in central government. *London: HM Treasury*.

Trigeorgis, L., 1996. *Real options: Managerial flexibility and strategy in resource allocation*. MIT press.

Ward, E.J., Dimitriou, H.T. and Dean, M., 2016. The application of policy-led multi-criteria analysis to mega transport infrastructure project appraisal. *Research in Transportation Economics*.

About the Author

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Eugene McGrath is a Chartered Quantity Surveyor with over twelve years' experience in the Irish and UK construction industries, working on various projects in the residential, civil engineering and oil and gas industries. Having completed his BSc in Quantity Surveying from the College of Estate Management, Reading, he followed up on this with an MSc in Project Management from the University of Salford. As well as being chartered by the RICS and SCSI, he is also a member of the AACEI (Association for the Advancement of Cost Engineering International), certified as a CCP.

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