# Decision making in the front end of large-scale projects: a scoping review.

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## Abstract

Decisions made by project managers at the front-end stage can have a significant impact on the success of large-scale complex projects, but there appears to be limited evidence on underlying behavioural decision-making processes. The analytical modes of decision-making are the more widely recognised decision-making approach in project management literature, while the typical errors relating to the use of other decision approaches, such as heuristics and the resulting biases, are emphasised. Behavioural decision making is relatively new and offers a different lens to studying decision making in the front end of projects. This scoping review aims to provide a structured overview of the debate and findings of studies on decision-making at the front end of large-scale complex projects to make suggestions for future research.

Methods: A scoping review was conducted using Arksey and O'Malley's framework. The literature review was conducted by scoping available peer-reviewed literature published in three major academic online databases: Scopus, EBSCOhost and Web of Science, by analysing 17 papers published between 1983 and 2023 (years inclusive).

More research needs to focus on actual decision-making behaviours at the front end of large-scale complex projects, as indicated by the low number of articles that were retrieved. A call for more investigation into how decisions are made at this crucial phase of project management is proposed to improve front-end value creation.


## 1. Introduction

Mega projects, Large-Engineering projects or Service-Led projects are labels used to describe very large-scale projects (Sanderson, 2012). The performance of these projects is not measured solely on project management success but also on the long-term value it brings to the organisation or population (Laursen & Svejvig, 2016; Morris, 2013). This recognition of the need to create value (Zerjav et al., 2021) has resulted in an increased focus on the front end of projects, because of the strategic decisions that occurs at this phase which has huge impact on the project's success (Edkins et al., 2013). It has also been acknowledged by Morris (2011) that many issues which are capable of determining whether the outcome of a project will be bad or good originate in the decisions made in the front-end phase of project management. Despite the significance of the front end of projects the ability to manage this process is still crucial stage is lacking (McClory et al., 2017) and problems emerging at the later phases of the project life cycle are often because of decisions made at the front-end (Williams et al., 2012). In a systematic review, Denicol et al. (2020), asserts that when it comes to discussing the performance or underperformance of megaprojects, much literature relates to Behavioural Decision Making.

The study of Behavioural Decision Making in project management is relatively new, emerging about 15 years ago (Stingl & Geraldi, 2017). Mullaly (2014) defines behavioural decision making as "endeavours to understand the actual influences on actors on making choices".

Generally, studies on project behavioural decisions making have tended to focus on ignorance or underestimation of risks (Flyvbjerg, 2013; Kutsch & Hall, 2010), biases and heuristics (Newman et al., 2016; Flyvbjerg, 2007). However, key behavioural factors such as emotions (Turner 2021) and Affect (Mosier & Fischer, 2010) tend to be overlooked in the front-end project management literature. In their systematic review that captured different philosophical views and theoretical foundations in behavioural decision making, Stingl & Geraldi (2017) identified 46 publications and group them into three schools based on their onto-epistemological foundation (Rational decision behaviour, Behaviour of the firm and Naturalistic decision making (Turner, 2021)). However, the study did not focus on issues in the decision making in the front end of projects. In another systematic review, a vague decision-making process based on an unstructured logical process and a lack of understanding of project manager's skills for front-end decision making was acknowledged as a vital issue in front end of project management (Babaei et al., 2021).

The front end of project management is a pre-planning process to develop a detailed definition of the scope of a capital project to increase the probability of project success in terms of cost, schedule, operability and value (Saputelli et al., 2013; Zerjav et al., 2021). The project management literature describes three phases in this process. The first phase involves the idea conceptualisation and assessment of opportunities. The second phase consists of assessing project options and selecting the preferred one. In the third phase the final implementation decision is made before full capital investment is committed (Volden & Samset, 2017; Edkins et al., 2013). According to Denicol et al. (2020), poor decision making, amongst other factors, is prevalent in the front end of large-scale complex projects, and it is a significant contributor to project underperformance or failure.

There is relatively extensive work carried out in the area of very large-scale projects relating to governance, decision making and front-end management. But the scope of work looking at behavioural decision making in the front-end of projects remains unclear. It is therefore necessary to undertake a scoping review to obtain knowledge on decision-making process at this crucial stage of large complex project to further advance this area.

## 2. Decision making

Decision making is an important cognitive skill for project managers, and it is critical to establishing long-term success via delivering benefits and creating value (de Rezende et al., 2021; Parth, 2013, Reidy et al., 2016). Problems which arise at the Front end of projects, for example, poor forecasting and issues related to human psychology and behaviours are not only due to technical reasons but also poor decision making (Klakegg, 2009; Williams & Samset, 2010). The process of decision making is usually not a straightforward one. The capability to make right decisions depends on the goal of the decision, the course of action and the amount of knowledge about the consequences of one's action (Bratvold and Begg, 2010). However, decision making in a work setting, are often made under time pressure, cost constraints and uncertainty (Jamshid, 2011) including decisions made at the front end of projects (Rezvani & Khosravi, 2019). Project managers' ability to carefully consider all the options or alternatives can be limited.

Psychologists have established that humans rely on two different processes when making decisions which are underpinned by fast and slow thinking-systems (Evans 2019, Kahneman 2011). The latter thinking system relates to normative approaches, which emphasizes how decisions should be made. The slow-thinking system is a deliberate and logical process involving rational thinking with many decision analysis and support tools that can be used to make the required calculations. The former relates to descriptive approaches that focus on observing, identifying and developing theories that explain an individual's actions and cognitive processes. The fast-thinking process tends to be more automatic and intuitive. Klein describes this process as expressions of experience occurring when experts create patterns that allow them to quickly evaluate the situation before taking a decision (Klein, 2022). Traditional research on the front end of projects have typically concentrated on analytical methods for complex decision making under uncertainty (Mackie et al., 2007) while highlighting the errors of the faster more intuitive approaches such as those relating to heuristics and biases.

There is an emerging interest in behavioural decision making (Stingl & Geraldi, 2017) and areas of psychology, cognition and emotion in project management (Turner, 2022). Given the importance of the front end of projects and the need to make right decisions that would contribute to project success, having a complete knowledge of existing studies and their findings is beneficial for the advancement of the research area. The aim of the scoping review is to explore the extent of knowledge on decision making behaviours in the front end of large-scale complex projects to recommend new approaches of investigation.

*Research questions*

1) What has been reported about decision making behaviours of project professionals in the front end of large-scale projects?
2) What research methods are adopted in investigating decision making at the front end of large-scale projects?

## 3. Research methods

Scoping reviews are becoming a popular method to inform investigation that is based on the identification and analysis of academic literature on a given problem (Peters et al., 2020). The purpose of conducting a scoping review is to provide a preliminary appraisal of the available research literature and the nature and extent of research evidence on an idea or topic (Grant & Booth, 2009). This method of synthesising empirical studies is increasingly becoming popular (Lockwood et al., 2019), and though it shares many commonalities with systematic reviews, the objectives of a scoping review sightly differs to that of systematic reviews (Pham et al., 2014). The main difference lies in the underlying reason for choosing to use either review approach. While a systematic review brings together evidence to answer a particular question, a scoping review maps the identified evidence in relation to an issue or multiple factors and also summarising the evidence to inform further study (Peters et al., 2017, Tricco et al., 2016). Another difference between a scoping and systematic review is that while the former sets out to provide a descriptive overview of reviewed literature and does not critically analyse them or

synthesis evidence from different studies (Brien et al., 2010), the latter aims to collate & synthesis different studies from different studies to minimise bias (Higgins et al., 2011). The justification behind conducting a scoping review is the need to access and understand the scope of the knowledge in behavioural decisions making at the front end of large-scale projects to identify and report the characteristics of the studies and suggest new approaches for investigation. Thus, the objective in a scoping review is different to that of a systematic review where the intention is to inform decision making (Peters et al., 2020).

In line with a scoping review method, various types of resources that are not limited to project management literature were reviewed and incorporated if found to be relevant to the research aim. Therefore, peer-reviewed literature published in major academic online databases, Scopus, EBSCOhost and Web of Science were accessed and reviewed. The methodology for the scoping review was based on an integration of the framework of Levac et al. (2010) and Arksey and O'Malley (2005). The two frameworks are similar because one is an improvement of the other. Arksey and O'Malley's framework outlines five key broad phases while Levac et al. provided more explicit detail on what should be done at each phase of the review process (Peters et al., 2017). See Table 1

| | Arksey and O'Malley (2005) Methodological Framework | Levac et al. (2010) Methodological Framework |
|---|---|---|
| Phase 1 | Identifying the research question | Clarifying and linking the purpose of the research question |
| Phase 2 | Identifying relevant studies | Balancing feasibility with breadth and comprehensiveness of the scoping process. |
| Phase 3 | Study Selection | Using an iterative team approach to select studies and extract data |
| Phase 4 | Charting the data | Incorporating a numerical summary and qualitative thematic analysis. |
| Phase 5 | Collating, Summarising and reporting the results | Identifying the implications of the study findings for policy, practice or research. |

Table 1 Adapted from Peters et al., (2017).

### 3.1 Literature search strategy

The scoping review was guided by the research questions highlighted above in section 2. The search was conducted in three major online research platforms (Scopus, EBSCOhost - Business source complete and Web of Science). These databases were chosen due to their comprehensiveness in covering an extensive range of disciplines. Papers published between 1983 and 2023 (years inclusive) were retrieved. The decision to limit the period of publication to 40 years was influenced by the review of forty years of organisational behaviour in project management (Turner 2022). In addition, limits were placed on the timespan and language to balance, comprehensiveness, breath, and feasibility (Levac et al., 2010; Arksey & O'Malley, 2005). Thus, only publication in English were targeted. The search strings consisted of

keywords and terms associated with front-end decision making in business and management discipline: Decision AND making AND front-end AND projects, Decision AND Governance AND front-end AND projects, Intuition (Intuitive) AND decision AND front-end AND project, Analytical AND decision AND front-end AND project. The search focused on published studies in peer reviewed journals and conference proceedings.

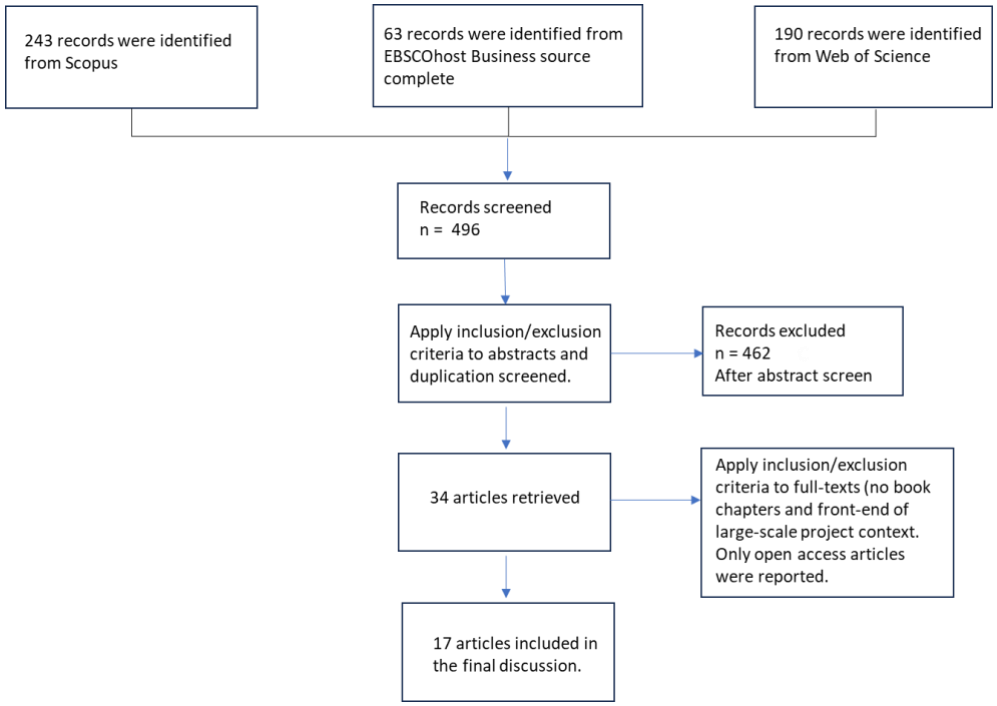


Fig 1

## 3.2 Data selection and eligibility criteria

In the data selection phase, a two-step screening process was used to analyse the relevance of the identified reference to the research questions. In the first screening phase, the title, abstract, and keywords of all the generated papers were selected using a predesigned screening formula to remove irrelevant studies. Journal articles, conference proceedings and book chapters were eligible for inclusion in this phase. If there was an available abstract, this would be checked and included if the aim concerned aspects of decision making in the front end of projects. Non-English sources were excluded. The second screening phase was a full text review of peer reviewed articles sources across all databases. At this stage only journal articles and conference papers were included (peer-reviewed sources). Articles without a main focus on large scale complex projects were excluded, for example, front end of product development, innovation development and health care systems. At a later stage, articles with no open access were excluded after all attempts to obtain them failed. A web search was not conducted in Google Scholar, since most business & management databases link to Google scholar. Charts were developed based on the different variables identifies.

| General Guidelines | Sources | Extracted data | Reporting the results |
|---|---|---|---|
| ▪ Sources: electronic databases. Must be peer-reviewed or conference proceedings | ▪ Scopus | ▪ Title, author(s), publication year, country. | ▪ Descriptive summaries |
| ▪ English Language | ▪ EBSCOhost Business source complete | ▪ Journal or Conference | ▪ Visual illustrations (charts and tables) |
| ▪ Timeline: 1983 - 2023 (40 years) | ▪ Web of Science | ▪ Methodological choice | |
| | | ▪ Main Foci of study/ Research questions | |
| | | ▪ Key findings | |
| | | ▪ Front-end phase/Application area | |

Table 2

## 3.3 Presenting data

Collecting, summarising and presenting the relevant information were undertaken in line with the research questions. Based on Levac et al.'s (2010) suggestion, the data extraction process was iterative and thus charting the data was continuously updated. A description of the characteristics of the studies are presented and these were classified by the year of publication, the main foci of the study or research question(s), the findings or what was reported, the front-end phase being investigated, methodological choices and the type of large-scale project. The results were reported as a combination of tables/charts and summaries.

| | Author(s) & year | Article | Study Focus/ Research questions | What has been reported/Findings | Front end phase | Methodological choices | Project type |
|---|---|---|---|---|---|---|---|
| 1 | Rahat et.al. (2023) | Developing an effective front-end planning framework for sustainable infrastructure projects. | Investigates the use of an infrastructure sustainability rating system (Envision™) in Front-End Planning (FEP) of sustainable infrastructure projects. | The frameworks conclude that linking the Envision™ system with FEP can support stakeholders to improve the decision-making process of infrastructure projects. | Not specified | The study validated the developed rating system matrix by surveying 109 construction stakeholders. | Small and large infrastructure projects |
| 2 | Gibson et al. (2023) | A novel approach for measuring the accuracy of front-end engineering design. | Measuring front end engineering design (FEED) accuracy | FEED accuracy (degree of confidence in the measured level of maturity of the FEED deliverables) supports informed decision making. | FEED phase before a capital investment decision is made | Mixed method – focus group and statistical analysis | Large industrial projects. |
| 3 | Siriram, R. (2023) | Integrating and transitioning the project front-end and project initiation phases in South African electrical engineering industrial projects. . | The objective of this research is to explore integration and transition activities in large industrial projects. | The findings provide guidance on integration and transition mechanism how and when these occur. It highlights the benefits of integration and transition activities. | Project Front end up to the first phase of the project lifecycle. | A qualitative research design methodology is followed, based on interviews using open-ended questions | Large projects in the South African electrical engineering industrial projects industry. |
| 4 | Lawani et al. (2023) | Naturalistic decision making and decision drivers in the front end of complex projects. | How decisions are made at the front end of oil and gas projects. | Both analytical and intuitive decision making process are relied upon. | Frond end – conceptual phase of a project before implementation (FEED) | Interpretivist Qualitative – semi structured interview | Oil and gas projects (e.g. hydrocarbon development, offshore installation) |
| 5 | Chenger & Woiceshyn (2021) | Executives' decision processes at the front end of major projects: the role of context and experience in value creation. | How executive decision makers at the front end of large-scale projects are making decisions. How they identify, evaluate and select project ideas. | An opportunistic, planned process and Team decision process are used to make major project decisions. Knowledge from past experience was relied on in choosing projects. The executives experience taught them to spot value creating opportunities among many possible ideas. | Ideation/Conceptual phase (Before project management process are applied). | 16 Semi structured interview | Large scale domestic and expansion project |
| 6 | Miranda et al. (2021) | Multicriteria analysis as a better tool for the selection of public projects alternatives. | A critical analysis on cost benefit analysis (CBA) and multicriteria decision analysis (MCDA) to the selection of projects. | MCDA is a better tool for public project alternative selection | Project selection phase of the Front End | A case study analysis | High Speed Railway project |

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|---|---|---|---|---|---|---|---|
| 7 | Zerjav et al. (2021) | The multiplicity of value in the front-end of projects: The case of London transportation infrastructure. | How does multiplicity of value manifest itself in front-end decision making and definition of infrastructure projects? | Identified three distinct levels of value: local value, sector value and user value that help clarify the complexity of project value and, further, provides an important argument for what is involved in the initiation of the project. | Project definition | Empirical data on infrastructure projects provision, including semi-structured interviews (inductive qualitative data analysis) | Infrastructure projects |
| 8 | Shi et al. (2020) | Exploring decision-making complexity in major infrastructure projects: A case study from China. | To identify, classify, explore, and understand decision-making complexity elements in major infrastructure projects (MIPs) | A comprehensive framework of decision-making complexity is developed, which divides the elements into six dimensions: technical, social, financial, legal, organizational, and time. The links between different dimensions are also illustrated. | Not specified | Inductive literature review and a deductive case study | Major Infrastructure projects |
| 9 | Avanzi & Zerjav (2020) | Caught in a crossfire: Front-end decision-making in airport expansion programmes. | Main factors and considerations that drive the decision to invest in airport expansion projects. What are the Key decision making challenges and expansion projects? | Project front end of large-scale projects is about identification of opportunities and having a viable planning solution. | Exploiting opportunity/Planning | A qualitative inductive methodology. A Mixed data collection method (document analysis and 4 semi structured interview | Large scale expansion project |
| 10 | Samset (2017) | Systems engineering in front-end governance of major public investment projects. | An account of how systems engineering principles are applied by the Norwegian government to improve up-front planning and decision-making of large public investment projects | Lessons indicate that projects subjected to a system engineering approach are now largely completed within their cost frames. Hence, at the portfolio level, the state is able to more effectively control the cost of major investment projects. | Conceptual estimates and project options phase of the Front end | Discussion (non-empirical) | Capital investment engineering projects |
| 11 | Samset & Volden (2016) | Front-end definition of projects: Ten paradoxes and some reflections regarding project management and project governance. | A work of the Concept research programme on front-end management and governance of major public investment projects in Norway. | One salient conclusion from the research is that ex post evaluation should be an essential element in any project governance scheme. When a project succeeds at all levels, it should be imperative to ask what was done right. | Early phase before the final choice of conceptual solution is made | In-depth case studies | Major public projects |
| 12 | Safa et al. (2016) | Optimizing contractor selection for construction packages in capital projects. | Investigating a case study to determine a computational tool for project decision support | The use of multi-objective optimization supports effective and transparent contractor selection | Contractor selection process in the front-end phase. | Non empirical (Analysing a case study) | Capital construction projects |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | Reidy et al. (2016) | Front end decision making for road projects-A sustainability framework. In Proceedings of the eighth international conference on maintenance and rehabilitation of pavements | Developing guidelines for decision making in road investment projects such that it aligns with corporate sustainability objectives. | Effective decision process should incorporate sustainability goals which includes a business case that uses a combination of Cost Benefit Analysis and Multi criteria Analysis | When the Business case documents are developed; where a number of delivery and operating options are analysed, and a final solution is proposed. | Discussion (non-empirical) | Road 9ptimization 9e projects |
| 14 | Haji-Kazemi et al. 2013 | Identification of early warning signs in front-end stage of projects, an aid to effective decision making. | Identifying early warning signs in the front-end phase to contribute to more effective decision making process. | Possible detectable early warning signs (related to aspect of market conditions, environmental effects, differing stakeholders' views) can provide more insights for PMs to making more effective decisions | Front – end; feasibility of a project | Mixed method – document analysis and semi structured interviews. | High Speed Railway project |
| 15 | Williams & Samset (2010). | Issues in front-end decision making on projects. | To show the main themes that need consideration at the front-end stage of the project | The article offered some insight into the complexity that confronts researchers. There is a need for alignment between organizational strategy and the project concept. Also, it is necessary to deal with complexity, particularly the systemicity and interrelatedness within project decisions, as well as the ambiguity implicit in all major projects | The front end of projects | Discussion (non-empirical) | Major projects |
| 16 | Cocodia et al. (2008) | Creating Better Cost Estimates for Floating Offshore Structures by Assessing Cost Correlation and Understanding Risk. | Making decisions in the concept selection phase by focusing on methods of estimating cost, uncertainties and risk. How do you know the real cost of floating offshore structures in the concept selection phase? | Paper discusses a cost correlation and cost estimate validation process, as a means of identifying and assessing risks in the conceptual and front-end phases of the project | Concept selection. | A qualitative assessment of uncertainty in each cost component | Floating offshore structures. |
| 17 | Shafer (1994) | Front-end cost engineering. | Core decision processes used in developing capital information during the front end of a project. | The use of analytical approaches such as indexed and factored costs, NPV and Decision analysis is needed for | Conceptual estimates and project options phase of the Front end | Discussion (non-empirical) | Capital investment engineering projects |

| | |
|---|---|
| | effective decision in complex projects. |

Table 3

## 4. Results and discussion

A total of 496 potentially relevant sources were initially identified using the search strategy. 243 were identified in Scopus, 63 were in EBSCO Host and 190 records were found in Web of Science. The first stage of screening the abstract, by applying various relevant search phrases, and removal of duplicates excluded 422 articles while 34 articles were retrieved for the second screening phase. For the screening of the full text, the second phase of data selection, book chapters and articles not focusing on front end of large-scale project context were eliminated. After another round of elimination due to irrelevance, i.e., the focus not being on large-scale projects (e.g. front end of product development, innovation development and health care systems) a further 12 articles were excluded. This brought the total to 22. Out of these, 5 conference papers were not open access. Efforts to use the inter-library loan system of the university were unsuccessful. Therefore, these were not included in the report. The flowchart of literature search and data extraction from the initial identification to the final articles included in the scoping review is demonstrated in Fig.1

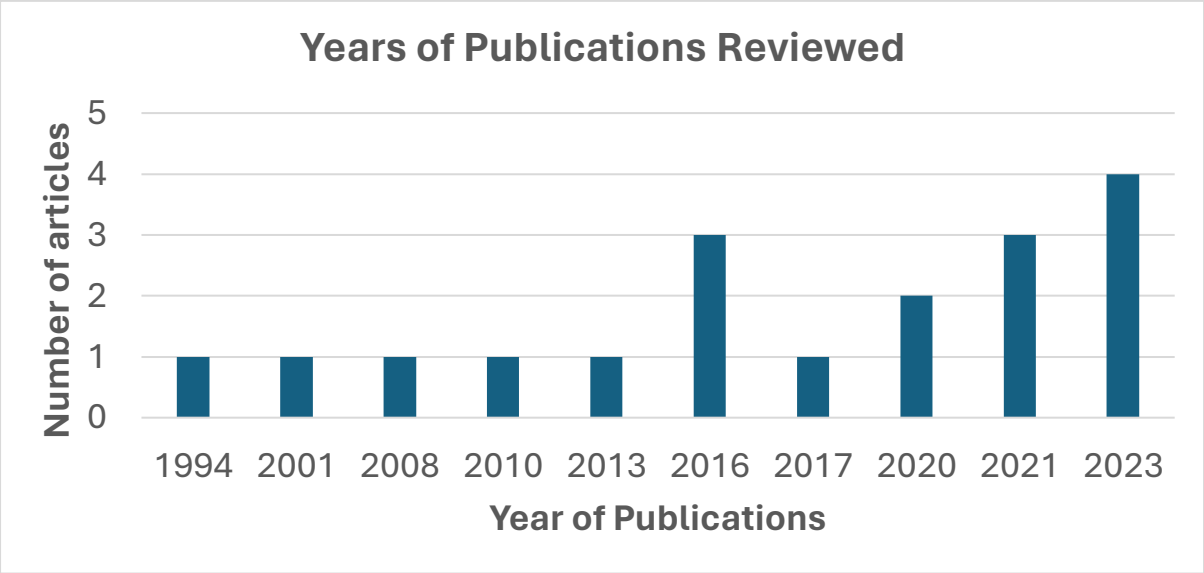


Fig. 2: Years of publication for reviewed articles

There was no relevant study for years prior to 1994. The earliest literature on governance in relation to a project's front-end is 2006. Fig. 2 above is the summary of articles reviewed based on the publication year. The final articles selected span from 1994 to 2023 (about 30 years), to obtain a wide range of views and perspectives. However, about 78% of the articles were published after 2012. The earliest study looking at intuition in front end of projects is in 2018. Prior to this period, the studies focused primarily on analytical processes for example cost estimate validation, cost benefit analysis, optimisation processes (e.g. Shafer (1994), Cocodia et al. (2008) and Safa et al. (2016)). Although some more recent studies such as Miranda et al. (2021) still emphasise analytical measures in the selection of infrastructure projects, conclusions of intuitive approaches of decision making have been recently reported (Lawani et al., 2023; Chenger & Woiceshyn, 2021) and the participants in these studies were senior/executive decision makers at the front end of large complex projects. It has been reported elsewhere in project management literature that that project managers sometimes use intuition and sensemaking when deciding on a course of action (Leybourne and Sadler-Smith, 2006,

Alderman et al., 2005). Turner (2021) identified that project professionals appear to be influenced by emotions, and thereby may be relying on instinct during decision making in projects. Nevertheless, the concept of intuition in decision making is under researched in a vital phase of project management which depends principally on decision making techniques.

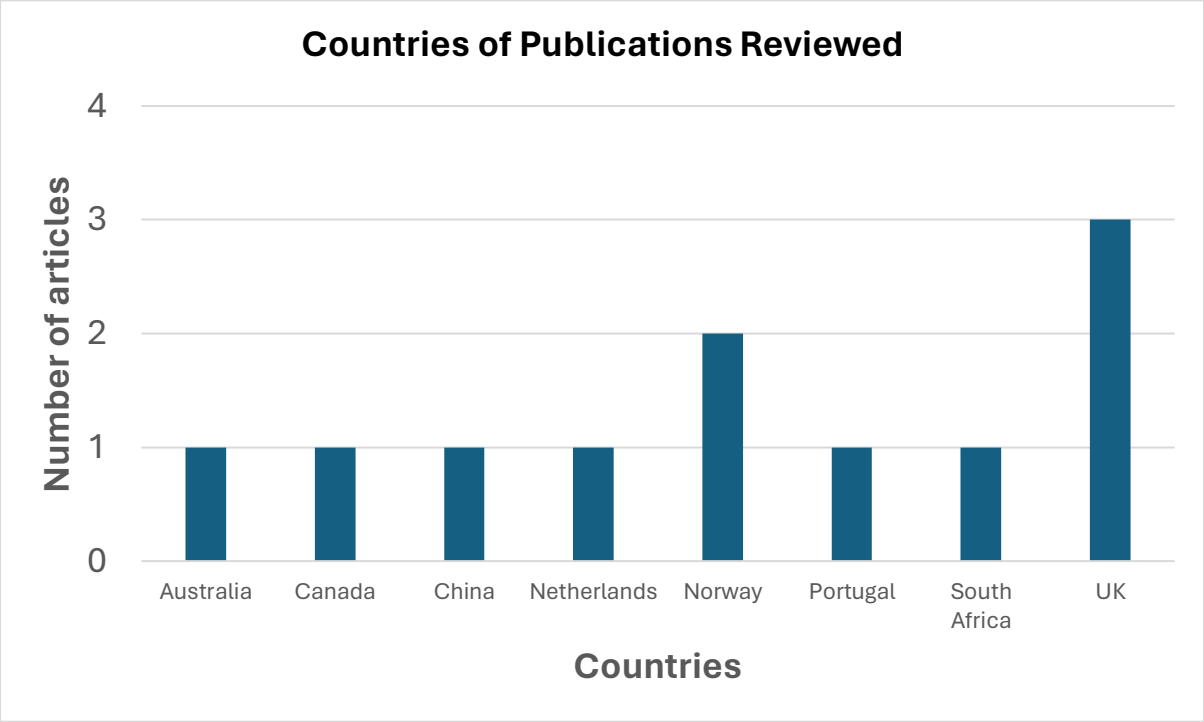


Fig.3: Countries of publication for reviewed articles

Fig. 3 above represents the countries of publication of the reviewed articles. These include Australia, Canada, China, Netherlands, Norway, Portugal, South Africa and United Kingdom. This shows a wide reach as most of the continents are adequately represent as shown on the map in Fig. 4. As countries are embarking more on very large-scale infrastructures projects, the front end will continue to garner much attention as it is a vital process in the lifecycle that ensures project value and success (Zerjav et al., 2021). Therefore, a call for more investigations in the front end of various types of large-scale projects is essential. A flawed decision-making process is not a unique issue within the front end of projects (Denicol et al., 2020) but improving this aspect is a step closer to increasing front-end value creation and consequently project success. Stingl & Geraldi, (2017) and William & Samset (2010), suggests that is necessary to increase understanding of behavioural decision processes to move towards optimal judgements.


Fig. 4: A geographical representation of countries of publication for reviewed articles

The results from the scoping review validate Turner's (2022) assertion that studies of behaviour relating to psychology and emotions have received almost no focus in project management literature. It is recognised that project decision makers often have to rely on other decision-making cognitive abilities outside the normative analytical process (e.g. Stingl & Geraldi, 2021; Musca et al., 2014). However, more studies are required to understand situations in which experienced project managers who are familiar with the features of a particular project are making decisions for which they have previously received feedback. More investigations on how alternative decision-making processes are being relied upon at the front end of large-scale complex projects which are infamous for elusive decision-making practices (Babaei, 2021) is required to gather an evidence base for developing a holistic decision-making framework for professional practice.

## 5. Conclusion

Project managers with a high level of decision-making authority are likely to use intuitive decision approaches in the front end of large complex projects due to the characteristics of these projects - high uncertainty and risks, time and schedule pressures. However, these have not been studied extensively. Existing gaps in this area of study will pose questions such as: how are decisions made at the front end of large-scale complex projects? Are experienced project managers relying on intuition at some phases on the front end and when? Are there certain situations in which experienced project managers are very familiar with the features of a project that they are making decisions based on pattern recognition? If intuitive decision methods are used, then are they applied appropriately? More empirical studies are required to get a comprehensive understanding of decision making at the front end of large-scale projects. As much more research are conducted on the decision making which occurs in front-end phases

of large-scale complex, more insights will be made available as to how these decisions are made and their resultant effects especially in organisations which risk-tolerance levels are low. Furthermore, it is imperative that professionals who make this decisions and those who implement them are able to review and find opportunities for obtaining better performances in future projects in terms of the tracked metrices.

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