ACIS 2023 Proceedings   Australasian (ACIS)

12-2-2023

Artificial Intelligence System Development in terms of People-Process-Data-Technology (2PDT): Results from Government Case Studies

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Full research paper

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Abstract

Artificial Intelligence (AI) System Development (SD) is an organisational activity characterised by diverse opinion and an industry approach with limited research reporting the outcome of proposed frameworks. This paper aims to analyse the outcome of a previously proposed framework in terms of People-Process-Data-Technology (2PDT). We argue that organisations can improve their effectiveness by promoting an agile organisational culture, and better data management. The findings suggests that people and culture are critical in taking timely actions, and that use of quality data and development of ethical and explainable AI systems are required.

In this paper, we evaluate the use of 2PDT by investigating nine case-studies and demonstrate its effectiveness in the formulation of research design, data collection and analysis. The findings highlight that the 2PDT offers a useful conceptual framework examining this phenomenon due to its characteristics of agility, rigour, dynamicity, and completeness.

Keywords Artificial Intelligence System Development, Evaluating the 2PDT Framework, Government Case Studies

1 Introduction

Artificial Intelligence (AI) is an important phenomenon in the Information Systems (IS) domain, however given AI technologies are being developed and commercialised at a rapid rate it is extremely difficult for IS researchers and practitioners (Ransome et al. 2019) to examine this phenomenon in order to advance essential knowledge in this area. It has been found that one essential knowledge concerning AI is in relation to effective AI System Development (SD). This knowledge area requires a new approach, structure, and standardisation to promote effective organisational AI SD.

Essentially covering both technological and non-technological aspects, the want for AI rises from the need to have machines complete tasks for people and give them additional time to focus on more value-add tasks. AI enables organisations to automate repetitive learning and discovery through data, add intelligence and self-learning capability to existing products, to deeply analyse more data accurately and get the most out of data (Anton et al. 2020; Department of the Prime Minister and Cabinet 2019; NSW Government 2019; Sari et al. 2020; SAS Insights 2020). AI is a fast growing and widespread field, organisations use AI for many business processes such as fraud detection (Department of the Prime Minister and Cabinet 2019; Lacheca 2018; Zhang et al. 2019), providing healthcare to patients (Adadi and Berrada 2018; Schiff et al. 2021), and policy development in government organisations (Organisation for Economic Co-operation and Development 2022; Ras et al. 2022).

AI SD is an important area of focus for government organisations (Desouza 2018; Organisation for Economic Co-operation and Development 2022; Yigitcanlar et al. 2021). Research has found that 40% of Australian Public Service employee effort is spent on tasks that can be transferred to an AI system. Such tasks include reviewing licence applications, deposit collection, and regulatory compliance (Department of the Prime Minister and Cabinet 2019). By 2028, digital technologies including AI is predicted to provide $315 billion in gross economic value in Australia (AlphaBeta 2018). By 2030 AI is predicted to offer $22.17 trillion to the global economy (Rao and Verweij 2017). There is a significant demand for AI specialists in Australia with an estimated 160,000+ additional people required (CSIRO Data61 2019).

Management of AI projects is complex as there are several challenges such as identifying the additional skills required for people working with AI through training and development (Ichishi and Elliot 2019), and identifying the effective information security standards such as introducing the additional controls required for AI systems. These areas have not been addressed in existing research. Although these complexities remain open there is still a significant curiosity in AI SD from academia and industry driven by the perceived benefits AI can offer (i.e. automation of manual tasks people complete) (Anton et al. 2020; Department of Industry Science Energy and Resources 2020; Department of the Prime Minister and Cabinet 2019; NSW Government 2019).

Research highlights that AI SD is an important area of focus for government organisations around the globe (Miller and Stirling 2019; Organisation for Economic Co-operation and Development 2022; Wirtz et al. 2019). AI SD is an important focus area for organisations as it provides an opportunity to build systems that can undertake tasks for people. Enabling people to spend energy on finding solutions to other organisational requirements. AI SD can be described as a cycle where people, provided they have the knowledge and skills, build an AI system that can perform a task that people are able to perform or have knowledge of. This enables people to focus on new ways of working and improving which provides the capacity to then build new AI systems which can do other tasks. This is an ongoing process, which can only be stopped in the unlikely event that AI is overtaken by another advancement in technology. AI systems have proven that they can handle large volumes of data with high accuracy better than people. This enables AI systems to process and output information efficiently enabling people to infer from. Examples of AI systems development in government organisations include facial recognition systems to verify traveller identification at airports (Department of the Prime Minister and Cabinet 2019), to enhance cyber security capabilities (Desouza 2018), and drones to assist with the inspection of power grids (Office for Artificial Intelligence 2020).

This study aims to address the following question: How can government organisations effectively improve AI SD in terms of the People-Process-Data-Technology (2PDT) framework? The study consists of two main objectives: (1) the study investigated the conceptualised 2PDT framework in terms of government cases, and (2) the effectiveness of the 2PDT framework and the research design have been analysed.

2   AI System Development

The Information Technology (IT) System Development Lifecycle (SDLC) provides a process for planning, analysis, design, and implementation of an information system (Mantei and Teorey 1989; Valacich et al. 2004; Zhang et al. 2005). It is an important framework for developing information systems. Given the unique challenges associated with AI it is critical to determine what are the relevant aspects of AI SD which need to be included and addressed for AI SD. Discussion of AI SD in the domain literature demonstrates that existing system development approaches are being applied (Adadi and Berrada 2018; Ichishi and Elliot 2019). There is limited discussion of the need to identify and enhance elements of these approaches. This is an area that existing studies into AI frameworks have attempted to examine. However, a holistic AI SD framework is needed to complement the SDLC, and in unison promote the development of effective organisational AI systems. AI SD is undertaken in the same manner as other systems are developed. This includes using existing approaches of eliciting requirements, selecting an approved methodology, and allocating a team to work on development (i.e. developers, project managers) (Desouza et al. 2020). While this approach might be sufficient for building some AI systems, it is extremely risky for all AI systems. For example, a methodology that is used for developing a system that users access to purchase a service is more straightforward. It is straightforward to identify, design, and implement the processes involved. Taking that methodology to developing an AI system is extremely risky if the methodology is not reviewed to ensure it covers important concepts unique to AI. For example, how will the methodology ensure robust oversight of bias, and human rights which ensure development of responsible AI systems. It is critical to follow a framework that can inform the methodology used to develop AI systems, which would promote development of effective organisational AI systems. There is limited discussion of people, process, data, and technology in the existing studies. It is pragmatic to examine how these important concepts can be applied to conceptualise and examine a holistic approach to effective organisational AI SD.

3   Challenges of Effective AI System Development

Recent studies have identified key AI challenges inhibiting effective organisational AI SD. This study has found that effective AI SD is about completing the development of an AI system that produces the intended results while it is operational. Examples of challenges presented in the domain literature included the difficulty with selecting the right algorithm for a use case (Baker et al. 2022; Dwivedi et al. 2021; Kelly et al. 2019), cyber security (Poulsen et al. 2020), and overseeing the development of ethical AI systems (Choudhary et al. 2020). Existing literature highlights that organisations are facing several challenges that are unique to AI. Examples of these challenges include identifying appropriate use cases (Lacheca 2018), obtaining people with the right skills to leverage AI (Ichishi and Elliot 2019), and information security policies restricting the use of AI (Alsheibani et al. 2019; Choudhary et al. 2020). The domain literature highlights that the main areas of challenge for organisations are security, legal, governance, ethics, and data quality. With regards to security, the nature of AI is that it is characterised by changing how traditionally tasks and decision making have been performed. This creates a divergence between AI systems and existing security policies and standards, which have been developed for non-AI systems (Berente et al. 2021). It is important to enhance security policies and standards (Desouza 2018) to promote effective organisational AI SD. In the legal area, it is important to develop laws to support AI SD that is fair and does not contain bias (Dwivedi et al. 2021). Governance is another key AI challenge for organisations to ensure appropriate governance mechanisms are in place (Choudhary et al. 2020; Sicular et al. 2020) to achieve value from AI SD. The ethical challenge is related to having the required checks in place to ensure an AI system does not have an adverse impact on people (Lee and Shin 2020; Schiff et al. 2021). Data quality was also found to be another key challenge for organisations (Desouza et al. 2020). With data being a critical input for AI systems it is imperative that data quality issues are resolved and an AI system is fed by accurate data (Sun and Medaglia 2019). It is pragmatic to examine how people, process, data, and technology can be uplifted to better support effective AI SD.

4   People-Process-Data-Technology (2PDT)

The 2PDT incorporates key components of interest within the IS domain to assist with capturing what issues organisations need to overcome in order to develop effective AI systems. This study adopted the components which were found to be of interest within the IS domain. This includes people (Jessup and Valacich 2008; Lyytinen and Newman 2008; Rezazade Mehrizi et al. 2019), processes (Jessup and Valacich 2008; Rezazade Mehrizi et al. 2019), data (Jessup and Valacich 2008; Rezazade Mehrizi et al.

2019), and technology (Jessup and Valacich 2008; Lyytinen and Newman 2008; Rezazade Mehrizi et al. 2019).

Characteristics of People-Process-Data-Technology (2PDT)

The 2PDT framework is not a SDLC process. While the SDLC generally provides a process for planning, analysis, design, and implementation of an information system (Mantei and Teorey 1989; Valacich et al. 2004; Zhang et al. 2005), the 2PDT will assist organisations with evaluating the environment for their AI systems regardless of the stage they are in (i.e. not started, in progress, implemented). This evaluation will assist in introducing or enhancing practices of AI SD. We however claim that the 2PDT complements the SDLC. Justified by its agility, rigour, dynamicity, and completeness; we assert that the 2PDT provides an effective framework that will support and improve AI SD. The agility comes from the expectation that the 2PDT can be easily integrated into existing organisational settings for developing AI systems. The rigour is provided by following an accepted research design which includes views of AI experts. Dynamicity is provided with continuous improvement being an important part of the framework to make it inherently adaptable to cope with change and progress made in AI SD practices. Finally, completeness comes from bringing together a combination of existing theory and data collected from case studies.

The 2PDT (Monshizada et al. 2021) shares common components and concepts with related frameworks (Chowdhury et al. 2023; Eschenbrenner et al. 2022). For example, this includes the key concepts of technology, data, and people. Process has not been identified as a standalone concept in the aforementioned studies. While the study into the development of the 2PDT is related to these studies, the 2PDT is a unique framework which can be applied for effective AI SD.

Justification for 2PDT

Currently, a holistic end-end framework for AI SD is lacking within the AI domain, which can offer the key characteristics of agility, rigour, dynamicity, and completeness—as discussed above. To fill this void, the 2PDT framework has been developed to contribute to effective organisational AI SD.

There are several studies examining different frameworks within the AI domain (Ashok et al. 2022; Chowdhury et al. 2023; Dobbe et al. 2021), aimed at different aspects of AI systems. This includes an AI ethics framework (Ashok et al. 2022) for developing ethical AI systems, an AI capability framework (Chowdhury et al. 2023) for human resource management, and a framework to support decision making in AI system design and development (Dobbe et al. 2021). However, there is no holistic framework which can drive requirements regarding end-to-end development of AI systems.

Although AI is a key area of focus for organisations around the globe (Alnefaie et al. 2021; Organisation for Economic Co-operation and Development 2022), only 15% of AI system use cases are expected to be successfully delivered (Sicular et al. 2020). Organisations have attempted to implement AI but have failed due to a poor understanding of what AI is (Ransome et al. 2019). The 2PDT framework will enable organisations to examine the key requirements for developing effective AI systems, which will enhance their understanding of what AI is and ensure the development of effective AI systems. The framework will ensure use cases are effectively assessed to ensure minimal effort is exerted to determine their merit and value. This will ensure a greater number of AI system use cases are operationalised that produce results.

The domain literature highlights several challenges which are inhibiting effective organisational AI SD. For example, selecting appropriate algorithms for identified uses case (Baker et al. 2022), development of ethical AI systems, and cyber security challenges (Poulsen et al. 2020). The 2PDT will enable organisations to examine the challenges which exist in their environment and implement remedial responses to alleviate them. The 2PDT framework also enables organisations to identify new requirements for effective AI SD over time, as new challenges are identified within the domain.

The domain literature also demonstrates that there is a greater focus on the mechanics of AI in comparison to theoretical frameworks. There are many studies which discuss how AI is being used in organisations. For example, in healthcare AI systems are employed in diagnosis of health conditions (Adadi and Berrada 2018), and in government organisations for policy development (Ras et al. 2022). This demonstrates that there is a considerable hype surrounding AI SD resulting in greater organisational motivation to develop such systems to provide better products and services. Meanwhile, there are unresolved challenges such as ensuring appropriate management of AI ethics (Schiff et al. 2021), and lack of skills and experience in leveraging AI (Lee and Shin 2020). Given this environment, the 2PDT is well-timed in being available to organisations to shift the focus to the means by which AI systems are developed, to ensure organisations are investing in AI systems that are pragmatic and

produce value and benefits. Based on the empirical findings of the study the 2PDT will enable better understanding of AI SD in government organisations.

5   Research Design

Case study approach is an empirical method which can be applied to investigate phenomenon in depth (Yin 2018, pp. 14-15). Essentially there are two types of case study approaches, single and multiple case studies. This research adopted a multiple case study approach as it is considered more compelling and robust in comparison to a single case study approach (Yin 2018, p. 54). It is more compelling and robust as it includes participation from different teams and across different organisations. Including multiple case studies allowed better inferences to be made based on information gathered from more than one team and organisation. This research included multiple cases which were randomly selected from organisations with current and/or previous AI projects. This involved inviting five organisations initially to participate in the study, if no response was received within a week a follow up message was used and then additional organisations were contacted. Organisations were randomly selected from information available on the directory of government departments and approaching professional networks. Organisations had the opportunity to include more than one AI project in the study if they preferred, at the same time it was acceptable for organisations to participate from the perspective of one AI project.

The reliability and validity of the research study were managed by employing the four tests prescribed by Yin (2018). The tactics employed by this study within the framework of the prescribed four design tests included (1) employing a case study protocol, (2) using multiple sources of evidence, (3) developing a case study database, (4) establishing a chain of evidence, (5) employing validating procedures, (6) using thematic analysis, (7) using replication logic, (8) publishing progress work at different stages of the research study, and (9) maintaining ethical conduct of the research study. Participant recruitment and data collection commenced after clearance from the Human Research Ethics Panel.

The semi-structured interview technique was employed for data collection for enhanced interaction with participants, and to allow follow-up questions to be asked. Interviews were conducted by the primary researcher. Three categories of questions were prepared for data collection which were based on the 2PDT concepts. Firstly two questions were asked seeking for background information to assist with understanding the position of AI within the case. The next category of questions related to the main concepts of the framework (people, process, data, and technology), where participants were asked to first describe their thoughts on the topic and secondly what challenges they are experiencing and working through. Lastly, participants were asked to provide some closing remarks, which included an opportunity to add any information they wished to provide. A sample of research questions is provided below in Table 1. In addition to recording audio of interviews, a data collection instrument was developed to assist with data collection and for taking notes during interviews. This included prompts for follow-up questions and information which would assist with data collection and analysis. The instrument was constructed based on the format of the interview questions and included space for notes related to each question. The interview audio recording and information in the data collection instrument were used to prepare the interview transcript. Interview transcripts were provided to participants for verification.

Questions
• Please outline the essential skills, experiences and/or qualifications required in your role and how can people acquire these?
• From your perspective what are the major people challenges in your role and what are some of the approaches being used to work through them?
• Please describe the processes, framework and/or project methodologies you use to move towards achieving the goals of your AI project(s)? Where possible, please provide related documentation (i.e. project plan, process/framework details), and/or references (i.e. research, case studies).
• Please outline the challenges which arise in delivering AI project goals related to above approach and what steps are taken to work through them?

Table 1: Sample Interview Questions

Documents were an additional source for the study and were collected for analysis. The interview questions were designed referring to additional documentation being supplied to ensure participants considered this aspect of the research study. This resulted in important documents being obtained from interviews for further analysis afterwards. In addition, the researcher performed internet searchers and organisational website searches to obtain publicly available information for additional analysis.

The type of documents shared by participants included project management documentation, published AI papers, and technology related strategy documents. The type of documents obtained from organisation websites included corporate plans, data plans and strategy, and security strategy. A sample of exact titles of documents includes, 'Government Artificial Intelligence Readiness Index 2019' (Report), and 'Artificial Intelligence: The Global Landscape of Ethics Guidelines' (Research Paper). Interview participants were from various roles including AI executive, senior managers, and practitioners. For example, this included roles such as; Data Scientist, Chief Digital Officer, Chief Data Officer, First Assistant Secretary Analysis and Data.

A pilot study was used to refine data collection plans including content and procedures being followed, and to identify any other methodological issues which needed to be addressed (Yin 2018, pp. 106-108). The pilot study was conducted after human ethics approval was obtained. Two interviews including two different cases were part of the pilot study.

Data was collected from nine government organisations in Australia, which included 28 interviews, and 75 documents were obtained and analysed. Case-1 (8 interviews, 17 documents, size—up to 10,000 staff) is responsible for ensuring economic benefits from education, skills and employment. Case-2 (3 interviews, 7 documents, size—more than 10,000 staff) is responsible for revenue collection, and administration of payments and services. Case-3 (3 interviews, 10 documents, size—up to 10,000 staff) administers data collection and statistical analysis to support Australian federal and local government organisations. Case-4 (3 interviews, 5 documents, size—more than 10,000 staff) administers welfare, health, and child support payments. Case-5 (3 interviews, 11 documents, size—more than 10,000 staff) is responsible for safeguarding Australia's national interests, while also promoting international security. Case-6 (3 interviews, 14 documents, size—more than 10,000 staff) is made up of several directorates which are supported by a central information technology division. This organisation is responsible for providing local government services such as healthcare, transportation, and city services (i.e. waste collection). Case-7 (3 interviews, 9 documents, size—more than 10,000 staff) is responsible for law enforcement policy management and national security. Case-8 (1 interview, 1 document, size—up to 1,000 staff) is accountable for the whole of government information and communications technology and digital policy, strategy, and leadership support. Case-9 (1 interview, 1 document, size—up to 10,000 staff) is responsible for law enforcement. Examples of organisational AI projects include; facial recognition, voice recognition, and machine learning.

Data coding involved identifying data segments which are relevant to the research question and coded using NVivo qualitative data analysis software (Miles et al. 2020, p. 41; Patton 2015, p. 529). This involved using a combination of research questions, literature information, interview data, and document data. NVivo was used to create multi-level nodes to group codes. The coding manual for qualitative researchers (Saldana 2013) was used to assist with data coding. The research study employed three rounds of coding. First round coding assisted with the identification of initial themes from the collected data. This included interview transcripts. documents, and website information. Initial themes were derived using the categories based on the elements of the 2PDT. First round coding involved analysing the collected data to identify key information related to the research question. Data extracts from the individual data sources were identified and coded into NVivo. Second round coding assisted with developing summary themes for the key concepts of people, process, data, and technology. The summary themes enabled better descriptions of data from the initial themes. Which resulted in more meaningful themes which better represent the important findings. The third round of coding produced the final themes for the case study. This involved organising the initial and summary themes into broader level themes to work out what themes best represent the initial codes. The final derived themes produced meaningful information which describe the findings from the analysis of the case study data. Data analysis was led by the primary researcher and verified by the supervisory panel.

6 Conceptualised 2PDT Framework in terms of Government Cases

This section presents the empirical version of the 2PDT framework contributing an approach for effective organisational AI SD (see Figure 1). The aim of the different colours used in this figure is to

illustrate different elements of the framework. The final themes derived from the empirical data are organised around the main concepts of the 2PDT. In this empirical version of the 2PDT, all themes are based on final round of coding. Organisational culture was a common theme for all four concepts of the 2PDT and it has therefore been included inside the core part of the framework. Another common theme is data management which applies to data and technology, and this is included in the outer part of the framework connected to both related concepts. All remaining boxes on the outer part of the framework are the themes which apply to each concept and as such they have been grouped next to the concept they apply to. A connecting line is used to indicate the concept each theme applies to. People are critical for developing and overseeing management of AI systems. Processes are designed to support people and organisations to develop effective AI systems. There are important process elements which are essential for building effective AI systems. Data is the critical requirement for building effective AI systems. As such data must be accurate, secured, available, and have quality metadata and lineage information. Technology is the enabler for developing effective AI systems. There is a plethora of AI technology options for organisations to access. An important finding was that technology is less complex to manage in comparison to people, process, and data. Continuous improvement is an important part of the framework. The purpose of this part is to encourage review and assessment after the framework is applied in practice. This step will identify the themes that are accomplished and any new themes which require focus. For example, once an organisation has setup the means to engage people with a depth and breadth of skills, they can monitor and ensure this continues to be effective. Likewise, they can identify other people elements which they need to manage. This element also includes human oversight which monitors AI systems and how they learn from their environment ensuring responsible organisational AI SD. The key elements for continuous improvement are effective collaboration between stakeholders, planning, and communication.
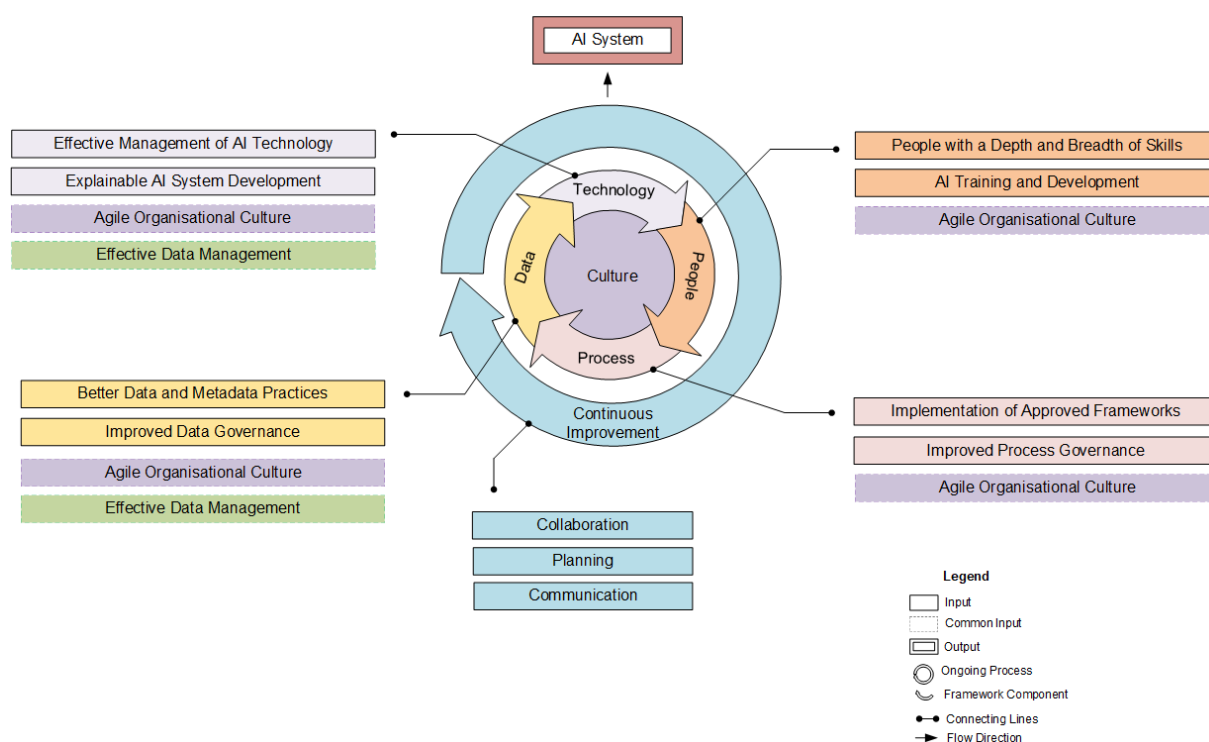

Figure 1: 2PDT with Empirical Themes

Theme 1: Agile Organisational Culture

The initial conceptualisation of the 2PDT framework did not identify culture as one of the main concepts of the 2PDT framework. The thematic analysis and coding resulted in determining that culture is an additional main concept for the 2PDT framework. Distinct aspects of culture were identified for people, process, data, and technology. There are different culture aspects within cases which are inhibiting the development of effective AI systems. It was found that adopting an agile organisational culture is critical for developing effective AI systems. An agile organisational culture will assist cases identify and implement appropriate cultural changes that are required to promote the development of effective AI systems.

Theme 2: Effective Data Management

Government organisations also need to implement effective data management practices to collect, organise, protect and store, and use organisational data. Examples of key elements for effective data management include using federated data models, sharing and integrating data with partners. Appropriate data management enables organisations to develop effective AI systems which can improve organisational performance.

Theme 3: Collaboration

An important finding was that collaboration is essential for continuous improvement of AI SD activities. A high level of collaboration promotes the development of effective AI systems. The data highlighted that cases recognise the value of collaboration, and that it is an important factor for promoting development of effective AI systems. Collaboration is needed between key stakeholders to ensure the required input is being provided by each stakeholder area. Through collaboration which ensures appropriate input from key stakeholders, organisations will be empowered to develop effective AI systems.

Theme 4: Planning

Planning is critical for continuous improvement. To assist with accurate planning cases use research and engage with relevant stakeholders. It was found that having multiple plans in place is important when a change in direction is required. This is a valuable approach, as having multiple plans enables an organisation to efficiently implement change if a selected plan is found to be ineffective. Having multiple plans provides better clarity for AI SD teams, by enabling them to make important decisions that promote continuous improvement in their AI SD work.

Theme 5: Communication

Communication is crucial for promoting continuous improvement of AI SD activities. A strong level of communication ensures that issues and lessons are raised through relevant channels. Communication was demonstrated as a key area of focus for continuous improvement for cases and was commonly discussed among cases. It is clear communication that enables problems and issues to be raised and addressed. An organisation with clear communication channels allowing problems and issues to be addressed will more effectively identify and implement change and continuously make improvements in the area of AI SD.

Theme 6: People with a Depth and Breadth of Skills

Given that the AI domain is characterised with limited people who possess experience and skills related to developing AI systems, it is crucial for organisations to build AI capability by developing and nurturing people who possess a depth and breadth of a variety of skills and experiences.

The AI domain is still growing and there is a paucity of people with enterprise level AI SD experience. It is advantageous for organisations to build AI development teams consisting of people with AI development experience. This experience will be pivotal at all stages of AI SD. This includes business case development, use case development, technology selection, and SD. However, due to the skills shortage some organisations may not be in a position to engage people with prior AI experience. In this case, such organisations can employ other strategies, such as taking advantage of potential partnerships with other organisations.

Theme 7: AI Training and Development

AI training and development can assist with attraction and retention of AI skills. Examples include industry level courses to gain knowledge, and higher education research projects. Other key areas that training and development can assist with are to reduce siloed thinking and human error. Given the interest in AI, organisations should not only invest in developing AI capability of their people if they are working on AI projects but should also make this investment even if they do not have AI in their immediate project pipelines. This tactic has the potential for AI enthusiasts to emerge, who can start organisational AI activities.

Theme 8: Implementation of Approved Frameworks

Developing AI systems following a framework provides the structure that will assist an organisation with process governance and design. There are several helpful existing frameworks available for organisations, covering areas such as project management, information security, data management, and SD. When organisations identify the need for a framework that does not exist, they should develop

bespoke frameworks to work with. Research into frameworks for developing AI systems is essential for framework development and refinement.

Theme 9: Improved Process Governance

Strong governance is also essential to ensure AI SD projects are executed as per approved standards. The empirical data shows that some governance is in place regarding AI SD but needs to be improved. Strong governance will ensure frameworks approved at the organisational level are followed with discipline, and also enable for feedback, which can be used as a basis for improvement. Appropriate level of governance does require investment to ensure there are people available to manage governance, for example, of data, security, and the AI SD lifecycle.

Theme 10: Better Data and Metadata Practices

Data quality is a critical area that requires appropriate organisational focus to manage. To improve data quality, organisations need to validate the accuracy, completeness, consistency, and reliability of their data. Organisations must also develop robust metadata and make data available for developing AI systems. Collectively these are the key areas that are important for promoting availability of quality data for organisational development of AI systems.

Theme 11: Improved Data Governance

Organisations need to have appropriate data governance structures in place to support effective development of AI systems. The empirical data also highlighted that some data governance is in place, but it needs to be improved. Effective data governance ensures developing standards and policies to support availability of quality data, and that data is appropriately used. Data governance requires an organisational approach, and therefore key stakeholders must be engaged with.

Theme 12: Effective Management of AI Technology

It is essential to acknowledge at the outset that AI technology is generally inaugural in nature. This sets clear expectations with stakeholders, which will ensure that AI is not overhyped as a silver bullet that can solve all organisational problems. Although AI technology is inaugural in nature it is rapidly evolving and improving. If managed effectively organisations can benefit from this through experimentation and innovative thinking.

Theme 13: Explainable AI System Development

Organisations need to focus on building explainable AI solutions that can be understood by people. This includes the people responsible for approving the use of AI solutions and end users who may want to access this information before providing consent to use it. Organisations are developing AI solutions that are black box in nature. Delivering explainable AI increases the success rate of AI in that it passes compliance checks (i.e., ethics, privacy) and the end user can confidently consent to uptake.

7 Analysing Interdependencies of the 2PDT Framework

In this section, interdependencies within the 2PDT framework have been analysed contributing to effective organisational AI SD. This analysis resulted in establishing that people, process, data, and technology play an integral part in effective organisational AI SD.

People are Critical for Process Data and Technology

People are critical for effective system development, and they influence the quality and value in relation to processes, data, and technology. People's knowledge, experience, and skills enable development and adoption of processes to ensure effective organisational SD. This requires a strong understanding of contemporary standards and methodologies, and organisational needs. People with a depth and breadth of skills are critical for ensuring effective system development. As such, it is valuable to identify the roles required and engage people with the right skills to fill them. With regard to technologies such as AI for which there is a lack of people with the required level of skills, it is important to build up the skills before significant investment in developing these types of systems. Building up people's knowledge and skills must be a collective effort between industry and education providers. It is important to ensure soon-to-be graduates in SD who are closer to employment are equipped with required skills. There is also an opportunity to ensure that young people at primary and secondary phases of education are exposed to important skills regarding SD. Such an approach will enable effective organisational AI SD and development of complex systems in general. People are the most critical element for SD, without people it is inconsequential to consider process, data, and technology.

Process Relies on People and Culture to Drive Data and Technology Aspects of System Development

Strong processes reflect the knowledge and experience within an organisation. Poor processes for system development provide a strong indication that the people within the organisation are lacking the appropriate knowledge and experience, or that organisational culture may be inhibiting people to improve and introduce required processes. Therefore process is an important element for AI SD and system development in general. It is a critical element that is influenced by people. Having strong processes today does not guarantee that will be the case permanently. Always having the right people overseeing processes, and a culture of continuous improvement will ensure that strong processes exist within an organisation over time. Strong processes will ensure robust organisational data holdings, and technology management. An agile culture and strong processes will collectively drive organisational efforts to having robust data and appropriate investment in the appropriate technology to produce value. Organisational processes must be objectively assessed to ensure there is a balance between bringing structure, standardisation, and risk mitigation. Without the right balance organisational processes can inhibit development of effective AI systems.

Strong Dependency of Data on People Process and Culture

Based on the above, data is a product of people with the right knowledge and skills, robust processes, and an agile organisational culture. Data relies on people and processes to ensure data is viewed as the queen. Organisations lacking a positive data culture will exhibit poor quality data, poor data literacy, and being overprotective of data in fear of a data catastrophe such as a data leak. It is critical for organisations to ensure their people, processes, and culture promote a culture that accepts data as the queen to ensure it is cultivated. This will ensure effective organisational AI SD and system development in general. It is critical for people, processes, and organisational culture to have a stronger focus on data modelling from when specific data is born. When a transactional system is being designed data requirements which enable development of effective AI systems must be considered. This will ensure data which supports AI use cases is captured by the system. Additionally, from a general analytics perspective, analytics data holdings such as data warehouses and data lakes, must also take into consideration use cases for AI SD.

There is no Technology without People Process Data and Culture

As an enabler technology is merely the instrument that relies on people, process, data, and an agile culture. Technology is not the foundation for system development, and it cannot independently promote development of effective organisational systems. People's knowledge and skills are critical for adoption and improvement of technology. Processes ensure appropriate and accurate organisational technology investments. Technology also requires accurate data which is critical for output from technology. Indecisive output from technology is not only a reflection of the capabilities of technology. It is important to use indecisive output from technology to question the quality of data, the processes applied, and how people have manoeuvred the technology. This also provides an opportunity for continuous improvement of a group of factors which influence one another. Lastly, an agile culture ensures that technology is managed effectively. This includes turning over technology that becomes obsolete, while also experimenting and investing in new technology on demand. It is critical that organisations update their technology and not be in fear of the risk of issues resulting from being early adopters. It is important to have a strategy and be calculated. While being early adopters of contemporary technology presents some risks, delaying technological updates brings about its own significant risks and issues. For example, this includes security risks for unsupported technologies, and a reduction in the availability of the required skills in the workforce. Another important consequence is that young people who learn about contemporary technologies during their education, are forced to forget what they have learnt, instead they are forced to learn to work with outdated technologies. This has a significant impact to an organisation in the long run also as they are remaining behind and unable to exploit the latest technological advancements.

Culture is a Key Ingredient for People Process Data and Technology

An agile organisational culture plays a critical role in system development. It is an organisation's culture that ensures the right people are in the right roles and ensures that people are equipped with the knowledge and skills before they are expected to develop a system such as an AI system. As discussed above, an agile organisational culture also provides opportunities for processes to be improved over time with obsolete processes being removed, it ensures that data is an important area of focus and that it is made available for use and promotes appropriate management of technology. Culture has an important influence on all aspects of people, process, data, and technology. It is

important for organisations to have an agile culture that evolves and is dictated by its environment and requirements. For example, if an organisation's environment and requirements dictate for investment to explore AI systems then the organisation must oblige rather than be in fear of being an early adopter. Unequivocally, such a decision will need to include appropriate planning and governance which cannot be avoided. A culture that is inhibiting progress and innovation within an organisation is unlikely to produce the outcomes that are required.

Lastly, although the 2PDT has been examined from AI SD perspective, it is a framework for development of all types of systems that are characterised by complexity.

8   Conclusion

In this research, we analysed findings from government cases in terms of the People-Process-Data-Technology (2PDT) framework within the AI domain. To address the first objective of this paper, we discovered thirteen government related themes. The findings of the study conclude that these themes contribute to effectiveness of AI SD. Additionally, the findings highlighted that an agile organisational culture and effective data management contributes to improved culture, timely action, and better use of quality data. The analysis of themes discovered the importance of people, their skills, training, collaboration and communication in promoting improved AI SD. The remaining themes contributes to better management of processes and data to better understand effective management of AI.

To address the second objective of this paper, we have analysed interdependencies within the 2PDT framework and discussed the effectiveness of the research design. This framework was useful in investigating requirements for effective AI SD and resulted in discovering concepts such as agility in organisational culture and effective data management which were not explored in previous studies. The findings support the 2PDT's characteristics of agility, rigour, dynamicity, and completeness. The agility resulting in learning from previous organisational processes and positively effecting continuous improvement. The rigour resulting in robustness of analysed data in three rounds of thematic coding, interviews with participants and document reviews. The dynamicity in concluding that the AI domain is evolving and that the continuous monitoring of the framework's application improves organisational AI SD. The completeness resulting in understanding that people, process, data and technology has captured major themes required for effective system development in the AI domain.

We conclude that the case study research design was useful to examine this phenomenon. The development of interview questions and data collection instrument based on the conceptualised framework assisted to collect relevant data in terms of people, process, data, and technology. The analysis of interdependencies within the 2PDT resulted in the identification of culture as a key factor that can affect people, process, data, and technology both positively and negatively. Culture was found to have a positive impact on AI SD when it promotes improvement and an environment for effective organisational AI SD. Culture was found to have a negative impact on AI SD when it inhibits positive progress and is inherently accepting the status quo.

In this study, we argue that to achieve effective AI SD outcomes, government organisations should promote, (1) an agile culture: to positively influence all aspects of people, process, data, and technology, and (2) effective data management: which is a major element to be considered for effective AI SD.

The examination of 2PDT found new challenges impacting effective AI SD and possible areas for further investigation. We recommend evaluating the use of 2PDT in different environments to further analyse this framework.

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Acknowledgements

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