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Minimum Viable Governance for Data Science Initiatives

Abstract

Too much governance can stifle innovation in organizations. Too little governance can waste precious organizational resources. Business agility demands empowerment of people to take decisions on initiatives designed to deliver innovative products and services. Traditional monthly and quarterly governance forums such as steering committees and program boards for decision-making potentially impede the flow of work when the delivery of a program or project is done using agile methods in two-weekly sprints and decisions are required at a different and more frequent cadence. Data Science Initiatives (DSIs) which are exploratory and innovative in nature follow agile delivery methods.

This chapter is an exploratory study of implementing governance for DSIs based on a single case study at Transport for NSW. It investigates agile governance at project, program, and portfolio level for DSIs and suggests eight guiding principles focusing on product and portfolio governance. It is targeted at practitioners to guide them in setting minimum viable governance to ensure value is realized from their DSIs and for academics to advance research in governance of DSIs.

Keywords: Agile; Exploratory Projects; Project Management; Program Management; Portfolio Management; Change Management.

Introduction

Year 2020 saw one of the biggest disruptions seen by mankind in recent history due to Covid-19 pandemic which impacted businesses and individuals globally. Businesses which were able to adapt to a new world order survived while those who failed perished. In addition, individuals who traditionally worked in offices of organization had to adapt working from home. In the meantime, the need for business agility and data-driven decisioning did not slow down. The largest companies in the world such as Google, Amazon and Facebook which are data science fueled enterprises using data to improve customer satisfaction and maximize profits continued to thrive despite the pandemic.

Data Science Initiatives (DSIs) have emerged as a popular mechanism for extracting value from data in several organizations. Mathur, Sankaran, MacAulay, and Tsang (2021) define DSIs as investments in Data Analytics, Business Intelligence and Data Science supported by Machine Learning and Artificial Intelligence technologies.

DSIs being exploratory in nature follow agile delivery methods. They have unique characteristics which separate them from how a typical ICT-enabled program is conceptualized and managed as per Table 1.

Table 1

Unique Characteristics of DSIs (Mathur et al., 2021)

No	Description
(i)	DSIs carry high degree of uncertainty right from initiation through to closing phases except for when the data is from a well-defined and structured source
(ii)	DSIs are often enablers for decision making & may not have a direct benefit contribution.
(iii)	Neither the goals nor the means of attaining them are clearly defined from the outset for a DSI with the caveat that as the market matures, the emergence of pre-built solutions will reduce the uncertainty.
(iv)	DSIs are not independent of each other and act as an enabler to next one

- (v) Skills required to deliver a DSI are different to those required for a typical ICT program
- (vi) DSIs do not end and after initial delivery convert into managing the product, model, and data

In addition, the track record of these initiative has drawn substantial criticism from sponsors. For example, the success rate of delivering DSIs is not perceived to be high with Gartner estimating that 85% of big data projects fail (Asay, 2017), 87% of DSIs never make it to production (VentureBeat, 2019) and through 2022, only 20% of analytic insights will deliver business outcomes (Gartner, 2019). Becker (2017) identified seventeen areas causing large rate of failure in DSIs and all of them can be attributed to insufficient project, technology, or data governance.

Portfolio planning and budget cycles in most organizations are annual which does not allow organization to adapt to market changes and digital disruption requiring a more dynamic approach. The problem is compounded when agile delivery methods are used especially for DSIs where scope and design decisions are required in a typical 2-week sprint cadence. Following Goldilocks principle of just right, Governance which is not too light and not too overbearing is recommended (Knapp, Zeratsky, & Kowitz, 2016; Mullaly, 2009; Mullay, 2010; Williams, 2017). Both Project Management Institute (2021) and Association for Project Management (2016) provide twelve principles each on Agile governance as per Table 2 and provide a foundation for governance of DSIs.

Table 2
Guiding Principles for Agile Governance

Principles of Project Management (Project Management Institute, 2021)	Principles for governance of agile change (Association for Project Management, 2016)
1. Be a diligent, respectful, and caring steward	1. Focus on the business need
2. Create a collaborative project team environment	2. Value driven
3. Effectively engage with stakeholders	3. Incremental delivery
4. Focus on value	4. Timebox delivery
5. Recognize, evaluate, and respond to system interactions	5. Empowered teams and decision making

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|--|--------------------------------------|
| 6. Demonstrate leadership behaviors | 6. Collaboration |
| 7. Tailor based on context | 7. Enhanced communication |
| 8. Build quality into processes and deliverables | 8. Just enough definition |
| 9. Navigate Complexity | 9. Constant striving for improvement |
| 10. Optimize risk responses | 10. 'Learn forward' |
| 11. Embrace adaptability and resiliency | 11. Demonstrate control |
| 12. Enable change to achieve the envisioned future state | 12. Change Control |

This chapter investigates governance of DSIs at portfolio, program and project level and draws upon experiences from Transport for NSW (Transport) as a case-study. The primary author works in Active Transport branch of Transport and has implemented Scaled Agile Framework (SAFe) (Scaled Agile, 2020) to manage the \$950 million Active Transport projects portfolio. Active Transport portfolio is transforming from project to product mindset for both digital and engineering initiatives in order to improve flow of work (Kersten, 2018). This entails funding value streams and not projects and thus keeping teams persistent.

Building on findings from case study which are still emerging, we argue that practitioners need to understand the portfolio and product governance requirements when planning and delivering the DSIs and move away from traditional approaches which fail to account for the nuances this class of programs brings to the field especially in handling the uncertainty and ambiguity that continues during the life cycle of a DSI. We build upon current principles on Agile Governance to provide eight guiding principles which are specific to DSIs. We also introduce the term “Minimum Viable Governance” or MVG for DSIs to ensure that they have a balanced governance strategy from ideation through to delivery and benefits realization to support their exploratory nature.

Active Transport – Case Study

Background

Transport for NSW (Transport) is a state government enterprise that leads the development of safe, integrated and efficient transport systems for the people of NSW in Australia. Transport's functions include transport planning, strategy, policy, procurement and other non-service delivery functions across all modes of transport - roads, rail, ferries, light rail, metro and point to point. The organization is in early stages of executing \$72.1 billion worth of Future Transport 2056 Services and Infrastructure Plans (SIPs) which has set out more than 300 initiatives to be delivered in the first 10 years of the 40-year vision underpinned by data-driven technology roadmap (Transport for NSW, 2021). Most initiatives have a significant technology component including data and data-analytics

While Transport has been delivering Active Transport (Walking & Cycling) projects for past ten years, considering the significance of Walking & Cycling on economy, health, sustainability and contribution to strategy (Transport for NSW, 2018), a separate branch was established in July 2021 to manage the Active Transport portfolio. This contrasted with other modes of transport – Bus, Ferry and Light Rail which are part of operations and do not exist as a separate Branch. At the time of establishment, the Active Transport portfolio had three challenges:

- Manage the Active Transport portfolio efficiently and effectively,
- Use data for benefits tracking and investment decisioning, and
- Establish ways of working with the new team

Let us explore the challenges being faced by Active Transport. The Active Transport leadership team came from traditional engineering background. The portfolio management was largely focused on reporting and to a lesser extent on “doing the right thing”. The governance was

based on gated process suitable for large infrastructure projects and did not account for innovation and exploratory nature of DSIs. Large Excel spreadsheets with 30+ columns were used to manage the portfolio and management reporting was using Powerpoint slides. There was no mechanism to capture portfolio-level risks and issues. The portfolio budget was constructed manually by reviewing multiple sources, signed off by Deputy Secretary and shared with Minister of Transport and other stakeholders through House File Notes. The monthly data collection of project actuals for 100+ in-flight projects was a challenge to compile due to lack of technology, process, and resources. This meant that the confidence in accuracy of portfolio reporting was low.

Data & Analytics function of Active Transport branch was established for benefits tracking as well as understanding where the next infrastructure should be built. In case of Bus, Ferry, Light Rail, Sydney Trains and Metro modes, the usage can be derived by Opal Card tap-on and tap-off. However, for walking and cycling quantitative assessment of trips is challenging as the start and end of trip does not trigger any event which can be measured. Piezo-electric and pneumatic tube counters were deployed on some cycleways to count the cycles usage. Out of 100+ cycleways and walkways delivered since 2017, usage for only 14 Permanent Cycleways and 9 Pop-up Cycleways was being tracked daily in July 2021. Some of the counters were broken and could not be fixed as they were out of maintenance contract. While Covid-19 pandemic gave Active Transport once in a generation impetus, the ability to measure the walking & cycling volumes for overall Greater Sydney and Regional & Outer Metropolitan areas did not exist. To assess demand for the infrastructure across the state was similarly challenging in absence of any sensors, and surveys that were used were annual or at-best bi-annual thus did not provide any real-time pulse of the walking & cycling customers. This meant projects were being approved in absence of underlying data for both usage and voice of customer.

The Active Transport team brought two distinct streams of work together. The first stream of work is the management of civil engineering projects - working with local Councils to build new active transport infrastructure. The second stream consists of technology functions that support those civil engineering projects through functionality like the grants portal to support the Councils in applying for funding for Active Transport infrastructure and the collection and integration of data from embedded sensors which monitor usage and effectiveness and assist with program planning and rollout. The team blends a wide variety of skills from Civil Engineering to Project and Program Management, and to Technology & Data specialists. These different skill sets had their own ways of working which sat uncomfortably together and made planning and working as a team difficult. There was a common view across the team that planning and other upfront activities needed to be 100% complete and signed off before work could start which made the team slow and unresponsive to new or changed work. Planning and review cycles were annual which also limited their ability to respond. Establishing consistent ways of working was paramount for the Active Transport leadership team.

The Solution

To address the existing challenges and to ensure that Active Transport portfolio delivers the planned outcomes, any solution had to cover people, process, and technology. We explored the following options:

Establish Minimum Viable Governance

Considering the size of the portfolio and mix of Civil Engineering and Data Science Initiatives, we implemented minimum Portfolio and Product Governance which was sufficient to deliver strategic outcomes and at the same time supported business agility and transparency. This was aligned to the SAFe Lean-Agile Principles.

The first activity the team undertook was to establish the vision which aligned to wider corporate vision “More people walking and cycling in NSW” and the purpose “The creation of viable transport modes as an integral part of the NSW transport system to encourage mode shift by giving customers greater choice”. While powerful, the vision was simple enough for everyone to understand what Active Transport is trying to do.

Next step was to identify Portfolio Operational and Development Value Streams. Eight value streams emerged – Walking, Cycling, End-of-Trip Facilities, Micromobility, Schools, Change and Communications, Maintenance, Portfolio Management, and Data & Analytics. Metrics were established against each value stream. SAFe uses guardrails to implement portfolio governance. For Budget Guardrails, we allocated the portfolio funding across three horizons – Evaluating, Emerging, and Investing/Extracting and none in the Retiring horizon as per *Figure 1*.

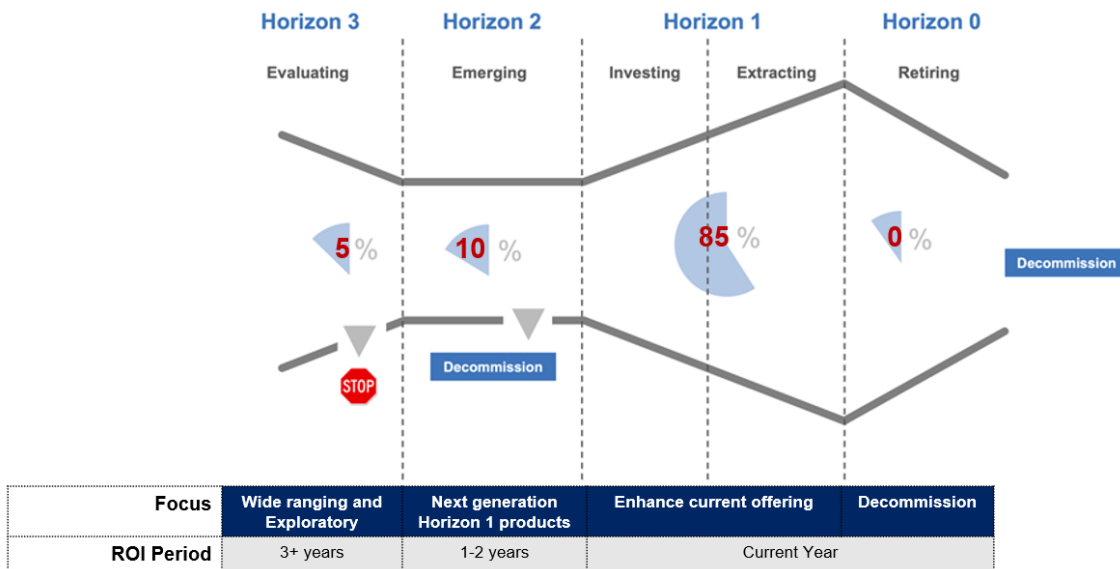


Figure 1. Active Transport Investment horizon budget guardrail

As Active Transport Portfolio supports wider Greater Sydney (GS) and Regional & Outer Metropolitan (ROM) Divisions, Active Transport Portfolio Board was established with dotted reporting to both GS and ROM Governance. The purpose of the Board was to:

- Oversee the Active Transport Programs and Projects and ensure they are continually aligned with the Future Transport 2056 (Transport for NSW, 2018),
- Oversee the identification and prioritization of Active Transport needs and initiatives for investment,
- Oversee development of the Active Transport Pipeline and ensure it is integrated into wider planning, development, and delivery sustainable of travel choices, and
- Oversee Active Transport Portfolio and ensure scrutiny is placed on projects and programs.

Product Manager and Product Owner collectively provided the Product Governance of artefacts such as Features, Stories, Non-Functional Requirements, Design Artefacts, etc. Product Manager owned the Vision and Roadmap and provided a list of outcomes for the Program Increment which spanned three months (or six two-weekly Iterations) prior to each PI Planning event. Product Owner defined the scope of Iterations and Stories and worked with Agile Teams to deliver.

Empower People

The Active Transport leadership had already considered SAFe as a basis for new ways of working. An initial investigation confirmed that choice. For the team, SAFe provided

- A consistent framework for ways of working,
- A means of coordinating and planning at the portfolio level through PI planning,
- A common language to describe the work and how the work flowed,
- Visibility through Iteration and PI showcases, and
- A mechanism for team led continuous improvement.

Although all the teams were new to agile, a decision was made to launch quickly with a PI planning event as the benefits of having a coordinated plan were seen to outweigh any advantages that might be gained by establishing agile team practices first. The key benefit was in the coordination regardless of practices at the team level. The Portfolio, Data and Analytics team, was split into four Teams:

- Data Analytics (Data Amigos),
- Agile Portfolio Management Office (BEAT),
- Get NSW Active (Walking & Cycling) Program (Active LAMS), and
- Parramatta Road Urban Amenity Improvement Program (Pruaipers)

Despite the limited time for the Teams to prepare, they were able to develop a well aligned plan for the first, shortened PI and a draft plan for the first half of the second PI. A decision was made by leadership not to establish transformation metrics for the SAFe implementation initially. The view was the transformation is for the teams, not to prove anything to anyone else. As per Portfolio Director “*We will measure what we need to help the teams but proof that we are doing better will come from delivering more value, not in optimizing some numbers*”. A coach was embedded to help the teams develop their own agile practices as the PI progressed.

Innovate Continuously

The Active Transport leadership team had already considered SAFe as a basis for new ways. We implemented tools such as Jira Align, Jira, Sharepoint and PowerBI in addition to SAP to capture portfolio epics, features, stories, and other artefacts. Our Iteration and PI Retros provide the feedback of what is working and what is not working to pivot if required.

Visualize Everything

Information Visualisation allows information to be conveyed efficiently and improves users' comprehension and memorability (Obie et al., 2019). We commenced with developing our Intranet for use as a channel to communicate with the Active Transport team. We then created visualisations for Portfolio Analytics using data from SAP & Jira Align to show various breakdown by Councils, Budget vs Actuals, length of cycleways delivered in Kms and Open to Traffic milestones etc. Next were visualisations on Network Analytics using PowerBI with the data coming from piezo and pneumatic tube counters and cameras deployed across the state of NSW collected every five seconds in some cases. While Active Transport's focus is on walking and cycling volumes only, the Machine Learning model has been trained to identify other vehicle types such as car, truck, bus, motorcycle as well which makes this solution scalable to entire Transport. The dashboards show near real-time movement of all vehicles within last 24-hour period at one intersection in Sydney.

Understanding Voice of Customer has become priority for Transport. One of solutions developed captures sentiments expressed in social media and other digital channels in near real-time and is expressed as Walking Sentiment, Cycling Sentiment and Active Transport Commuter Sentiment Score. In a Transport first, this will allow us to better understand the impact on commuters and stakeholders through-out the infrastructure project life cycle.

Visualization is a journey as we discover more datasets and new requirements emerge, our current Portfolio and Network Analytics have provided us great vehicle for storytelling.

Measure Performance

Active Transport has established Key Performance Indicators (KPIs) across three measurement domains – Outcomes and Flow for the Value Streams as per Table 3.

Table 3

Active Transport Metrics

Objectives	KPI
Enable safe, reliable, and connected walking & bike riding environments	<ul style="list-style-type: none"> • Kms of bicycle paths and shared paths delivered • No of bicycle parking facilities delivered [for Stations only] • Projects open to traffic (completed) • Trips planned which include cycling on Trip Planner • Percentage decrease in the ratio of walking and bike riding incidents • Percentage increase in stakeholder and commuter sentiment score • Percentage reduction in journey times, as indicated by Transport Customer Survey
Transform walking & bike riding experiences for customers	<ul style="list-style-type: none"> • Positive to very positive experience as indicated by quantitative and qualitative feedback • Feedback indicates X% would take part in a walking or bike riding experience again
Generate insights into demand and performance of the walking & bike riding network	<ul style="list-style-type: none"> • Percentage increase in walkway usage • Percentage increase in cycleway usage • Percentage of walkways mapped in ArcGIS • Percentage of cycleways mapped in ArcGIS • Number of cameras deployed on walkways and cycleways across NSW • Percentage coverage of cycleways through sensors
Provide leadership and advocacy for walking & bike riding within NSW	<ul style="list-style-type: none"> • Number of projects including active transport infrastructure • Increase in funding for Active Transport projects

In addition, Teams use localized outcome metrics such as Iteration Goals and PI Objectives to measure performance.

Outcomes Delivered

While the work is still in-progress, we have delivered:

- Portfolio, Program and Product Governance,
- Consolidated view of Active Transport Portfolio replacing multiple spreadsheets,
- SAFe processes (Daily Standups, Iteration Planning, Backlog Grooming, Iteration Reviews, PI Planning, Portfolio Sync meetings),
- Benefits Tracking across the state using Piezo & Pneumatic tube sensors,
- Ability to manage Get NSW Active Program Grants,

- Ways of working, and
- Flow Metrics (end-to-end delivery of projects).

Based on outcomes delivered so far in Active Transport, we can summarize our initial observations. DSIs benefitted with a product mindset not having to start and stop the work after ingesting each dataset as a project. The product delivered by DSIs continue to be enhanced with features being added in each iteration and each PI. Each dataset adds to better benefits tracking and investment decisioning capability. This leads us to our first guiding principle of **focusing on product and not projects** and using agile methods and program management for delivery.

In alignment with SAFe Lean-Agile Principles (Scaled Agile, 2020), we organized the teams around value both for engineering and DSIs. This reduced the handoffs and delays and now we are combining both engineering and technology teams to bring in efficiencies and increased focus on value. This leads us to our second guiding principle of **organizing teams around value** and not functions which has been traditionally done in our organization.

Traditionally, teams are formed and disbanded at the end of a project or a program. This brings in inefficiencies of ramping up the domain knowledge in the beginning and walking away with intellectual property at the end. In Active Transport, we have created persistent teams and keep bringing in work to them. In next round of funding for Get NSW Active Program, we are allocating a percentage of infrastructure budget to support persistent DSI team. This leads us to our third guiding principle of **funding value streams** which are multi-year and stepping away from project-based funding requiring individual business cases.

We stepped away from a centralized decision making and brought it to those who know the subject area well and are best positioned to make the decision. This is subject to financial delegation of authority as we still need to follow corporate governance. This leads us to our

fourth guiding principle of **empowering teams and decentralizing decisions** which are frequent, time-critical and require local context.

We observed that visualizing our portfolio and network data brought transparency to what we do and highlighted areas requiring attention. Visualization helped us identify blockages in our flow. This included Kanban boards using Jira to show work in progress for all teams and showing portfolio and network analytics using PowerBI dashboards. This leads us to our fifth guiding principle of **visualizing all aspects of portfolio** and provide transparency to all stakeholders.

Having right level of data helps in making sensible portfolio decisions – where the resources should be deployed and where next cycleway and walkway should be built. We are collecting both qualitative and quantitative data and just commencing to use for decision-making. While in early stages in Active Transport, it still leads to our sixth guiding principle of **collecting as much data** and using it for decision-making. The exploratory nature of data and DSIs is such that unless you try, you don't know what insights data can deliver.

While DSIs delivery timeframes are relatively short as compared to construction projects, there is a need to optimize them. The only way is to collect data and identify activities on critical path causing delays. Faster delivery of DSIs result in faster delivery of value and benefits realization and thus the flow needs to be measured. This leads us to our seventh guiding principle of **measuring flow** and addressing areas causing delay.

Baselining capability allows us to continuously improve. Since commencing our DSIs, we have continuously brought in changes to how we operate – in people, processes, and tools. The data tells us whether the changes are working or not. This leads us to our eight and last guiding principle of **relentless improvement** of people, process and tools and having a growth mind-set.

Findings

Using Active Transport case-study, we found that introducing SAFe (Scaled Agile, 2020) helped the newly formed team to adopt to new ways of working. The “command and control” mentality did not exist, and traditional hierarchical governance structures were not created. We also found that the best practice frameworks for portfolio management (Jenner & Kilford, 2011; Project Management Institute, 2017) or IT governance (Axelos, 2019; ISACA, 2018) are more suited for stable environments and traditional command-and-control settings (Horlach, Schirmer, & Drews, 2019). DSIs which are innovative and exploratory generally follow agile delivery methods and have scope and goals elaborated in a continuous and iterative process. This makes traditional project governance focused on successful delivery of iron triangle – time, cost and quality (Pollack, Helm, & Adler, 2018) less suitable for DSIs. This is a gap we have identified in literature in effective delivery of DSIs.

Just by taking the 2-days “Leading SAFe” training together, the team bonded and came to know each other. The team members came from engineering and technology backgrounds and different ways-of-working. While the technology teams were used to agile methods, engineering teams followed waterfall methods with stage-gates. SAFe allowed us to work as one team. We started talking more about minimum viable product and business agility. By having daily Stand-ups for each value stream, the primary author was able to interact with all the team members to know what they are working on and if they face any blockers on the day. Continuous communication and decision-making took place in these Stand-ups. Iteration Review at the end of two-week to review progress brought in transparency on Iteration goals and what was achieved. Successes were acknowledged and celebrated. Program Increment (PI) Planning ceremony allowed us to setup portfolio outcomes for each quarter and teams together unpacked them into specific epics/features/stories for delivery into iterations. Fully empowered, Teams decided on “when” and

“how” outcomes were achieved. Retrospectives at the end of Iteration and Program Increment allowed us to continuously see what was done well and identify areas of improvement. All improvement areas were turned into actions and assigned to individuals to work on.

We conclude using SAFe enabled the Active Transport portfolio to implement minimum viable governance of Portfolio and Product Management and bring in a degree of business agility not experienced by team members and stakeholders earlier. It allowed Active Transport to address the challenges it faced viz. managing the portfolio efficiently and effectively, using data for benefits tracking and investment decisioning, and establishing new ways of working with the new team.

Recommendation

Based on Active Transport portfolio case-study, we recommend eight guiding principles for minimum viable governance for DSIs as per Table 4. While Active Transport used SAFe for delivering DSIs, we believe that the guiding principles are generic and can be applied by organizations using any other Agile delivery method. Table 4 shows how these guiding principles are aligned to the twelve principles mentioned in Table 2 from Project Management Institute (2021) and Association for Project Management (2016).

Table 4
Guiding Principles for Minimum Viable Governance for DSIs

No	Description
(i)	Focus on product not projects – Use product management for DSIs and not project management for delivery [APM #1]
(ii)	Organize around value – Structure the teams around delivery of value and not functions [PMI #4, 7] [APM #2, 3, 4]
(iii)	Fund value streams – Instead of funding projects using business cases, fund the multi-year value streams [PMI #2, 4] [APM #2]
(iv)	Empower teams – Allow decision-making to be done by people who have the most knowledge and not based on hierarchy [PMI #1, 2, 5, 6] [APM #5, 6]
(v)	Visualize portfolio – Visualize all aspects of portfolio and make them available to all stakeholders [APM #7, 11]
(vi)	Data driven decision-making – Collect as much relevant data and use it for decision-making. [PMI #3, 8, 10] [APM #8, 10, 12]
(vii)	Measure flow – Identify steps causing most delay in the flow and address them. [PMI #3, 4, 5, 8, 11, 12]
(viii)	Relentless improvement of people, process and tools – Baseline capability and continuously improve [PMI #2, 3, 4, 7, 8, 9, 10, 11, 12] [APM #7, 9, 10, 12]

The chapter is based on Active Transport portfolio of Transport and less than a year of implementing Scaled Agile and Lean Portfolio Management. The \$950 million portfolio composition currently is 99% construction projects and 1% DSI. It is expected that as the portfolio matures and reliance on digitization and data increases, the composition may change. We believe that the guiding principles for minimum viable governance for DSI identified here do not present

an exhaustive and universal set and more may emerge as the field of data science advances. Another aspect is that DSIs are a more recent phenomenon and sit in a rapidly evolving technology and delivery space. This has an impact on the currency of the research work being done as some of the guiding principles may evolve as the maturity of DSI changes from being exploratory to exploitative.

Limited availability of methods and standards in delivery of DSIs has caused the business managers and practitioners to chart their own path and thus introduce inconsistency in how DSIs are managed and governed in different organizations. It is expected that the standardization on DSIs will increase over time and provide guidance to the business managers and practitioners in effective and efficient governance of the DSIs. As the field of data science is evolving rapidly, further research can be undertaken to understand the impact of emerging technologies and cross-cultural factors on these eight guiding principles.

References

- Asay, M. (2017). 85% of big data projects fail, but your developers can help yours succeed. *Big Data Tech. Republic*, 11, 1-5.
- Association for Project Management. (2016). Directing Agile Change.
- Axelos. (2019). *ITIL® Foundation, ITIL 4 Edition*: TSO (The Stationery Office).
- Becker, D. K. (2017). *Predicting outcomes for big data projects: Big Data Project Dynamics (BDPD): Research in progress*. Paper presented at the 2017 IEEE International Conference on Big Data (Big Data).
- Gartner. (2019). Our Top Data and Analytics Predicts for 2019. Retrieved from https://blogs.gartner.com/andrew_white/2019/01/03/our-top-data-and-analytics-predicts-for-2019/
- Horlach, B., Schirmer, I., & Drews, P. (2019). Agile portfolio management: design goals and principles.
- ISACA. (2018). *COBIT® 2019 Framework: Introduction and Methodology*: ISACA.
- Jenner, S., & Kilford, C. (2011). *Management of portfolios*: The Stationery Office.
- Kersten, M. (2018). *Project to product: How to survive and thrive in the age of digital disruption with the flow framework*: IT Revolution.
- Knapp, J., Zeratsky, J., & Kowitz, B. (2016). *Sprint: How to solve big problems and test new ideas in just five days*: Simon and Schuster.
- Mathur, S., Sankaran, S., MacAulay, S., & Tsang, I. (2021). Unique characteristics of Data Science Initiatives: Implications for Program Management. *Manuscript submitted for publication*.
- Mullaly, M. (2009). The '3 Bears' Theory of Project Management. *ProjectManagement.com*. Retrieved from <https://www.projectmanagement.com/articles/246650/the--3-bears--theory-of-project-management>
- Mullaly, M. (2010). The Goldilocks Theory of Governance: How To Get To 'Just Right'. *ProjectManagement.com*. Retrieved from <https://www.projectmanagement.com/articles/258853/the-goldilocks-theory-of-governance--how-to-get-to--just-right->
- Obie, H. O., Chua, C., Avazpour, I., Abdelrazek, M., Grundy, J., & Bednarz, T. (2019). A study of the effects of narration on comprehension and memorability of visualisations. *Journal of Computer Languages*, 52, 113-124.
- Pollack, J., Helm, J., & Adler, D. (2018). What is the Iron Triangle, and how has it changed? *International Journal of Managing Projects in Business*.
- Project Management Institute. (2017). *The standard for portfolio management*(Fourth edition. ed., pp. 1 online resource (129 pages)).
- Project Management Institute. (2021). The standard for project management and a guide to the project management body of knowledge (PMBOK guide).
- Scaled Agile. (2020). SAFe for Lean Enterprises 5.0. Retrieved from <https://www.scaledagileframework.com/>
- Transport for NSW. (2018). Future Transport Strategy 2056. Retrieved from <https://future.transport.nsw.gov.au/sites/default/files/media/documents/2021/FutureTransportStrategy2056.pdf>
- Transport for NSW. (2021). Future Transport Technology Roadmap 2021-2024. Retrieved from https://future.transport.nsw.gov.au/sites/default/files/media/documents/2021/NSW_Future_Transport_Technology_Roadmap_2021-2024.pdf

VentureBeat. (2019). Why do 87% of data science projects never make it into production?
Retrieved from <https://venturebeat.com/2019/07/19/why-do-87-of-data-science-projects-never-make-it-into-production/>

Williams, T. C. (2017). Lean Project Governance. In *Filling Execution Gaps* (pp. 157-192): De Gruyter.