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IDSS 2023

12 – 14 November
Hobart

Measuring Outcomes and Effectiveness in the NDIS

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Acknowledgement of Country

Before we begin, I would like to acknowledge the Traditional Owners and Custodians of the Country on which we meet today, and their continuing connection to land, sea, and community. I pay my respects to their Elders, past present and emerging.

I would like to extend that acknowledgement and respect to any Aboriginal and Torres Strait Islander peoples here today.

Outline

- Background
- A new outcomes framework
- The Investment Effectiveness Program (IEP)
- Pilot IEP funding-outcome analysis

BACKGROUND

The importance of measuring outcomes

Productivity Commission Report 2011[1]

The importance of measuring outcomes was recognised in the 2011 Productivity Commission report which led to the introduction of the Scheme:

> Data on outcomes in employment, education, social participation, and capacity for self-care, and on the measures that contributed to those outcomes, would help to build an evidence base for analysing which interventions or forms of assistance are more effective, and why.

The importance of longitudinal data was also recognised:

> the capture of longitudinal unit data would allow for investigation of the use of disability supports and services, associated costs and the outcomes for people with a disability over their lifetime.

[1] Inquiry report - Disability Care and Support - Productivity Commission (pc.gov.au)

The importance of measuring outcomes

National Disability Insurance Scheme Act 2013 (the NDIS Act)[2]

Chapter 1 Part 2 – Objects and principles

Objects include:

support the independence and social and economic participation of people with disability

promote the provision of high quality and innovative supports that enable people with disability to maximise independent lifestyles and full inclusion in the community

The first of 17 principles is "People with disability have the same right as other members of Australian society to realise their potential for physical, social, emotional and intellectual development"

Chapter 3 Part 2 – Reasonable and necessary supports

will assist the participant to pursue the goals, objectives and aspirations included in the participant's statement of goals and aspirations

will assist the participant to undertake activities, so as to facilitate the participant's social and economic participation

represents value for money in that the costs of the support are reasonable, relative to both the benefits achieved and the cost of alternative support

will be, or is likely to be, effective and beneficial for the participant, having regard to current good practice.

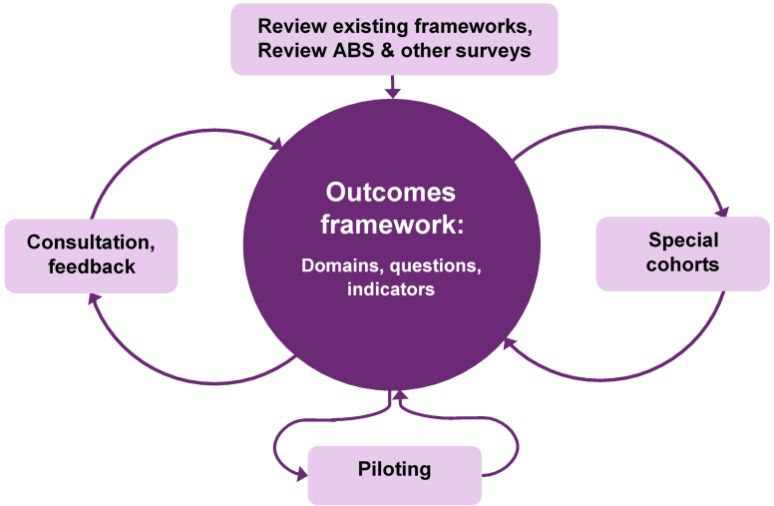
Objects are to be achieved by adopting an insurance-based approach, having regard to the financial sustainability of the Scheme, the broad context of disability reform, provision of services by other agencies, Departments or organisations, and the need for interaction between provision of mainstream services and provision of NDIS supports.

[2] National Disability Insurance Scheme Act 2013 (legislation.gov.au)

Existing NDIS Outcomes Framework

Developed through an extensive consultation process starting in 2014, as illustrated below. Feedback from all sources was incorporated into the final questionnaires.

Review of existing frameworks and population data to benchmark



Wide-ranging consultation:

- IAC
- Key stakeholder groups via workshops chaired by the IAC and Scheme Actuary
- Disability researchers
- Feedback from participants and family/carers who took part in the pilot study

Consultation on special cohorts:

- Experts working with special cohorts, including Indigenous and CALD groups, children
- Experts in specific disabilities, including intellectual disability and psychosocial disability

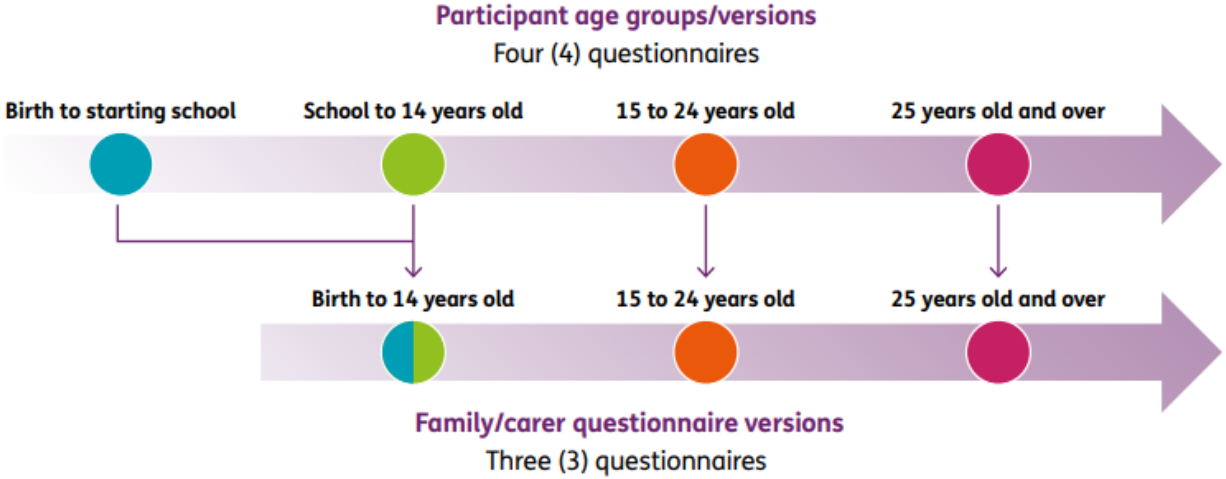
207 participants and 179 families and carers in the Barwon, Hunter and Tasmanian trial sites, in the first quarter of 2015
Outcomes Framework Pilot Study: Summary Report 2015 | NDIS

Existing NDIS Outcomes Framework

Questionnaires by life stage

Leveraging research commissioned by the Independent Advisory Council (IAC), the outcomes framework takes a life course approach to outcomes measurement.

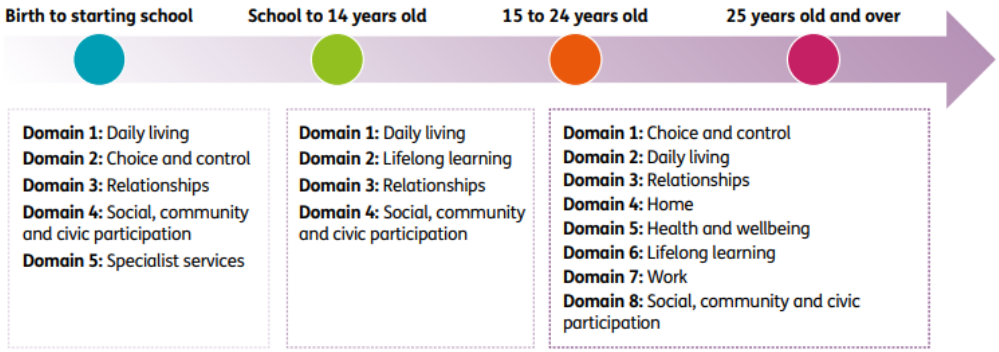
Recognising that different milestones are important for different age groups, there are different versions of the questionnaires, for both participants and families/carers, depending on the age of the participant.



Existing NDIS Outcomes Framework

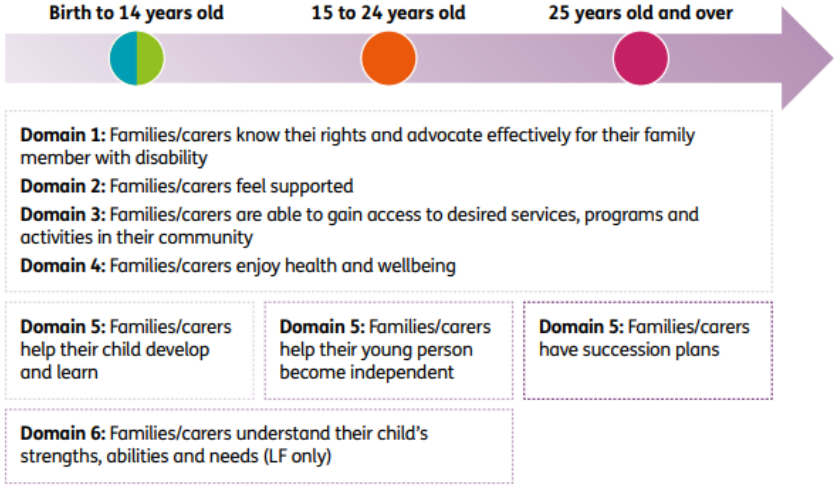
Participant domains by questionnaire

Participant domains vary for children and adults. While most domains overlap, goals and outcomes may differ depending on the age group.



Family/Carer domains by questionnaire

Many of the issues faced by families and carers are similar regardless of participant age, however there are some differences.



Insights from existing NDIS Outcomes Framework

SF data has been collected in CRM since 1 July 2016[3], and LF data has been collected annually since 2016, thus building up a rich seven-year longitudinal history.

Information collected from the questionnaires is used to contribute to a range of publicly available reports, including:

- Quarterly reports to disability ministers (Quarterly Reports | NDIS)
- Annual outcomes reports (Participant outcomes report | NDIS, Family and carer outcomes report | NDIS)
- Deep dives focussing on specific outcome areas, such as employment, and health and wellbeing (Employment outcomes - participants, their families and carers | NDIS, Health and wellbeing | NDIS).

Analysis includes longitudinal modelling (for example, transition models) linking outcomes to plan budgets, support types, and time in Scheme. This is the foundational work on understanding the link between funding/types of supports and outcomes that the Investment Effectiveness Program is building upon.

[3]Back-capture was also undertaken for trial participants, these data are held off-system.

A NEW OUTCOMES FRAMEWORK

A New Outcomes Framework

There has been increasing interest in Scheme outcomes amongst a wide range of stakeholders, including the Agency, the disability sector, government, and the community more broadly. Scheme outcomes, and potential new frameworks, have also been a focus of the NDIS Review.

There is general agreement that a comprehensive outcomes framework should not be limited to participant and family/carer outcomes but should also include indicators of the broader benefits of the Scheme.

Examples of these broader potential benefits include:

- Reductions in government income support due to increased participation in work for people with disability and their families and carers
- Reduced hospitalisations for people with disability through improved health and wellbeing and support in the community
- Less involvement with the justice system for people with disability through improved community connections and health and wellbeing outcomes
- Improved community awareness of, and attitudes towards, disability.

In addition, there is a need to embed the use of outcomes into day-to-day Agency practice: analysis and reporting on outcomes needs to be translated into actions that will improve the Scheme in the future.

Designing a new outcomes framework

It is important that the new outcomes framework is co-designed with participants, their families and carers, the disability sector and other key stakeholders.

Successful co-design will ensure that measurement of Scheme outcomes and effectiveness is trusted and ultimately owned by participants, their families and carers and the sector more broadly.

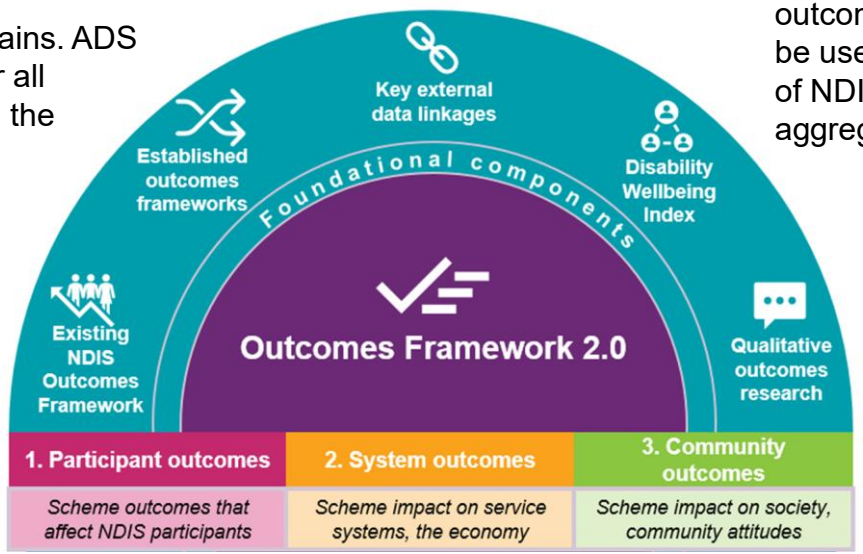
Initial thinking on a new framework is presented schematically on the next slide. The framework comprises three types of outcomes: participant, system, and community. Outcome measures are derived from five data sources, discussed in more detail on subsequent slides.

A suggested new framework for discussion

Australia's Disability Strategy Outcomes Framework (ADS OF) and other frameworks can form the basis for new system and community outcome domains. ADS OF includes outcomes for all Australians with disability, the economy and community.

Incorporating non-Scheme inputs, drivers and outcomes into a new NDIS outcomes framework communicates the effectiveness of the Scheme for the wider social services system and the economy.

An aggregate measure of wellbeing incorporating weights which reflect the relative importance of different outcomes to participants. Can be used to measure the impact of NDIS investment on aggregate wellbeing.



Developed through an extensive consultation process in the early years of the Scheme, now contains 7 years of longitudinal data. Produces valuable insights into participant and Scheme progress.

Talking directly to participants provides insight into the outcomes that matter most to them. Enriches the quantitative research by explaining why participants answer the way they do.

Participant and family/carer self-reported outcomes

The existing framework collects longitudinal self-report data from participants and their families and carers using a series of age-based questionnaires. Self-report methods are valuable because they allow people to describe their own experiences and feelings, such as whether they feel supported, or how they perceive their own health.

The suggested new framework retains a self-report component which will build on the existing framework, and will be guided by the following principles:

- Co-design and engagement, with input from participants, their families and carers, and the disability sector.
- Consideration of specific cohorts, such as Indigenous and CALD participants, to ensure that the measurement instruments are culturally appropriate and accessible, and are collecting information important to these cohorts.

It is also recognised that some participants are not able to self-report, for example, those with severe cognitive impairment or who are non-verbal. Appropriate ways of measuring outcomes for these cohorts will be considered.

ADS Outcomes Framework and other frameworks

The ADS Outcomes Framework measures progress under ADS 2021-2031. It was developed in consultation with people with disability and currently has 85 measures across seven outcome areas. There are three types of measures:

- System measures: track the contribution of key systems, such as health care, housing, education, and employment, to achieving outcomes.
- Population measures: track the changes in outcomes over time for people with disability.
- Community attitude measures: track the change in attitudes towards people with disability, and how people with disability experience community attitudes.

The ADS Outcomes Framework and established international examples can form the basis of an expanded set of system and community outcome domains.

Australia's Disability Strategy - Australian Institute of Health and Welfare (aihw.gov.au)

External data linkages

Linking NDIS data with external sources serves two main purposes:

1. Obtaining more objective outcome measures for NDIS participants and other people with disability. Using linked data can overcome some of the limitations of self-report data and provide more accurate estimates for “objective” outcomes (such as income, hospitalisations).
2. Measuring the impact of the NDIS on other service systems and the broader economy. Using linked data covering a broad spectrum of government benefits and services also removes many of the limitations to measuring economic benefits, such as cost offsets across government.

Linked data assets include:

- Person-Level Integrated Data Asset (PLIDA, formerly MADIP): a secure data asset combining information on health, education, government payments, income and taxation, employment, and population demographics (including the Census) over time. The Australian Bureau of Statistics (ABS) is responsible for collecting and combining the data.
- Australian National Data Integration Infrastructure (ANDII). ANDII will enable the linkage of a combination of Commonwealth and State and Territory datasets. ANDII is being used to deliver the National Disability Data Asset (NDDA) with intended linkage of over 200 Commonwealth and State and Territory datasets (including NDIS data) to better understand how people with disability are supported through services. The asset is expected to be useable by 2025.

Disability Wellbeing Index

Research is being undertaken by the NDIA Research and Evaluation Branch (REB), in collaboration with Monash University, to develop a preference-based wellbeing index.

The initial phase of this work considered outcome domains and measurement generally, and the second phase is considering preference weights which reflect the relative importance of different outcomes to participants.

Combining outcome measures with weights produces a single index. Observing how this index changes as the level and mix of NDIS supports are varied can assist with measuring the impact of NDIS investment on aggregate wellbeing.

Qualitative research

Qualitative research collects and analyses non-numeric data, for example through interviews and focus groups.

The REB has conducted qualitative research into participant outcomes. For example, interviews and focus groups with participants, families and carers, and NDIA staff and partners produced valuable insights into barriers and enablers of employment outcomes for participants with autism, psychosocial disability or intellectual disability.[6] These results enriched the results obtained from quantitative modelling of the structured outcomes framework data.

It is proposed to more formally embed the use of qualitative research methods into the future outcomes framework. For example, asking a broad sample of NDIS participants to consider the outcomes that matter to them consolidates existing research and builds on the consultation undertaken for Australia's Disability Strategy.

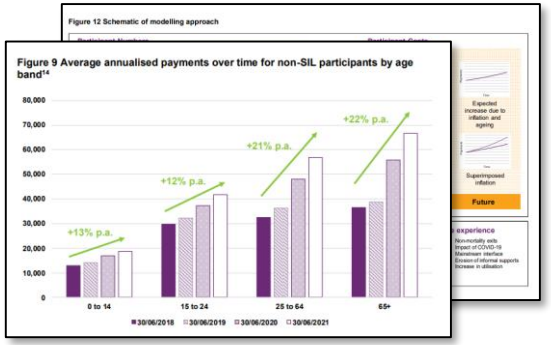
6 Exploring participant experiences: Achieving a sense of purpose | NDIS

THE INVESTMENT EFFECTIVENESS PROGRAM (IEP)

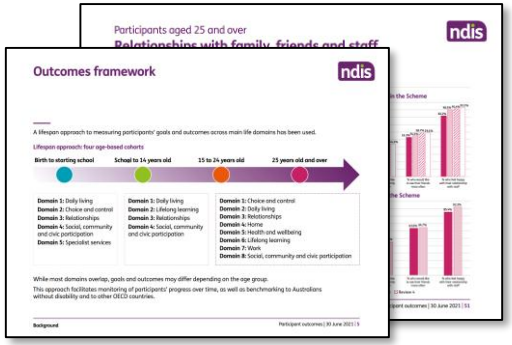
Background

There is limited understanding of the link between participant funding and outcomes, resulting in suboptimal funding allocations

Funding project examples:
Annual Financial Sustainability Reports, Consistent Decision Making Framework, Improved Typical Support Packages



Outcomes project examples:
Participant Outcomes Reports, Participant Wellbeing Index, CB supports on H&L outcomes, Behavioural interventions in children with ASD…



By improving our understanding of this link, we hope to:

1) build the evidence about the benefits of NDIS spending to provide some counterbalance in the public debate around NDIS costs and;
2) do so with an applied focus such that participants and planners can derive insights about the funding level and mix which has been effective in very similar scenarios to their own, and use this to maximise the benefits of their spending and;
3) better define a set out outcomes that matter to participants and government

Objectives

The Investment Effectiveness Program is being undertaken to understand the link between funding and outcomes

Developing an evidence-based understanding of the link between participant support funding and the attainment of participant outcomes can help to answer key policy questions and help to address Government priorities

1. Value

Can a link between support funding and the attainment of outcomes be established to understand the effectiveness of the NDIS?

2. Future state

How can we maximise the benefits of the NDIS based on the link between funding and outcomes to be more efficient, financially sustainable and deliver optimal outcomes for participants?

3. Implementation

What implementation strategies and policies should be developed based on the link between participant outcomes and funding?

Co-design and effective incorporation of stakeholder input remain a key factor in determining the answer to these questions, including through the IEP

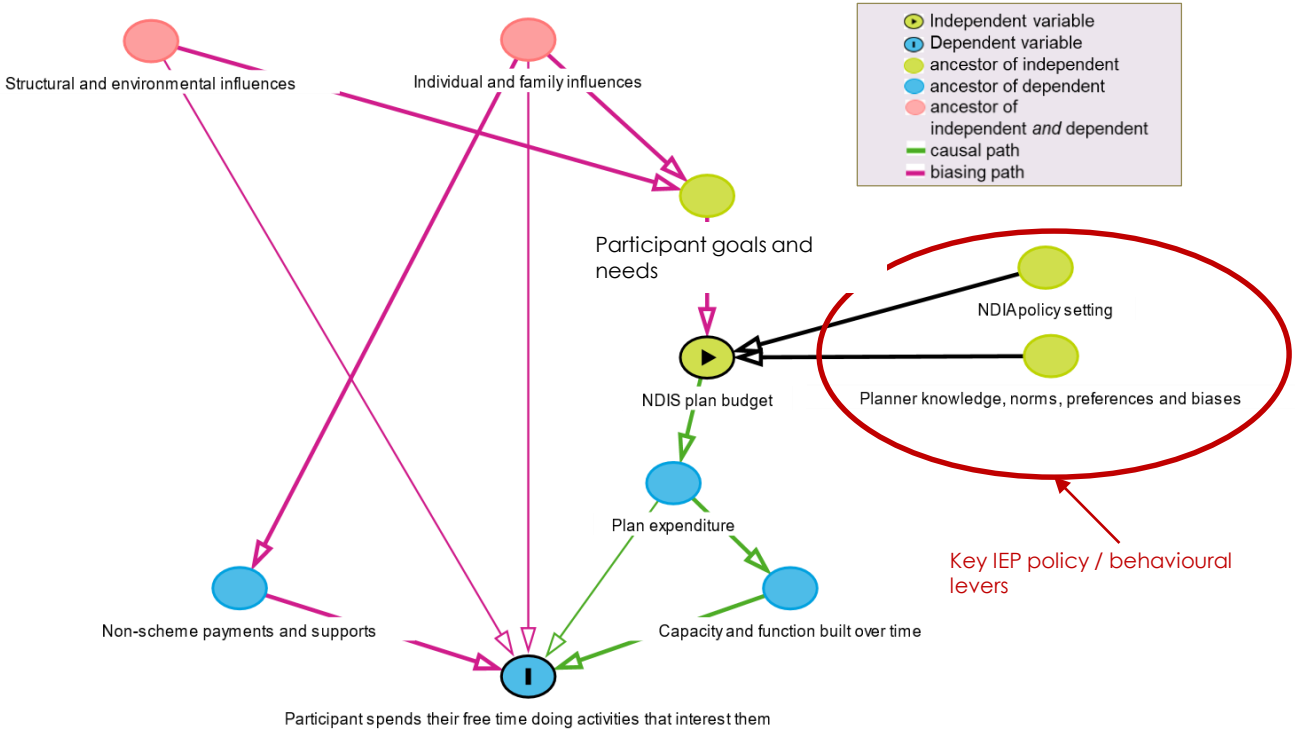
Key deliverables

The focus will be to understand the impact of funding on outcomes to ultimately deliver outcomes focussed funding

Project phase		Key question to be answered
Phase 1 Research and scoping	**Pilot Phase (2022-2023)** For a single priority cohort (participants aged 15-24 with an intellectual disability including down syndrome) provide answers in a shorter timeframe to each of the questions answered in phases 1-5	What is the scope of the program and assessing what existing work can be leveraged?
Phase 2a Outcome funding analysis		What is the marginal impact of support funding on participant outcomes?
Phase 2b Qualitative outcomes funding research		Do results from the outcome funding analysis (2a) accord with expert and participant perspectives?
Phase 3 Outcome value assessment		How do we measure the 'value' of participant outcomes and their relationship with scheme objectives and participant goals?
Phase 4a Cost effectiveness modelling		How could a funding mix for participants be changed to better support scheme objectives, participant goals and outcome attainment?
Phase 4b Economic benefits analysis		What are the total economic benefits the Scheme delivers and how does Government best incorporate those benefits into policy and budgeting decisions?
Phase 5 Recommendations and Roadmap		How might the scheme be adapted to be more efficient and outcomes focussed?

Causal assumptions

The IEP design and analysis assumes that evidence-based tools introduced at the planning stage can influence budgeting behaviour to ultimately improve outcomes



PILOT IEP FUNDING-OUTCOMES ANALYSIS

Pilot funding-outcomes analysis

IEP pilot funding-outcomes analysis investigates the marginal effect of NDIS funded supports on participant outcomes

Its aims as a pilot study are to:

1. Identify how probability of outcome attainment and maintenance increases with changes in NDIS payments;

2. Assess the suitability of available NDIS data for understanding the effectiveness of NDIS funding, and;

3. Determine the limitations of the analysis to inform the extent to which it could be used for subsequent IEP analyses, policy and operational purposes.

Pilot funding-outcomes analysis data

A comprehensive modelling dataset has been built, linking NDIS support payments, outcomes and controls datasets

Category	Description
NDIS participants	Data includes NDIS Participants who had NDIS plans between July 2016 and March 2022. The pilot cohort was selected from this group of participants against an assessment of factors such as Agency priorities, data quality and funding/outcomes variability. **Participants aged 15-24 with an intellectual disability including Down syndrome** were selected as the cohort for pilot analysis.
NDIS support payments	Data includes NDIS support payments made to participants or service providers and in-kind payments for existing state/territory programs. Payment data is captured at a transaction level, with each transaction specifying the participant for whom the support was provided, the support that was provided, and the cost of providing the support.
Additional controls	Controls included in the initial pilot modelling include data related to demographics, disability characteristics, participant goals, Socio-economic indicators & geographical information, other NDIS related information (e.g Scheme entry date, time in scheme).
Participant outcomes	Outcomes modelled come from key indicators from a questionnaire completed at entry and annually by all NDIS participants. A subset of indicators was selected for modelling in the pilot phase through consultation with SMEs.

Pilot cohort

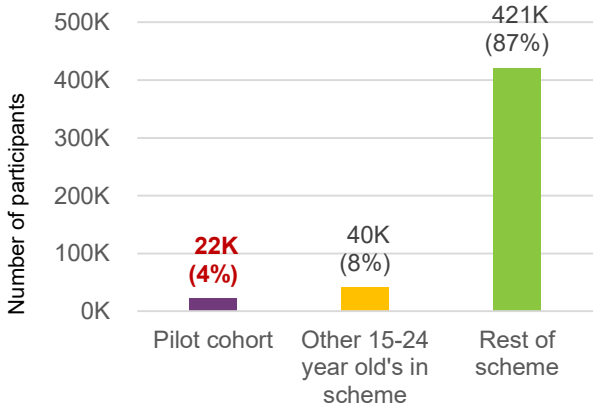
Pilot Participant Cohort: 15-24 with Intellectual Disability or Down Syndrome

The pilot cohort accounts for approximately 4% of scheme participants

Pilot cohort | Other 15-24 year old's in scheme | Rest of scheme

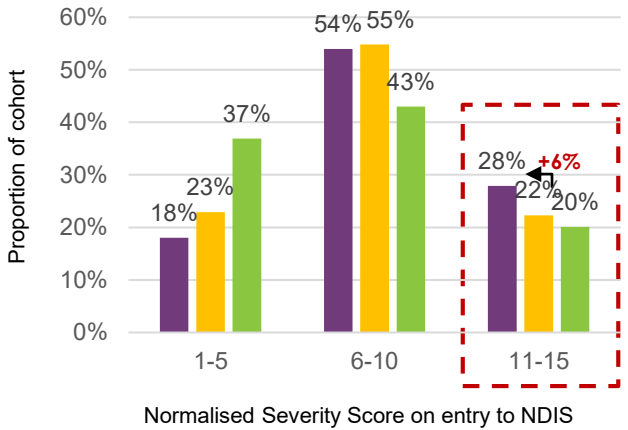
Number of participants

The pilot cohort represents approximately **22k** participants which accounts for **4%** of the total scheme participants



Normalised severity score

28% of the pilot cohort has a normalised severity score of at least 11, **6%** greater than other 15-24 year old participants in the scheme



Data includes all Participants who has had plans with effective date from July 2016 to March 2022. Pilot cohort defined as participant with primary disability Intellectual Disability or Down Syndrome and between ages 15 and 24 at baseline review. Participants in the NDS trial cohort have been removed from the analysis.

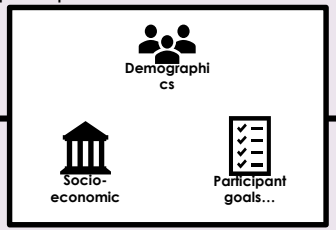
IEP pilot funding-outcome analysis

This analysis quantifies and isolate the impact of participant funded supports on attainment of outcomes

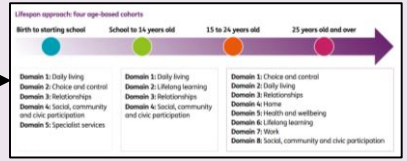
Modelling

Participant Support Funding
What NDIS supports were funded for the participant?

Controls
Which other factors might impact the participant's attainment of outcomes?



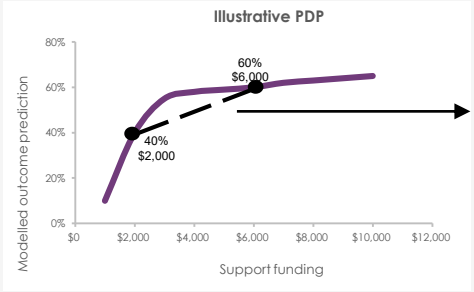
Participant Outcomes
Which outcomes were attained by the participant?



Output

Partial dependence plots (PDPs) show the marginal effect each feature has on the predicted outcome of a machine learning model.

They assist in understanding and quantifying inferences about differences in level of support funding and how that impacts outcome attainment.



Interpretation
Controlling for all other features within the model, an additional $4,000 in support funding could lead to a 20% increase in the probability of the attainment of the outcome

Modelling approach selection (1)

The scale and requirements of the project directly influenced selection of the modelling approach

Consideration	Description	How it impacts modelling approach selection
Scale	The project has highly applied aims, so outputs need to be relevant to all participant cohorts, support types and outcomes.	Only scalable analysis techniques with automated acceptance criteria can accommodate analysis of 400+ cohorts, 90+ outcome measures, and at minimum 15 support categories, essentially creating 500,000+ output permutations
Interpretability	The ability to explain the model process and results in a uniform manner that aligns with real world applications.	Machine learning models tend to be 'black box' models and require various techniques to explain the relationships being modelled. Selecting a machine learning process which is easily explainable and interpretable is key in utilising the modelled results in broader policy considerations.
Accuracy	The ability of the models produced to accurately predict outcome attainment of the participant.	Higher accuracy models result in more confidence in the modelled relationships. A comparison of accuracy metrics across different modelling approaches is **presented on the following slide**.
Design constraints	As a social intervention to cover all Australians with permanent and severe disability, many research designs are impractical.	Experimental designs such as randomised control trials are not feasible in the absence of a control group. Therefore an observational design and associated statistical techniques are necessary.

Modelling approach selection (2)

The Gradient Boosting Machine (GBM) approach was selected as it addressed the key considerations outlined in the previous slide

Scale

- GBM enables scalable analysis techniques and automated acceptance criteria.
- GBM efficiently handles large datasets, making it suitable for analysing a high number of outcome/funding/cohort permutations.

Interpretability

- GBM provides interpretability through techniques like feature importance analysis and partial dependence plots, helping explain the model's process and results.
- This enhances policymakers' understanding and alignment of the model's insights with real-world applications, facilitating informed decision-making and effective utilisation of the model in broader policy considerations.

Accuracy

- GBMs ability to handle complex relationships and capture nonlinear patterns contributes to accurate predictions, instilling confidence in the model's ability to predict outcome attainment for participants.
- GBM performs consistently well across multiple accuracy metrics vs. other algorithms for our dataset

Model	AUC	RMSE	Log Loss	MSE	AUCPR
GLM	0.653371	0.454148	0.598583	0.20756	0.736013
DRF	0.68356	0.471773	0.653336	0.223461	0.767489
GBM	0.688508	0.442061	0.577999	0.198065	0.762212
StackedEnsemble	0.714417	0.470862	0.713853	0.222612	0.778629
DeepLearning	0.714771	0.529742	1.911539	0.282802	0.772191

Table: A comparison of accuracy metrics across different modelling algorithms

Constraints

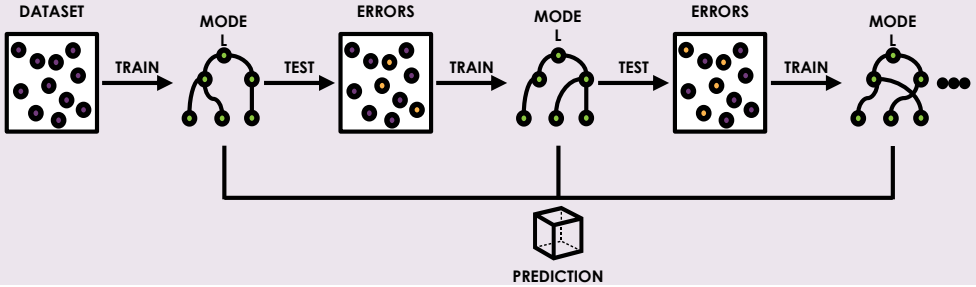
- GBMs can address the design constraints by effectively utilising observational data instead of relying on experimental designs like randomised control trials.
- By applying statistical techniques to observational data, a GBM can analyse and model complex relationships, providing valuable insights about the social intervention's impact without the need for a control group.

Gradient Boosted Machines (GBM)

GBMs have been used as the modelling technique due to their strong ability to detect patterns within data and their ease of implementation

Model Type

A Gradient Boosting Machine (GBM) is an ensemble machine learning modelling technique where 'weak' models are improved sequentially by learning from errors to produce 'strong' models



Pros & cons

Despite GBMs being powerful in detecting complex patterns and relationships, there are certain shortcomings that need to be controlled for

Pros	Cons
Trends and patterns are identified with ease GBMs are capable of automatically identifying and quantifying complex interactions and relationships within datasets	**High level of error susceptibility** GBMs and machine learning models are susceptible to over-fitting and finding 'noise' within the data
Ease of implementation GBMs can more easily produce accurate predictions compared to traditional statistical methods	**Time and resources** GBMs are more computationally expensive than traditional statistical methods and as such can take a long time to execute
Fit for purpose Model outputs can be extracted in a way that will allow for direct interpretation of the marginal impact of funding on outcomes	**Interpretation of algorithm** GBMs are sometimes referred to as black boxes due to their algorithmic complexity meaning interpreting their output can be complicated and additional methods need to be applied

XGBoost

XGBoost is an enhanced implementation of the GBM algorithm and is widely used to produce high accuracy models

XGBoost has **four** key differences compared to a standard implementation of a GBM

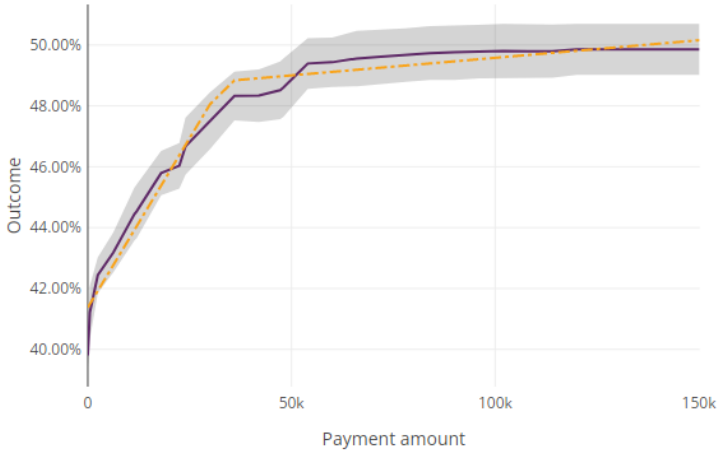
Difference	Relevance to project
Regularisation: A technique used in machine learning used to prevent overfitting and improve the generalisation ability of a model. This is done by adding a regularisation term in the objective function.	The IEP models have a high number of potentially noisy features, which increases the risk of overfitting, which is mitigated by regularisation. The models are also used for optimisation which requires the model to be generalisable to new data.
Parallel processing: The ability to use multiple cores of a CPU to significantly reduce the model training time is built directly into the implementation.	The models are trained on a large amount of data, and are bootstrapped, meaning training runs can take up to multiple days. Parallel processing reduces this time which allows for more experimentation.
Handling of missing values: During the training process, handling of missing values is learned by the algorithm, whereas in a standard GBM, missing values must be imputed manually.	The base data consists of many data sources, each with differing completeness, resulting in some missing values for a decent number of variables. The ability to handle these automatically is critical and is addressed by XGBoost.
Tree pruning: Early stopping during construction of trees, which reduces computation time and overfitting.	Similarly to regularisation and parallel processing, tree pruning improves the generalisation ability of the model and reduces computation time respectively.

Partial Dependence Plots (PDPs)

PDPs are used to simplify and understand modelled relationships between the response and a single feature within the model

- PDPs show each feature's marginal effect on the predicted outcome whilst holding all other model features constant
- The relationship described by a PDP can often vary in complexity with some relationships being simple to summarise while others are more volatile and vary for different groups of values
- PDP's from recent pilot model runs have identified both intuitive and surprising relationships between payments (at a payment category level) and outcomes

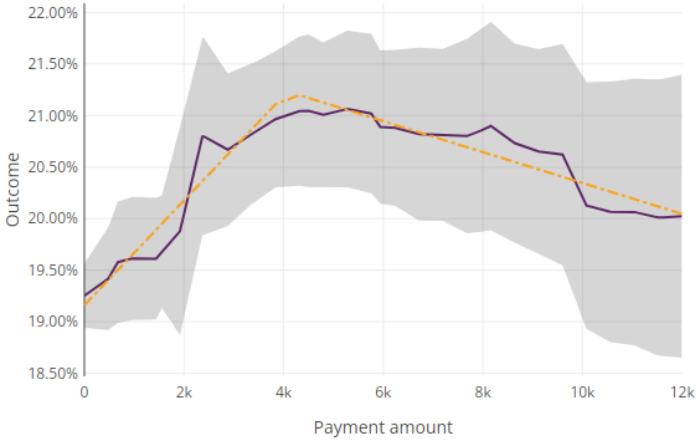
Daily Activity Support payments and their relationship with the outcome 'has the NDIS helped with daily living activities'



Partial Dependence Plots (PDPs)

Some PDPs have shown flat or negative relationships between funding and outcomes

Capacity Building Daily Activity Support payments and their relationship with the outcome 'has the NDIS helped with daily living activities'



The analysis, at times has shown a negative relationship between outcomes and funding. In very rare circumstances, this may be expected, but with the above example we would, at worst, expect to see a flattening relationship. We suspect the reasoning for the above, is that the 'controls' in the model do not fully capture the participant experience. 'Better' controls may improve the modelled relationship between supports and outcomes.

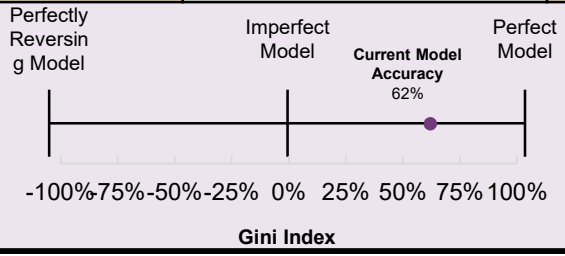
Pilot modelling results

Participant is currently working in a paid job

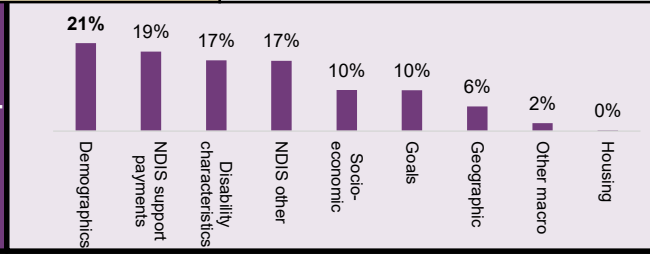
Scenario

Cohort	Participants 15-24 with Intellectual Disability or Down Syndrome	**Outcome treatment**	Attain or maintain outcome at any review period
Outcome	Participant is currently working in a paid job	**Funding treatment**	Individual plan support payments

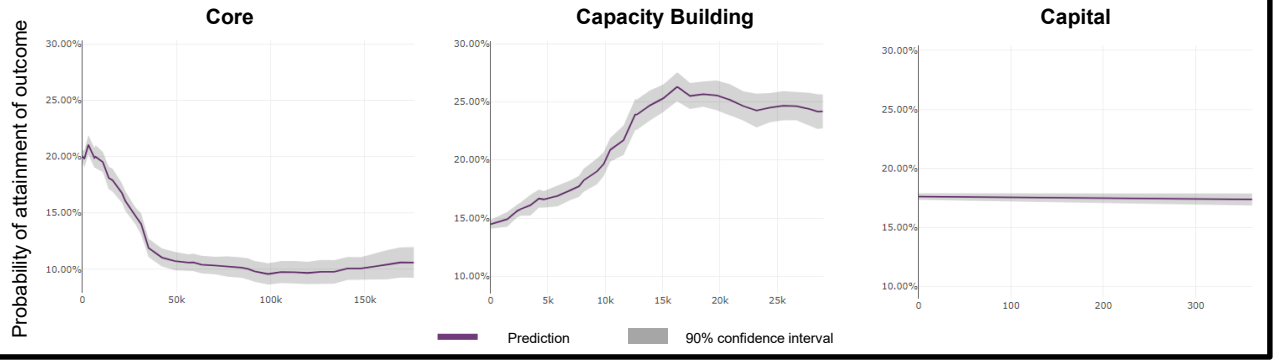
Accuracy



Feature Importance



NDIS support payments



Data includes all Participants who have had plans with an effective date from July 2016 to March 2022. Pilot cohort defined as participant with primary disability Intellectual Disability or Down Syndrome and between ages 15 and 24 at baseline review.

APPENDIX

ABS DataLab

The DataLab environment is a unique analytical solution for researchers and policymakers, however several challenges need to be understood to maximise the potential of the data

Key requirements	Challenges encountered
Accessing large volume of data	Lead to slower execution times
Organise large and complex data efficiently and effectively for reproducibility	Issues maintaining and managing data, integration complexities and scalability issues
Efficiently handling pre-processing and integrating data, including performing complex modelling	Processing speed can be a significant bottleneck, leading to delays in obtaining results

An operative layer within the Datalab environment helps address these challenges

Databricks in ABS DataLab

The team are using Databricks in the DataLab environment store, query, analyse and model MADIP data

Databricks is adept at:

- Handling and processing large volume of data efficiently
- Performing complex modelling and analysis tasks effectively
- Enabling reproducibility in data processing and analysis tasks
- Developing an enduring data product and fostering a one-source-of truth approach
- Leverage **Medallion Architecture** to organised data infrastructure and enhance data management workflows

Actuaries Institute.

Thank you

IDSS 2023

12 – 14 November
Hobart