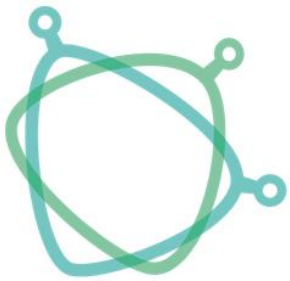


Software Innovation New Zealand

Submission to MBIE's Te Ara Paerangi Future Pathways Green Paper

Review of Aotearoa New Zealand's research, science and innovation system

About Software Innovation New Zealand: Software Innovation NZ (SI^NZ) (https://softwareinnovation.nz) is the New Zealand software research network. Established in 2016, Software Innovation NZ brings together software researchers from academia and industry in a coordinated network of research excellence with demonstrable scholarly and industry impact. Software Innovation NZ has developed a proven capacity to attract, grow and retain global research leaders who make a substantial and sustained contribution both to software-related research and to the NZ economy. Members of Software Innovation NZ interact with a wide range of companies, public sector agencies, educational bodies and international collaborators to deliver on its twin goals of science excellence and socio-economic impact.

Summary of Recommendations

Software Innovation NZ welcomes this review. New Zealand's approach to the research and innovation system has been too hands-off at a time where we need to be proactively creating change.

On the back of this timely review we recommend that government:

1. urgently pursues the establishment of a base grant-supported national organisation, equivalent to a Crown Research Institute, that will leverage and grow the country's world-class research capability, underpin the innovation needs and aspirations of the poorly understood digital technology sector, and drive the digital transformation of all other sectors.
2. sets national research and innovation priorities following the principles and processes of mission-led research as enacted by the Science for Technological Innovation National Science Challenge.
3. ensures that the teams gathered to address research and innovation priorities are formed based on capability and impact potential, with next- and end-users engaged as partners from the outset.
4. creates a single, connected and highly visible system to support researcher development from students through to early career, mid-career and leading researchers and innovators where the mechanisms are demonstrably fit for purpose at each level.
5. establishes a diverse cross-agency Funding Council for each priority area or each set of related platform technologies, comprising leading, mid- and early-career researchers, innovators, advisers and officials that understand excellence, impact and connectedness in context.
6. leverages the Digital Tech Industry Transformation Plan to co-construct and incentivise new models for sustained government-Māori-research-education-industry interaction.
7. urgently and significantly increases expenditure on research and innovation in digital technologies.
8. considers a shift to platform specialisation where specialists work collaboratively on missions and projects 'for the nation'.
9. funds ongoing partnership-oriented engagement over and above the funding of research itself.
10. more proactively looks to support senior, active researchers and innovators to move *part-time* into research system leadership, advisory, policy, mentor and governance roles.
11. urgently develops stable funding mechanisms to obviate the loss of our own PhD graduates to a high-demand global employment market.

Background

Software Innovation NZ welcomes this review. New Zealand's approach to the research, science and innovation[1] (RSI) system has been too hands-off at a time where we need to be proactively creating change. We also support the desire expressed in the Green Paper that our RSI system should be connected, diverse and dynamic, more so than adaptable and resilient, which are important but sound merely reactive.

We in Software Innovation NZ have already been working towards such an ambition. In the two years prior to this review being initiated a proposal for a national digital tech research and development network – the *Aotearoa Digital Alliance (ADA)* – has been in development (see **Appendix 1**). That proposal directly addresses many of the issues raised in the Future Pathways Green Paper and so we refer to sections of it here in our response.

Research in digital technologies should have been a priority before now, particularly if we compare ourselves internationally[2] (see also **4. Institutions** below). In our *ADA* proposal we note: *It has been acknowledged that New Zealand needs far stronger uptake of digital technologies in our enterprises, and that exporting enterprises that invest in R&D are more innovative[3]… Government's own planning has identified digital tech as key to 'building back better' [from the pandemic], to delivering positive economic, environmental and social impacts.[4] While our frontier digital firms are doing well, deeper R&D investment will enable more in the sector to scale up, or to scale out through new digital ecosystems[1,5] …while also enabling the digital transformation of all other sectors.*

This review, sitting alongside the Digital Technologies Industry Transformation Plan, the pending establishment of a Digital Technology Strategy for Aotearoa, and the upcoming national AI Strategy, presents an opportunity to urgently address this major gap in our research and innovation system.

Position Statement

The hands-off approach and market-like processes underpinning investment in the current RSI system have simply not worked for newer fields of investigation such as digital tech. MBIE itself has acknowledged for much of the last decade that public investment in digital tech research (comprising computer science, software engineering, information technology and information systems) has been too low. This is borne out starkly in data from Stats NZ below (see **3. Funding**).

Yet, despite strong sector support[6], government has struggled to find ways to shift the dial, the 2019 SSIF Data Science Platform investment notwithstanding. Even then, in funding four projects that investment addresses a very small proportion of the capability and opportunity offered by the digital tech research community for the future of Aotearoa New Zealand. Undoubtedly, data science and artificial intelligence (AI) require attention but (i) other areas of digital tech, including cybersecurity, digital assurance and analytics, and authentic user experiences, are equally important (e.g., recall the 2021 cyberattack on the Waikato DHB), (ii) AI is software too – and as with all software that is to be increasingly relied upon it needs to be properly engineered and put into production effectively to operate as needed and in context, and (iii) some AI has been and will continue to be commoditised as the field matures. A *digital tech* strategy needs to be just that – *an ambitious plan for all digital tech*, rather than for a structure of artificially separated technology silos that will simply replicate the competition that we see at present between our institutions.

[1] We prefer "research and innovation" as more accommodating of non-science research disciplines (e.g., the humanities, engineering) and knowledge systems.
[2] https://www.cwi.nl/news/blogs/europe-needs-strong-software-research
[3] New Zealand Productivity Commission (2020) Issues Paper – *New Zealand firms: reaching for the frontier*
[4] Office of the Minister for Economic Development (2020) *A Refreshed Industry Strategy in Response to COVID-19*
[5] TIN Report (2020) *Technology Industry Analysis New Zealand* (16th Ed.)
[6] https://techblog.nz/1634-Is-NZs-funding-of-research-futurefocused

It is *across* these very areas of AI, software and user experience that Aotearoa New Zealand has breadth and depth of research capability, with excellent scientists, engineers and technologists undertaking world-class research relevant to the future of this country. Including graduate students, the computing research community nationally numbers several hundred. The 2018 PBRF census reported close to 300 FTE staff (291.91) in the funded Quality Categories across eight tertiary providers, with 40 FTE at A grade[7] and a further 129 FTE at B grade[8]. This was a step up on the 2012 census: around 260 FTE (257.43) included 23 A and 112 B grade researchers (and this was better in turn than 2006). Of nine Entrepreneurial Universities initiatives funded by TEC (until the programme was closed in 2019) six were in computing, across four providers. Of note is that this does not account for the sector-relevant digital tech capabilities across our Crown Research Institutes (CRIs) and Independent Research Organisations (IROs). (See also **4. Institutions.)**

In spite of this evident capability there has been no cohesive national R&D strategy for digital tech. The Science for Technological Innovation (SfTI) National Science Challenge has been the primary enabler of digital tech research in recent years, supporting nearly fifty small-scale Seed projects and five larger Spearhead projects aligned to varying degrees with their Data Science & Digital Technologies theme – but SfTI will end in 2024. Some elements of digital tech research have been supported by the discontinued MedTech CoRE and NZ Product Accelerator. Both have since been re-funded but through out-of-cycle one-off mechanisms. Marsden funding for digital research has been steady, but at *very* low levels – typically one or two Standard and Fast-Start projects per year. The MBIE Endeavour programme has been a virtual wasteland for digital tech research, funding just a handful of projects over the last decade.

Aotearoa New Zealand urgently needs a sustained, strategic programme of research investment in digital tech to deliver the transformation that is so often spoken of, by successive governments. Other jurisdictions have found the will and the way, including other small nations such as Ireland and Norway (see **4. Institutions**). Without such deliberate change the system will look the same tomorrow as it does today (see **3. Funding**), and we will lag further behind our trading partners and comparative economies. This review offers a chance to ensure strategy and investment match ambition and opportunity.

Key Recommendation

As an outcome of this review, we recommend that government urgently pursues the establishment of a base grant-supported national organisation, equivalent to a Crown Research Institute, that will leverage and grow the country's world-class research capability, underpin the innovation needs and aspirations of the poorly understood digital technology sector, and drive the digital transformation of all other sectors.

[7] Quality Category A: expected to contain evidence of research outputs of a world-class standard; research-related activity that shows a high level of peer recognition and esteem within the relevant research subject area; indicates a significant contribution to the New Zealand and/or international research environments; may also show evidence of other significant demonstrable impact. Tertiary Education Commission (2019) *Improving Research Quality: The results of the PBRF 2018 Quality Evaluation.*

[8] Quality Category B: expected to contain evidence of research outputs of a high quality; research-related activity that shows acquired recognition by peers for their research at least at a national level; indicates a contribution to the research environment beyond their institution, and/or significant contribution within their institution; may also show evidence of other significant demonstrable impact. Tertiary Education Commission (2019) *Improving Research Quality: The results of the PBRF 2018 Quality Evaluation.*

Software Innovation NZ's Responses to the Green Paper Questions

1. Research Priorities

1 (1.2.2) **Priorities design**

- What principles could be used to determine the scope and focus of national research priorities?

We recommend that government sets national research and innovation priorities following the principles and processes of mission-led research as enacted by the Science for Technological Innovation (SfTI) National Science Challenge (NSC)[9]. We have seen evidence of the effectiveness of those processes in the formation of SfTI's Spearhead projects[10]. We have drawn extensively on these approaches for the *Aotearoa Digital Alliance* proposal and reiterate particularly important aspects here, as follows:

Broad acceptability – to provide a rationale for buy-in and to motivate engagement, from researchers, partners, next- and end-users, *missions* work more effectively than more general goals or reductionist KPIs. Missions do not need to be citizen-led as this carries a risk that shorter-term issues will predominate, but they should be citizen-informed and mean something to everybody – in that if we were to ask a random sample of New Zealanders whether we should invest time/effort/money into [this mission] most should respond positively. If missions are arrived at collectively they typically provide something that people can mobilise around, creating an initial coalition of the willing who can then get on with advancing the 'who', 'how' and 'when' and with the right KPIs in place as part of that. On the other hand, if a mission just does not resonate then it is probably not a good one to pursue, no matter what goals or KPIs are identified.

Providing optionality – in order to give a level of continuity but also to accommodate known and unknown future directions a portfolio approach is key. In regard to national research priorities this should enable support to be given to a balanced (though not necessarily evenly split) combination of Continuing Strengths, Current priorities, and Emerging Opportunities. The latter is especially important to ensure we are responsive to advances in digital tech.

Cross-cutting emphasis – we would advocate that priorities be built around enabling technology and capability platforms rather than sector-specific needs, a point made previously in our submission to the Digital Technologies Industry Transformation Plan and supported internationally[11]. This is a more effective and efficient approach in that expertise and learning can be shared across the platform *and* within/across sectors, and the best teams can be formed as needed to address specific project opportunities.

2. (1.3.2) **Priority-setting process**

- What principles should guide a national research priority-setting process?
- How can the process best give effect to Te Tiriti?

A range of methods may be useful in different contexts to ensure diversity and inclusiveness of views, and we would encourage piloting and experimentation with candidate approaches in order to inform the priority-setting process. We note that SfTI has used and reported on the success of several of: Foresighting and Delphi surveys, the Concept-Knowledge (C-K) methodology, Mission Labs, Hui and Wānanga (on marae), followed by a co-constructed Mission Design process. As part of this process next- and end-users are always in the room/at the table, as *partners* rather than the more passive/consumptive *stakeholders*. In-person hui have many advantages and should be used where feasible but they can also exclude those unable to attend for a range of reasons, so the complementary use of technology platforms, such as the locally developed 1000minds[12], should also be seriously considered. (Note that while we later recommend Funding Councils for priority areas (**3. Funding**) we do not suggest that Councils should *set* the priorities.)

[9] http://sftichallenge.govt.nz

[10] https://www.sftichallenge.govt.nz/assets/Uploads/Download-PDFs/Te-Ara-Paerangi-Future-Pathways_-SfTI-submission.pdf

[11] https://digital-strategy.ec.europa.eu/en/library/future-trends-and-research-priorities-area-software-technologies

[12] https://www.1000minds.com/

3. (1.4.2) **Operationalising Priorities**
-How should the strategy for each national research priority be set and how do we operationalise them?

Given their national importance there is a need to ensure that priorities have a degree of longevity. In part this is indeed about sustained funding as noted in the Green Paper, but it is also about ensuring continuity and succession of capability. Established researchers may well have the career security to align to grand challenges but emerging researchers may need to be more opportunistic, going where the shorter-term gains (for funding, promotion) lie, or moving on incrementally from their PhD studies. Specific mechanisms are needed to address this. For instance, SfTI ensured that any call for engagement placed an emphasis on capability, on 'impact potential' rather than on pet projects or track record, to broaden involvement in priority research. Similarly, their use of relatively permissive ballots once science excellence thresholds were reached did not shut out excellent emerging researchers (see also **5. Workforce**). Such approaches also go some way to building and sustaining a collaborating research community around each priority that may then engage in other ways and via other mechanisms, rather simply a one-off, transient 'project team'.

We recommend that government ensures that the teams gathered to address research and innovation priorities are formed based on capability and impact potential, with next- and end-users engaged as partners from the outset.

Effective operationalisation also requires appropriate governance and leadership. By 'appropriate' we mean that leaders and governors need to put the priority first (ahead of institutional and individual ambitions), meaning they need to be trusted to operate independently of research providers and of government – albeit with suitable accountability and reporting requirements. Through working with SfTI we have observed the positive effect of having credible and engaged leadership, who are active researchers in their own right, working alongside the researcher community during and beyond the limited life of a project, supported – and challenged – by impact-oriented governance. No matter what the governance structure – shared or separate – such a group needs to encompass economic, environmental, cultural, social, health/well-being and mātauranga expertise.

2. Te Tiriti, mātauranga Māori and Māori aspirations

We endorse the submissions of Te Pūtahitanga and of FOMA Innovation regarding how the research system and the innovation system, respectively, need to change to work (and work more effectively) for Māori.

5. (2.3) **Mātauranga Māori**
- What are your thoughts on how to enable and protect mātauranga Māori in the research system?

It is for Māori to say how mātauranga Māori should be enabled and protected so we do not provide a response as such here. Rather, we would simply note the work done by Māori with the SfTI NSC in the design of their Tranche 2 policies and procedures for managing IP, mātauranga and taonga species, as informed by their Māori Data Futures hui[13]. This thinking has also informed the operational design of the proposed *Aotearoa Digital Alliance.*

6. (2.4) **Regionally based Māori knowledge hubs**
- What are your thoughts on regionally based Māori knowledge hubs?

In acknowledging that some degree of both expertise and need are already regionally concentrated we have recommended the use of national facing but regionally located hubs in our *ADA* proposal. This may or may not align with Māori aspirations.

[13] https://www.sftichallenge.govt.nz/about-us/documents-and-reports/

3. Funding

8. (3.3.2) **Establishing a base grant and base grant design**

- Do you think a base grant funding model will improve stability and resilience for research organisations, and how should we go about designing and implementing such a funding model?

Provision of base grants may be well-suited, and in fact necessary, to enable longer-term, mission-led, strategic research to be undertaken. As there is a need to balance continuity and relevance in respect of such funding a trusted and transparent negotiated approach with periodic reviews would be essential – both effectiveness and efficiency would be compromised if a more frequent or competitive approach were employed. While performance against outcomes must still be measured as part of that process, making this unit-based rather than individually-based (with the latter currently used in the PBRF) would seem to balance visibility, continuity accountability and workload (for submitters and monitoring bodies.)

More generally we support the Green Paper proposal that a mix of investment types and timelines is needed – as has been designed in *ADA*. We would advocate for an approach that in part mirrors that exemplified by the SfTI National Science Challenge, in supporting both mission-led *and* investigator-led efforts. In addition, for the digital tech sector we would suggest complementing those approaches with support for industry-led projects, including short-term proofs of concept (see the *ADA* proposal at **Appendix 1**). Missions sit above individual businesses, individual researchers, individual institutions. They are genuinely in the national interest and should be supported and funded as such directly by government.

In principle, industry- or researcher-led projects should find support through competitive processes. As noted earlier in this submission, however, digital tech research has not fared well via such processes, to the point where continued rejections of grant applications have led to researchers simply opting out.

Again, this is particularly problematic for emerging researchers where the 'cold-start' problem of not having a track record becomes self-perpetuating. Compare this to the approach used by the Natural Sciences and Engineering Research Council of Canada[14], where expectations shift as researchers progress through their careers. The recognition of the need to nurture a pipeline of research capability, with differing forms of support available competitively to students, junior and then senior faculty and on to the Canada Research Chairs, is a model we could look to if there is genuine commitment to growing (as opposed to buying in) research capability. Another example is Germany's Emmy Noether programme[15] through which early career researchers can qualify for the post of professor at a university by leading an independent junior research group for a period of six years. **We recommend that government creates a single, connected and highly visible system to support researcher development from students through to early career, mid-career and leading researcher and innovators where the mechanisms are demonstrably fit for purpose at each level.**

We are also aware of large-scale digital tech research programme proposals here in Aotearoa New Zealand that have been reviewed very favourably for science and that secured in-kind commitments from seventeen digital tech businesses, but the platform nature of the proposals meant they were assessed poorly with respect to impact: this ignores the enabling technology and capability opportunity offered by such a programme and the shorter timelines that frequently apply in the digital tech sector.

To better support shared understanding, **we recommend that government establishes a diverse cross-agency Funding Council for each priority area or each set of related platform technologies, comprising leading, mid- and early-career researchers, innovators, advisers and officials that understand excellence, impact and connectedness in context.** Overlaps of personnel are already evident across PBRF, Marsden and NSC panels and Endeavour's College of Assessors. Creating Councils that have stability over time and that can deliver *across* the funding mechanisms, rather than in silos, should give more consistent system-wide outcomes that take disciplinary context into account (cf. Panel-specific Guidelines in PBRF).

[14] https://www.nserc-crsng.gc.ca/NSERC-CRSNG/Index_eng.asp

[15] https://www.dfg.de/en/research_funding/programmes/individual/emmy_noether/index.html

We noted earlier in this submission that digital tech research has received minimal public funding. This is evident in Stats NZ's national biennial surveys of R&D expenditure[16]. Data from 2008 to 2020 is available, and is depicted graphically at **Appendix 2**. In summary, the data behind those graphs reveals the following:

- Total R&D expenditure directed towards Information & communication services has nearly tripled, rising from $208Mill in 2008 to $617Mill in 2020, moving from fifth to essentially third-equal across the ten sectors depicted – this appears to be a strongly positive indicator
- By far the bulk of that expenditure, however, has been incurred by the Business sector (with their contribution rising from $163Mill to $555Mill)
- In contrast, over the period 2008 to 2018, Higher Education R&D expenditure directed towards Information & communication services has risen from $38Mill to $58Mill; Government R&D expenditure has moved from $6Mill in 2008 to $18Mill in 2018 (noting that data for four of the seven surveys is held in confidence for these two sectors)
- Considered together, Government and Higher Education expenditure on digital tech R&D has increased by around 38%, from $45Mill (2008) to $62Mill (2020); in the same period Business expenditure increased by around 240%
- Comparatively, Government and Higher Education expenditure on R&D directed towards Health, Primary industries and the Environment have increased from between $176Mill and $264Mill in 2008 to between $295Mill and $424Mill in 2020

We are not questioning the importance of expenditure in other sectors – we simply provide that information as a basis for comparison. Nor are we wishing to understate the importance of Business' substantial and rapidly increasing expenditure in the digital tech sector (although the OECD notes it is the lowest among small advanced economies[17]). However, most of that Business investment in digital tech R&D is in the form of direct costs to business, as there is minimal engagement with the research community. While that expenditure is key to the development and deployment of new digital products and services, it is understandably focused on current challenges and short-term ambitions. It does not leverage the world-class research capabilities that exist in this country to address longer-horizon, higher-risk questions. This is a missed opportunity that *ADA* has been designed to address (**Appendix 1**). If we wish to achieve the ambition of transforming to a more knowledge-intensive economy this must change: **we recommend that government urgently and significantly increases expenditure on research and innovation in digital technologies.** A sustained, strategic investment in digital tech research would deliver the following:

Higher productivity – New Zealand's poor record with respect to productivity is well-known. Digital systems underpin everything we do but they are expensive to acquire or create in a timely manner. Improving our ability to build them is a significant multiplier and enabler to national productivity[18].

Transformative capability for all sectors – digital tech is driving advances in almost every other field: think fintech, agritech, healthtech… By ensuring domain experts are always at the table and by including social scientists in the *ADA* programme we will maximise relevance and uptake in all sectors.

A trusted source of independent advice – government needs to lead by example when it comes to engaging with and leveraging digital research. *ADA* would be a single, independent entity that can provide advice not captured by commercial self-interest, and the digital tech research community should be seen as a first and natural partner for the public sector, Māori and industry.

Sustained capability in digital tech research – computer science and information technology are at the foundation of almost all of modern society. They are fundamental to digital system capabilities, and these capabilities are realised through software. The engineering of software systems to ensure that they are safe, secure, usable and reliable remains a challenge. All of this requires continual investment in platform research and capability and any increase in capability will have wide-ranging and significant benefits.

[16] https://www.stats.govt.nz/topics/research-and-development

[17] OECD Economic Survey: New Zealand (2022)

[18] New Zealand Productivity Commission (2020) Issues Paper – *New Zealand firms: reaching for the frontier*

4. Institutions

9. (4.4.1) **Institution design**

- How do we design collaborative, adaptive and agile research institutions that will serve current and future needs?

It might well be argued that for a population of five million we have more than enough research institutions so it is indeed a redesign that is needed. In this regard, horizontal and potentially virtual platform 'institutions' that draw on and bring together the best and most willing capability can break down actual institutional barriers. Computing researchers in this country connect readily, irrespective of institutional boundaries – this is evident in the existence and activity levels among the software[19], AR/VR[20] and artificial intelligence[21] research communities, and in their interactions with industry. Our CRIs have also recently established a cross-institutional group in data science, so impediments to connecting can be overcome. In *ADA* we are proposing a meta-network, a single, national centre given our scale, lending critical mass and a single point of entry to national capability, but regionally distributed to reflect strengths and opportunities.

Along with this **we recommend government considers a shift to platform specialisation.** We do not need five slightly different and competing AI Institutes. Yes, resilience is important, but this can be obtained through disciplinary depth as much as through breadth, where the latter also risks excessive competition and redundancy. Greater overall value would accrue if virtual institutions could enable platform **specialists to work collaboratively on missions and projects 'for the nation'**, rather than compete for projects that are seen to benefit their institution. Evidence of how this can be achieved is presented in SfTI's submission to this review. In contrast, and while well-intended, this is where the SSIF Data Science Platform investment failed; rather than resulting in a single national platform, institutional barriers saw this effort result in a disconnected set of four promising but distinct programmes hosted by four separate institutions.

A 'for the nation' approach to and by institutions would also more effectively underpin a genuine *system* that promotes partnerships in a pipeline, enabling blue sky, public good AND commercial research to occur on a 'messy continuum' with networks and overlaps, not discrete blocks in some idealised linear chain. An options/portfolio approach would mean a range of project types and timelines could readily be accommodated, with room for pivots and, nominally, 'failures'. Some research should prove infeasible, some will proceed and conclude largely as planned, and some will fly – all should be acceptable in a system that is genuinely pushing science, engineering and technology boundaries.

In looking for models for digital tech research institutions a range of examples can be found offshore. Our small advanced economy counterparts all have at least one, often several, transformative digital strategies and centres; e.g., the Lero Irish software research centre[22] contributed €515Mill to Ireland's GDP 2005-18, and Denmark's Digital Growth Strategy[23] 2018-25 has been allocated €134Mill, for an expected return of €12Bill. Australia's Data61[24] secured 51 patents in 2016-17, and in 2019-2020 Canada's Natural Sciences and Engineering Research Council invested CA$200Mill+ in ICT research alongside co-investment from 30+ industry partners[25]. Other examples in the digital space can be found in Sweden, Portugal, Austria, Finland and Norway[26] and in Europe generally, where the importance of strong software research has been acknowledged[27],[28]. Aotearoa New Zealand has no such centre of digital R&D excellence – if we genuinely wish to be a global leader in addressing problems and opportunities relevant to this country and the world, creating a high-wage, knowledge-based economy as we do so, this must be urgently addressed.

[19] http://softwareinnovation.nz
[20] https://arive.me/
[21] https://www.airesearchers.nz/
[22] http://www.lero.ie/
[23] http://digitaldenmark.dk/
[24] http://data61.csiro.au/
[25] https://www.nserc-crsng.gc.ca/db-tb/index-eng.asp?province=0&category=4
[26] http://softwarecenter.gu.se, http://www.inesctec.pt/en, http://www.scch.at/en/news, http://www.n4s.fi/en/, http://www.sintef.no/en/digital
[27] https://www.yumpu.com/en/document/view/23936750/software-technologies-the-missing-key-enabling-cordis
[28] https://www.cwi.nl/news/blogs/europe-needs-strong-software-research

10. (4.4.2) **Role of institutions in workforce development**

- How can institutions be designed to better support capability, skills and workforce development?

Ensuring clarity for each type of institution regarding their 'swim lane' within the domains of education, training and research is key to a *system* that functions effectively. The overlap of lanes served by private training establishments, institutes of technology and polytechnics, and universities has been competitive and counterproductive. The review of vocational education (RoVE) and the establishment of Te Pūkenga could have been 'for the nation' efforts. However, for digital tech this opportunity was squandered, in part due to a Workforce Development Council that was not fit for purpose[29]. The focus of Te Pūkenga on pre-degree learner and industry requirements, and the shoehorning of Information and Communication Technologies with other trades and associated 'technologies', impeded the coherent development of a research strategy for the sophisticated disciplines encompassed in the digital tech sector. The challenges and opportunities of digital tech R&D will not be met in such an arbitrary set of groupings as an industry comprising both vertical (and often niche) creators and developers, in contrast to the pervasive sets of horizontal technology users (with often very basic sets of skills in use across every industrial sector).

13. (4.6) **Knowledge exchange**

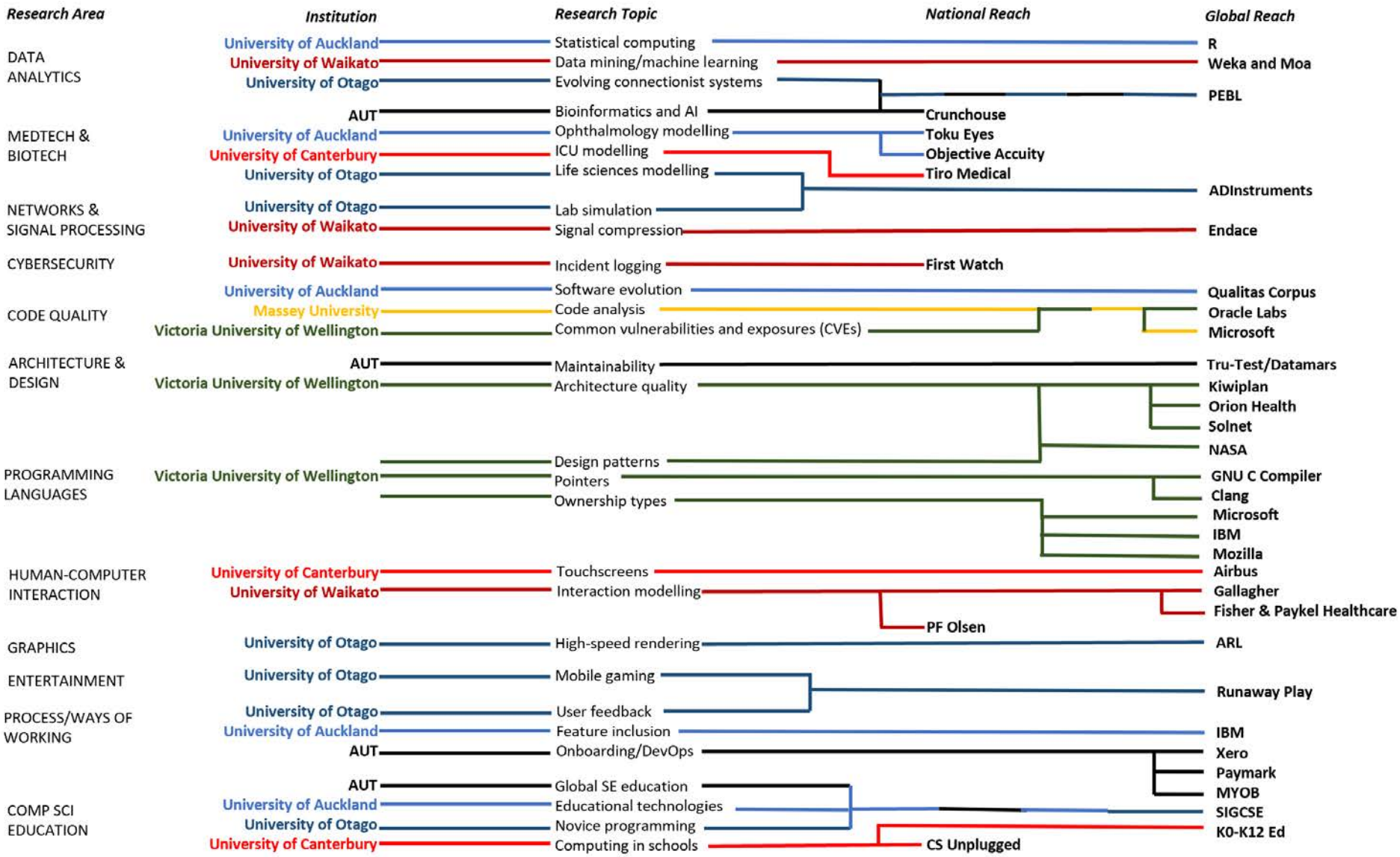
- How do we better support knowledge exchange and impact generation?
- What should be the role of research institutions in transferring knowledge into operational environments and technologies?

While not normally viewed as part of a researcher's day-to-day work we have seen good examples of where funded and rewarded relationship building and networking have been beneficial. SfTI's Capacity Development programme, funded entirely separately from the science, has enabled digital tech researchers to engage early and often with the intended users of their research. This can fundamentally change the questions being asked; or it can ensure that a prototype is built in a technology stack that can be picked up more readily by a company. The NZ Product Accelerator[30] and the McDiarmid Institute[31] engage full-time intermediaries that bridge the research-commercialisation gap. SfTI provides guided opportunities for researchers to engage with Māori, supported by trusted brokers. Activities such as Hackathons and Industry Days[32] can bring research and practice communities together for mutual success. In some (especially professional) disciplines such interaction is inherent; excellence without impact is a missed opportunity.

We have found that with the right approach – primarily highlighting our capabilities and aligning those to their needs/goals – industry is keen to engage with the digital tech researcher community, as is evident in the *ADA* proposal and in the 'tyre tracks' figure overleaf. It may be worth incentivising the engagement of early adopters and 'first followers', but in any case, a partnership philosophy is key. In turn we need to see researchers valued for their impact-oriented efforts – work by UKRI[33] on an impact toolkit and an impact-focused CV could be a model to consider. **We recommend that government funds ongoing partnership-oriented engagement over and above the funding of research itself.**

It is also important to note that while industry partnership makes particular sense for sub-disciplines such as information technology and software engineering it may not be appropriate for early-stage computer science research. This reinforces the need for a range of funding approaches and timelines. Early-stage (and therefore higher-risk) research is understandably unlikely to generate co-funding interest from industry, so partnership with government makes better sense here[34].

[29] https://techblog.nz/2040-Update-from-ITPNZ
[30] https://www.nzproductaccelerator.co.nz/
[31] https://www.macdiarmid.ac.nz/
[32] https://doi.org/10.1109/SEAA53835.2021.00040
[33] https://www.ukri.org/
[34] Mazzucato, M. (2015) The *Entrepreneurial State: Debunking Public vs. Private Sector Myths*, Anthem Press.



'Tyre tracks' diagram for Aotearoa New Zealand showing just some of the connections between digital tech research and national and international companies.

5. Research workforce

14. (5.2) **Workforce and research priorities**

- How should we include workforce considerations in the design of national research priorities?

As noted above, mechanisms that place greater emphasis on capability and impact potential than on track record can mean that early career researchers (ECRs) can – and should – be included in priority research. Actively involving ECRs and exposing them to leadership opportunities early, through research team membership but also in priority setting, or in observing grant assessment processes, can enhance career prospects but can also deliver system continuity and diversity. In contrast, short-term mechanisms that encourage star researchers to 'briefly stop' in New Zealand on their way to other opportunities in fact harms the workforce long-term as they are likely taking the place of at least one other researcher more committed to Aotearoa New Zealand. At the same time, **we recommend that government more proactively looks to support senior, active researchers and innovators to move *part-time* into research system leadership, advisory, policy, mentor and governance roles.**

15. (5.3.1) **Base grant and workforce**

- What impact would a base grant have on the research workforce?

A base grant may enable us to move away from the funding model of predominantly EFTs based precarity that pervades the junior research employment space. Restrictions of funding and continuity even for Teaching Assistant (TA) roles and Research Assistant (RA) roles, to support advanced study and research for students and supervisors make longer term commitments impossible to make. Postgraduate study would be a more attractive pathway if students were also employed and paid a living wage for TA and RA roles.

We recommend that government urgently develops stable funding mechanisms to obviate the loss of our own PhD graduates to a high-demand global employment market. The ability to offer Postdoctoral positions enabling graduates to develop a research portfolio of PBRF acceptability that will support their employment locally within Universities, CRIs/IROs or industry research roles is key to researcher attraction and retention. It is also key to domestic researcher development, otherwise we will exacerbate the established pattern of employing 'high-performing' researchers from offshore because they have benefitted from such development opportunities. We have seen examples of our own emerging researchers missing out on opportunities to grow their careers post-PhD, and as a result they have had to move into roles that do not utilise the research expertise developed, giving no return on that significant investment.

16. (5.3.2) **Better designed funding mechanisms**

- How do we design new funding mechanisms that strongly focus on workforce outcomes?

In digital tech there is a clear need to make greater use of placements, internships, secondments and sabbaticals to improve the flow of expertise in both directions. We would support the view of IT Professionals NZ that this is not just an issue that the research and education sectors need to address, it also requires active industry commitment[35]. It would also require a shift in the recognition and reward structures for academics so that the likes of an industry secondment is seen as enhancing, rather than impeding, career progression. Under such an approach researchers could spend time at the 'coal face', working on technology artifacts that are intended for market. Alternatively, rather than have the researcher engaged full-time in a development role, they could be embedded as a jointly appointed action researcher – in this way value accrues to both the researcher and the industry host. Such a model could be enabled very effectively within a base grant supported virtual/independent institution such as *ADA*.

[35] https://itp.nz/Our-Work/Digital-Tech-Skills-Plan

We also need to better prepare our research graduates for non-academic roles. This should involve short courses in entrepreneurship, IP management, business leadership and governance, or training for industry-based research roles. A return to the use of something like the Technology in Industry Fellowships could further support both workforce development and impact delivery, as could a Marsden Fast Start/SfTI Seed Project equivalent in MBIE's Endeavour Programme.

As we have noted previously, a differentiator in the digital tech projects undertaken with the SfTI NSC has been the provision of funding for capacity development completely separated from that for the technical work, to support researchers in their Vision Mātauranga journey, to enhance their relational leadership, to seek commercial mentoring, and to support proposal and work programme development. This had led to the creation of a willing community of research collaborators that better meets our aspirations for workforce equity, diversity and inclusion.

We recommend that government leverages the Digital Tech Industry Transformation Plan to co-construct and incentivise new models for sustained government-Māori-research-education-industry interaction.

Our mechanisms also need to enable and incentivise/reward individual and collective excellence and impact, with a 'whole is greater than the sum of the parts' imperative that means that the individual nature of PBRF, career progression and other such assessments does not impede collective efforts, nationally but also crucially internationally, where the value is grown and shared. Just as the market for digital products and services is international, so the 'market' for digital research and researchers is similarly global. So that Aotearoa New Zealand is able to continue to produce world-class digital tech research we need funding mechanisms that incentivise and sustain international engagement in the form of a) collaborations, b) recruitment of researchers/senior academics (with the goal of them relocating long-term to Aotearoa New Zealand), and c) recruitment of research students to augment talent developed within the country.

6. Research infrastructure

17. (6.2.2) **Funding research infrastructure**

- How do we support sustainable, efficient and enabling investment in research infrastructure?

Here we would simply note that care is needed to ensure that the collective and enabling/service ethos that underpins research infrastructure is retained with sufficient funding, so that research infrastructure providers do not need to become research institutions in their own right in order to survive. The REANNZ network is one such case where a shared service is made available for national benefit, currently on a pooled basis between institutions, but this is a fragile funding model. Should partners withdraw then local researchers will depend on discrete project research funding to pay private network providers for projects requiring the transfer and analysis of big data.

With respect to digital infrastructure members of and associated with Software Innovation NZ and the SfTI NSC recently proposed an approach founded on Te Tiriti and that adheres to Māori data sovereignty principles (in regard to notions of data stewardship, for instance)[36]. The proposal for the *Aotearoa Digital Alliance* is founded on similar principles.

[36] https://veracity.wgtn.ac.nz/#engage

Submitted:	9 March 2022
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On behalf of:	*Software Innovation New Zealand* https://softwareinnovation.nz

Appendices:

Appendix 1 – Draft Concept Proposal for the *Aotearoa Digital Alliance (ADA)* (11 pages)

Appendix 2 – Graphs of R&D Expenditure by Purpose of research and Sector 2008-2020 (3 pages)

Aotearoa Digital Alliance (*ADA*) – Concept Proposal

A National Digital Tech R&D Ecosystem for New Zealand

Professor Stephen G. MacDonell

Our Vision: A future where New Zealand's prosperity is underpinned by a dynamic digital tech research and innovation ecosystem fuelled by a sustained pipeline of world-class talent.

What is ADA? The *Aotearoa Digital Alliance* (*ADA*) is a national, visible industry-facing network that actively brings together ambitious New Zealand enterprises with world-leading digital tech research expertise located in the country's tertiary, Crown and independent research organisations (Fig.1).

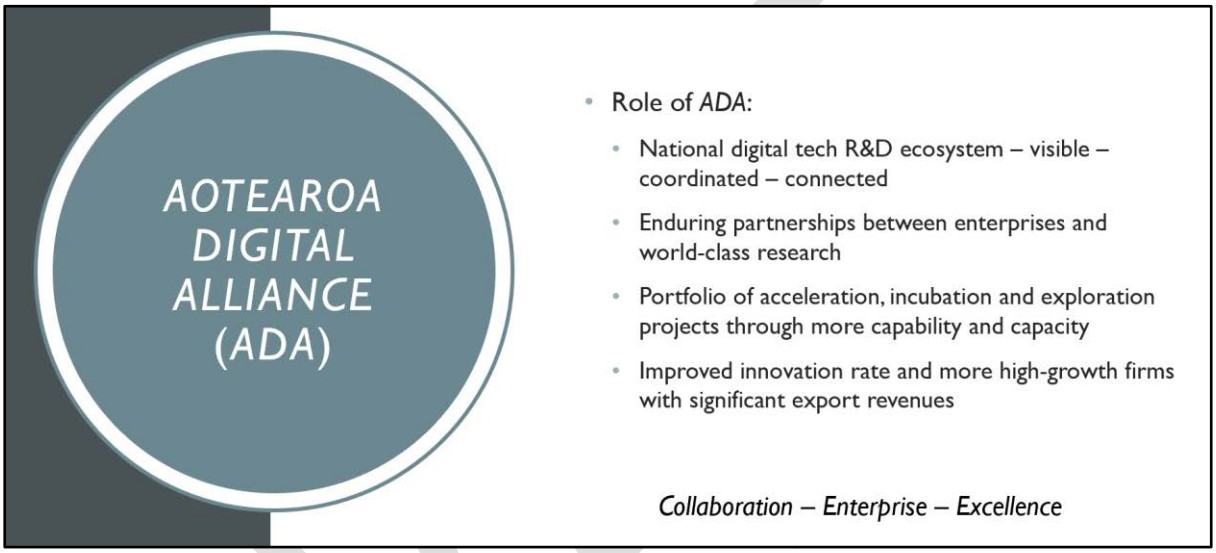


Figure 1: Key aspects and underlying principles of the *Alliance*

Why is ADA Needed? It has been acknowledged that New Zealand needs far stronger uptake of digital technologies in our enterprises, and that exporting enterprises that invest in R&D are more innovative[1]. The opportunity to drive uptake, investment and innovation is even more pressing today as we learn how to manage the effects of Covid while pursuing economic recovery from the pandemic. Government's own planning has identified digital tech as key to 'building back better', to delivering positive economic, environmental and social impacts.[2] While our frontier digital firms are doing well, deeper R&D investment will enable more in the sector to scale up, or to scale out through new digital ecosystems.[1,3] And the opportunity is inherently global, through weightless exports that leverage our reputation for innovative, trusted solutions.[4]

ADA's Initial Focus: The *Alliance* will aim for the 'sweet spot' of established, innovative enterprises working in areas of national or international strength but that are resource-constrained in terms of R&D capacity or could benefit from non-BAU research undertaken with R&D partners.[5] Initial high-growth sectors targeted[3] will be financial and related services, agriculture and aligned areas, smart and hybrid manufacturing, and independent software vendors (ISVs). The core capabilities of the *Alliance* will be centred on areas of research depth across key technology platforms, in digital automation, assurance and analytics, data science and artificial intelligence (DS-AI), and empathic computing and user experience (UX) leveraging virtual, mixed and augmented reality (XR) (Fig.2).

[1] New Zealand Productivity Commission (2020) Issues Paper – *New Zealand firms: reaching for the frontier*
[2] Office of the Minister for Economic Development (2020) *A Refreshed Industry Strategy in Response to COVID-19*
[3] TIN Report (2020) *Technology Industry Analysis New Zealand* (16th Ed.)
[4] https://www.usnews.com/news/best-countries/
[5] Ministry of Business, Innovation and Employment (2015) *National Statement of Science Investment 2015-2025*

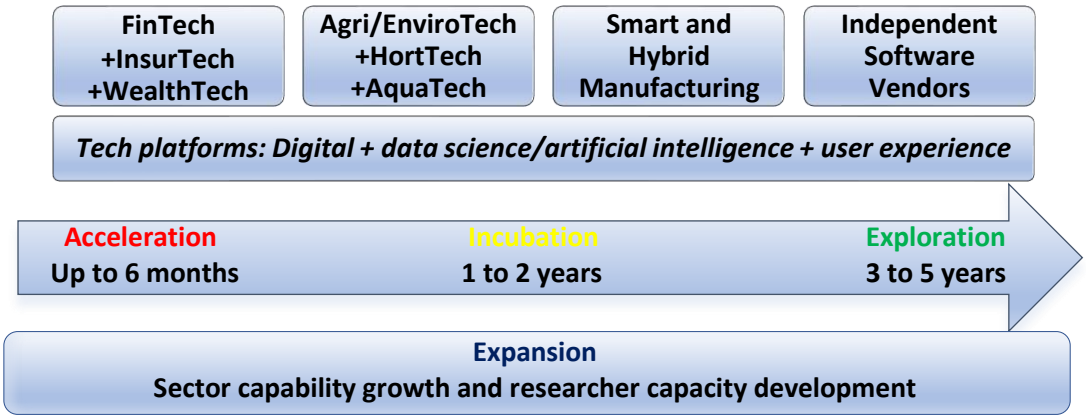


Figure 2: Sector, platform and activity focus of the *Aotearoa Digital Alliance*

Internationally: Our small advanced economy counterparts all have at least one, often several, transformative digital strategies and centres; e.g., the Lero Irish software research centre (www.lero.ie/) contributed €515Mill to Ireland's GDP 2005-18, and the Danish government's Digital Growth Strategy 2018-25 (digitaldenmark.dk/) has been funded to the tune of €134Mill, with an expected return of €12Bill. Australia's Data61 (data61.csiro.au/) secured 51 patents in 2016-17 alone. Other examples in the digital space can be found in Sweden (softwarecenter.gu.se/), Portugal (www.inesctec.pt/en), Finland (www.n4s.fi/en/), Austria (www.scch.at/en/news) and Norway (www.sintef.no/en/digital/). New Zealand has no such centre of digital R&D excellence.

Value Proposition for the Enterprise:

- Experiment with new ideas quickly, and explore high-risk ideas thoroughly and safely
- Gain direct access to a world of auditable and actionable research thinking… but tested, refined, extended and customised for local conditions
- Engage with a talent pipeline of students and researchers who can offer an independent view based on the synthesis of evidence

Value Proposition for the Research Community:

- Experiment with new ideas quickly, and explore high-risk ideas thoroughly and safely
- Gain direct access to local enterprises with New Zealand-specific real-world problems, systems, developers and data
- Engage with industry and Māori who will use the research results to inform the development of new and improved processes, products and services

What Makes ADA Unique?

Other RS&I entities and investments	*How is ADA different?*
Accelerators (NZPA, BPA)	Accommodates longer-term research horizons and challenges in digital services
Callaghan Innovation Grants/RDTI	At the "R" end of R&D with compulsory involvement of Uni/CRI/IRO researchers
Centres of Research Excellence	Research programme is industry- and mission-led and includes non-tertiary providers
Endeavour Fund Investments	Emphasis on tech platforms and long-term sector capability/capacity development
SSIF Data Science Platform	Broader coverage with greater emphasis on innovation and research impact

Sector/Industry Consultation: We are continuing to test and refine the idea of the *Alliance* with industry input (Fig.3). All to date have given support in principle and have expressed an interest in keeping the dialogue going and actively engaging in *ADA*. Industry consultation notes can be provided on request – in summary, there is a recognised need for a range of industry-relevant R&D solutions as well as a mix of delivery timelines, the idea of a single-entry point to the country's digital research capability is supported, and a more facilitated engagement model has been welcomed.

Figure 3: Industry and sector organisations consulted to date

Examples of Industry Feedback:

John Spray, Datamars: "There is a shortfall of industry tied research that has longer term benefits, at least in smaller companies. The results of academic research are usually a little too disconnected or abstracted from a specific project in industry, and so not generally adopted. A funding provision to fill this gap is what is needed to correct the imbalance."

Chris Lennon, Frædom: "From a business point of view, I can see real value in being able to partner with an academic institution and run safe, focused, high-tech digital experiments. Safe not just physically but in terms of IP protection, [and] not disruptive to current roadmaps."

ADA, the Digital Economy and New Zealand's Digital/AI Strategies:

The tech sector is New Zealand's second-largest earner of export revenue, with digital tech at its core.[3] Rapid sector growth in the last five years has seen the Digital Tech Industry Transformation Plan (ITP) be the second undertaken (after AgriTech). Five ITP workstreams align with the activities and aspirations of the *Alliance*, the two having complementary industry and research perspectives and a respective focus on digitisation (broad for all) and digital innovation (deep for some):

- AI Strategy: *ADA*'s DS-AI tech platform R&D is delivered through the NZ AI Research Institute
- Data-driven Innovation: the regional i4 Accelerator programmes align with *ADA* hubs
- Māori Tech Success: *ADA* involves Māori digital tech companies and FOMA Innovation
- Skills Pipeline: workforce development will occur through *ADA*'s expansion strategy
- NZ's Tech Story: successful *ADA* collaborations will contribute to international visibility

Strong links to the NZ AI Research Institute and with the AI Forum should ensure that *ADA* aligns with the emerging AI Strategy. More broadly, industry, sector and research community engagement across the digital tech ecosystem should see *ADA* similarly aligned with the National Digital Strategy.

How Could ADA Work?

Governance

The *Alliance* will have an independent governance Board, comprising digital sector, industry, Māori and government representatives, supported by one or two independent digital tech science advisors. The Board will be co-chaired by tangata whenua and tangata tiriti members.

Leadership and Management

ADA will be led by a Director (0.6 FTE), supported by a Business Development Manager (BDM 1.0 FTE), a Research Programme Manager (RPM 1.0 FTE), a Vision Mātauranga Advisor (VMA 1.0 FTE), a Communications Specialist (0.6 FTE) and an Executive Assistant (1.0 FTE). *ADA*'s Leadership Team will comprise the Director, the BDM, RPM and VMA, plus six Research Leaders (each 0.2 FTE). These Research Leaders will be an established and emerging researcher in each of the three areas of research capability (digital, data and UX), with each working for, but not representing, a different institution. The Director and Research Leaders will be seconded and on three-year terms.

Operation

The work programme of the *Alliance* will be mission- and industry-led. It will comprise a mix of (i) shorter-term acceleration engagements (typically 3-6 months) delivered by Rapid Response Units, (ii) core business incubation projects (6 months to 2 years) involving researchers and postgraduate students, through to (iii) longer-horizon fundamental and applied explorations (3-5 years) supported by doctoral study. All engagements will be led by experienced scientists and engineers. Risk and return profiles would follow that variable model – shorter term engagements would be lower risk, lower return, while longer horizon investigations would be higher risk, higher return. Initial engagements will be fully funded; as relationships are built and value is demonstrated, the mix of projects, timelines and funding arrangements will vary.

Projects will be drawn from industry. The *ADA* Business Development Manager will continuously engage with industry and Māori enterprises to identify project opportunities, through individual interactions as well as via meetups and sector events. The *ADA* Research Programme Manager will run industry days and start-up/hackathon weekends. The *ADA* Director will lead Mission Labs to identify sector-wide opportunities. Once projects are identified, the *ADA* Research Programme Manager will oversee the negotiation of the engagement, ensuring that each problem description is specific and actionable. Specifications will set out how mātauranga could be used, created and protected by Māori researchers and innovators. Timelines will also be proposed.

The RPM will then work with *ADA* researchers to identify the most relevant capability and capacity, and ongoing researcher relational capacity development will be supported and funded. Project details and plans will be clarified and confirmed by the team (RPM, enterprise, lead researcher). Arrangements regarding IP and mātauranga will be agreed between the research and enterprise partners as part of contracting, noting that the *Alliance* itself will not hold any non-sharable IP.

In addition to enabling longer-term non-BAU research to be delivered involving enterprise and research staff and students, Rapid Response Units comprising researchers, professional software engineers, data scientists and/or UX specialists will also operate at three of the five hubs (see below) to develop prototypes and proofs of concept in 3-6 month bursts (under NDAs rather than full contracts). These Units will double as 'living labs', enabling software process researchers to observe, analyse and improve their ways of working. Empirical evidence of observations, interventions and outcomes will be anonymised and stored in a single national repository to enable shared learning across the *Alliance*, and a Data Trust will support secure, user managed-access to data and code.

Tentative ADA Structure:

One National Alliance, Three Technology Platforms, Five Regional R&D/Sector Hubs

Auckland Hub:

- Empathic Computing
- Data Science + *DS/AI Rapid Response Unit*
- Fin/Insur/WealthTech
- *Potentially:* Smart Cities, HealthTech

North-Central Hub:

- Digital Assurance & Cybersecurity
- Artificial Intelligence
- Agri/Enviro/HortTech
- *Potentially:* Food/FibreTech

Wellington Hub:

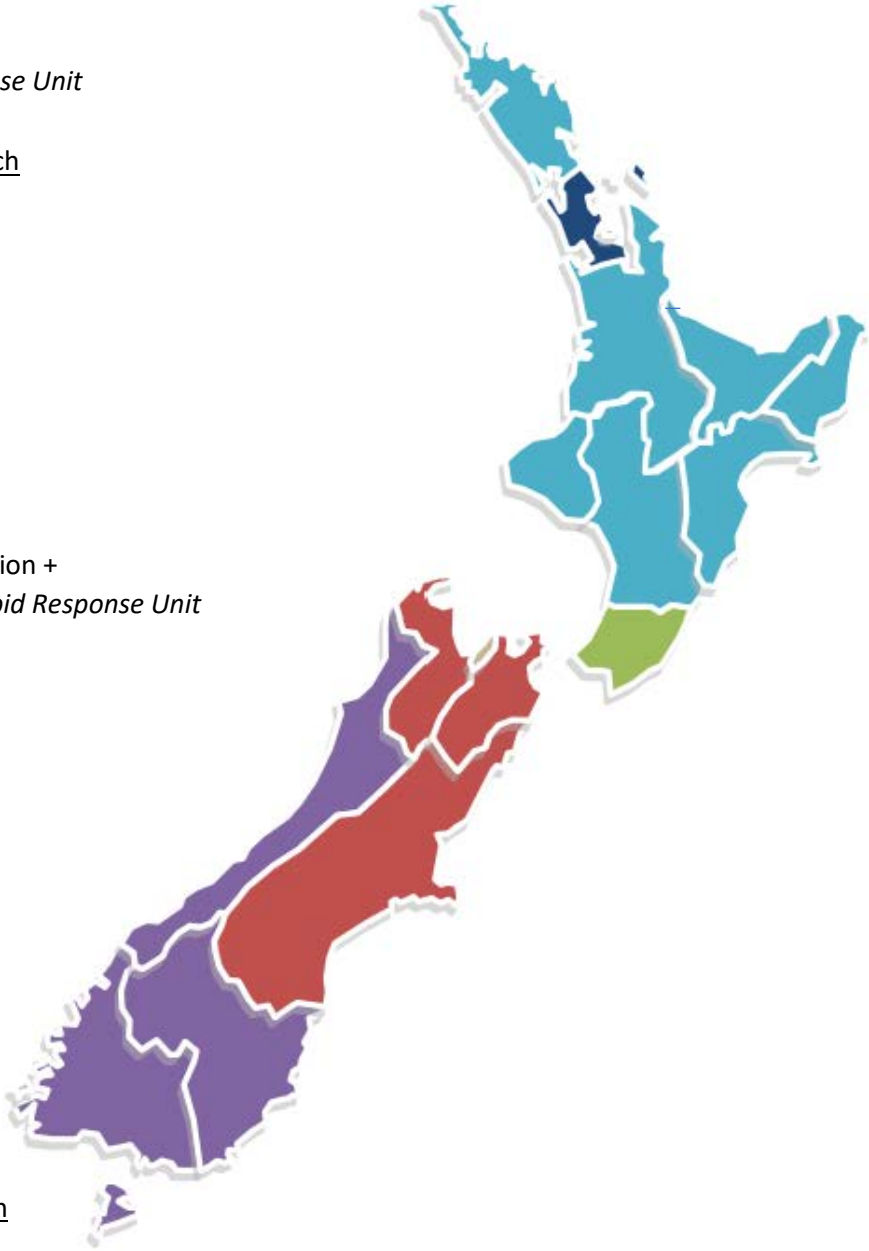
- Evolutionary Computing
- Programming Analytics & Automation + *Software Innovation NZ Digital Rapid Response Unit*
- Independent Software Vendors
- *Potentially:* GovTech

South-Central Hub:

- Digital Automation
- Human Interface Technology
- AquacultureTech
- Smart Manufacturing

South-Western Hub:

- Virtual & Augmented Reality + *ARIVE UX-XR Rapid Response Unit*
- Empirical Software Analytics
- Smart Engineering
- *Potentially:* Gaming, Smart Tourism



These five hubs reflect current research strengths (Fig.4) and sector depth in each location but they are not intended to be exclusive, and project teams will draw on expertise from all centres and disciplines as needed to meet each specification.

Software Innovation New Zealand

Artificial Intelligence Researchers Association

Australasian Researchers in Interactive Virtual Environments

ARIVE

Figure 4: New Zealand's three digital tech research networks

Potential ADA Missions: Sector-wide missions will be identified through Mission Labs – facilitated workshops involving Aotearoa Inc. thinkers that surface ambitious, value-based aspirations and outcomes that will be key to the (digital) future of New Zealand. Achieving these missions will require collaborative teams of industry, Māori and research partners to be formed, to co-design research programmes and to work together over three to five years. This approach will help to reduce siloed learning: Agritech, Construction, and the Screen Sector are all increasingly digital but have their own ITPs. *ADA* missions will be deliberately sector-agnostic and look for best teams across industry, Māori, government, and the research providers.

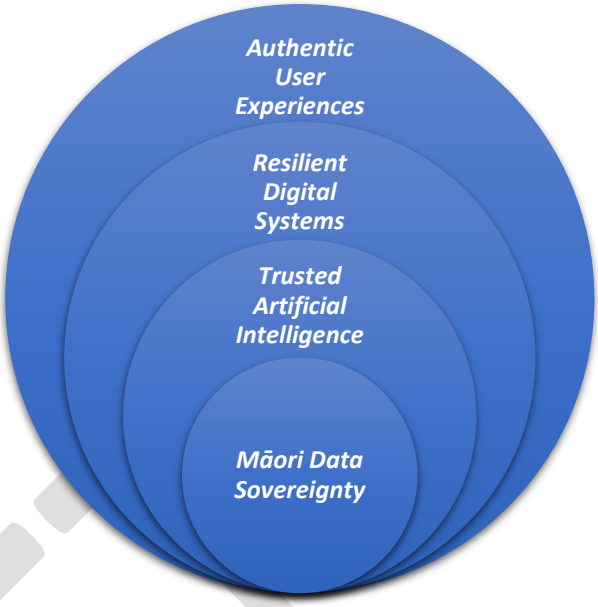


Figure 5: Potential ADA mission areas

Without intending to pre-empt the Mission Lab process, potential digital missions could fall into and across the four overlapping areas shown above (Fig.5), as these bring together our national technology platform R&D strengths and the reputation New Zealand enjoys as a nation.

The nature of national missions is that they should be as meaningful to the Mission Lab attendees as they are to the 'person on the street', the researcher in the lab, and the entrepreneur running the start-up – if we are to invest in those missions we should expect everyone to see value and relevance in them. Trust, resilience and authenticity reflect characteristics reflective of New Zealand as a nation and how are products and services are perceived internationally, built upon infrastructures that honour Te Tiriti. Innovative digital and data products and services that adhere to and represent these values will be highly desirable in international export markets.

Research missions, and the technology platform developments that are required to deliver on them, are inherently multi-party, requiring contributions from multiple disciplines and institutions, while research projects are more likely to involve a single enterprise. Multi-party efforts raise challenges regarding the attribution, ownership and management of intellectual property (IP). In addition, Māori have specific requirements regarding stewardship, rather than ownership, of IP, and its values-based protection and exploitation.

There are a number of models that can by employed to incentivise collaboration and identify, secure, manage and exploit IP. Some initial work would be required to design a fit-for-purpose model that selects from tried and tested approaches then customised for the local context. Considering that the *Alliance*, once established, will look to attract enterprises to explore research opportunities and develop some multi-party collaborations, *ADA* will provide a transparent process of engagement and project development together with a toolkit of pre-approved template agreements, in a similar vein to the Lambert Toolkit[6]. This will require a period of upfront work to negotiate agreement around this toolkit among research, Māori and industry parties. Once developed it will provide enterprises with clarity around how to engage and what to expect before they even begin to engage the *Alliance*. For their part, the *ADA* research partners will have certainty of a consistent engagement experience across the various public research organisations.

[6] https://www.gov.uk/guidance/university-and-business-collaboration-agreements-lambert-toolkit

The detailed aspects of the model and how it applies to acceleration, incubation and exploration opportunities need to be determined, but will draw from various existing large-scale research collaborations/cooperatives/consortia, e.g., Australia's Data61[7] and the Heavy Industry Low-carbon Transition CRC[8], our own Meat Industry Association[9], the NZ Product Accelerator[10] (particularly in relation to the management of shorter-term single-party acceleration project engagements under NDAs), Kiwinet[11], and the New Zealand Association of Clinical Research[12]. From recent enquiries and investigations, we already anticipate a multi-party engagement model with the following elements:

- Initial matchmaking/relationship formation under confidentiality and/or in "safe space" workshops
- Brainstorming and project scoping under a lightweight, short form agreement, e.g., IPENZ consultancy agreement
- Longer-term collaboration identification, formation and formalisation using a co-developed guides and agreements toolkit, e.g., R&D collaboration (with FROR/licensing terms), unincorporated JV formation, research syndication (a "horses for courses" approach), and secure data sharing (via the abovementioned Data Trust)
- Project execution including performance monitoring and accountability to funders
- Support for managing party IP rights protection and exploitation

In relation to the management of IP but also the stewardship of mātauranga Māori by the *Alliance*, the approach taken by the National Science Challenge *Science for Technological Innovation* – Kia kotahi mai: Te Ao Pūtaiao me Te Ao Hangarau[13] is likely to provide a suitable starting point for the co-development of appropriate principles, policies and plans. We will continue to work directly with Te Mana Raraunga[14] and the Iwi Chairs' Data Iwi Leaders Group to ensure these developments and all *ADA* missions and projects are aligned with Māori data sovereignty expectations and aspirations, in accordance with the CARE Principles for Indigenous Data Governance[15] (Fig.6).

Figure 6: CARE principles and agencies for indigenous data governance

Learning across the *Alliance* will be facilitated through sector, regional and national hui. R&D uptake, outcomes and impact will themselves be the subject of social science research within the *Alliance*, with regular independent reviews ensuring that the *ADA* project portfolio is continually relevant to sector, industry, Māori and government aspirations.

[7] https://data61.csiro.au/
[8] https://www.hiltcrc.com.au/
[9] https://www.mia.co.nz/
[10] https://www.nzproductaccelerator.co.nz/
[11] https://kiwinet.org.nz/
[12] https://www.nzacres.org.nz/
[13] https://www.sftichallenge.govt.nz/for-researchers/commercialisation/
[14] https://www.temanararaunga.maori.nz/
[15] https://www.gida-global.org/care

Sample ADA Projects: The following are proposed Incubation projects that span the three technology platform areas at the core of *ADA*. While economic impact is inherent to each one, two of the three also have scope for other forms of impact. Finally, the partnerships involve a range of public and private sector enterprises and research institutions.

DATEM - Data Analytics for Transport and Environmental Management

Do weather forecasts impact air quality? Bad weather or even just forecasts of bad weather encourage commuters to drive, increasing congestion and contributing to poor air quality in urban settings. Can we improve air quality public health warnings based on weather conditions? How can environmental benefits of decongestion be included in our cost-benefit analyses?

Partners: NIWA, GWRC, Wellington City Council, Auckland Transport, Waka Kotahi NZTA with Victoria University of Wellington

Platform: Data Science-Artificial Intelligence

Impact: Economic, Environmental

Software Team Members and Task Self-Assignment

Task self-assignment is a core agile software development practice but its use is not yet well understood. How is it undertaken in small, co-located teams? And in large teams that are globally distributed? How should the trade-offs between productivity, technical challenge and team learning be most effectively managed?

Partners: Quintiles IMS with the University of Auckland + AUT

Platform: Digital Analytics

Impact: Economic

Augmented Reality Telepresence in Corrections Facilities

Telepresence places people in the same virtual space using augmented reality technologies. Can we develop new telepresence tech to connect people in Corrections facilities to their families over new 5G cellular networks? The scenario proposed is of a parent reading a story to a child, as if they are together in the same virtual room.

Partners: Methodist Mission Southern, Department of Corrections, Te Rau Aroha Marae with the University of Otago

Platform: User Experience-Cross Reality

Impact: Economic, Social

Capacity Development of ADA Researchers: Success of the *Alliance* will be reliant on researchers being willing and able to engage effectively with industry and Māori collaborators. Funding will therefore be ring-fenced to support the ongoing development of researchers' human and relational capacity, until such collaboration becomes standard practice in the digital R&D ecosystem. This will create stronger mobility with the system, deployed through secondments and industry sabbaticals.

Capability Growth: The Skills Pipeline workstream of the Digital Tech ITP has identified multiple sector needs/opportunities for developing, retaining and attracting capability. *ADA* will contribute both directly and indirectly to capability growth. Direct contributions will occur through employment in the Rapid Response Units and through new enterprises emerging out of successful research efforts. Indirect contributions will occur when digital enterprise R&D is better supported, enabling enterprises to innovate and grow more rapidly.[1] Supporting regional concentration of research and sector capabilities will give each sufficient critical mass, around which custom education and training pathways can be built. This could also underpin the creation of regional alternatives to the former ICT Graduate Schools, offering specific digital tech internship, upskilling and reskilling opportunities for those with and from diverse backgrounds. This would see, for instance, specialist data science and AI pathways in Agritech and HortTech offered out of the North-Central and Auckland hubs, or cross-reality offerings for Smart Manufacturing and Engineering developed across the South-Central and South-Western hubs.

The importance of Māori and Pacific Peoples to the future of the sector pervades the Digital Tech ITP: Māori Tech Success is a workstream in its own right, and Māori values underpin the uniqueness of NZ's Tech Story and the need to carefully consider issues of ethics, bias and sovereignty in the AI Strategy. With respect to *ADA* Māori will be involved from the beginning (just as they have informed this proposal) in all aspects of governance, leadership and operation. Use of a hub-based structure will help to ensure that the relevant science 'goes to' the people, rather than requiring the reverse.

In addition to those that have already had input to the design of *ADA* other Māori-led digital tech enterprises will be sought out as potential R&D partners, and the explicit alignment of the *Alliance* with FOMA Innovation will further enhance the two-way exchange of expertise between Māori and the research community. In doing so *ADA* will create visible enterprise and individual role models complemented by education, training and R&D pathways. Funding to address equity, diversity and inclusion aspirations will also be ring-fenced to ensure growing support for capacity development is provided to those under-represented in the sector.

ADA and Just Transition: The *Alliance* has been designed to align with Just Transition plans by:

- contributing to the growth of a more knowledge-intensive economy
- offering multiple pathways to high-wage jobs and careers
- creating new pathways through internships, upskilling and reskilling
- shifting the balance towards more weightless exports of digital services
- driving growth in the number and scale of digital tech enterprises including ISVs
- enabling the digital transformation of all other sectors.

In doing so *ADA* will also adhere to the aspirations of Treasury's Living Standards Framework by directly contributing to:

- Income and consumption; Jobs and earnings; Knowledge and skills; Safety and security
- Human Capital; Financial and physical Capital

as well as indirectly to the remaining Domains of current wellbeing and Capital stocks.

ADA and the NSSI 2015-2025: *ADA* intentionally addresses government signals identified in the National Statement of Science Investment 2015-2025.[5] The relatively high and low levels of sector R&D expenditure across business and government, respectively (Fig.7), was particularly acknowledged as presenting an opportunity.

- "The boundary between R&D activity, product customisation (eg for export) and general product development is often fuzzy… We will seek to obtain a more secure long term basis for ICT R&D, rather than crowd out near-to-market, industry-led research activity."
- *ADA's connected portfolio approach will enable R&D to flow across all three horizons. We expect the bulk of ADA-funded activity to be Incubation and Exploration projects, to meet MBIE's aims and the timelines of industry. Acceleration projects at the "D" end of R&D will be pursued in association with Callaghan Innovation, Summer of Tech and the i4 Accelerator. Given the broad importance of mission-led research and the enabling potential of platform tech R&D within and across sectors, a base level of ongoing government funding for the Alliance would be necessary.*

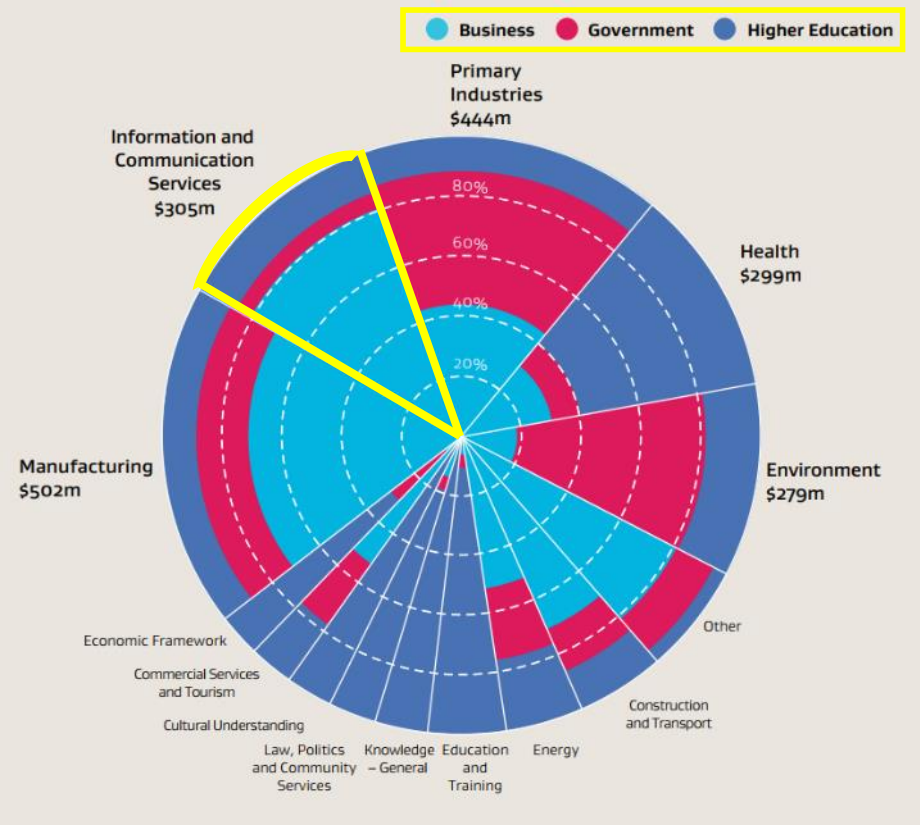


Figure 7: NSSI sector R&D expenditure 2014

- "Although primarily aimed at increasing the supply of skilled graduates for the ICT industry, ICT graduate schools should, over time, become hubs of excellence for research into ICT."
- *The proposed ADA R&D/sector hubs and customised specialist education and training pathways could better meet these dual objectives.*
- "We will examine opportunities for new investment in ICT research, particularly in basic research. This will support long term growth, encourage spillovers to New Zealand's economy and society, and develop our reputation as an international ICT destination."
- *Long-term support for digital R&D conducted through a single, identifiable entity such as ADA will directly support these aspirations and will generate international visibility.*

ADA's Positioning in the RS&I System: *ADA* has been designed to combine the best elements and characteristics of other funds, mechanisms and structures in the New Zealand research, science and innovation system (see Fig.8). In doing so it will form a unique, co-ordinated and connected digital tech platform R&D ecosystem in its own right. The NSSI 2015-2025 notes:[5] "Our academic research strength in ICT should increase over time to support ongoing innovation and talent development" and that "[t]he development of strengths in highly skilled, knowledge-intensive digital sectors is likely to be vital to our future". *ADA*, the *Aotearoa Digital Alliance*, is proposed as a means to deliver that future.

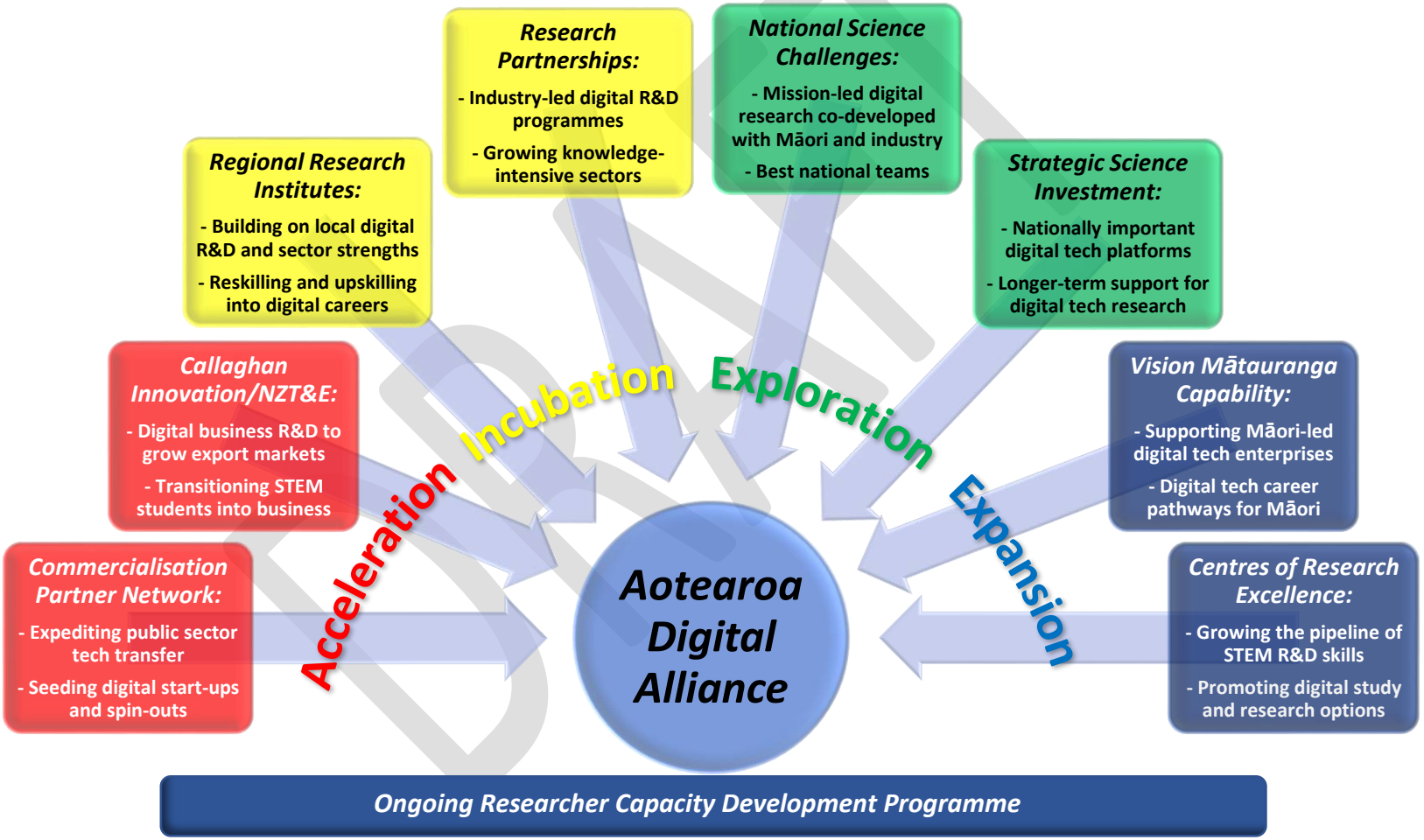
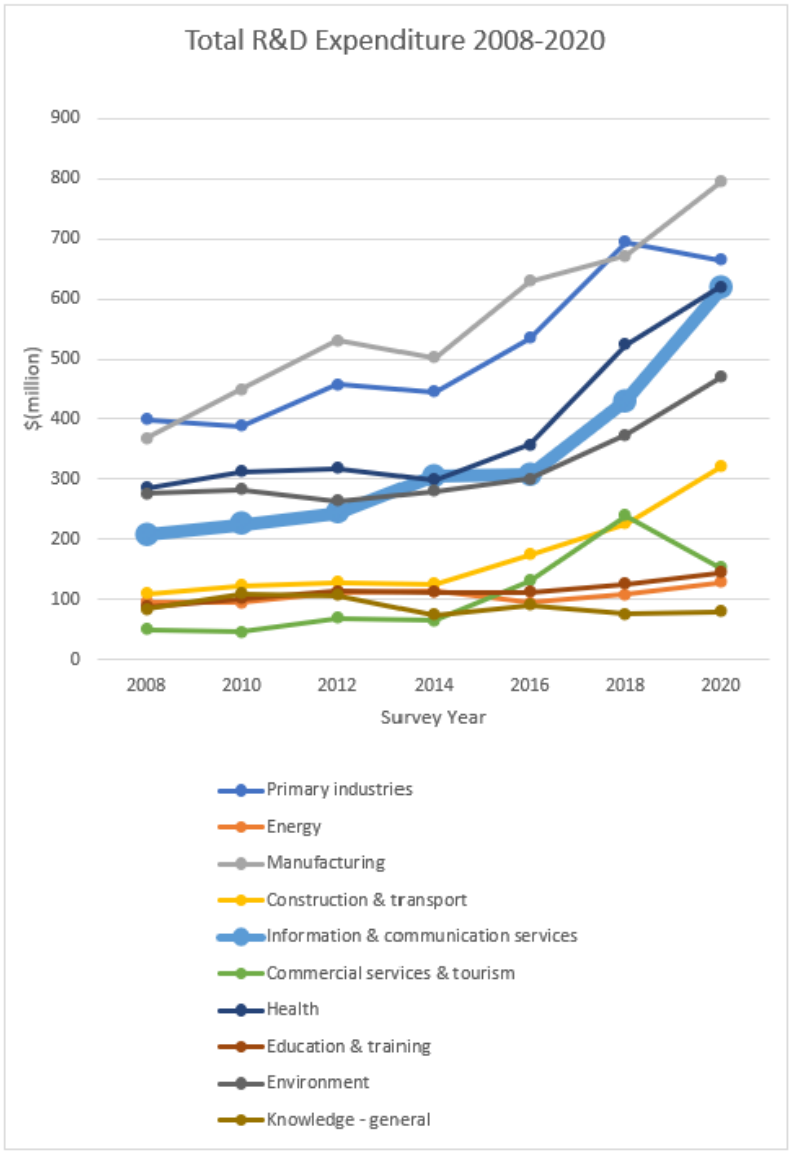
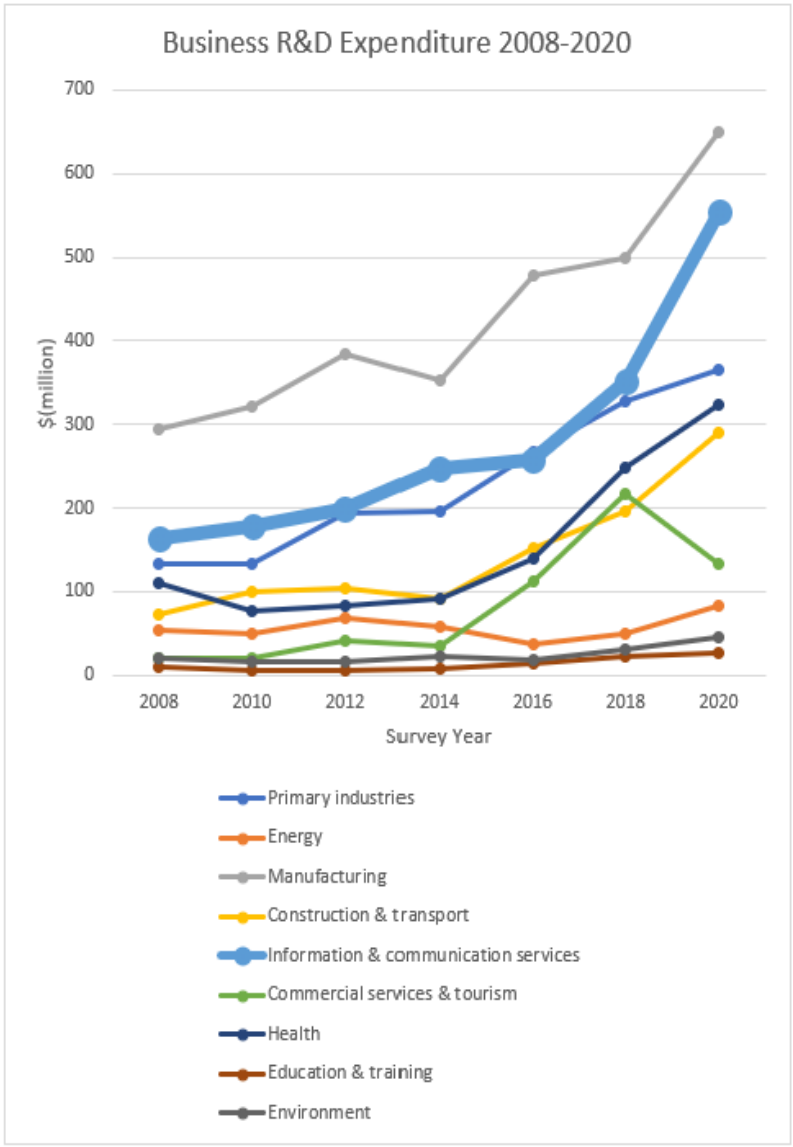
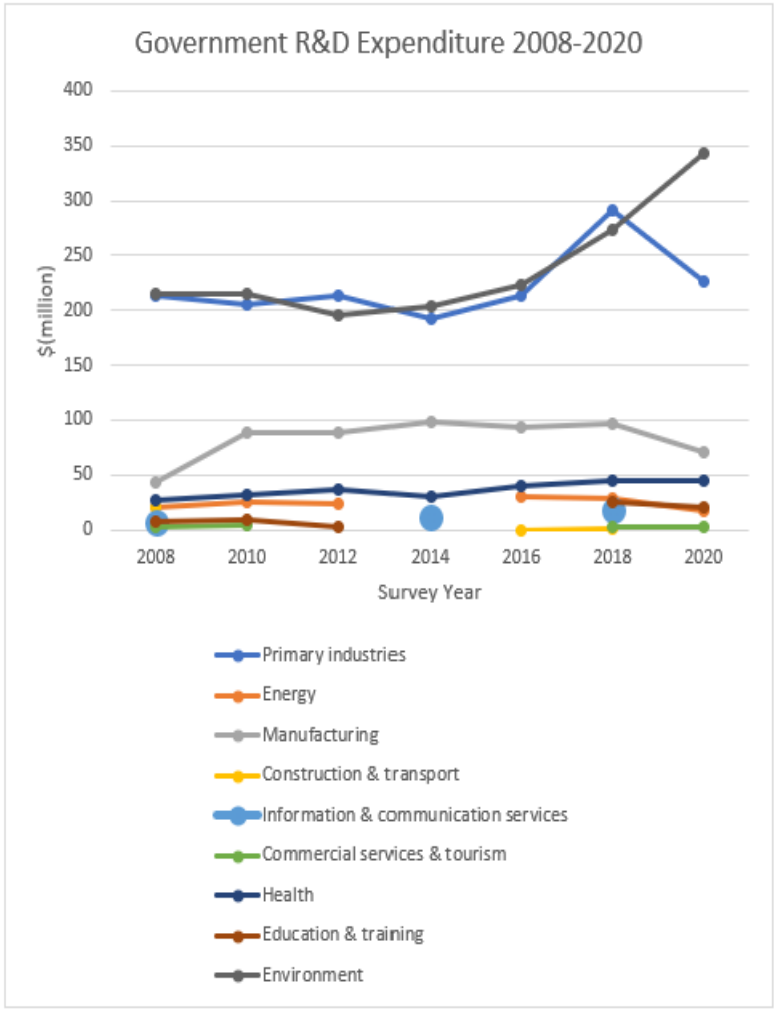
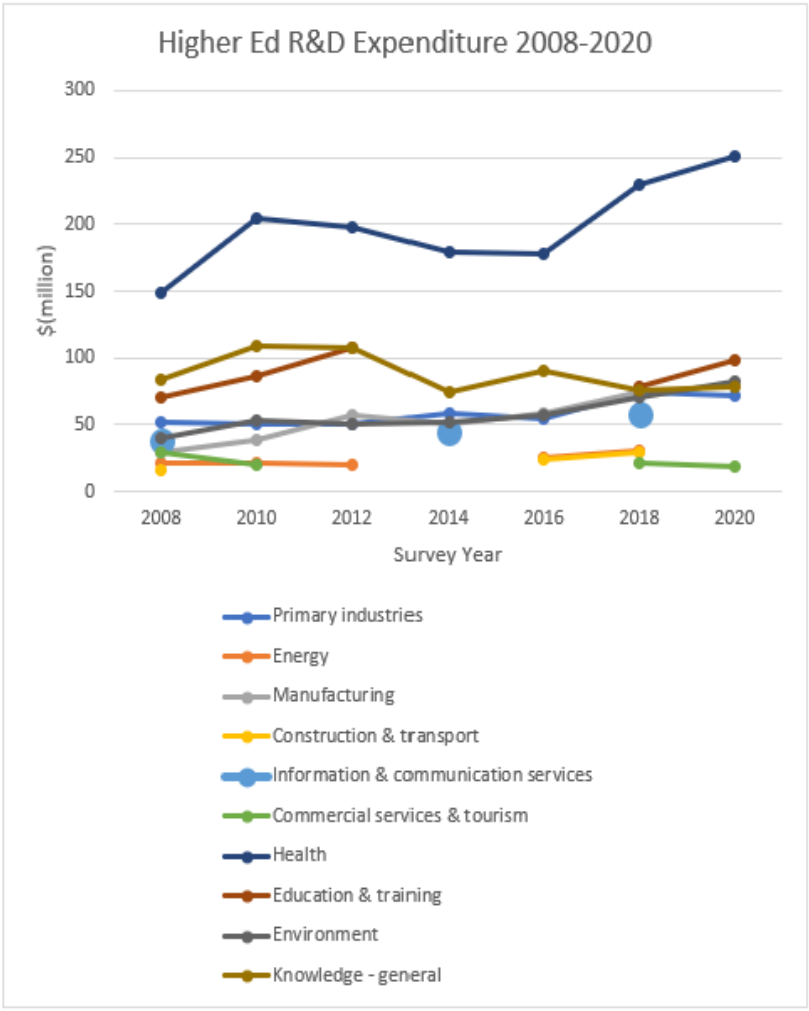


Figure 8: RS&I system characteristics underpinning the *Aotearoa Digital Alliance*


Total R&D Expenditure 2008-2020
$(million)
900
800
700
600
500
400
300
200
100
0
2008
2010
2012
2014
2016
2018
2020
Survey Year
Primary industries
Energy
Manufacturing
Construction & transport
Information & communication services
Commercial services & tourism
Health
Education & training
Environment
Knowledge - general


Business R&D Expenditure 2008-2020
$(million)
700
600
500
400
300
200
100
0
2008
2010
2012
2014
2016
2018
2020
Survey Year
Primary industries
Energy
Manufacturing
Construction & transport
Information & communication services
Commercial services & tourism
Health
Education & training
Environment


Government R&D Expenditure 2008-2020
$(million)
400
350
300
250
200
150
100
50
0
2008
2010
2012
2014
2016
2018
2020
Survey Year
Primary industries
Energy
Manufacturing
Construction & transport
Information & communication services
Commercial services & tourism
Health
Education & training
Environment


Higher Ed R&D Expenditure 2008-2020
$(million)
300
250
200
150
100
50
0
2008
2010
2012
2014
2016
2018
2020
Survey Year
Primary industries
Energy
Manufacturing
Construction & transport
Information & communication services
Commercial services & tourism
Health
Education & training
Environment
Knowledge - general