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Introduction

The focus of this paper is the programme of change carried out at the University of Otago Library to support Researchers and the University within the context of the development of a national framework for research information, which has enabled university libraries to contribute to institutional infrastructure. Library support for the building blocks required for the national research domain plan are also considered in this paper. We explore an example from the University of Otago and consider the Library's contribution to framing the requirements of an institutional Research Information Management System that will inter-connect with the national reporting infrastructure.

A report from ITHAKA S+R released earlier this year points out that "there appears to be no single optimal model for a research library's organizational structure. Different approaches are being pursued that reflect different views on leadership, and organisational backgrounds" (Schonfeld 2016 p.3). "Research libraries are undertaking a number of radical transformations: from print towards electronic, from local towards shared, from licensed towards open, from general towards distinctive, from collections towards engagement, from selector towards partner. To support this transformation, libraries are evolving structures designed to embrace the library's full potential as a central campus partner supporting the use, and sometimes creation, of information resources for research, teaching, and learning" (ibid p.2).

We outline the implications for the University of Otago Library and the organisational changes implemented in response to institutional and national initiatives. How librarian skills and expertise are contributing to University and national outcomes, and how these drivers are shaping library services, are considered.

Context

New Zealand is in the south west of the Pacific Ocean; part of the OECD "developed nations" but geographically like our closest neighbour Australia (who is 4000 km away) we are not "in the north". Our nearest neighbours are the island nations of Polynesia and Melanesia. New Zealand has eight universities and 10 Polytechnic/Institutes of technology as well as providers of tertiary education within a Maori cultural context known as *Wananga*. There are also Crown Research Institutes (CRIs) which are corporatised public entities who work primarily in applied research in agriculture, earth sciences and the environment.

New Zealand has a population of about 4.6 million about the same size as Ireland. The structure of the economy is less sophisticated than many in the OECD with below average medium to high technology companies and no advanced/leading tech industries. With 0.18% of the world's researchers, in 2015 New Zealand produced 0.60% of the world's research publications, generating 0.71% of citations with 0.68% of highly cited articles (SciVal™ 2015). While New Zealand researchers publish more papers per capita than in comparator countries over the last few decades New Zealand productivity generally has not kept pace with OECD averages and per capita income has not kept up. According to Statistics New Zealand, total R&D as a proportion of gross domestic product increased to 1.3 percent in 2015/2016, up from 1.2 percent in 2014. The OECD average is 2.4 percent.

Businesses spent a total of $1.6 billion on R&D. In contrast, research spending by the Government and the higher education sectors showed more modest growth: A $32 million increase for government spending and $143 million increase for higher education spending. This is now running at about NZ$1.55 billion per annum. In the 2017 budget announced late May around a quarter billion dollars over four years has been added to funding for science and innovation, growing Government investment by 26 per cent.

Performance Based Research Funding or PBRF assesses the research performance of degree-granting tertiary institutions in New Zealand and allocates funding based on research performance. Performance is measured through a combination of research degree completions and peer review by expert panels that assess individual researchers' research outputs and contribution to their research field. External research income is also considered. Similar to ERA in Australia and REF in the UK, the New Zealand PBRF is unique in its use of a peer-review process based on the individual rather than the school or department.

The University of Otago

The University of Otago is NZ oldest university founded in 1869. Otago was one of the few at that time to admit women to the university, although none graduated with a degree until the 1880s. Our home campus is in Dunedin in the south of the South Island and we have medical schools in Christchurch and Wellington as well as facilities for teaching in Auckland. Otago has around 18,500 full time equivalent students and we pride ourselves on being a research intensive university with excellence in teaching. We are New Zealand's only truly residential university with 85% of students coming from other parts of the country, as well as overseas although our international numbers aren't high just 2,500 from around 100 countries in 2016

The University has a number of areas of Research Themes and Research Centres. Many of these are multi-disciplinary and they encourage research across a range of academic fields. Amongst these is the Research Unit that runs the Dunedin Study, which is a detailed study of human health, development and behaviour. The Study has followed the lives of over a thousand babies born in 1972 and 1973 in Dunedin. It is now in its fifth decade and has a participant retention rate of 95%, which is remarkable for such a longitudinal study.

The Centres of Research Excellence (CoREs) were established by the Government to encourage the development of tertiary based research than creates significant knowledge transfer. Otago leads one CoRE (the Centre for Photonic and Quantum Technologies) and co-host the Brain Research CoRE with Auckland University. Otago leads two of the 11 National Science Challenges. These are long term programmes that take a strategic approach to national scale issues. "Aging Well" is a research programme into sustaining health and well-being in later life and "Healthier Lives" focusses on research into cardiovascular disease, cancer, diabetes and obesity.

The Library

At the University Library, we have a number of tools and services including research skills support for Post Graduates. One tool we have found useful is the research readiness self-assessment tool, which assesses how student research attitudes and perceptions correlate to their actual research skills (Ivanitskaya, 2004). We subscribe to a number of proprietary platforms for bibliometric analysis: SciVal and InCites now known as Clarivate Analytics. Expertise in citation metrics as part of the Library's skill set is important for the strategic positioning within the University. This has been extended to include supporting staff with their PBRF submissions. In particular, Librarians were called upon to assist academics assemble their evidence portfolios of their best research outputs, contributing through citation analysis and bibliometric reviews.

We have also responded to the needs of researchers for better access to primary materials. Our digital asset management system has been designed to preserve and make assessable born digital archival objects or digitised material and is the platform we will use to make our other special collections accessible. The Library developed the Marsden Online Archive as a platform for Researchers to analyse and review manuscripts, journals and letters of the Christian Missionary

Society, and diaries of the Missionaries send to New Zealand, including Samuel Marsden who was instrumental in establishing NZ as a British crown colony.

Like others, we support the publication of scholarly materials using OJS and OMS and the University's institutional repository. These types of services have become "par for the course" but they are important foundational services that support the changes in the way the scholarly record is made available: changes to scholarly publishing and how librarians need to respond to these changes is a recognised trend in the development of academic library services in the 21st century.

Developments in research data management throughout the world was a driver for the creation of a data literacy skills development programme to increase capabilities in this area and further work was initiated with a national working party that examined developing a set of national standards and some consistency across the sector. The goal is for the Library staff across the New Zealand universities to share and contribute to consistent and standardised ways of arranging and describing data sets to facilitate discovery and use: something we have been doing for published material for few hundred years. Unlike other parts of the world, New Zealand does not have a national approach to managing research data. Although the university libraries have made recommendations on describing and managing research data – and the development of a national research data registry there has been no funded initiatives to improve research data management.

As with other institutions we found that the most common, well-articulated requirement was for storage and facilities for backup and recovery. The University of Otago Library made it clear from the beginning that storage and backup/recovery was the purview of ITS and Library staff have been and continue to work with ITS staff to provide data management and storage services although providing a seamless service to researchers remains elusive. What was less understood by academic staff was the need to create a data management plan and detailed descriptions of data formats and metadata schemas employed. Even more uncertain was how to assign access rights that could provide controlled access to data sets.

With the development of skills and expertise in research support, a decision point was reached where we needed to consider how these activities would be embedded in our Library services. The challenge has been to take ad hoc requests for advice and assistance and identify those that are drivers for change and that represent common/broader issues, allowing the library to build sustainable researcher driven programmes. The Library today must be seen to be more than the gatekeeper to information resources and the provider of information literacy training to undergraduates. Work by the likes of Ithaka S+R and New Media Consortium's Horizon Report reinforce and confirm the need for Academic Research Libraries to focus on how we contribute to the wider academic endeavour and where the Library fits into the life of the user. In contrast to the past library-centric view of passive engagement by staff and students accessing library resources.

New Library Roles

A developing role of libraries is in defining and supporting the "research ecosystem," - the interconnected environment of publications, data, researcher identities and their profiles. As scholarly outputs proliferate online in different formats, libraries play a major role in understanding and measuring their impact for the wider research community. Examining the influence of research in various mediums outside of formal publications and citations. Librarians and library systems such as the repositories we manage play a key role in the development of researcher/school/faculty/university "profiles"- and how that feeds into international university ranking systems. At the University of Otago there has been a shift so that, while still having a project based approach we are focussing on the strengthens and skills that have been developed over the last few years.

The 2017 NMC Horizon Library Report has *Advancing innovative services and operations requires a reimagining of organizational structures* as one of their "top 10". When considering organisational change we need to ensure resourcing was retained for the continued management of our legacy systems and activities as well as developing new organisation structures. Organisational change also needs to be reflected in the strategic planning and direction the Library is working towards. Otago University Library has a strong link to user focussed needs with our vision of the Library partnering to

enrich world class scholarship. For us, with a constrained financial environment it was not possible to add new staff. We needed to determine what resources could be realigned to achieve the outcomes we were seeking. To do that we needed to consider the shifting demands of our users, and the evolving roles of librarians in an academic library. Inflexible hierarchies from a collection centric past are no longer effective in how we meet users' needs, libraries must draw from different functional areas and expertise, adopting agile, matrix like paradigms. Traditional functional hierarchies need to give way to more flexible, team-based organisational structures to remain innovative and responsive to needs.

One example of the changing requirements for new skills in librarianship, currently in its infancy is the Library Carpentry programme. The initial course was held in London in 2015. One workshop has been held at Otago early in 2017 in association with a software carpentry workshop and Library staff contributes to the carpentry sprint later that same year. Library carpentry introduces the fundamentals of computing and the software tools used in research. It is an introductory software skills training programme with a focus on the needs and requirements of library and information professionals. World-class research relies on the use of software and tools for managing and cleansing data. If we are to realise the vision of Librarian as research partner we will need to have the skills that will enable us to play a greater role in supporting researchers.

Library carpentry is one model for acquiring these skills. It is based on the software carpentry models that has been active in the last few years and covers short intensive sessions online using collaborative tools. This is relevant to how we equip ourselves with the tools and capabilities to contribute to the changing research world. Skills such as programming and data analysis are not yet routinely taught as part of the library science curriculum in New Zealand. We need to acquire these skills so we can play a greater role in supporting researchers.

Library Research Support Unit

Leveraging the project activities and ad hoc support for individual researchers, we have created a new unit for library expertise in research data management best practice and activities including the development of a registry of research datasets – this is in a pilot stage using library generated datasets. The skills in developing repositories also lives in this team as does the expertise in research information management and the deployment of systems as part of the "research ecosystem". Librarians have always played an important role in supporting research and increasingly, modern research involves some form of computation. So one important element of the unit is in skills development: developing the capabilities of library staff, particularly subject librarians to extend their expertise across a wider landscape, crossing over into areas of IT and data management.

The new unit will leverage off existing skills and experience that I've outlined. It is designed to be flexible and nimble in how it supports researchers - with an increased emphasis in developing extensible and sustainable tools and services. There is a small team with a flat reporting structure. And recognition that somethings will work and others might help individual researchers but can only be considered as one off projects. Efforts will be spent on building a research support clearing house supported by research groups and the University's IT Division with an emphasis on digital humanities. Other major deliverables are wider institutional engagement for the integration of ORCID into our systems across the university and the development of research information management platforms. The Research Support Unit is charged with continuing to build expertise and staff capabilities so that programmes like the Library carpentry workshops are embedded in staff development programmes

As well as these outcomes that we want to achieve there are gaps in the Otago and New Zealand research landscape that need to be addressed – some of these are institutional: there needs to be better coherency in how the University supports Digital Humanities for example. The new Research Support Unit will help define what that support should be and how it can be resourced so that Humanities scholars can engage with digital services and tools in their work. The establishment of a Centre for eResearch for which the University's eResearch Advisory Group has been advocating will advance this.

There are also gaps in the national research environment: there needs to be sustained activity to build support for Open Data/Open Science at the policy level. More needs to be done to ensure research data is discoverable and accessible. The current situation (as for the National Science Challenges) only asks that Researchers consider how generated data sets might be available under NZGOAL guidelines. NZGOAL is a set of guidelines that aims to standardise the licencing of government copyright works for re-use using Creative Commons licenses and recommends statements for non-copyright material.   What is now occurring within some of the Challenges is that researchers are facing numerous barriers when trying to use cross-discipline dataset from different sources. Some of the outcomes and gaps identified will be addressed by continuing to work at the national level, through the New Zealand University Librarians Council and with direct engagement with Government – in particular the Ministry of Business Innovation and Employment (MBIE) on the development of a national research information system. The Library's Research Support Unit will take the lead in the implementation of ORCID at the University of Otago and will continue the work with the University's Research Office to improve information flows around research management information and citation analysis.

National Infrastructure

Over the last two to three years, through work on the New Zealand Libraries Research Data Management Working group and the National Research Information System working parties, staff at the University of Otago Library have taken on a national role in helping to shape the development of research support infrastructure. We want now to provide some background on the policy-setting environment within the New Zealand research system. Foundational policy documents are the National Statement on Science Investment (NSSI) and to support and realise those goals a Strategic Science Investment Fund (SSIF) was established in the 2016 budget. The Government's vision is to deliver a highly dynamic research system that makes a more visible and measurable contribution to national productivity and well-being. The NSSI sets out the Government's long-term vision for the national research system, and provides a strategic direction to guide future investment. Its goals are:

- a better-performing science system that is larger, more agile and more responsive, investing effectively for long-term impact
- growth in business investment in research and development
- reduced complexity and increased transparency in the public science system
- continuous improvement in New Zealand's standing as a high-quality research and development destination, resulting in the attraction, development and retention of talented researchers
- direct investment by multinational organisations.
- comprehensive evaluation and monitoring of performance, underpinned by easily available, reliable data on the reseaehd system, to measure our progress towards these goals.

The SSIF Plan supports the NSSI by clarifying government's role in setting the direction for investments by simplifying and stabilising funding arrangements and by increasing the transparency of negotiations with research organisations. Through the SSIF the Government invests in research programmes and infrastructure in support of research capability. The plan provides a framework for strategic discussion between Government and research organisations and provides for consistent and transparent decision-making and performance monitoring. The fund has a long term view with investments made for up to seven years.

Investments in infrastructure are structured around research 'platforms'. A 'platform' is "a combination of people, facilities, information and knowledge that provide a particular, ongoing science and innovation capability for New Zealand. The SSIF is part of a suite of three funding instruments targeting mission-led or applied research that is expected to lead to increase impact:

The new (2016) Endeavour Fund supports discrete science projects through a contestable process that provides agility to respond to new opportunities. Through this fund, the Government invests in research that could be high risk, but has potential impact in areas of future value, growth and critical need for the country.

The Challenges target eleven big challenges in New Zealand which, if successfully addressed by science, will have major and enduring benefits. They are cross-organisation, cross-disciplinary programmes and involve the Universities and the CRIs.

The Investment Fund also supports longer-term investment in underpinning science platforms. This component is non-contestable and focussed on long-term capability to support priorities across the New Zealand science system.

Research Domain Plan

The Research, Science and Innovation Domain Plan has been established to better understand New Zealand' research ecosystem and provide evidence of return on investment from data gathered on research inputs and outputs and the impact of these to generate informed evaluation of research activities. Information and data on NZ's innovation system has suffered from a lack of oversight and coordination for many years. The Research Science and Innovation Domain Plan contributes to the vision of the NSSI by establishing a framework for a national system-wide data infrastructure.

The purpose of the Domain Plan is to address the enduring questions related to the research system and to set a balance between addressing these with the cost of data collection. The Domain Plan provides a long-term picture of what is required to improve official statistics and data on the New Zealand research system. In addition, it will inform changes to the collection analysis and dissemination of data and aims to ensure data collected in relevant useful and will meet future needs. The Domain Plan is designed to address information needs for a number of stakeholders in a coordinated and collaborative way:

- Government and policy agencies require information to set policy priorities and funding allocations; undertake evaluations and for accountability purposes
- Funding agencies require information on where and how to invest funding and on what research other funders are funding
- The research community requires information on the research landscape, research priorities, funding sources and the needs of end users
- Businesses and the end users of research require information on where research expertise lies and with whom to partner; what research is being undertaken and the results from research activities.

The domain plan is under pinned by these principles. It needs to

- Provide a system-wide view of science and innovation
- Ensure open data, easily and widely accessible while protecting personal and commercially sensitive data
- Enable the reuse of data
- Reduce collection burden by automating systems connectivity
- Ensure data is trusted authoritative and well-managed.

Domain plans use the enduring questions construct to frame strategic knowledge needs. By their very nature, enduring questions are difficult to answer and it is likely that over time answers will change. For the policy makers certain questions endure for research, science and innovation over the long term such as these.

- What is the contribution of research, science and innovation to economic objectives?
- What is the contribution to social, health and environmental objectives?
- What is the social return to the marginal dollar of government investment?
- How should government design its investments in research and science?
- How should government design its support for business R&D and innovation?
- What is the role of people in the research, science and innovation system?

These questions help categorise and structure the things that we need to know into the future to inform policy, strategy and decision-making. Of course, for each of these there are other questions like:

- Who is doing what research & who is funding it?
- What is being produced?
- What people and skills are employed?
- What infrastructure is being used?
- What collaboration and commercialisation is there?

The process of developing the Domain Plan centred on the set of high-level questions that need to be answered to inform decisions on research, science and innovation in New Zealand. The process began with a series of workshops with Government and funding agencies. This was followed by engagement with the research community and business on knowledge needs, data gaps and solutions.

Evidence is expected to underpin policy and investment decision and help address these enduring questions. There are a number of data sources that inform policy and investment decision-making. This includes data from funders on research project and grant application as well as information from their management systems. There are bibliometric data sources that are familiar to librarians, which may be bundled with intellectual property indexes of copyrights and patents. Research organisations and Educational Institutions also provided data from internal systems on research outcomes as well as on staff and student qualification completions. Other data, socioeconomic and information on individuals contribute to an integrated data infrastructure (IDI) that is maintained by Statistic NZ. There are also international agencies such as the OECD, the World Bank and World Intellection Property Organisation that provide a range of science, technology and research indicators.

A data stocktake was carried out to assess what information is currently collected across the sector and how it is used. An analysis of the gaps that hindered our ability to answer the enduring questions was followed by considering the options available to identify what will allow us to better meet the most pressing information and data needs. Finally, a staged set of actions that will enhance our ability to answer the enduring questions was produced.

Significant data gaps exist specifically on funding and expenditure, research output and people and their skills. The multi-disciplinary and complexity of both the CoREs and the National Science Challenges have shown there are short falls in how the current system can provide evaluation and regular reporting. There is a piecemeal approach to activity, often sector by sector CRIs report and hold data differently to the Universities and from the independent research organisations. Reporting is reactive and provides only a narrow view of activity. Current reporting processes do not meet the needs of the long-term, multidisciplinary nature of the National Science Challenges. Reporting and data gathering is duplicated - the same information or a small variation is asked for many times.

Data and information gathered is often used for a single purpose: there is no infrastructure in place to share data or cross validate data. What became to be recognised as a major gap was that New Zealand does not have a National Research Information System (NRIS) platform. Despite these challenges the process of establishing the research domain formed a response to what is needed to enable stakeholders to meet their information needs: What will success look like? Fundamental to all needs is for more accurate, reliable, accessible and timely data. With better data, research organisations, researchers, commercial enterprises and the New Zealand public will have:

- Greater public accessibility of data about research
- Reduced transaction costs for researchers in applying for funding and in reporting
- More efficient and effective processing of research grant applications and reporting data
- Greater visibility of New Zealand's innovation system, both domestically and internationally.

Government agencies and funders will have :

- A greater understanding of how New Zealand's innovation system works and performs
- More evidence-based policy settings
- Better evaluation of the impact of government's investment in research
- Improved transparency of the research and system.

Following the identification of knowledge and data needs, and the gap analysis, the domain plan process identified actions to improve the data on research, science and innovation in New Zealand. These actions are designed in line with the domain plan principles and focus on improving data on the inputs and outputs of the research and science system. The information will also be critical for investment decisions and for raising the visibility and profile of New Zealand's innovation system. Implementation of the actions is expected to take at least five years and will require coordinated effort across various government agencies and close engagement with the research community. Key funding agencies and the research community will need to work closely to formulate minimum datastandards which will enable the development of linked data on research in New Zealand and this is well underway. As part of the action plan, in July 2016, MBIE and New Zealand's key research and science organisations endorsed the adoption and use of ORCID identifiers in New Zealand. With the establishment of a national consortium. Research institutions will implement the ORCID API through a New Zealand ORCID hub, which will facilitate the establishment of a trusted network of New Zealand researchers, institutions and research outputs.

A Research, Science and Innovation Data Conceptual Model for the NRIS was developed out of the Domain Plan framework. The conceptual model helps define the scope of the system and contributes to the process of defining a common set of definitions for concepts and data elements. Implementation of a NRIS began in March 2017. Initially MBIE funding data will populate this data-mart and other Funder organisations such as the Royal Society will follow. The New Zealand NRIS will not be a single platform. This funding data-mart will be one of several platforms and systems so that complete information can be captured, shared and reported on. Work is now being undertaken to develop the social license to ensure support across all stakeholders. The Australian and New Zealand Standard Research Classification (ANZSRC) was developed for use in the collection, analysis, and dissemination of research and experimental development statistics in Australia and New Zealand. To support the Domain Plan an action is also underway to undertake a review and revision of the ANZSRC to modernise them and ensure they are fit for purpose.

Implications for Librarians

What does this mean for Librarians and Library Directors? As well as building our skills to partner with researchers at the local level – and set out organisational change to support researchers today, it is important for Librarians to contribute to national initiatives and activities. We need to play an active role in contributing to these developments. This highlights and reinforce the skill sets and expertise we have that support research activities and information management about research.

Librarians organise for use and describe for discovery and reuse and working at the national level, and engaging with University senior management means these skills are being recognised. In the New Zealand context, Librarians are at the national table in recognition of their expertise and skills in metadata management, research outputs definitions, people and organisation disambiguation and research support services including skills in deploying and using bibliometric analysis tools. With our experience in the challenges of disambiguation – we have a lot to contribute: Librarians are or should be institutional lead on ORCID (building influence with researchers) and active contributors at the national level.

With the ANZSRC update, librarian expertise with taxonomies and classifications will be required. In addition, Librarian as honest broker means we will have input into the successful development of the social license for an NRIS. All this furthers the goal of recognising Librarians as research partner.

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