Improving Data Management Practices of Researchers by Using a Behavioural Framework

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Given the value of research data at the local, national and international levels, considerable attention is being focused on its management, discovery and re-use. This paper examines the current data management practices among researchers and the barriers—both perceived and real—for them to reassess those practices and, where appropriate, adopt new ones. The authors have drawn upon key insights from the major models and theories of behaviour and behaviour change to develop a proposed framework for understanding researcher behaviour. The paper discusses how this framework assists service delivery teams to look at issues from the individual researcher perspective and, as a result, develop a more effective planned intervention to change behaviours where necessary. The authors conclude with suggestions as to the potential wider applicability of the behavioural framework within an organisation.

1. Introduction

Research data is the new gold (Simons and Richardson, 2013; High Level Expert Group on Scientific Data, 2010) or data is the new black (de Montcheuil, 2015), depending upon one's perspective. With the rise of eScience / eResearch, there has been considerable national and international investment in the development of infrastructure to support the growth. In turn, universities are having to develop their own infrastructure to address the needs of their researchers, particularly in regard to data management (Peters and Dryden, 2011). In the context of this paper, *data management* follows the definition by O'Reilly et al. (2012, p. 2): "all aspects of creating, housing, delivering, maintaining, and retiring data".

In this paper, the authors briefly examine some of the concerns about the current data management practices of researchers, and suggest that key insights from the major models and theories of behaviour and behaviour change could help to promote sustainable improved practices. Having outlined some of the key theories and models, the authors present a proposed behavioural framework, which analyses the context in which a researcher and their cohort operates. The proposed framework is a tool for service delivery teams to a) better understand the cohort with which they are engaging, b) identify where and when to focus their attention, and c) develop more effective plans to bring about changed researcher practices. The purpose of this paper is not to identify specific interventions to improve data management practices.

2. Drivers for improved research data management

In Australia, the *Australian Code for the Responsible Conduct of Research* (NHMRC et al., 2007) was developed in its current format by the National Health and Medical Research Council (NH&MRC), the Australian Research Council (ARC) and Universities Australia. It provides a guide to responsible research practice and covers a wide range of topics associated with research, including the management of research data and associated materials, and the publication and dissemination of research finding. The Code assigns both researchers and their parent institutions a shared responsibility to appropriately manage research data and primary materials. A key driver is the desire to enhance discoverability and re-use of data, i.e. "connecting" end-users as "consumers".

In line with funding agencies in other countries such as the United Kingdom and the United States, as of 2014 the ARC (Australian Research Council, 2014) requires funding applicants to outline their plans for the management of data produced through the proposed research. Plans are expected to cover—as a minimum—storage, access and re-use arrangements. This plan relies on a base level of competency and practice on the part of the researcher. It also relies on institutions to provide a base level of services to support this approach, e.g. make systems and infrastructure available to store data sets.

Another important driver is the pressure to make publicly funded research openly available. As a result, publishers are "seeking to be responsive to calls for transparency and reproducibility of the scientific record" (Rice and Haywood, 2011, p. 262). A newer trend is that of journals requesting data deposit to accompany journal article submission and, in some cases, to link the article with the underlying data. In both cases good research data management inherently underpins the ability of a researcher to provide the requisite data. Costello (2009) has outlined the major benefits and challenges for researchers in this space.

3. Current data management practices of researchers

Data management practices of researchers are coming under increasing scrutiny. According to Yanosky (2009, p. 120), "Traditionally, researchers have kept and maintained their own data. But the size and complexity of modern data sets increasingly makes this impractical, while obvious economies and research benefits would be realized from making data available to a wider community of investigators". However, as Jahnke et al. (2012) have outlined in a recent report, the importance of good data management practice tends to be overshadowed by other demands. While attention seems to be focused on the end of the research cycle, i.e. the publishing phase, the challenge of improving data management practices covers the whole research cycle from grant inception to data capture/creation through to archiving. At the end of the project not all data collected may need to be published but may still warrant preservation for re-use or to meet regulatory requirements.

While attention may seem to be focused on the big science fields, such as physics and astronomy, which are frequently associated with large-scale projects, large quantities of data often gathered from sensor-derived sources, and high-level funding, the smaller-scale research projects also have their own data-related challenges. Normore and Tebo (2011, p. 1) note:

> Small science projects, on the other hand, are more often associated with small research groups, usually consisting of a primary researcher and graduate students, who collect data in a more individualistic way (Borgman et al., 2007; Heidorn, 2008). While we hear more about the large science projects, small science projects are quite important since they are a "breeding ground for new ideas" (Heidorn, 2008, p. 282) and because, as an aggregate they are very large in number. They pose a challenge, however, because the data are often less well curated, described and preserved (Borgman et al., 2007; Heidorn, 2008; Marcial & Hemminger, 2010).

Tenopir et al. (2011) also found significant differences based on subject discipline for how respondents' organizations are involved with data. In terms of having a formal established process for managing data during the life of the project, respondents from atmospheric science (54%) and environmental sciences and ecology (48%) report the most involvement, whereas social sciences (38%) report the least.

O'Reilly et al. (2012) have reported on a survey of the data management practices of researchers at a US research university. While a large percentage of respondents (60.7%) had a formal data management plan, 39% reported backing up their data monthly or less frequently, and 41.3% reported that they had neither expertise themselves nor access to expertise in addressing the tasks normally associated with a research data management plan. The authors note that "Researcher self-reported competence is highest during the data collection stage and most consider their efforts adequate for data housing—although certain questionable practices, such as no backup plans for data, were reported" (p. 8). Good data management practices would require that attention be paid to the recovery of data because of external factors such as loss or disaster. Data loss can have significant impacts, especially in the case of collaborative groups working on large complex projects.

It should not be assumed, however, that all researchers do not exercise good practice in managing their data; they may do so using a variety of readily available tools and technologies. The problem is how to bring about a change in behaviours of researchers to reassess their current practices and, if necessary, adopt new practices. In Australia and internationally there has been much discussion about how to improve engagement and support within the institutions. This paper will further that discussion by applying a different lens to the problem of data management, i.e. from the researcher perspective, and by using well-known models of behaviour and behavioural change.

4. Theories and models for behaviour and behaviour change

In regard to the adoption of research data management practices, the tendency to date has been to attribute researchers' non-compliance, or reluctance at best, to factors such as lack of time and / or resources, lack of recognition for undertaking such an initiative, lack of confidence as to how their data (if shared) may be used by others, and basic lack of awareness of the potential benefits. However as contemporary behavioural literature suggests, there are additional factors which should be considered so as to better understand any perceived "resistance to change".

Theories and models of human behaviour are commonly applied throughout the social sciences. There have been attempts to extend these for broader use to isolate controlling factors and causes of behaviour, taking into account anthropological factors such as habit, ritual, politics and influencing factors of institutional structures (Morris et al., 2012). They have been applied widely (e.g. agriculture, recycling, community health) where intervention is required to bring about adoption of new practices and behaviours.

Utilising the broad categorisation of behaviour developed by Morris et al. (2012), either the individual is seen as the "locus of behaviour" (p. 3) or the focus shifts more towards the impact of social and technological elements. These categories are reflected in the following two tables (Table 1 and Table 2), which identify several of the major theories / models and briefly outline their key tenets.

Table 1.
Comparison of Major Theories of Individual Behaviour / Change

Theory	**Major Tenets**	**Comment**
Theory of Planned Behaviour (TPB)	• Examines the link between intention to act and performing a behaviour. • Intention is determined by an individual's attitude (belief and values about the outcome) and subjective norms. • Behaviour is also determined by an individual's perceived behavioural control.	Useful for reinforcing the need to present information in a way which helps shape positive attitudes toward behaviours.
Health Belief Model (HBM)	• Examines the impact of perceived threats to an individual's well-being and subsequent actions / behaviours. • A perceived threat is apt to lead to the adoption of mitigating behaviours. Corollary is also true. • Individual's self-efficacy (perceived capacity to adopt the behaviour) is a key component.	Major criticism is that it does not include behaviour determinants other than personal cognitive factors.
Stages of Change (Transtheoretical)	• Examines an individual's readiness to act based on six milestones. • Contemplation (serious consideration of change in behaviour) and consciousness raising (increasing information about self and problem) are important elements.	Useful for highlighting need to match behaviour change interventions with people's stages. Without a plan, people will remain stuck in the early stages because of lack of motivation.

Table 2.
Comparison of Major Social and Technological Theories of Behaviour / Change

Theory	**Major Tenets**	**Comment**
Social Practice Theory (SPT)	• Examines linkages between practice and context within social situations. • Critical reflection is important in "unfreezing" habitual behaviours.	Useful for identifying self-perpetuating practices, which are difficult to break
Social Cognitive Theory (SCT)	• Examines how behaviour, personal and environmental factors interact to determine human functioning. • Major elements which may intervene include self-efficacy, outcome expectations, reinforcements (something that increases / decreases likelihood a behaviour will continue), and observational learning (acquiring behaviours by observing others' behaviour).	Useful for looking at resources which could raise self-efficacy, determining whether incentives are required, and recognising environmental constraints that might deter behaviour change.
Diffusion of Innovation Theory	• Examines how new ideas and technology are taken up in a population. • Behaviour will change more rapidly if innovations are perceived as being better than previous options and consistent with the existing values, experiences and needs of potential adopters, if they are easy to understand as well as testable via limited trials, and their results are visible.	Useful for building awareness that interacting individuals with similar attributes tend to act as a barrier for innovation to occur. Tends to be used within economics

Each of the aforementioned theories / models has defined variables which are considered as essential. However, among these are variables which are common to many of the theories / models. The following table lists some of the key elements (World Bank, 2010, pp. 1-2).

Table 3.
Key Elements Common to Many Theories / Models of Behaviour

Key Element	**Definition**
Threat	A danger or a harmful event of which people may or may not be aware
Fear	Emotional arousal caused by perceiving a significant and personally relevant threat
Response Efficacy	Perception that a recommended response will prevent the threat from happening
Self-Efficacy	An individual's perception of, or confidence in, their ability to perform a recommended response
Barriers	Something that would prevent an individual from carrying out a recommended response
Benefits	Positive consequences of performing a recommended response
Subjective Norms	What an individual thinks other people think they should do
Attitudes	An individual's evaluation or beliefs about a recommended response
Intentions	An individual's plans to carry out the recommended response
Cues to Action	External or internal factors that help individuals make decisions about a response
Reactance	When an individual reacts against a recommended response

These elements are important when considering the factors which may contribute to current data management practices of researchers.

While the abovementioned theories and models of behaviour and behaviour change may be diverse and sometimes conflicting, they can provide some key insights that can help to promote sustainable behaviours. As Morris et al. (2012, p. 20) note, it is important to address "both the individual as a

decision-maker and the wider social context in which they live." Other factors such as the perceived "do-ability" of a desired behaviour, the importance of deliberation in achieving change, and the adherence to entrenched technologies impact on the ability to create sustainable behaviours.

In the following section, the authors will draw upon the key elements described above to arrive at a proposed framework to assist service delivery teams to better understand why researchers behave the way they do in regard to the demand for their improving data management practices.

5. Proposed framework

Unquestionably behaviour and behaviour change theories / models are highly complex, especially for non-experts. As a result there have been a range of efforts to reduce core components into a "framework" so as to "inform research design, policy and intervention design, and assist non-experts such as policy-makers in understanding behaviours and how they might engage with them. This distillation necessarily reduces the complexity of behaviour, trading it off against comprehensibility and usability" (Morris et al, 2012, p. 15).

The authors examined several of these frameworks as part of their investigation, particularly "4 E's" (HM Government, 2005), MINDSPACE (Dolan et al., 2010), "energy cultures" (Stephenson et al., 2010), the "behaviour change wheel" (Michie et al., 2011), and "ADKAR" (Hiatt, 2006). Ultimately they chose the "COM-B" system developed by Michie, van Stralan and West (2011) as the simplest yet most comprehensive framework on which to base their approach. In the COM-B system, C = Capability; O = Opportunity; and M = Motivation, all of which interact to generate behaviour (B).

However the authors were also influenced by the work of Piderit (2000) in examining the role of attitude in implementing organisational change. A key question posed by the World Bank (2010, p. 4) – "What if attitude change (as opposed to behavior) is your goal?" –also caused the authors to reassess the COM-B framework and determine that attitude would be key to any discussion about behaviour and behaviour change in terms of research data management. Figure 1 (below) offers a diagrammatic representation of this concept, now presented as A-COM-B. The single-headed and double-headed arrows represent the potential for influence between the various elements.

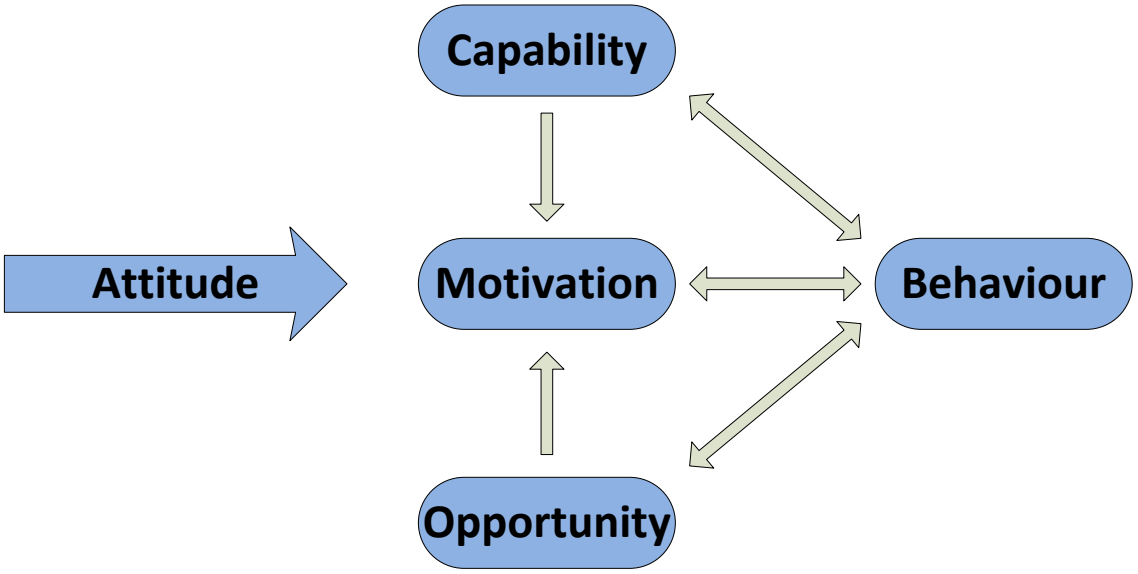

Figure 1. A-COM-B framework for understanding behaviour

5.1 Attitude

Attitude is an individual's evaluation or belief about something. Piderit (2000) further qualifies this concept by arguing that attitude is actually comprised of 3 dimensions: cognitive, emotional and intentional. Cognitive refers to an individual's beliefs about the object towards which they have attitude. These are expressed as positive, negative or possibly neutral (Eagly and Chaiken in Piderit (2000, p. 786)). For example, researchers may be neutral about the potential re-use of their data because they have not yet fully considered the matter. Jahnke et al. (2012) found that few researchers, especially among those who are early in their career, do think about long-term preservation of their data. O'Reilly (2012) also found that researchers in their study regarded the research cycle as: a) collect data b) analyse and store and c) publish. This is at odds with the practices many change initiatives are hoping to instil, i.e. a focus on long term retention and re-use. The point here is that there needs to be a shared understanding between service delivery teams and researchers before proceeding further.

Emotional refers to an individual's feelings, which includes moods and emotions. Researchers may be too focused on the need to finish a journal article and meet deadlines to feel positively about the need to preserve their data. Intentional reflects an individual's evaluations based on past and future actions, e.g. the researcher needs time to think about new requirements and decide upon what action to take. Jahnke et al. (2012) found that the demands for recording better metadata and documentation are of interest, for example, only if they help a researcher complete his or her work.

There are a number of studies that highlight that resistance to change increases when the forces of change negatively impact organisational stability (Bercovitz and Feldman, 2008; Hannan and Freeman, 1984; Leonard-Barton, 1992; Nelson and Winter, 1982; Tolbert and Zucker, 1983). Old habits and norms of behaviour will persist even if the university executive publishes and develops new initiatives, even when providing incentives and resources to develop new organisational structures and processes. The literature shows that the challenge is even greater where organisations are highly institutionalised with strong traditions and well established norms of behaviour. It could be argued universities and many disciplines are highly institutionalised.

Piderit (2000) found that individuals generally do not form resistant attitudes without thinking about the potential negative consequences and that there is a tendency to lay blame for the failure of a change initiative at the door of others rather than on the change initiative itself. When planning to initiate a plan to change behaviours of staff, consideration should first be given to the attitudes of staff and having an appreciation of their views and attitudes in relation to the change being considered.

Understanding the nature of the attitude (more often than not ambivalence in relation to how researchers regard data management) should provide insights into the most appropriate responses that will garner the desired attitudinal change. As mentioned above, Jahnke et al. (2012) found that many of the researchers in their study were sceptical of long-term interest in their data and were often doubtful that future researchers would be interested in their primary materials. Therefore to change their current behaviours, their current attitudes to the long term usefulness of their data need to change first.

There are opportunities to develop attitudes from the ground up. As a practical example, Bercovitz and Feldman (2008) in their study on technology transfer noted that the longer the time that had elapsed since graduate training, the less likely the individual was to actively embrace a new norm. This reinforces the need to target early career researchers and PhD students to develop positive attitudes about the need for good data management practices.

5.2 Capability

Capability is the psychological or physical ability to enact the behaviour (Michie et al, 2011, p. 4). This perceived capacity to adopt a behaviour (their self-efficacy) is fundamental to a person taking any action to change their behaviour. If they do not believe they have the skills or knowledge to change their behaviour, they are unlikely to take any action to do so.

The literature has highlighted researchers' concerns about self-efficacy based on the lack of knowledge and skills as well as the lack of opportunities to gain that knowledge and those skills, whether as a formal

training course or seeking out assistance from organisations such as the library. Jahnke et al. (2012) found that researchers expressed dissatisfaction with their level of expertise in data management and that knowledge is usually acquired on the job and through trial and error. This study also noted that in a research project, data management tasks could not be easily delegated to the transient administrative staff, meaning this becomes an extra task of the researchers themselves who are already being burdened with additional tasks, e.g. not just in research but also in teaching. Their capacity to undertake these extra tasks is limited.

5.3 Motivation

Motivation is defined as "all those brain processes that energize and direct behaviour, not just goals and conscious decision-making. It includes habitual processes, emotional responding, as well as analytical decision-making" (Michie at al., 2011, p. 4). Bercovitz and Feldman (2008) assert that motivation is a process that not only causes a person to act but also to maintain certain behaviours.

The presence of external pressures (e.g. mandated policies and guidelines, training and new support services) does not guarantee that new initiatives such as the drive to improve research data management practices will be embraced. An individual's behaviour can be influenced by prior behaviour, professional relationships external to the institution and the local social context. The local work environment can play a major role in how a new initiative is received. If individuals observe their peers engaging in the initiative, then they are more likely to engage. Even if this engagement conflicts with previous behaviours or experiences, the local group norm will prevail (Festinger, 1957). In the case of researchers, the local group norm may be those experienced within the School or, increasingly in the age of cross-institutional collaboration, within the research group. Considering the local group norm, Bercovitz and Feldman (2008) found that when the chair of the department is active in technology transfer, other members of the department are also likely to participate, if only for symbolic reasons. Identifying local champions amongst the more senior staff would seem to be a priority to act as motivators for the group targeted. Conversely these senior staff not being on board would seem to be a barrier to sustainable change.

O'Reilly et al. (2012) found that lack of formal policies and lack of training programs around data management provided a motivation for not changing practices.

5.4 Opportunity

Opportunity is defined as "all the factors that lie outside the individual that make the behaviour possible or prompt it" (Michie et al., 2011, p. 4).

A survey of the literature has identified a number of barriers to improving data management practices based on researchers' beliefs and perceptions. These include:

- Lack of tools – Tenopir et al. (2011, p. 7): Only about a quarter (26%) of the respondents were satisfied with the tools for preparing metadata, while over 32% were dissatisfied. Jahnke et al. (2012) also noted that there was a lack of effective collaboration tools, as well as online spaces that support the volume of data generated and provide appropriate privacy and access controls. O'Reilly et al. (2012) found lack of storage to be an issue.
- Lack of resources - time and money – Tenopir et al. (2011, p. 20): This study found the reasons scientists cite for not making their data electronically available to others were insufficient time and lack of funding.
- Legal and policy issues - O'Reilly et al. (2012) found that a common complaint was attempting to overcome the lack of policies on data management and how best to deal with legacy data. This is typically beyond the capability of researchers to resolve.

In terms of addressing researchers' negative self-efficacy, O'Reilly et al. (2012, p. 4) suggest:

> The implementation of effective data management systems for research data throughout its entire life cycle requires involvement from the subject matter experts within the information systems (IS) communities on research campuses. Without the IS community taking an active role in finding solutions that ease the data burdens for researchers, the new regulations for data management combined with performance-based bibliometric

> systems of evaluation for research quality may dramatically reduce meaningful research output due to core skill gaps in data management by the research community.

According to Jahnke et al. (2012), few researchers are aware of the data services that the library might be able to provide and seem to regard the library as a dispensary of goods (e.g., books, articles) rather than a locus for real-time research/professional support.

5.5 Behaviour

Behaviour is the result of the interaction between the four key elements: attitude, capability, motivation and opportunity. In seeking to change / improve behavioural practices, context is key to designing and implementing interventions, i.e. strategies to modify those practices (Michie et al, 2011, p. 8). The four elements provide the context for understanding existing behaviours as well as those which may be identified as target, i.e. new.

Enacting a behaviour can alter capability, motivation and opportunity as reflected in the diagram with the two-way arrows. For example, a researcher may upload a data set for the first time. Once they get through this experience, their capability improves, which may positively influence their motivation. This in turn may lead the researcher to apply for additional grant funding for data management in their next project.

6. Discussion

The previous section outlined a framework for understanding researcher behaviour. The discussion so far has been about data management practices. However, data management practices do not constitute a single behaviour; instead they are made up of numerous behaviours, some of which may need to change in order to improve overall practice.

As a consequence, any effective (intervention) activity to improve these practices will require 1) identifying the underlying elemental behaviours that make up the practice and 2) identifying which of these needs to be changed. For example, two different underlying behaviour modifications could be a) to stop using local hard drives and to store data in an institutional repository and b) to improve descriptions of data sets held so they are more suitable for sharing and re-use.

The next step is to identify current attitudes to the desired change in behaviour. However a challenge is that unlike behaviour, attitudes are more difficult to observe, measure and quantify. Therefore attention may need to be paid to employing techniques such as qualitative interviewing coupled with good listening skills. This is an important step as understanding the nature of attitudes will normally provide insights into the other elements of the framework, i.e. capability, motivation and opportunity. An understanding of all these elements creates a foundation for developing an intervention plan.

Analysis and planning may need to be undertaken at both the individual and cohort level. As discussed previously, individual behaviours are driven by their local settings rather than at the larger faculty or institutional level, and different disciplines have different practices and requirements. To understand the current attitudes and to plan an “intervention” plan, local service delivery teams may need to understand their local cohort to develop an effective response. To change behaviours and increase uptake, any (intervention) plan needs to be a multi-pronged approach which targets the different elements of the framework.

Moreover any resultant behavioural change ideally should be replicable (i.e. become habit forming) to be an effective change (Michie, 2012). A corollary is that researchers’ responses to change may evolve over time, and paying attention to this evolution might yield insights about how to manage ongoing change initiatives successfully (Piderit, 2000). Therefore changing researcher behaviour needs to be seen as an ongoing process and not as a program of work with an end date.

There are opportunities at the institutional level to develop a generic planned response toolkit, which the local service delivery teams can then utilise to fine tune their response to meet the behavioural patterns of their local individuals/cohort. For example, in the above case of poor storage practice, the local team may utilise resources from the institutional level to achieve the desired outcome, e.g. train researchers on how

to use institutional data repositories. Alternatively in the case of poor data set descriptions, the local team may run workshops targeted at specific disciplines on how to better describe data sets.

The purpose of this paper was not to identify specific interventions; rather the approach was to show that a different lens needs to be applied to improving "data management practices". The suggested A-COM-B framework provides a holistic approach, which analyses the context in which a researcher / cohort operates. One of the drivers for this paper was that an individual researcher is not forced to use any one system nor are there constraints forcing them to utilise a single solution (e.g. a researcher has no choice but to use a HR system to apply for leave). In managing their research data, researchers have many available alternative solutions and options open to them and little by way of control mechanisms to ensure a certain level of compliance. This framework assists service delivery staff in looking at an issue from the individual researcher perspective and, as a result, to develop a more effective planned intervention to change behaviours where necessary. It also provides them with a better understanding of individual researchers' behaviours. The A-COM-B framework complements well-known IT change management frameworks such as Prosci's ADKAR Model (Hiatt, 2006) and Kotter's Eight-Stage Change Framework (1996).

7. Conclusion

The increased value of research data in a worldwide scale has highlighted the importance of its appropriate management, i.e. storing, describing and preserving (where appropriate). As a result, the practices of researchers in this arena have come under scrutiny. While the literature abounds with concerns about many of these practices, there appears to have been little attempt made to analyse researchers' behaviour from a holistic perspective.

In examining the basis on which successful interventions might be structured, the authors have turned to key models and theories of behaviour and behaviour change to better understand a researcher's perspective. As a result of their investigation, the authors have proposed a behavioural framework which distils the major elements common to many of these theories and models.

This framework has broader application than just addressing the issue of data management. It can be used in many initiatives where a change to individual behaviour is sought, whether to use, for example, new unified communication technologies or a new learning platform. It is especially useful in situations where a new system or initiative is being implemented.

References

Andreoli-Versbach, P., & Mueller-Langer, F. (2014). Open access to data: An ideal professed but not practised. *Research Policy, 43*(9), 1621-1633.

Australian Research Council, 2014. Funding Rules for schemes under the Discovery Program for the years 2014 and 2015. Available at: http://www.arc.gov.au/pdf/DP15/Funding%20Rules%20for%20the%20Discovery%20Program.pdf

Bercovitz, J., & Feldman, M. (2008). Academic entrepreneurs: Organizational change at the individual level. *Organization Science, 19*(1), 69-89.

Borgman, C.L., Wallis, J.C., & Enyedy, N. (2007). Little science confronts the data deluge: habitat ecology, embedded sensor networks, and digital libraries. *International Journal of Digital Libraries, 7*(1-2), 17-30.

Costello, M. J. (2009). Motivating online publication of data. *BioScience, 59*(5), 418-427.

de Montcheuil, Y. (2015, 27 January). Data is the new black. *InfoWorld*.

Dolan, P., Hallsworth, M., Halpern, D., King, D., Metcalfe, R. & Vlaev, I. (2010). *MINDSPACE: Influencing behaviour through public policy*. Cabinet Office and The Institute for Government.

Fecher B, Friesike S, Hebing M (2015) What drives academic data sharing?. *PLoS ONE 10* (2): e0118053. doi:10.1371/journal.pone.0118053

Festinger, L. (1957). *A theory of cognitive dissonance*. Stanford, CA: Stanford University Press.

Heidorn, P.B. (2008). Shedding light on the dark data in the long tail of science. *Library Trends, 57*(2), 280-299.

Hannan, M. T., & Freeman, J. (1984). Structural inertia and organizational change. *American Sociological Review*, 149-164.

Hiatt, J. M. (2006). *ADKAR: A model for change in business, government and our community: how to implement successful change in our personal lives and professional careers*. Loveland, CO: Prosci Research.

High Level Expert Group on Scientific Data. (2010). *Riding the wave - How Europe can gain from the rising tide of scientific data. A submission to the European Commission*. Luxembourg: European Commission

HM Government. (2005). *Securing the future: The UK Government Sustainable Development Strategy*. London, HM Government

Jahnke, L., & Asher, A. (2012). *The problem of data*. Washington, DC: Council of Library and Information Resources.

Kotter, J. P. (1996). *Leading change*. Cambridge, MA: Harvard Business School Press.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: a paradox in managing new product development. *Strategic Management Journal*, *13*(S1), 111-125.

Marcial, L.H., & Hemminger, B.M. (2010). Scientific data repositories on the web: an initial survey. *Journal of the American Society for Information Science and Technology*, *61*(10), 2029-2048.

Michie, S. (2012, November). *Which behaviour change approach should I choose? An introduction to the Behaviour Change Wheel*. Presentation at a BehaviourWorks seminar, Melbourne.

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42.

Morris, J., Marzano, M., Dandy, N., & O'Brien, L. (2012). *Theories and models of behaviour and behaviour change*. Edinburgh: Forestry Research.

National Health and Medical Research Council, the Australian Research Council and Universities Australia. (2007). *Australian Code for the Responsible Conduct of Research*. Available at: http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/r39.pdf

Nelson R. R., & Winter, S. G. (1982). An evolutionary theory of economic change. Cambridge, MA: Harvard Business School Press.

Normore, L. F., & Tebo, M. E. (2011). Assessing user requirements for a small scientific data repository. *Proceedings of the American Society for Information Science and Technology*, *48*(1), 1-4.

O'Reilly, K., Johnson, J., & Sanborn, G. (2012). Improving university research value: a case study. *SAGE Open*, *2*(3), 2158244012452576.

Peters, C., & Dryden, A. R. (2011). Assessing the academic library's role in campus-wide research data management: A first step at the University of Houston. *Science & Technology Libraries*, *30*(4), 387-403.

Piderit, S. K. (2000). Rethinking resistance and recognizing ambivalence: A multidimensional view of attitudes toward an organizational change. *Academy of Management Review*, *25*(4), 783-794.

Rice, R., & Haywood, J. (2011). Research data management initiatives at University of Edinburgh. *International Journal of Digital Curation*, *6*(2), 232-244.

Simons, N., & Richardson, J. (2013). *New Content in Digital Repositories: The Changing Research Landscape*. Cambridge, UK: Chandos.

Stephenson, J., Barton, B., Carrington, G., Gnoth, D., Lawson, R. & Thorsnes, P. (2010). Energy cultures: A framework for understanding energy behaviours. *Energy Policy*, 38**,** 6120-6129.

Tenopir, C., Allard, S., Douglass, K., Aydinoglu, A. U., Wu, L., Read, E., & Frame, M. (2011). Data sharing by scientists: practices and perceptions. *PloS one*, *6*(6), e21101.

Tolbert, P. S., & Zucker, L. G. (1983). Institutional sources of change in the formal structure of organizations: The diffusion of civil service reform, 1880-1935. *Administrative Science Quarterly*, 22-39.

Van den Eynden, V., & Bishop, L. (2014). *Sowing the seed: Incentives and motivations for sharing research data, a researcher's perspective*. Copenhagen: Knowledge Exchange.

World Bank. (2010). *Theories of behavior change*. Communication for Governance and Accountability Program (CommGAP). Washington, DC, World Bank.

Yanosky, R. (2009). *Institutional data management in higher education*. Boulder, CO: EDUCAUSE Center for Applied Research.

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Please cite as: Wolski, M., & Richardson, J. (2015, May). *Improving data management practices of researchers by using a behavioural framework.* Paper presented at the THETA 2015 Conference, Gold Coast, Australia.

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