WE REVIEW, EVALUATE, ANALYZE, RECOMMEND.

YOU SUCCEED.

Do Your Research Management Operations Need Improvement?

SRAI offers comprehensive review and evaluation of POLICIES, PROCEDURES & PRACTICES in areas crucial to a SUCCESSFUL research management office.

Visit www.srainternational.org/learn/consultingpeer-review for more information.
The Journal of Research Administration

The Journal of Research Administration is published by the Society of Research Administrators International, Arlington, Virginia 22209 USA. Founded in 1967, the Society of Research Administrators International is dedicated to the education and the professional development of research administrators and to enhance public understanding of research and its administration. Representing all disciplines and sectors in research administration, it serves as the international society to promote quality and innovation in research administration. USPS No. 008245. ISSN No. 2573-7104 (online).

Correspondence

Manuscripts are to be submitted to the Editor. Submission of a manuscript is considered to be a representation that it is not copyrighted, previously published, or concurrently under consideration for publishing in print or electronic form. Consult the Journal web page (www.srainternational.org/journal) for specific information for authors, templates, and new material. The preferred communication route is through email at journal@srainternational.org, Attention: JRA Editor.

Copyright © 2018 by the Society of Research Administrators International.

All material subject to this copyright may be photocopied for limited non-commercial educational purposes with the written permission of the SRA and with appropriate credit. Opinions expressed in this Journal represent the opinions of the authors and do not reflect official policy of either the SRA or the author-affiliated institutions unless so noted in the Author’s Note portion of the specific article. Papers prepared by employees of the U.S. government as part of their official duties may not be copyrighted, but the Journal format is copyrighted and requires written permission of the Society of Research Administrators International, as outlined above. Copying for general distribution, resale, or other purposes may be authorized only with specific written permission from the Society of Research Administrators International. Requests for such permission must be made in writing to the Society of Research Administrators International, 1560 Wilson Blvd., Suite 310, Arlington, VA 22209 USA or through email at journal@srainternational.org.
2018 Journal Editorial Board

**Editor-in-Chief**
Nathan L. Vanderford  
University of Kentucky

**Deputy Editor**
Jennifer Taylor  
University of Arkansas

**Editorial Board**
Amy Cuhel-Schuckers  
Franklin & Marshall College

- Deborah Derrick  
  University of Nebraska at Omaha
- Diane Gavin  
  University of Phoenix
- Ira Goodman  
  University of California at San Diego
- Tanisha Hammill  
  DOD Hearing Center of Excellence
- Carson Harrod  
  Baylor Scott & White Health
- David Huang  
  National Institute of Education, Singapore
- Sharon Kitt  
  Federation University Australia
- Alison Krauss  
  Western Carolina University
- Kirsten Levy  
  Boston University Medical Campus
- Timothy L. Linker  
  High Point University
- Kimberly McKoy  
  University of North Carolina Wilmington

- Diane Nagy  
  South Dakota State University
- Alicen Nickson  
  Brunel University London
- Sandra Nordahl  
  San Diego State University Research Foundation
- Simon Philbin  
  Imperial College London
- Nani Pybus  
  Oklahoma State University
- Dhanonjoy Saha  
  Albert Einstein College of Medicine
- Cliff Studman  
  St. John’s University of Tanzania
- Renee Vaughan  
  Duke University, School of Medicine
- Lisa Walker  
  University of North Carolina at Greensboro
- Holly Zink  
  Children’s Mercy Kansas City

**Intellectual Property Counsel**
J. Michael Slocum

**Business Manager**
Rene Hears  
Louis Stokes Cleveland Department of Veterans Affairs Medical Center

**Journal Liaison**
Dilyana Williams

**Copy Editor**
Leanne Jernigan  
High Point University
The Society of Research Administrators
International Board of Directors

President
Cindy Kiel
University of California Davis

President Elect
Kim C. Carter
University of Kentucky

Immediate Past President
John Westensee
Aarhus University Hospital

Treasurer
Rene Hearns
Louis Stokes Cleveland Department of Veterans Affairs Medical Center

Secretary
Bruce W. Steinert
Cancer Treatment Centers of America

At Large Board Member
Dominic Esposito
College of New Rochelle
Gloria Greene
University of Alabama, Huntsville
Mark B. Hochman
Central Queensland University
Susan Wyatt Sedwick
Attain LLC
Annedorte Vad
Copenhagen Business School
Gayle Walters
Johns Hopkins University School of Medicine

Ad Hoc Board Member
Silke Blohm
University of London
Alex Delavan
Research Administrators Certification Council
Devin Kreuger
University of Toronto Mississauga
Angela Sherman
University of Virginia

Prepared by SRA International
1560 Wilson Blvd., Suite 310, Arlington, Virginia 22209
www.srainternational.org
Table of Contents

From the Editor’s Desk .......................................................................................................................... 7

        Nathan L. Vanderford

Articles

Building the science of research management: What can research management learn from education research? ........................................... 11

        Jun Song Huang, Wei Loong Hung

American Institutional Review Boards: Safeguards or Censorship? .......... 31

        Kristi N. Hottenstein

Research and Grant Management: The Role of the Project Management Office (PMO) in a European Research Consortium Context .................. 43

        Gerben Kristian Wedekind, Simon Patrick Philbin

Utilization of Lean Methodology to Refine Hiring Practices in a Clinical Research Center Setting ................................................................. 63

        Marcus R. Johnson, A. Jasmine Bullard, R. Lawrence Whitley

Assessing Research Collaboration through Co-authorship Network Analysis ......................................................................................... 76

        Jesse Fagan, Katherine S. Eddens, Jennifer Dolly, Nathan L. Vanderford, Heidi Weiss, Justin S. Levens

Commentary: Research Administrators Should Contribute to Improving Faculty Hiring Practices ................................................................. 100

        Nathan L. Vanderford
Please send manuscripts to journal@srainternational.org
Change is also afoot at the *Journal of Research Administration* (Journal). This issue marks my beginning as the Journal’s new Editor-in-Chief. Likewise, I am happy to report that Jennifer Taylor has taken the reigns as the Journal’s new Deputy Editor.

Tim Linker, the previous Editor-in-Chief, has not gone far, as he will be remaining on the Journal’s editorial board for the foreseeable future. Tim has served the Journal for over five years; first as an editorial board member, then as Deputy Editor, and most recently as Editor-in-Chief. The Journal has made remarkable progress under Tim’s leadership. Just to name a few of his accomplishments, Tim marshaled the Journal to its current electronic, open access format; he oversaw the creation of the successful Author Fellowship Program; he established the Most Valuable Editor Award; and he greatly enhanced the Journal’s marketing presence through actions such as creation of a Journal logo and enhancement of the Journal’s website and annual meeting presence. On a personal level, Tim has also been a great mentor and friend to me, to many colleagues on the editorial board, and to others in our profession. Please join me now in thanking Tim for all his efforts. I am also happy to announce that Tim’s exceptional leadership, dedicated service, and outstanding accomplishments will be recognized at the Society of Research Administrators International (SRAI) Annual Meeting in Orlando, Florida on Tuesday, October 30, 2018, during the Annual Membership Business Meeting, Awards and Distinguished Faculty Recognition ceremony.

As we move forward, the Journal will remain steadfast in its dedication to publishing scholarly work related to the profession of research administration. The Journal serves as a medium for disseminating our profession’s best practices and novel methods of managing research at our institutions and this issue certainly reflects this purpose.

In this issue, Dr. Jun Song Huang, in his paper titled “Building the science of research management: what can research management learn from education research?,” suggests using a methodology from the field of education research, the Design-Based Research method, to study research management as a research topic. Dr. Huang provides an example from education research to illustrate his argument. In her article “American institutional review boards: safeguards or censorship?,” Dr. Kristi Hottenstein examines the U.S. Institutional Review Board (IRB) system using the Multiple Streams Theory and explores the question of whether the IRB system provides a safeguard or censorship. In “Research and grant management: the role of the project management office (PMO) in a European research consortium context,” Gerben Wedekind and Dr. Simon Philbin describe project management offices and their use within the context of a European Union consortium research project. Marcus Johnson and colleagues present their findings on using Lean methodology to identify and eliminate non-value added steps in the hiring process of staff in a clinical research center in their article titled “Utilization of Lean methodology to refine hiring practices in a clinical research center setting.” In their article titled “Assessing research collaboration through co-authorship network analysis,” Dr. Jesse Fagan and his colleagues use social network analysis to measure the
change in collaborative publications within a cancer center over time as policies were put into place that promoted team science initiatives. Lastly, in a commentary article, I describe some challenges with current faculty hiring practices and encourage research administrators to become involved in improving the way in which their institutions evaluate faculty hires. I hope that you enjoy reading the articles as much as we have enjoyed bringing them to you.

In closing, I extend gratitude to the Journal’s Deputy Director, Dr. Jennifer Taylor, and the entire editorial board for their tireless efforts to bring you this and every issue of the Journal. I also thank SRAI staff, particularly Dilyana Williams and Jim Mitchell, for their support of the Journal. Lastly, if you are a non-SRAI member and wish to have the Journal delivered to you via email, please sign up through the online system at http://www.journalra.org.
Building the science of research management: What can research management learn from education research?

Jun Song Huang, Ph.D.
National Institute of Education,
Nanyang Technological University, Singapore

Wei Loong Hung, Ph.D.
National Institute of Education,
Nanyang Technological University, Singapore

Abstract: Research management is an emerging field of study and its development is significant to the advancement of research enterprise. Developing the science of research management requires investigating social mechanisms involved in research management. Yet, studies on social mechanisms of research management is lacking in the literature. To address this gap, this paper proposes importing methodologies and theories from other social science disciplines to study the social mechanisms of research management and to build the science of research management. The paper first articulates what constitutes the science of research management, then proposes to appropriate Design-Based Research (DBR), a methodology in education research, for building the science of research management while at the same time strengthening the theory-practice nexus. A study of education research is then presented to illustrate how DBR is used to enact the theory of homophily which is imported from sociology. It reveals an opportunity to use social designs to develop social relationships among teachers from different schools for networked learning. Such a research endeavour also has potential to advance theories of relationship-building in sociology. Inferring from the example as an analogue to what is suggested for research management, the paper advocates a way to reciprocally connect research management as an emerging research field with more established social science disciplines at large and to advance both the theory and practice of research management.

Keywords: Science of research management, social mechanisms, Design-Based Research, theory-practice nexus, education research
Introduction

In the knowledge economy, research plays a critical role in regional and global innovation systems (Cooke, 2004). How to manage research activities effectively is significant to the success of research enterprise. For example, building research collaborations enhances an institute's research capacity and performance of knowledge production (Katz & Martin, 1997). Translating research to practice enhances the role of research as a key driver that propels the advancement of the knowledge economy (Olssen & Peters, 2005).

Research management, as an emerging field of study, is becoming increasingly comprehensive. There are useful descriptive studies, like Hazelkorn’s (2005) case study that describes how new institutions develop research. Such studies focus on describing a research phenomenon, classifying its attributes, and defining patterns and relationships (e.g., correlations between certain attributes and outcomes) in research activities. There are also insightful studies that establish and examine causal relationships in research activities. For example, Gao, Zang, Roth and Wang (2017) use a data set covering 156 countries between 1964 and 2010 to empirically examine whether democratization leads to the growth of research innovation.

However, the research management literature has an inadequate focus on understanding social mechanisms (Hedström & Swedberg, 1998) which specify the processes through which causal relationships arise and produce the observed outcomes in research management. For example, Gao, Zang, Roth and Wang’s (2017) study does not answer why, how (i.e., in what causal processes) and in what conditions democracy produces or does not produce research innovations. Hedström (2005) argues that the absence of a plausible mechanism linking X and Y gives us a good reason to be suspicious of the relationship between them being a causal one. But studies that examine social mechanisms in research management are still lacking in the research management literature.

In this paper, we regard scientific knowledge on social mechanisms involved in research management as the science of research management (in short, SciRM). Insufficient understanding of SciRM limits our ability to enhance research management practice. This limitation is recognized in Cooke and Hilton’s (2015) consensus study on how to enhance research collaborations. Due to the scant literature on social mechanisms involved in research collaboration, Cooke and Hilton have to rely heavily on drawing inferences, for example from the literature of group dynamics in general settings. Cooke and Hilton’s approach is similar to what Tight (2014) observes in higher education research which ‘imports’ theories from another discipline when the ‘home-grown’ theory is lacking. We recognize importing theories and methodologies from other disciplines as a promising way to build SciRM.

This paper advocates and proposes a way forward to build SciRM. First, we articulate what constitutes SciRM and the significance of developing such knowledge. Second, we make reference to education research and propose that Design-Based Research (DBR) can be appropriated as a methodology for building SciRM. Third, we illustrate a study in education research. In this example, DBR is used as a methodology to import theories from sociology to develop social relationships among teachers for networked learning (i.e., the practice) while at the same time
advance the understanding of social mechanisms in building social relationships (i.e., the theory). The example serves as an analogue to what we advocate for research management, revealing a feasible way to use DBR as a methodology to import theories in social science research for building SciRM.

The science of research management

Research management is a complex social phenomenon. It involves complex processes with constant changes and challenges (Tauginiene, 2009). Hence, the causal mechanisms specified in SciRM are hardly simple, linear and deterministic causal chains, such as those in a mechanical clock. SciRM is not prescriptive knowledge (Van Aken, 2005) or universal truths that are deterministic or can be used to make precise predictions. It is an explanatory tool that is provisional (hence subject to refinement in future) and has significance in guiding the formulation and rationalization of research management decisions. It empowers research management practices by enabling new practices that open up possibilities for certain desirable events to take place. As James (1907) argues, such knowledge is “instruments, not answers to enigmas, in which we can rest. We don't lie back upon them, we move forward, and, on occasion, make nature over again by their aid” (p. 46).

Let us use physical proximity (Katz, 1994) for illustration. Physical proximity refers to the extent to which researchers’ office rooms are located close to each other. Physical proximity promotes research collaboration (Katz & Martin, 1997), but the psycho-sociological mechanisms through which physical proximity leads to researchers’ social interactions and their trust-building and collaboration is not explicitly examined within the research management literature. SciRM specifies and examines such psycho-sociological mechanisms. Building such scientific understanding not only provides strong explanatory power on why research collaboration takes place, but also has potential to inform how to enact causal mechanisms related to physical proximity to promote collaborations. For example, such knowledge may inform the design of common spaces in offices, such as Google’s ‘150-feet from food’ rule and high-traffic staircases (Alter, 2015), to increase informal interactions among researchers at these common spaces. Such interactions enact related psycho-sociological mechanisms for building trust and research collaborations.

Criteria for the science of research management

If SciRM is provisional, how do we differentiate it from our intuitive causal link? With reference to the philosophy of science (Machamer & Silberstein, 2002), we highlight three key criteria of differentiation, namely clearly specified causal mechanisms, scientific warrant assured by rigorous research methodology, and practice impact through a strong research-practice nexus.

Firstly, SciRM emphasizes understanding causal mechanisms in research management. Salmon (1984), in his book Scientific explanation and the causal structure of the universe, highlights that scientific explanation requires causal knowledge. He distinguishes causal process (e.g., ball collision) from pseudo-process (e.g., overlapping of the shadows of balls) and emphasizes the importance of tracing and explaining causal interactions when one causal process intersects with another and produces a modification of its structure. This disposition of causality regards relational structures and change of internal dispositions as the causes of phenomena (Lloyd,
1993). In this view, SciRM, for example the account of human agency in research collaboration, should at least trace to the psychological level explaining how people think and behave and the sociological level explaining how people interact with each other (Coleman, 1988).

The causal mechanisms need to be clearly specified. Clearly and precisely articulated accounts of a mechanism can be subjected to scientific scrutiny and their implications can be assessed more accurately (Glennan, 2002). SciRM does not aim at an exhaustive account of causal details. It seeks to capture the crucial elements of the process by extracting away the irrelevant (or less important) details. It also emphasizes the intellectual virtues of precision and clarity.

Secondly, SciRM is assured by scientific warrant. Scientific knowledge is subject to critical scrutiny (Popper, 1959; Worrall, 2002). This demarcation differentiates SciRM from everyday intuition. For example, the statement “all swans are black” remains a hypothesis if it is not examined through critical, empirical and systematic observation. The hypothesis will be rejected as a scientific statement if one swan is found to be not black. Rigorous research methodology provides scientific warrant, and the rigor of a methodology is generally earmarked by its trustworthiness (Guba & Lincoln, 1989). For a methodology to be trustworthy, Kelly (2004) suggests that it should have argumentative grammar, and a coherent and explicit chain of reasoning on using a set of procedures of the methodology (Shavelson, Phillips, Towne, & Feuer, 2003). For example, the argumentative grammar of randomized control trials includes the justification of small sample analysis, statistical reasoning and randomization procedures. Violating the chains of reasoning underpinning a methodology is often a key reason for rejecting the rigour of a research study (Kelly, 2004). Hence, rigorous research methodology is necessary to assure the scientific warrant of SciRM.

Thirdly, SciRM does not just render explanations to a phenomenon, it also has significance in enacting desired changes in practice. As research management is an applied field, building SciRM is necessary only when it is for impacting the practice. For example, to understand why researchers collaborate, Katz and Martin (1997) categorized six main factors, such as the reduction in research funding, increasing specialization of science, the need for intellectual companionship, and other factors. While informative, many such causal explanations have limited power to be used to intervene and enhance research collaboration. For example, the increased specialization of science means that researchers are on a lone journey probing the frontiers of knowledge. Their needs of intellectual companionship could be satisfied through research collaboration. But it does not make sense for research management practitioners to make researchers feel lonelier in order to promote more collaboration.

In this regard, we advocate that SciRM emphasizes both “why” and “how to”, which is akin to Bennis’ (1966) advocacy of theory of change and theory of changing in organizational change. Theory of change explains why organizational change takes place (i.e., mechanisms through which an organization changes, for example, why and how people adapt in the process of change). Theory of changing seeks to understand how to change an organization (how to design an intervention, for example organization re-structuring, to enact people’s adaptation so as to lead to desired organizational change). Building scientific knowledge on why things happen (akin to theory of change) and how to design an intervention to make things happen (akin to theory of changing)
is significant to the research-practice nexus (Tucker & Lowe, 2014) and should be maintained in research management.

Maintaining a strong research-practice nexus is best achieved from the onset of building SciRM, rather than after the building of SciRM. Tucker and Lowe (2014) caution about the gap between research and practice. While research work traditionally develops scientific knowledge first and then seeks to translate research findings into practice, this research-to-practice translation is, though useful (Woolf, 2008), often challenging and problematic (Glasgow & Emmons, 2007). In response, Baumbusch et al. (2008) suggest a collaborative model of knowledge translation between research and practice, rather than from research to practice. They argue that the action to mend the research-practice gap is for research to simultaneously achieve the academic aim of rigorous theory building while at the same time addressing the need in practice.

In summary, SciRM is distinctive knowledge in the research management literature. It seeks to establish explanatory power by understanding clearly specified causal mechanisms. It differs from everyday intuition because it is critically scrutinized with rigorous methodology. It also encompasses both the deep theoretical understanding of why (i.e., causal mechanisms) and the knowledge of how to (i.e., design of research management interventions to enact causal mechanisms) with a strong research-practice nexus.

Highlighting the significance of building SciRM in the research management literature by no means undermines the importance of other types of studies on research management. Carlile and Christensen (2004) posit that advancing a field of study starts from a descriptive stage which involves observing a phenomenon, classifying attributes, and defining relationships between attributes and outcomes. Eventually, the research field evolves into a normative stage which shifts from correlations to causality involved in a phenomenon. While developing practice-based knowledge, descriptive knowledge and evaluative knowledge remains important in the research management literature, we argue that building SciRM is a necessary complement as the field of study progresses.

What can research management learn from education research?

To build SciRM, we need to manage methodological challenges. The methodology to build SciRM needs to be capable of investigating causal mechanisms in research management, ensuring scientific warrant, and strengthening the research-practice nexus from the onset.

Since the research management literature is at an emerging stage, importing theories and methodologies from another discipline can be a promising way forward. For this purpose, we turn to education research, an applied discipline with which we have relative familiarity.

Traditional methodologies in education research have limitations in addressing the methodological challenges in building SciRM. For example, qualitative methodologies, such as grounded theory (Charmaz, 2000), and quantitative methodologies, such as experimental studies (Christensen, 2007), have methodological rigor and argumentative grammar. However, the theory-to-practice nexus is not sufficiently dealt with from the onset of the research process. Often, the practice
impact has to be addressed through separate processes, like research translation and dissemination. Burkhardt and Schoenfeld (2003) find that such processes are often not effective in impacting practice. Their review of six effective models in education recognizes that Design-Based Research “represents a much-needed melding of research and practice” (p. 4).

Design-Based Research

Design-Based Research, in short DBR, seeks to build learning theories and, at the same time, improve the practice of teaching and learning (TDBR Collective, 2003). It focuses on designing a learning environment (e.g., learning tasks, resources, collaboration structure, etc.) that better enables learning. The design is informed by existing cognitive-psychological, socio-cognitive and socio-cultural theories of human learning. The research findings contribute to the advancement of these theories and the design frameworks that enact these theories.

Ann Brown (1992) introduced design science in the educational research community. She discusses analytic science such as anthropology, which seeks to understand how a phenomenon can be explained, and design science, which aims to determine how designed artefacts, such as designed learning environments, affect teaching and learning. The distinction between analytic and design science recognizes that theories of learning (e.g., learning mechanisms) are often quite different from design frameworks for learning (e.g., how to design learning activities that enact the learning mechanisms). Both are critically needed in research and practice.

In DBR, an education researcher is engaged in an iterative process of design, implementation and evaluation of learning activities in real classroom contexts (Sandoval & Bell, 2004). As the design of the learning environment is critical in DBR, researchers often work in collaboration with practitioners, such as teachers, in order to bring the practice expertise and knowledge into producing and analyzing the design. The initial design of learning activities is informed by existing learning theories from the literature. Through the iterative and collaborative process, researchers and practitioners develop new learning and design conjectures which may be tested in future iterations. Hence, DBR contributes to the advancement of learning theories (i.e., the science of learning) and, at the same time, to the improvement of teaching and learning practices (Plomp, 2007). The advancement of learning theories is used to inform the next iterative design of learning activities, which lead to further advancement of learning theories and improvement of practice.

There are two key critiques to DBR as a research methodology. Firstly, Kelly (2004) critiques that design research lacks an argumentative grammar. He asserts that DBR is committed to the joint pursuit of practical improvement and theoretical refinement, but does not contain logic that supports reasoning about its data, for example, the link of designed learning activity, the process of learning and the observed learning outcomes. Secondly, Phillips and Dolle (2006) critique that design research cannot meet one of its basic commitments: the simultaneous evaluation of designs and testing of theory. The joint design and theoretical ideas embodied in the same intervention makes it difficult to test them simultaneously.

As a response to the critiques to DBR, Sandoval (2014) proposes the conjecture mapping approach which emphasizes investigating and uncovering causal effects in each design iteration. In the following, we discuss conjecture mapping as an important and necessary complement to
DBR as a methodology.

Conjecture mapping

According to Sandoval (2014), researchers conducting DBR need to specify two sets of conjectures; design conjecture and theoretical conjecture.

Design conjecture refers to how a designed learning activity (such as the learning material, the sequence of lessons and how students work together) enacts desired learning processes. Theoretical conjecture refers to how the occurrence of the learning processes leads to desired learning outcomes. For example, when students are given a problem to solve before they are taught the knowledge that is needed to solve the problem, they will struggle on the problem-solving task. This creates a condition for them to activate their prior knowledge (Loibl, Roll, & Rummel, 2016). The activation of prior knowledge leads to their differentiation of prior knowledge and noticing of their knowledge gaps. When students notice their knowledge gap, they will better attend to subsequent instruction, better encode the target knowledge and, hence, experience better learning outcomes (Loibl et al., 2016). In this example, the design is ‘problem solving first and instruction later’. The first design conjecture is that the ‘problem solving first’ design leads to students’ prior knowledge activation in the problem-solving phase. The cognitive process is that prior knowledge activation leads to knowledge differentiation and noticing knowledge gaps (i.e., the first theoretical conjecture). This leads to the second design conjecture: when the instruction is provided later, students who notice their knowledge gaps will better attend to their knowledge gap in the instruction. This leads to the second theoretical conjecture; students attending to their knowledge gaps in the instruction will encode the target knowledge well.

The two sets of design and theoretical conjectures make distinctions between how a design functions and how those functions lead to learning outcomes. Together, they capture the hypothesized learning trajectory afforded by the designed activities. They help researchers focus on design elements that are theoretically salient and contribute to theoretical advancement. When the two sets of conjectures are clearly specified and rigorously examined, the development of theoretical conjecture leads to the advancement of learning theories, and the development of design conjecture contributes to practice impact.

Sandoval (2014) argues that making distinctions between design and theoretical conjectures and clearly specifying them for investigation provide argumentative grammar that articulates the causal attributes of the data (e.g., design, learning process and outcome). The research question is not about whether a design works, but how and why it works. Linking the data of design enactment and learning processes allows design evaluation (e.g., how the design enacted hypothesized learning processes). Linking the data of learning processes and outcomes allows theory evaluation (e.g., how the enacted learning processes lead to learning outcomes). This allows the conjecture mapping approach to address the critique of being able to simultaneously evaluate design and develop theory.

In summary, DBR with conjecture mapping, hereafter simply referred to as DBR, is a rigorous methodology to investigate causal mechanisms in education research and is capable of strengthening the research-practice nexus. It embodies the following characteristics. Firstly, it
involves iterative design and implementation of interventions that seek to address complex real-world problems. Secondly, it works in the authentic real-world context and in partnership with practitioners. Thirdly, the design of intervention is theory-driven: the initial design is informed by the existing theories and, through iterative design, it seeks to advance both the theory (by developing and testing theoretical conjectures) and design framework that enacts the theories (by developing design conjectures).

** Appropriating DBR for building the SciRM**

There is a good match between what DBR can offer and what is needed in building SciRM. DBR has potential to be appropriated to address the methodological challenges faced by the research management field. It also has potential to both understand the social mechanisms involved in research management, and the design framework to enact these mechanisms, strengthening the research-practice nexus.

Appropriating DBR allows importing social and psychological theories to bootstrap the building of SciRM. The journey of DBR starts with the design of the first iteration which is informed by the existing literature. To investigate the social mechanisms involved in research management, the journey does not have to start from scratch. The research management field is connected to established disciplines, such innovation management, management, psychology and sociology. The rich and deep understanding of causal mechanisms in these related disciplines can be borrowed to inform the design of the first iteration. For example, research is an innovation endeavour and managing research is analogous to managing innovations. Findings on innovation management, such as the mechanisms of managing radical innovations (McDermott & O’Connor, 2002) may bootstrap the building of SciRM.

Appropriating DBR to build SciRM requires close collaboration between research management scholars and practitioners. The scholarly and professional communities of research management possess at least two key strengths to appropriate DBR.

First, the research management profession has existing scholarly capacity to pursue SciRM. For example, the Journal of Research Administration (JRA) is a premier peer-reviewed academic journal in the field of research administration and management. A review of the manuscripts published by JRA in the past ten years shows that about 36% of the 149 manuscripts were authored or co-authored by research management practitioners. Some of the most recent issues (i.e., Vol. 46.2, Vol. 45.2 and Vol. 45.1) have 50%, 83% and 50% respectively of the manuscripts authored by practitioners. Anecdotal evidence on the membership of the research management societies also suggests that more and more research management practitioners are now holding PhD degrees. These practitioners understand research management practice, have solid understanding of research methodologies, and have completed rigorous research training. They are capable of building and advancing SciRM.

Second, the research management profession is further benefiting from its closeness to research enterprise. Research management practitioners support research enterprise and they work closely with researchers in various disciplines. This makes it possible and convenient for research management practitioners to gain access to knowledge and skills that researchers possess.
Benefiting from this closeness, Pongpirul and Srisasalux (2007) note that research management practitioners develop academic capacities, such as knowledge of research methodology, ability to review and map existing knowledge, research program evaluation skills, etc. Research management practitioners could leverage their close relationship with the research enterprise and intentionally develop further capacities for building SciRM.

In addition to capacities, there is also a need to understand how to appropriate DBR and import theories from other disciplines to build SciRM. In the following, we present a concrete example of how an education study imports social theories to building social relationships among teachers. Although in the education research context, the example is analogous to the research endeavor we advocate for research management.

**An education research example that imports social theories**

This example arises from one of our research projects on teacher learning. More specifically, we present an example focusing on how DBR is adopted to borrow social theories and design activities of a Networked Learning Community (NLC) (Jackson & Temperley, 2007) to build social relationships among teachers from different schools. It simultaneously advances theoretical understanding on the social mechanisms related to relationship building and designs frameworks that enact such mechanisms.

**Contextual background**

The example arises from our study on NLC in Singapore. A NLC involves a network of schools working together in intentional ways to enhance teacher professional learning (Jackson & Temperley, 2007). It connects the within-school professional learning communities and eventually leads to within-school and between-school learning communities that are networked. Hence, building laterality (i.e., peer-level social relations) among teachers from different schools is critical to the success of NLCs.

The NLC presented in this paper is championed by Master Teachers from the Academy of Singapore Teachers of Singapore’s Ministry of Education. The Master Teachers are experienced expert teachers who are the leading teaching practitioners in Singapore. They operate across schools to help develop the teaching workforce through mentoring and demonstrating good teaching practices. To fulfil this role, Master Teachers develop NLCs as a professional development platform for teachers from different schools to come together to deepen the knowledge base of the profession (Academy of Singapore Teachers, 2012).

In this example, we present a NLC event which took place in June 2016 for science teachers. More specifically, we focus on one session of an outdoor learning trail of this NLC event. In this one-and-a-half-hour activity which took place in a national park, teachers from different schools were to gain first-hand experience of an outdoor learning inquiry designed by the Master Teachers. The teachers were first assigned to respective tables for briefing in a seminar room. Subsequently, teachers from each table were led by a Master Teacher to experience the outdoor learning trail. Upon returning to the seminar room, teachers in each table worked together to reflect upon their
experience. This was followed by a consolidation given to all the participants. The intention of the NLC event was for the teachers to adopt the outdoor learning trail for student learning in their respective schools. While the main purpose of this NLC activity was for teacher learning, it provided a platform for teachers to build lateral relationships with their peers from other schools and thus, through them, to connect professional learning communities in the respective schools.

In this example, we illustrate how DBR, with its origination in research on learning, is appropriated for building laterality among teachers for networked learning. By importing theories from sociology to design for social interactions and to build laterality among teachers, it enables the advancement of social mechanisms of building social relationships.

The design: Group membership assignment

The participants of this NLC activity were mostly first time participants who did not have prior social relationships with each other. The design elements for relationship building included group membership assignment, lunch arrangement (i.e., no lunch was catered, hence, teachers needed to self-organize lunch partners for lunch at nearby coffee shops), “illegal” group adventure (i.e., the group excitedly ventured into a prohibited spot to take group photos and was stopped by the park guards for entering the area ‘illegally’), etc.

In the following, we focus on one particular design element, the assignment of group membership for each table. Before the start of the outdoor learning trail, the Master Teachers paired the participants in groups and each group was assigned to a table. Every group comprised 4-5 participating teachers led by a Master Teacher (or equivalent).

One group embodied a “2+1+1” group membership design: besides the Master Teacher, the group included two teachers from School A, one teacher from School B and one from School C. The two teachers from School A were colleagues and knew each other well. The teachers from School B and School C met each other for the first time at this NLC event. They did not know the two teachers from School A either.

Design conjecture and theoretical conjecture

We first specify the design conjecture related to the “2+1+1” membership design. The two teachers from School A had more shared identities (i.e., colleagues from the same school) and common knowledge and interests. The teachers from Schools B and C did not know each other, nor did they know the teachers from School A. They have fewer shared identities, or shared understanding of their common knowledge and interests. In the “2+1+1” membership design, every member needed to face a large percentage of strangers. For the teachers from School A, 50% of the group members (i.e., teachers from Schools B and C) were strangers. For the teacher from School B, 75% of the group members (i.e., the two teachers from School A and the teacher from School C) were strangers. The same was true for the teacher from School C. This design influences the two teachers from School A to feel similar to each other, and the teachers from Schools B and C to feel similar to each other.

The theoretical conjecture homophily (Kadushin, 2011), borrowed from sociology, suggests
that “birds of a feather flock together”. Individuals enjoy the comfort of interacting with others who are similar (e.g., shared identity). Communication is also more effective between people who are homophilous, for example, when they share common meanings, beliefs, and mutual understandings. Homophily produces homophilous group members over time as well. People in the same social group tend to become homophilous over time (Kadushin, 2011). This is often referred to as “similarity breeds connections” (McPherson, Smith-Lovin, & Cook, 2001). Hence, members of the same network create group tastes and preference, and inspire conformity in thought and action (Burt, 2003).

Putting the design and theoretical conjectures together in the “2+1+1” group membership design, the homophily between the two teachers from School A causes them to feel comfortable staying close to each other and naturally nudges them into a cluster. As interactions among teachers transpire during the outdoor learning trail, the homophily between the teachers from Schools B and C builds up, predominantly because they shared the same identity of ‘being left out’, and they eventually form another cluster. Because the two clusters (i.e, the two teachers from School A as one cluster and the teachers from Schools B and C as the other cluster) had equal size in membership, they progressively evolved into one homophilous group as a result of other design conjectures mentioned earlier, such as “illegal” group adventure, lunch arrangement, etc.

Process and outcome: Evidence of relationship building

The laterality among teachers in the group developed in a similar way as what the design and theoretical conjectures projected. During the outdoor learning trail, although the Master Teacher focused primarily on teacher learning, rather than the growth of laterality, the “2+1+1” membership design enabled the lateral relationships to emerge when the four teachers followed the Master Teacher to explore and experience the outdoor learning trail.

As per the conjecture, when the outdoor learning trail first started, the two teachers from School A clustered together. The two teachers from Schools B and C were as random in their interactions between each other as with the two teachers from School A. Figure 1 shows the initial dynamics in the group. The two teachers from School A walked together. The teacher from School B walked behind, and the teacher from School C walked in the front, closely following the Master Teacher.
As the outdoor learning trail unfolded, interactions between the two teachers from Schools B and C increased. Toward the latter part of the outdoor learning trail, the two teachers from School A walked in the front, the teacher from School B walked behind them and the teacher from School C was left far behind as she stopped to tie her shoelace. As she was catching up, the teacher from School B stopped, turned back and said to the teacher from School C: “I missed my partner”. Figure 2 below captured the moment of interaction. The behaviour and the utterance by the teacher from School B indicates a growth of a social closeness between her and the teacher from School C.
The example illustrates the first iteration of DBR in which the social design (i.e., the design of environment for social interactions) enacted social theories, such as homophily for teachers to build lateral relationships in a NLC event. The group dynamics observed in the outdoor learning trail, in particular the growth of laterality between the teachers from Schools B and C, is generally consistent with the design and theoretical conjectures.

**Possible conjectures for the next DBR iteration**

While the “2+1+1” design works in this example, there are competing conjectures that can be investigated in future iterations. For example, what about teachers with different personalities, what about alternative designs, such as a “1+1+1” design, etc.

Take the alternative “1+1+1” design for example, we hypothesize that this design would not be as effective as the “2+1+1” design. This is because in the “1+1+1” design, everyone feels equally ‘left out’. There is no initial presence of a strong cluster, for example, the cluster formed by the two teachers from School A in the “2+1+1” design. Without the presence of a strong cluster at the beginning of the activity, the members of the “1+1+1” design would not produce a strong feeling of ‘being left out’. This would not effectively enact homophily to foster their interactions for developing laterality.

The hypothesis of the “1+1+1” design may lead to a new conjecture which can be a direction to further investigate the theory of homophily, for example the condition in which homophily takes place, and why and in what condition homophily outweighs other social theories. Investigating alternative design conjectures in the second DBR iteration allows deeper and broader investigation of theoretical and design conjectures in building laterality.

In summary, the example reveals a possibility to adopt DBR and to borrow social theories for building laterality among teachers in NLC. It allows simultaneously building and improving social theories while enhancing the NLC practice. Although the example is in the context of teacher learning, it informs how a similar approach may be adopted to enhance the theory and practice of research collaborations and contributes to the building of SciRM.

**Discussion and conclusion**

Research management is an emerging field of study. To develop this emerging field, this paper proposes to build the science of research management (SciRM) with two advocates. Firstly, it argues for a need to build SciRM and highlights three key criteria that differentiate SciRM from other types of knowledge: investigating on clearly specified causal mechanisms, assured by rigorous scientific warrant, and contributing to a strong research-practice nexus. Secondly, the paper proposes a way forward to build SciRM. It examines the Design-Based Research (DBR) methodology in education research and suggests adopting DBR to import theories from other disciplines to bootstrap the building of SciRM. An example on networked learning in education research is then presented to illustrate how the design of a social context enacted the homophily theory (imported from sociology) and fostered social interactions among teachers for building lateral relationships. The example, serving as an analogue to what we advocate in the research
management field, reveals a possibility in which DBR can be appropriated to import theories from disciplines, such as psychology and sociology, to bootstrap the building of SciRM.

The paper makes three main contributions to research management. Firstly, it is significant to the advancement of research management as a field of study. Building SciRM is a response to Cooke and Hilton’s (2015) consensus study which highlights a lack of theories on research collaborations. It also corresponds to Tight’s (2014) observation of importing theories from another discipline when the ‘home-grown’ theory is lacking in higher education research. Building SciRM should not be regarded as the only research direction or the only productive research direction. Nor should DBR be regarded as the only appropriate methodology to be adopted to build SciRM. What we highlight in this paper is the deficiency in understanding social mechanisms involved in research management. Addressing this deficiency is important and necessary to complement the existing research management literature. Using DBR to import theories from other disciplines to bootstrap the building of ‘home-grown’ theories in research management is only one useful and promising approach.

Secondly, importing theories from disciplines such as psychology and sociology not only helps to bootstrap the building of SciRM, but also connects studies on research management with social science research at large. This is significant to emerging fields of study such as research management, because it reduces “wheel reinvention and replication” (Tight, 2014, p. 94). For example, in social sciences research, there is a long tradition of research on groups and teams, including studies on group membership (Hogg & Williams, 2000), team communication (Frey, Gouran, & Poole, 1999), team assembly (Guimera, Uzzi, Spiro, & Amaral, 2005) and more. Importing these theories for building SciRM contributes to the further development of these theories as well. This is because when adopting DBR and importing theories to build SciRM, research management becomes a field in which research such as psychological and sociological studies are situated. Such studies not only bootstrap the growth of the research management field in specific, but also reciprocally complement social science research and basic research on psychology and sociology at large.

Thirdly, building SciRM is significant to the research management practice by opening up new possibilities of thinking and doing research management. Research management is an applied field of study with a strong root in practice. The methodology we propose, DBR, contributes to both the theoretical advancement, such as why, how and in what causal processes things happen, and the advancement of design frameworks which answers in what conditions causal processes take place. In this sense, SciRM is useful to practice because it informs practitioners how to enact SciRM for their research management needs, such as building research collaborations.

Building SciRM also pushes new structures and capacities in managing research. For practitioners to make use of design frameworks to achieve desired outcomes in research management, they need to have sufficient information for decision-making. For example, analyzing social networks among researchers, such as their grant collaboration and co-authorship, may inform how management enacts the homophily theory among a groups of researchers to foster their collaboration. Such decision-making is only possible if institutions build up their data management structure and analytical capacity (Terenzini, 2013).
To build and appreciate SciRM, the research management community needs to embrace research culture. Traditionally, the professional community focuses on sharing practical knowledge with an aim to apply what is learned to practice. The scientific community, although it also shares knowledge, holds an important role in gatekeeping what is warranted as scientific knowledge. In order to scrutinize the scientific warrant of a piece of knowledge, the scientific community, in comparison to the professional community, tends to be more critical, argumentative and skeptical before accepting the knowledge for sharing. Given the cultural difference between the two communities, building SciRM requires a progressive embracement of criticality as a useful and necessary complement to the existing culture of the research management community.

In conclusion, this paper advocates for building SciRM and suggests adopting DBR as a research methodology to import theories from the broad social science domain to bootstrap the building of SciRM. Such a research direction also reciprocally complements social science research at large. It opens up possibilities of new practices in research management. It is envisaged that, as the research management community pursues this much-needed research direction, and as the reciprocity between research management and social science research progressively enlarges, the research management practice will be more effective in supporting research enterprise. It will also turn research management into a fertile field of study, leading to 'home-grown' theories in research management and contributing to social science research at large.

Authors’ Note

We thank Emeritus Professor John Furlong of the University of Oxford for encouraging us to explore the idea of research management learning from education research. We are also grateful to the project team members and participants of our project AFR 1/15 HJS (NTU IRB Ethics Approval No. IRB-2015-12-014). The project was funded by the Ministry of Education, Singapore. Part of the project data was used to illustrate the example in this paper.

The preparation of this manuscript was partially supported by the Endeavour Executive Fellowship awarded to the first author by the Australian Government in 2017 and the JIAS Writing Fellowship awarded to the first author by the Johannesburg Institute for Advanced Study (JIAS) in 2018. We also thank Ms Sasha Raj Lawrence for her support in manuscript preparation.

Correspondence concerning this article should be addressed to:
Jun Song HUANG (David), Ph.D.
Assistant Dean, Research Strategy
National Institute of Education
Nanyang Technological University
1 Nanyang Walk
Singapore, 637616
Email: junsong.huang@nie.edu.sg
References


American Institutional Review Boards: Safeguards or Censorship?

Kristi N. Hottenstein, Ph.D.
University of Michigan-Flint

**Abstract:** The United States is a world leader in biomedical clinical research. America's existing human subject research regulations structure affords sizable protections for the ethical treatment of research volunteers. Early initiatives such as the Belmont Report were specific to federally funded research. Over the past several decades guidelines such as the Belmont Report, along with more stringent policies, have been applied to non-federally funded research and research in the social sciences, and have branched out over areas, which many argue, they were not initially intended. Institutional review boards were codified to protect human subjects, an ethical and noble concern, but arguably these regulations were hastened both in response to a highly publicized research experiment and political considerations. This article explores the creation of the American IRB system through the lens of John Kingdon’s Multiple Streams Theory and examines critical viewpoints surrounding a longstanding inquisition over whether human subject research regulations are safeguards or censorship.

**Keywords:** Institutional review board, federal regulations, public policy, human subject research, academic freedom

**Introduction**

In 2010 the United States government spent over $16.5 billion dollars on human subject research conducted at institutions of higher education and other non-governmental institutions (AAUP, 2013). Over 55,000 human subject research projects were conducted by the 18 U.S. federal agencies that same year. By 2015, 98,352 clinical trials were being conducted in the United States, putting the U.S. at the forefront of biomedical research (U.S. National Institutes of Health, 2016). Human subject research in the United States is regulated through the Common Rule within the Code of Federal Regulations, a uniform set of rules for the protection of human subjects. The need to protect human subjects is crucial but some argue current government regulations are too strenuous and impede legitimate research. There are mixed reviews among administrators and academicians possibly arising as a result of a shift from individual to collective responsibility in the protection of human subjects and it has left many within the research community feeling uneasy about IRBs.

The ethical treatment of human subjects dates as far back as 1760 B.C.E. where government penalties for medical error were acknowledged in Hammurabi’s Code (Sanders & Ballengee-Morris, 2008). The Hippocratic oath, required of physicians as early as the late 4th century B.C.E., states “to abstain from all intentional wrong-doing and harm, especially from abusing the bodies of man or woman, found or free” (Sanders & Ballengee-Morris, 2008, p. 313). The
Nuremberg Code, established in 1947, was a result of unethical medical experiments conducted on concentration camp prisoners in Germany and in German-occupied countries. The Nuremberg Code helped place human subject research on the U.S. governmental agenda (U.S. Department of Health and Human Services, 2016a). Although the code never became law in neither Germany nor the United States, it was the basis for the Code of Federal Regulations, Title 45, part 46, which was adopted in 1991, over 40 years later (White, 2007). In 1953, the National Institutes for Health (NIH) opened their Clinical Center in response to the growth in clinical research following World War II (Bankert & Amdur, 2006). It was also during this time social scientists experienced a funding boom in the United States increasing the volume of social and behavioral research being conducted (Stark, 2007). Social and behavioral research’s utilization of human subjects gained attention in 1961 with Stanley Milgram’s study on obedience to authority (Stark, 2007). This well-known and highly debated experiment was the first outside the biomedical venue to receive such publicity. In 1966 the U.S. Surgeon General became involved in the regulating of human subjects by requiring reviews of studies receiving funding from the U.S. Public Health Service.

On July 26, 1972, the *New York Times* broke a story on one of the most highly publicized studies in history, the Tuskegee Syphilis experiment. This federally funded study, which ran for nearly 50 years before the U.S. Department of Health, Education and Welfare put an end to it, knowingly withheld information and treatment from syphilis patients. The story was high profile, incredibly political, and quickly spread throughout the country. As a result, federal regulations on human subject research moved from governmental agenda to decision agenda. It took only two years for the National Research Act to be passed in 1974. The act required institutions to have diverse boards of at least five members to review federally funded research on human subjects, thus beginning the history of institutional review boards (IRBs) in the United States. Figure 1 represents an evolutionary timeline of human subject research regulations in the United States and the following section examines the timeline through the lens of John Kingdon’s Multiple Streams Theory for policy creation.

![Figure 1](https://example.com/figure1.png)

*Figure 1. An evolutionary timeline of human subject research regulations in the United States.*
Kingdon’s Multiple Streams Theory

John Kingdon (2010), a scholar in American politics, notes the political structure in the United States as fractured more than anywhere else in the world. Policy proposals are developed according to their own incentives and selection criteria, whether or not they are solutions to problems or responsive to political considerations. Kingdon’s Multiple Streams Theory is based on the premise that three, independently flowing streams of problems, actors, and processes, may converge at any point to create a policy. Figure 2 below illustrates Kingdon’s (2010) Multiple Streams Theory.

In what Kingdon (2010) calls “policy primeval soup,” (p. 35) ideas float around, bumping into one another, encountering new ideas, and forming combinations and re-combinations. If the right combination of problems, policies, and politics come together, government takes action and regulations or laws are formed (Kingdon, 2010). In the consequent sub-sections below, Kindgon’s streams are further defined and then used to analyze the creation of a policy window for human subject research regulations.

**The three streams**

Problem recognition occurs in the problem stream and is critical to agenda setting. Large magnitude events or changes such as disasters or crises catch officials’ attention and can draw their attention to some items more than others. Kindgon does an excellent job of illustrating the difference between conditions and problems noting how conditions can become problems when they violate important values. He uses the following example. A lack of public transportation can be viewed as a transportation problem or a civil rights problem, and he notes that the treatment of the subject varies greatly based on how the problem is classified.

Different policy versions develop within the policy stream. It is in this stream that ideas float around, change, reform, combine, and await implementation.

The political stream refers to the willingness and ability of the politicians or actors to implement a policy change. Kingdon (2010) discusses how powerful changes in administration or shifts in national mood are to agenda and policy setting.
The policy window

The policy window refers to the convergence of the aforementioned streams. Applying Kingdon’s model to human subject research regulations, one could assert the Tuskegee Syphilis experiment provided just that window for federal regulations on human subject research. A condition (a lack of human subject research regulations) became a problem when it violated the rights of human subjects. Additionally, the magnitude of the media coverage and negative publicity forced politicians to focus their attention on human subject research regulations. At the time the Tuskegee experiment became public, some human subject research regulations had been implemented while others remained floating in the policy soup. The below chart is a modified version of Kingdon’s (2010) Multiple Streams Theory illustrating how his theory can be used to inform the creation of human subject research policy following the Tuskegee Syphilis Experiment.

![Diagram of Kingdon's Multiple Streams Theory](image)

Figure 3. A modified version of Kingdon’s (2010) Multiple Streams Theory illustrating how his theory can be used to inform the creation of human subject research public policy.

The National Research Act [1974] was actually codified five years before the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, a federal advisory committee on the topic, issued the Belmont Report, the first handbook for IRBs. The notion that the Act was passed and implemented prior to (or not in conjunction with) the release of a supporting handbook for researchers and institutions lends support to the argument that IRBs were created in reaction to the policy window being opened at the convergence of the three streams instead of being implemented in a proactive fashion. By 1986 the Applied Research Ethics National Association, a professional association for those working with IRBs, was formed to provide leadership and guidance to the IRB community, but by this time, the umbrella of
IRBs had already ballooned (Bankert & Amdur, 2006). IRBs were responsible for oversight of any research involving human subjects deemed to have generalizable knowledge. In 1991, 14 other federal departments and agencies joined the Department of Health and Human Services and adopted the Common Rule from the Code of Federal Regulations. The Common Rule is identical to subpart A of 45 CFR part 46 of the Health and Human Services regulations (U.S. Department of Health and Human Services, 2016a, para 3). Throughout the following decade, many institutions of higher education adopted the Common Rule, not only for federally funded research, but for all research involving human subjects (White, 2007). By the turn of the 21st century, the National Bioethics Advisory Commission, established by executive order in 1995 to advise government entities on bioethical issues, proposed even more guidelines including the certification of IRB members. These regulations were not decided on, but rather returned to the policy stream, a place White (2007) refers to as bureaucratic limbo, until another policy window is opened.

The Common Rule has generally remained unchanged since 1991. This is surprising in some respects given increased legal pressure on IRBs. In the early 2000's, individual IRB members were named as defendants in the Robertson v. McGee lawsuit [2002] involving cancer research. Suit was also filed against individual IRB members over a lack of informed consent in Townsend v. University Hospital [2002] and the Kennedy Krieger Institute was named as a defendant in 2001 in Grimes v. Kennedy Krieger Institute, again, over informed consent (Beasley, 2009). Arguably, advances in science and research, inquiry, and methodology warrant updates to the human subject research regulations governing them. While the Office of Human Research Protections has issued Advanced Notices of Proposed Rule Making (ANPRM), Draft Guidance for Institutional Review Boards, as well as other recommendations, changes have not been implemented. Amending these regulations appears to have been a series of fits and starts over the last decade, but upon closer review, what appears to be a spasmodic pattern of revision attempts, may actually be an emerging pattern of discovery, policy review, and, finally, resistance. When the Department of Health and Human Services published an ANPRM in 2011 and solicited feedback, it received over 1,100 responses (AAUP, 2013). This is a clear indicator of the importance of IRB policy within the research community. Few will argue against the need for the protection of human subjects, but many believe a handful of isolated unethical practices have created a spiral of knee-jerk reactions resulting in a loss of academic freedom and a laundry list of other problems for researchers alike. Chadwick and Dunn (2000) sum up the last 50 years of IRB evolution by saying “Like many highway projects, the IRB system was sound when it was designed, but became out-of-date and overloaded almost from the start” (p. 21).

The Office of Human Research Protection database now contains over 10,500 records of registered IRBs (U.S. Department of Health and Human Services, 2016b). Additional data from the Office of Human Research Protections indicates the United States is leading the world in number of clinical trials. The Commission Report, Moral Science: Protecting Participants in Human Subjects Research (2011) completed by the Presidential Commission for the Study of Bioethical Issues, further illuminates the national stage human subject research has been placed on. While America appears to be at the forefront of assuring policy is in place for the ethical treatment of human subjects, there still maintains a level of dissonance between the federal
government creating and handing down the regulations and the researchers who must abide by their parameters. The following sections highlight a number of critical issues surrounding the IRB debate in the United States.

**Critical viewpoints**

Research suggests a number of concerns regarding IRBs (AAUP, 2006; Bosk & De Vries, 2004; Feeley, 2007; Grady, 2010; Howard, 2006; Stark, 2007; White, 2007). Academic freedom, power, appeal process, and terminology were specifically listed as concerns by the AAUP (American Association of University Professors, 2006). Social and behavioral sciences professors have noted concerns specific to their professional areas including cookie cutter bio-medical and clinical best practices being implemented for social science research. American ethnographers have taken issue with the impact IRBs have had on their research noting that IRB processes slow their research and impede interviews (Jaschik, 2008). Over 300 publications and presentations have come into existence in the last 20 years highlighting concerns with IRBs (van den Hoonaard & Hamilton, 2016).

**Academic freedom infringement**

Literature suggests IRBs can infringe on academic freedom (American Association of University Professors, 2006; Feeley, 2007; Howard, 2006; & Stark, 2007). Academic researchers postulate IRBs not only infringe on academic freedom, but on the very principle of freedom for which America was founded (Feeley, 2007; Stark, 2007). Safeguards for academic freedom evolved during the 1930’s and were codified in the American Association of University Professors’ 1940 Statement of Principles on Academic Freedom and Tenure. The 1960s and 1970s afforded federal regulations that protected the rights of human subjects. Ironically there is contention over which of these two liberties should supersede.

The literature indicates problems with IRBs have only been widely discussed in the last few decades. Malcolm Freeley, former President of the American Association of University Professors, in his 2006 AAUP presidential address, sparked great debate over the topic stating that IRBs “represent a failure of law” (p. 2). This address created momentum, especially in the humanities, among those opposed to IRB regulations. The Oral History Association, the primary membership organization for oral historians, voted this same year (2006) to endorse the AAUP’s report on academic freedom, specifically asking institutions to outright exempt IRB applications “whose methodology consists entirely of collecting data by survey, conducting interviews, or observing behavior in public areas” (Howard, 2006, p. 1).

To some, IRBs are viewed as governmental sanctioning of research which violates freedom of expression and thus the American Constitution (Feeley, 2007). Stark (2007) argued that the regulations aimed to protect the rights of human subjects actually violate the rights of researchers. While the federal government issues no official license for IRBs, it does (via its agencies) create and hand down the regulations. The notion that researchers with IRB approval are “licensed” to do research, and those without approval are not, certainly makes for a plausible argument that IRBs are equal to a governmental licensing agent.
Terminology

Subjectivity of regulatory terms used to define the scope of practice for institutional review boards has been scrutinized in the literature. One example of this is the term risk. Risk is a concept built on harm, yet another very subjective term. According to federal regulations, risk should be assessed based on whether the potential harm to participants is reasonable in relation to the benefits of the research (Hemmings, 2006). This subjectivity requires the IRB members to form their own assessment of risk and then either approve or deny based on their opinions. In a published report on Research on Human Subjects, the AAUP (2006) speaks out strongly against this stating, “there could hardly be a more obvious potential threat to academic freedom” (p. 1). Even in the most well thought out equations of cost-benefit ratios there is room for subjectivity. Many IRB members are not qualified to assess risk and often rely on a “no risk” line in the sand (White, 2007). Dingwall (2016) argues, “the risk to human subjects must be balanced against the wider societal benefits to sick people in the future” (p. 31), but the literature suggests that IRBs often struggle to find this balance erring too heavily on the side of caution because of vaguely defined regulatory terms.

Inconsistency

With over 10,000 IRBs nationwide and a vague set of federal regulations, interpretation of the regulations is not consistent. In addition to the sheer number of IRBs, consistency problems are compounded by the rotation and appointment of IRB members. Feeley (2007) states ongoing turnover leads to a lack of institutional memory and consistency. Yanow and Schwartz-She 2008) shed light on the inconsistencies of IRBs revealing it is not uncommon to have discrepancies in approvals for identical research seeking approval at multiple site locations. O’Neill (2016) notes inconsistencies in IRB decisions as a result of differing assessments of risk. Again, this differing assessment of risk is likely a product of the subjectivity of the term itself. He also purports that inconsistencies exist in who the board is protecting from risk. Some boards view risk only through the lens of risk to the participant, while other boards consider risk to others involved in the study including observers, researchers, and even institutions.

Mission creep and self-sustainment

Early initiatives such as the Belmont Report were specific to federally funded research. Over the past several decades regulations have been applied to non-federally funded research and have branched out over areas, which some argue, they were not initially intended. This phenomenon has been referred to throughout the literature as mission creep or mission drift (Sullivan, 2011; Trimmer, 2016; van den Hoon aard & Hamilton, 2016; White, 2007). White (2007) defined mission drift as “the process of co-opting a successful and well-conceived process, then gradually and mindlessly expanding it until it is no longer capable of performing its original function” (p. 548). In their recent book, The ethics rupture: Exploring alternatives to formal research-ethics review, van den Hoo naard and Hamilton (2016) state, “perhaps the most problematic and pervasively noted complaint about IRBs is their expansion of their scope” (p. 77). Grady (2010) claims over time, IRBs have shifted to protect institutions as much as individual subjects. The mission of IRBs is to protect human subjects. The Federal Code of Regulations lists “protecting the rights and
welfare of human subjects of research” as a fundamental aspect to assuring regulation compliance (U.S. Department of Health and Human Services, 1999, p. 5). It may be possible over time the mission of IRBs has drifted to protect institutions as much as human subjects. From a societal context this aligns with the cultural shift from individual to collective responsibility over the past several decades, and it is certainly plausible that IRB mission drift is an effect of institutions, IRBs, and individual IRB members being named in lawsuits.

Feeley (2007) asserts that self-appointed protectors of ethics will gravitate toward these self-appointed positions. He concludes by stating IRBs confirm role theory in that when a censor role is created and someone is appointed to it, they will most likely fulfill that role. Role theory is based on the premise that an individual acts within the socially defined category (or role) they are fulfilling. Furthermore, colleges and universities have created positions, departments, and entire divisions dedicated to IRBs and human subject research. One explanation may be that mission creep is a product of IRB self-sustainment. It is also plausible that subjectivity of regulatory terms and scope of IRB practice may also contribute to IRB mission creep.

**Power**

Institutional review boards are not advisory boards. They are often viewed as authoritarian in nature and working against, instead of in collaboration with, the researcher. The IRB dictates to the researcher what he or she can and cannot do and there is often no appeal process, or, if a process exists, it affords the IRB ultimate decision authority. This puts all the power in the hands of the board. This process is contrary to most shared governance or faculty governance structures with which academicians may be accustomed, thus contributing to the dissonance between researchers and IRBs. Howard (2006) notes in practice IRBs may expand their scope past federal regulations, setting mandates at their discretion. There is no outside monitoring or assessment to evaluate the board's performance. This seems ironic as a key function of the board is to monitor processes, yet no consistent set of checks and balances exist for the IRB itself. Brainard (2006) noted this problem as it relates to IRB members having conflicts of interest with the research being proposed to them. Specifically, IRB members did not disclose when they had financial conflicts with proposed research and some did not fully understand the meaning of this conflict. Other IRB members acknowledged voting on proposals where a conflict of interest existed, for example, having relationships with companies sponsoring the research, or relationships with competing companies (Brainard, 2006).

**Regulating outside the purview of biomedical models**

IRBs face a number of criticisms, including being largely based on quantitative biomedical models. Some of the largest critics of IRBs stem from the social sciences and humanities, because they view their research, which is predominately qualitative, as misunderstood by IRB members (Howard, 2006). Social scientists have reported instances where IRBs expect all research questions, questionnaires, and the like be presented to the IRB up front. This is not always conducive to qualitative inquiry. Oral historians, for example, conduct interviews and much of what is asked of the subjects is based on their answers to previous questions. The nature of oral historian research is very interactive and open-ended. Because biomedical models prefer to see
complete protocols up front, including set questionnaires during the review process, often times research of this nature is frowned upon or delayed (Jaschik, 2008). Qualitative researchers argue, in many cases, their methodologies are outside the IRB’s scope of knowledge, yet still within their scope of practice. Furthermore, Dingwall (2016) argues there is “no historical evidence of the abuse of human subjects [in the social sciences] that is in any way comparable to that perpetuated by biomedical researchers in the last 150 years” (p. 27), yet social science research is still largely bound by the same regulations. This was a hot topic among oral historians specifically as it relates to privacy issues and informed consent. Historians report being asked to delete tapes and shred transcripts instead of archiving them for future use. Oral historians fought diligently to make their concerns heard, and as a result the Office of Human Research and Protection (OHRP) granted them an exclusion status in 2003 for most oral history research (White, 2007).

This article explored the creation of the American IRB system through the lens of John Kingdon’s Multiple Streams Theory. We have examined the critical viewpoints surrounding the discord between researchers and IRBs. Literature suggests these viewpoints are often times problematically interwoven, creating a muddied implementation and practice of human subject research regulations for end users. The following section summarizes the article and makes recommendations for future research.

Conclusion

Institutional review boards were codified to protect human subjects, an ethical and noble concern, but arguably the regulations were hastened both in response to a highly publicized research experiment and political considerations. The Tuskegee Syphilis experiment opened the public policy window for human subject research regulations almost 50 years ago and researchers and law makers have been at odds ever since as to whether IRBs are safeguards or censorship. Advances in science and technology certainly warrant updates to existing regulations but there is clear apprehension from the academic community. This apprehension stems from how these new or revised regulations will impact their research practices. For many in the academic world of “publish or perish” time is of the essence and additional regulations have implications for their research timelines. Furthermore, the reactionary nature by which human subject research regulations were originally put into practice created a significant learning curve for implementation. This learning curve is a cause for concern among researchers. Whether these concerns raised by researchers elevate to a level of censorship is still widely debated.

The literature on institutional reviews boards leaves a number of unanswered questions. Are the issues surrounding IRBs a result of individual IRBs, the federal regulations, or a lack of clarity and scope with regards to implementation? Sizable research gaps exist within these areas. Future research on these topics may help to clarify for IRBs and researchers alike the scope of practice for IRBs going forward. A research gap also exists with regards to the training and accountability of IRBs. To this end, a more formalized and systematic IRB training for researchers and IRBs alike, is key to producing quality, ethical research. Appropriately aligned training by both parties is a proactive approach to ensuring a common understanding of human subject research regulations.
Literature on the effectiveness of IRBs leaves much to be desired. Despite a vast amount of research on, and opinions of, IRBs, little is actually known about their impact on the protection of human subjects. One suggestion would be to fill the research gap that exists as to the effectiveness of IRBs in preventing unethical treatment of human subject research participants. Such a study would not only inform IRBs and researchers, but policy makers as well.

Like it or not, it seems institutional review boards are a permanent part of higher education research. Positions, departments, and entire divisions governing human subject research now exist on college and university campuses. Moreover, if IRB mission creep continues, as it has since the creation of IRBs, more disciplines and departments will find their research subject to IRB approval. If human subject research and IRBs must come hand in hand, additional studies to fill existing research gaps is critical to ensuring amicable relationships between IRBs and researchers.

References


Dingwall, R. (2016). The social costs of ethics regulation research. In Will C. van den Hoon-aard and Ann Hamilton (Eds.) The ethics rupture: Exploring alternatives to formal research ethics review (pp. 25-42). Toronto: University of Toronto.


Research and Grant Management: The Role of the Project Management Office (PMO) in a European Research Consortium Context

Gerben Kristian Wedekind, MSc MA
Ernst & Young LLP

Simon Patrick Philbin, PhD MBA
Imperial College London

Abstract: This paper illustrates how a university-based project management office (PMO) can provide focused support across the entire grant project lifecycle within a European research context. In recent years, EU (European Union) research and innovation grant programs have increasingly shifted to support multidisciplinary consortia composed of industry, academia and end-users, which collaborate to achieve tangible and sustainable socio-economic impact. This scope change, from traditional academic research projects to research and innovation projects, has created the need for professional project management and has provided a fertile environment for PMOs to flourish. The paper includes discussion of an illustrative case study based on the EDEN2020 project - an ongoing, international, multidisciplinary consortium project in robotic neurosurgery that is coordinated by Imperial College London and supported by a grant from the EU’s Horizon 2020 research and innovation program. Imperial College’s PMO provides project management and dedicated support to the academic team to enable delivery of the overall consortium project. In so doing, the PMO involved in EDEN2020 clearly adheres to the PMO roles identified by the PMBOK® standard, i.e. supportive, controlling and directive, albeit at different levels depending on the grant lifecycle stage. In EDEN2020, the PMO was predominantly confined to a supportive (advisory) role in the project’s ideation and grant negotiation stages, a controlling (supporting delivery through standardization, templates) role in the proposal preparation stage, and a more directive (leading) role in project implementation. The paper concludes with a recommendation to increase the number of cases under investigation and expand the scope beyond Europe.

Keywords: Project Management Office (PMO); European Research Grant Management; Consortium Management; Horizon 2020; Collaborative Projects.

Introduction

In order to facilitate successful research outcomes, universities and public research institutions are increasingly focused on providing adequate capacity in research administration and management. (Nguyen and Meek, 2015). In this context, faculty members and their research teams work with support and administration colleagues to enable the delivery of research projects that may be supported by a range of different funding sources, such as governmental agencies, industrial
companies and charitable foundations. Indeed, the process of managing the research grant itself may involve a number of professional service teams and departments at a university or research organization, such as a central research office, sponsored programs office as well as administration teams that reside at the departmental or divisional level. Moreover, faculty members increasing face pressure to secure research funding and especially where tenure is being sought (Reiser et al., 2015). Therefore, faculty members are required to work alongside research administrators, maintaining communication channels and a two-way flow of information if they are to successfully navigate the world of research grant management. This is required from the initial ideation stage through to proposal development and possible award of the grant followed by the eventual delivery of the project.

This process can run smoothly due to the joint working adopted by research administrators and faculty members, and especially in the case of more straightforward research grants, e.g. a research project based on the work of a single graduate student (i.e. at PhD level) or post-doctoral researcher. However, in the case of more complex projects, such as those involving large scale consortia with several research partners, there may be a number of challenges encountered (see the work of Philbin and Mallo, 2016). Such challenges include a lack of planning of how to engage all the partners, the need for financial and commercial work to be undertaken rapidly and in parallel with the development of the technical (academic or scientific) case, as well as the difficulties in estimating the true costs for complex research projects.

In the case of large scale projects that include a funded work package for project management, when the project has been awarded the principal investigator may need to recruit a new project manager to the research group in order to manage the project. Such a project manager may or may not also be a researcher on the project. While this approach has some merit, there can also be a number of obstacles encountered. There is the need for the new project manager to rapidly move up the ‘learning curve’ in terms of knowledge of the project and the university infrastructure (including processes and systems), and establish working relations with all the partners. Indeed, there may even be a hiatus in project delivery at the beginning of the project, while the new project manager is recruited, which can sometimes take several months to conclude, potentially delaying the start of the project. A further challenge is that the project manager may well be working without the support or guidance of any peer project managers plus there may be a lack of standardized tools and templates available to support the project management process. Dedicated project management resource is also an essential part of managing large scale research consortium projects, such as those funded in Europe by the European Commission as part of the Horizon 2020 program. In other work, recent studies (Rolland, Lee, and Potter, 2017) have highlighted how coordinating centers can provide four types of facilitation work to enable consortium initiatives to be delivered and these are as follows: (a) structural work; (b) collaboration-development work; (c) operational work; and (d) data work.

The traditional approach of resourcing the project management function in the academic department presents a number of challenges as described above and these issues can in some cases impede the progress of the project and have a negative impact on the project’s performance. A potential organizational solution to address such challenges is to establish a so called project management office (PMO) in order to provide a dedicated resource as part of a focused strategy
to support the research administration and management of large scale research consortium projects. The PMO is an organizational structure that is established to nurture strong project performance through adopting supporting process models and a standardized approach to the delivery of projects (Dai and Wells, 2004). Moreover, the PMO approach can help ensure knowledge is shared across projects through the PMO essentially acting as a knowledge broker (Pemsel and Wiewiora, 2013) and is therefore ideally suited to the academic world and research projects where knowledge generation and dissemination is of paramount importance. In terms of the nature of a PMO, and although there can be a variance in the actual structure and resourcing adopted, it is likely to be based on a team of project managers that are supported by a back-office or administrative unit. The PMO adopts standardized processes and tools so that it can deliver a portfolio of projects across an organization or part of the organization, such as division or department.

Consequently, this paper will explore how a PMO can be configured and deployed at universities and public research institutions to support research grant management and this will be considered in the context of the European research funding landscape. An illustrative case study involving a European research consortium project will be described in order to identify the structure, processes and supporting strategies needed for a PMO to be successful, which will be helpful to practitioners and organizations looking to establish a new PMO.

Background on the Project Management Office (PMO)

The project management office (PMO) is an organizational unit that is established to improve the performance of projects through the provision of standards and methodologies, thereby leveraging knowledge on project management practices and also benefiting from lessons learnt through the delivery of multiple projects across the organization (Desouza and Evaristo, 2006). These benefits can also be viewed in terms of ‘economies of repetition’ through adopting best practice for routines and learning processes so that a growing portfolio of projects (and bids) can be delivered more efficiently and effectively (Davies and Brady, 2000). With foundations in the information technology (IT) and engineering sectors (Martin et al., 2007), PMOs are now becoming more popular in other sectors and in governmental organizations. The PMO approach has been implemented to support the operational delivery of projects and also as part of the development of strategic projects, where a PMO can help provide alignment of such projects with corporate strategy. More generally, a PMO can help organizations to maintain the delivery of projects according to the schedule, avoid cost overruns and generate the required project specification according to the defined quality levels, i.e. delivery according to the project’s ‘iron triangle’.

Previous research has identified various potential benefits for the PMO and this has been articulated in terms of corporate efficiency, client satisfaction as well as staff effectiveness, although such benefits would need to outweigh the costs of resourcing and operating a PMO (Desmond, 2015). The PMO has been found to support more accurate control of project information, for example, as reported by Bettin et al. (2010) in the case of a PMO established at a research institute. Further research has identified how a PMO can help ensure quality assurance
for projects (Andersen et al., 2007) and other work has shown how the PMO can help maintain alignment of projects with organizational strategy (Chen & Mo, 2008). The former of these two benefits can be regarded as an operational benefit and the latter may be regarded as a strategic benefit. This approach of considering a PMO from strategic and operational viewpoints has been extended further according to work by Philbin (2016), which identified both strategic and operational benefits for engineering projects managed by a PMO (as depicted in Figure 1).

While implementation of a PMO may provide scope for such benefits to be realized, there should however be caution. For instance, excessive levels of standardization may even hinder flexibility and creativity, which are essential components for research projects. Establishing a new PMO should also take account of the specific organizational context so that a PMO structure and processes are designed to accommodate the needs of the organization and relevant stakeholders. In regard

![Figure 1. Benefits of the PMO approach for managing projects (adapted from Philbin, 2016).](image)

Table 1 provides a summary of the characteristics for these three types.

As can be observed from Table 1, all three types of PMO support adoption of a standardized approach to managing projects that will likely include provision of standard project documentation, templates and tools (i.e. management products), which enable delivery of the project outputs (i.e. technical products). The PMO effectively provides a portfolio (or program)
Table 1. Summary of the characteristics for PMO types identified by the PMBOK® (PMI, 2013).

<table>
<thead>
<tr>
<th>PMO Type</th>
<th>Main Characteristics</th>
</tr>
</thead>
</table>
| Supportive | • Providing a consultative role for projects as part of the provision of documentation, templates, project management best practice, training, access to project information in addition to lessons learnt from other projects.  
• Acting as a knowledge repository for organizational project management.  
• The degree of control exercised by the PMO is low. |
| Controlling | • Supporting and crucially ensuring compliance of projects according to a range of control levers, namely through the adoption of appropriate project management standards, using specific templates, documents, forms or via conformance to required governance arrangements implemented by the organization.  
• Acting as a control mechanism to ensure standardization of projects.  
• The degree of control exercised by the PMO is moderate. |
| Directive  | • Providing direct control of projects through provision of project management services to enable delivery of projects. This is accompanied by systems and processes to ensure compliance with project management standards and organizational protocols.  
• Acting as a central project management resource for the organization.  
• The degree of control exercised by the PMO is high. |

level oversight of projects to maintain the performance of projects and quality levels according to defined key performance indicators (KPIs). Therefore, adopting a PMO approach to managing projects at universities and independent research organizations that are engaged in the delivery of research projects offers significant potential.

Exploring the PMO role in EU-funded research and innovation grants

European grant programs for research and innovation provide ample opportunity for PMOs based at academic institutions to add value. Acknowledging the need to foster intra-European collaboration and integration as well as leveraging economies of scale, the European Commission has supported collaborative research projects since 1987 - when the first Framework Programme for Research and Development was launched. Since then, the related European budgetary
envelope has grown steadily - surpassing €70 billion for Horizon 2020, the EU’s main funding program for research and innovation for 2014-2020 (European Commission, 2013). Alongside Horizon 2020, a range of other funding programs currently exists, which exclusively or partially provide grant-based funding for research projects, e.g. Interreg Europe, the European Regional Development Fund (ERDF), EUREKA or the European Commission’s Joint Programming Initiatives.

Despite differences in thematic outlook and eligibility rules, European grant programs in this field almost unequivocally fund collaborative projects in which a consortium of project partners work together on a shared (research and innovation) challenge. Funding is generally allocated competitively, with the most excellent proposals being retained for funding. Traditionally, European grant programs have focused on facilitating joint research and co-publication between European academic institutions and research performers. Due to this emphasis on research, project management was often taken-up by the (team of the) principal investigator coordinating the project. More recently however, the scope of European research grant programs has widened beyond their traditional academic realms. Programs such as Horizon 2020 increasingly aim at bolstering the innovation capacity of Europe by funding impact-oriented research and innovation projects. Such projects are required to have clear outputs and provide tangible benefits for the economics and societies of European states. In these projects, partners from industry, (local) authorities and end-users collaborate alongside universities and research performers on developing or refining innovative products, solutions, services or processes. As such projects span larger areas of the innovation chain, involve different stakeholders and in effect have become more complex; the need for standardized and professionalized project management has therefore increased.

At European level, grant programs for research and innovation are generally over-subscribed and only the very best proposals are retained for funding. Cuts in the research and development (R&D) budgets of many EU Member States, coupled with a broadened scope of European research programs have resulted in significant levels of competition. For instance, the average success rate for a Horizon 2020 application currently stands at 10.7% (European Commission, 2016). Consequently, being excellent in this regard is not confined to research only: proposals are evaluated on a wide range of non-research related aspects, such as the socio-economic impact and visibility of the envisaged project as well as the project and risk management processes and competencies. This concretely means that more than ever - and already at the application stage - a European research and innovation project entails the involvement of a wide range of non-related research roles. Such requirements add further weight on the shoulders of the researcher (principal investigator) coordinating the grant proposal (and later, project). Projects have become more complex and the skills and knowledge requirements to successfully complete a European grant application and project often exceed thematic scientific knowledge. Whereas coordinating researchers can be expected to be masters of their academic domain, requirements for them to be an equally competent project manager, innovation manager, business developer, stakeholder manager or dissemination manager would be challenging and undesirable as it could entail a deviation from their core capability, namely conducting academic research alongside their teaching responsibilities. This supports the need for dedicated project managers to be employed by universities engaged on such consortium projects, who can provide close support to academic
teams as part of a professional and focused project management service.

The collaborative yet competitive nature of European-funded research and innovation projects, combined with a change in programmatic outlook and broadened skills requirements provides a fertile ground for university-based PMOs to flourish. As Figure 2 shows, PMOs can act as the linchpin between the grant-making authority (i.e. the European Commission), project partners (including academic and non-academic entities) and academic support such as faculty administrations or central research offices. In this regard, the PMO can interpret and convey needs and expectations of different project parties while ensuring that the coordinating academic institution delivers the project according to the aforementioned iron triangle of project needs.

![Figure 2. Positioning of university-based Project Management Office (PMO) among stakeholders involved in European grant applications.](image)

Within a European research and innovation grant context, PMOs can deliver meaningful support across all five phases of the grant cycle (see Figure 3). In accordance with PRINCE2® definitions (Office of Government Commerce, 2009), which is a United Kingdom (UK) standard for project management, all such phases can be regarded as distinct projects as they are unique, have a (more or less) defined start and end date, aim to introduce changes into the organization and bring together people with different skills and backgrounds. Adopting a process-driven approach for supporting research projects provides various advantages, such as ensuring project tasks are properly costed and scheduled as well as ensuring all the project deliverables are specified and risks are managed.
In a European academic context, PMOs can fulfil the three roles as identified in the PMBOK® (Table 2). Logically, a supportive PMO has the most confined role. This PMO type generally relates to the pre-submission, ideation stage of a grant - when a researcher is scoping the possibilities to submit a proposal and actual proposal submission is not yet certain. The main value-add for PMOs in this capacity is to act as an advisor or trainer, advising researchers aspiring to coordinate a project on grant requirements and the feasibility of the project idea. A supportive PMO often shares its experience without the ambition to partake in the actual project should it be retained for funding. In an academic context, the role of a supportive PMO might even be comparable to other academic support bodies such as research grant offices or technology transfer offices (TTOs) as it acts largely in an advisory capacity and retains relative proximity to the actual project or proposal. A supportive PMO might often work together with the aforementioned bodies to ensure an optimal relay of expert advice. Although a supportive PMO’s natural focus is the ideation phase, it can also assist during the other stages of the grant lifecycle.

Table 2. Summary of the characteristics for a university-based PMO in a European research and innovation grant funding context, according to PMBOK® definitions (PMI, 2013).

<table>
<thead>
<tr>
<th>PMO Type</th>
<th>Main Characteristics</th>
</tr>
</thead>
</table>
| Supportive | • Advising on calls for proposals and grant requirements.  
            • Sharing project management best practices.  
            • Facilitating set-up of the research team and networking with potential consortium partners.  
            • Providing training on consortium management where required. |
| Controlling | • Helping to prepare and submit grant applications to the funding body.  
             • Ensuring adoption of project management best practices.  
             • Ensuring usage of standardization tools (e.g. costing spreadsheets) and templates (e.g. risk registers).  
             • Providing input in project resourcing decisions. |
A controlling type of PMO is more actively involved. This PMO type is often prevalent during the preparation phase of a grant proposal - when a project idea has been positively assessed and the decision has been taken to pursue the project. During this phase, a controlling PMO provides the coordinating researcher with feedback on the ongoing grant application. PMO staff may proof-read, pre-evaluate proposals and actively ensure that project management best practices or expertise on budget or staff allocation are integrated in the grant proposal. Furthermore, the PMO may facilitate proposal submission by providing the coordinating researcher with standardized templates. A controlling type PMO however does not drive bid submission and is not necessarily engaged in the eventual execution of the project.

A directive type PMO actively takes charge of a grant application. Although the coordinating researcher retains overall responsibility for the grant submission process, the PMO acts as a bid manager, which drives the delivery of elements required for a complete, high quality bid submission. The PMO coordinates the bid team and ensures inclusion of its knowledge on project management, funding requirements (and possibly other elements related to the bid such as innovation management or communication and dissemination) in the submission. The PMO also uses its experience of funding programs and bid/project management, coupled with standardized templates and processes in order to support the academic team. A major task for a directive type PMO during the proposal phase is to shield the technical writing team from outside influences, ensuring that the writers can solely focus on achieving technical excellence. This is comparable to the role of a project manager in the agile project management approach (DSDM, 2014). As such, a major level of engagement entails a significant allocation of resources, a directive type PMO often partakes in proposal preparation with the intention of providing the project manager resource once the proposal has been awarded grant funding. It does so alongside the coordinating researcher.
(i.e. principal investigator), who retains the scientific lead role and is the overall coordinator of the project.

A directive type PMO supports the coordinating researcher during all phases of the project lifecycle from ideation to project closure (as depicted in Figure 3). Once a bid has been submitted, the PMO can assist in grant preparation. The grant preparation and negotiation phase commonly involves the completion of administrative details and negotiations between the funding authority and the project consortium and internal negotiations amongst project partners on for instance intellectual property (IP) or payment provisions. A directive type PMO can drive the grant preparation process, ensuring to liaise with the administrative teams from participating project partners in order to submit the required documentation (e.g. bank and contact details) to the funding authority.

Once the project has commenced, a directive type PMO takes responsibility for project management, ensuring delivery according to specification, time and budget. It acts alongside the coordinating researcher who is responsible for the project and the overall quality of the technical and scientific project work packages. Depending on arrangements with the coordinating researcher and in-house expertise, the directive type PMO might lead on work packages in addition to project management, e.g. communication and dissemination, innovation management or managing stakeholder relations. Similar to the preparation phase, a distinct value-add of the PMO is that enables focus within the technical team by ensuring to take on-board tasks such as project management, administration and reporting, contact with the funding authorities, quality assurance, risk management and auxiliary tasks (e.g. project communication, stakeholder management or innovation management). Also in the final phase of a project, the closure phase, a directive type PMO can have a meaningful role as it may help with preparing the final reports and reviews and paving the way for project audits. These activities are administrative in nature and as such project researchers are keen for project management support from the PMO to help in regard to the coordination and production of the required documentation. Conversely and in the case of technical publications (e.g. journal and conference papers), the researchers would take the lead on drafting and submission of the manuscripts to the relevant publication or conference. This differentiation in work is consistent with the PMO leading on management and administrative tasks, thereby allowing researchers to focus on the scientific aspects of the project.

PMOs in a European grant management context add value in multiple ways, helping the coordinating academic institution to attain numerous operational and strategic advantages. At a strategic level, PMOs foster economies of repetition, ensure compliance and alignment with the institution’s mission and vision and facilitate organizational learning. Bid and project management is not pursued in relative isolation at faculty or research group level, but rather at the higher, central level. Given a larger pool of bids and projects, more opportunities exist to gather and share expertise and knowledge. Strategic advantages of PMOs are particularly relevant for European grants for research and innovation: sunk costs for preparing such proposals are often significant, with relatively modest chances of being retained for funding. It is therefore paramount to pursue those opportunities that align clearly with the institution’s goals in a focused and professional manner. These strategic advantages are ultimately supported by more practical operational advantages. Despite thematic differences or funding rules, European grant programs for research
and innovation operate in largely similar ways, thus enabling standardization of work through the use of templates, facilitating common reporting metrics as well as the build-up of efficient and effective European project management expertise.

Case Study: The EDEN2020 project

The Enhanced Delivery Ecosystem for Neurosurgery in 2020 (EDEN2020) project serves as an interesting case for assessing the operation and strategy of a university-based PMO in a European context. As the project is still ongoing, the EDEN2020 case study is assessed from early 2015 until late 2016. This period covers the inception of the proposal idea, the proposal submission, grant preparation and first six months of project implementation.

EDEN2020 is a four-year project that started in April 2016 and is coordinated by Imperial College London in the United Kingdom. The project has received funding under Horizon 2020, the EU’s Research and Innovation Programme under grant agreement no. 688279. As such, it was one of the thirteen proposals retained for funding out of 194 submissions under the Horizon 2020 ICT-24-2015 call for proposals (European Commission, 2015).

In EDEN2020, eight partners from academia and industry collaborate to progress the scientific and technological state-of-the-art in the area of minimally invasive neurosurgical treatment, with an initial focus on brain cancer. In EDEN2020 a robotically-steered system for neurosurgical interventions is developed which will feature enhanced autonomy, surgeon cooperation, targeting proficiency and fault tolerance. This system will be supported by a range of steerable and flexible catheters which can be deployed robotically alongside research into new drug diffusion models and real-time imaging techniques. In doing so, the consortium aims to provide a step-change into today’s approach to brain disease management and contribute positively to the quality of life of cancer patients, by ensuring increased efficacy and accuracy of drug diffusion and neurosurgical interventions (EDEN2020, 2017). In addition to Imperial College London, the EDEN2020-consortium consists of the University Medical Center Groningen (UMCG), Politecnico di Milano (POLIMI), Renishaw PLC, Technische Universität München (TUM), the University of Milan (UMIL), The San Raffaele Hospital (OSR) of Università Vita-Salute San Raffaele (UniSR) and Xograph Healthcare.

Imperial College’s Programme Management Office (the PMO) provides management and administrative support for collaborative research programs and commercial projects coordinated by academics from its institution. The PMO team at Imperial was established in 2014 and includes both staff previously employed by the university as well as new staff. The team is part of Imperial’s Enterprise Division, which provides management support for the development of partnerships with industry, delivery of business ventures, entrepreneurship initiatives as well as project management services for major research projects. Delivering support for EU-funded consortium projects led by Imperial College is one of the Office’s main activities, which acts as PMO in a large number of bids and projects. As mentioned the PMO is an integral part of Imperial College’s Enterprise Division and, as such, is one of the professional services departments that works with academic teams across the university. The PMO provides a range of professional services to project teams engaged on EC funded consortium projects led by Imperial College, including consortium management,
project support, dissemination and communication, and support to the evaluation of exploitation opportunities. Imperial College’s PMO has been closely involved with the EDEN2020 project since its inception and has been instrumental in preparing and delivering the project. Table 3 summarizes the involvement of the Imperial College PMO in EDEN2020 for each phase of the grant lifecycle according to PMO typology developed in the PMBOK®.

Table 3. Involvement of Imperial College London’s Programme Management Office (PMO) in each of the grant phases of EDEN2020 according to the PMBOK® PMO typology.

<table>
<thead>
<tr>
<th>Project Lifecycle Stage</th>
<th>PMO Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Supportive</td>
</tr>
<tr>
<td>Ideation</td>
<td>x</td>
</tr>
<tr>
<td>Proposal preparation &amp; submission</td>
<td>x</td>
</tr>
<tr>
<td>Grant preparation &amp; negotiation</td>
<td>x</td>
</tr>
<tr>
<td>Project implementation</td>
<td>x</td>
</tr>
<tr>
<td>Closure</td>
<td>N.A. (The project is ongoing)</td>
</tr>
</tbody>
</table>

**Ideation**

Imperial College’s PMO was involved in the ideation stage, although it predominantly played a supportive role. Involvement of the PMO in this phase was largely advisory. The initial ambition to work towards a Horizon 2020 grant application came from the Principal Investigator (PI) of the Mechatronics in Medicine Laboratory in the Department of Mechanical Engineering at Imperial College. The PI had already a track record in successfully applying for European research grants and participating in consortium projects.

Thus, when the PI approached the PMO for potential support in early 2015, it was with an already well-defined project idea and thorough knowledge of EU grant requirements and consortium management practices. Based on his experience in previous EU projects, the PI already had a strong consortium in place that could carry forward his project idea successfully. Therefore, the PMO’s project management staff predominantly advised the PI on call requirements, procedures and intricacies of the Horizon 2020 program - for instance on the requirement to showcase clear and tangible socio-economic impact.

**Proposal preparation and submission**

The decision to kick-off grant submission was taken by the PI after having received approval to do so from Departmental and Faculty administrations. The PI formally approached the PMO for bid management in February 2015, given the complexity of the project and the need to proceed quickly. The respective call deadline was very nearby, i.e. on 15th April 2015. The PMO then
assessed the suitability of supporting the proposal. Since Horizon 2020 is highly competitive a thorough risk assessment was made in order for the PMO’s operating model to remain sustainable.

A Horizon 2020 grant application is complex. It requires thorough knowledge about the scientific/technical state-of-the-art as well as insight in project management, resourcing, the envisaged tangible socio-economic benefits and pathways to exploitation of the various project outputs. Moreover, as a Horizon 2020 grant application commonly includes multiple partners, there is a need to ensure that a complete and competitive grant application is submitted on time by managing the bid process in an efficient and effective manner.

After positive assessment, Imperial College’s PMO decided to deliver bid management support. The PMO delivered project management for the bid with a view of delivering consortium management, exploitation and communication management in case the proposal was selected for funding. During the proposal preparation stage, the PMO project manager and support team worked closely with the PI’s team. The academic team at the Mechatronics in Medicine Laboratory led the write-up of most parts of the proposal, except for parts related to consortium management and exploitation, dissemination and communication.

In this stage, the PMO predominantly played a controlling type role, although supporting the PI’s academic team throughout the process as well. With the exception of the funding authority, the PMO reached out to all the parties depicted in Figure 2. It advised the PI’s team on the format, requirements and layout of the grant application - providing a thorough review and revision of draft versions. Simultaneously, the PMO ensured to gather consortium members for a one-day proposal writing workshop in early March 2015, in which it outlined the rules and requirements as well as the ‘do’s and don’ts’ of a robust Horizon 2020 grant proposal and project.

While the PI’s team focused on the technical and scientific write-up, the PMO liaised with consortium partners to gather administrative details such as institutional information or researchers’ biographical details as well as information on resourcing - using standardized templates wherever possible (in order to ensure efficient data gathering and processing). The PMO maintained a shared, online working space - ensuring that all partners involved in the write-up delivered their sections efficiently while using the same document formats. The PMO also supported the PI by informing him about bid progress and flagging-up potential issues or inconsistencies. It maintained a detailed progress chart. In doing so, it enabled the PI to retain an accurate and updated overview of the status of the bid and take informed decisions. Results are to be reported.

Although the PMO mainly supported the PI, it worked with the entire consortium: informing partners on budgets and resourcing, flagging-up possible inconsistencies and working with the partners’ research administration departments in order to obtain the required administrative and financial details. The PMO did the same internally, working with Imperial College’s Research Office (to secure sign-off for the draft proposal) and the Faculty of Engineering (to ensure budget and costing details were agreed and in place).

The proposal was finalized well in time for the deadline. The PI ensured to retain strict version control, with himself taking the lead in various iterations. Based on prior partners’ input, PMO
prepared the administrative and financial sections of the proposal (which needed to be completed online). Eventually, the PI - as the coordinator retaining full responsibility for the proposal - submitted the proposal.

Grant preparation & negotiation

In mid-August 2015, the PI and consortium were informed by the European Commission that EDEN2020 had been evaluated favorably and was in principle retained for funding. A precondition for actually being able to start EDEN2020 was the signature of the so called Grant Agreement. This is an agreement between the European Commission and the project consortium, the latter being represented by the coordinating institution. The Grant Agreement spells out the modalities, rules and obligations that the project partners are required to take into account. The set timeframe for completing the Grant Agreement was approximately three months.

Imperial College’s Research Office led this phase of the grant cycle, as it is tasked to sign project agreements on behalf of Imperial College. The PMO supported the Research Office for instance by liaising with partners and ensuring that submission deadlines were met. In parallel, the PMO worked with the PI to (marginally) update the submitted project proposal as it was to be annexed to the Grant Agreement and provided the blueprint for upcoming project work. The Research Office also led on establishing a Consortium Agreement. This agreement governs the relations between project partners. Among others, it contains provisions on project structure, decision-making procedures and intellectual property (IP) arrangements. The PMO team supported the Research Office by providing input in the proposed project governance and management processes and by sending out hard copies of the agreement to partners for final approval and signature.

Other support activities by the PMO during this phase included entering project information (such as deliverables, milestones and work packages) into SyGMA, the European Commission’s online grant management system and supporting Imperial College’s Faculty of Engineering in preparing the grant disbursement arrangements. It did this work by collecting partner bank details and liaising with the Faculty on pre-financing arrangements.

Project implementation

This phase of the grant cycle covers the first six months of the project, until November 2016, during which the first deliverables where submitted and the project’s implementation phase was well underway. EDEN2020 commenced on 1st April 2016. Since then, the PMO has been responsible for the project management work package. The PMO delivers administrative and logistical support, as well as consortium management.

From a logistical and administrative point of view, the PMO team is responsible for consortium-level meeting organization (e.g. project kick-off and review meetings) and maintains the project’s online file repository and work space. In regards to project management, PMO monitors project progress by maintaining frequent contacts with other work package leaders and liaising with the PI. Following the PRINCE2 project management standard, it retains oversight of project progress by gathering periodic technical and financial progress reports, at quarterly and six-
monthly intervals respectively. In order to do so, it liaises with work package leaders. Such reports are template-based and serve to inform the PI about project progress - an important activity as the project consortium is dispersed across Europe. As these templates mimic the templates of the funding authority, it is ensured that obligatory periodic reporting (which is linked to further grant payments) can be undertaken efficiently and effectively. Furthermore, it maintains a risk log for EDEN2020 on a quarterly basis, which helps to identify potential bottlenecks in project delivery from technical, logistical, commercial and managerial perspectives.

Imperial College’s PMO is also responsible for delivering the dissemination, exploitation and communication work package of EDEN2020. To this end, it has set the exploitation framework of the project by leading on EDEN2020’s exploitation and communication strategy. It has appointed a dedicated exploitation manager, which has been liaising with project partners to scout (future) commercial opportunities of the technologies developed under EDEN2020. The exploitation manager’s function is to kick-start preliminary discussions within the consortium on how to arrange exploitation of developed project outputs, with a view to facilitate the future commercialization of leading technologies with industrial partners. In addition, the PMO acts as the management structure for the project. It has been responsible for branding, social media outlets and the website and ensures that outreach moments and publications are properly recorded and are in accordance with the non-disclosure provisions of the exploitation strategy.

In this phase of EDEN2020, the PI retained overall leadership of the project by coordinating its scientific and technical delivery. Yet, by having recurring catch-ups, the PMO has effectively acted as an advisor to the PI; thereby sharing insights and experiences on how scientific and technical project work could be addressed efficiently and effectively. Furthermore, the PMO was also able to facilitate a smooth handover when the project manager left the organization and an alternative project manager was recruited. The PMO was able to ensure that there was an effective handover of background knowledge on the project along with information relating to the performance of the project (e.g. according to achievement of project milestones) from the departing project manager to the new project manager.

The value added by the PMO in this phase of EDEN2020 is clear. It has occupied multiple project roles, from advisor to work package leader and consortium manager. Following the PMBOK® typology on PMO’s, the Imperial College PMO is playing supportive, controlling and directive roles simultaneously - working with, for and alongside the PI. It is important to mention in this regard that multiple staff from the PMO team have been engaged in the project and that these roles do not fall only on one person, but rather on a focused team, where the consortium management and work package roles are shared by the project manager and other dedicated staff engaged for support and exploitation management as well as overall team supervision and direction. Moreover, this highlights a key benefit for faculty members to engage with PMOs, which is the continuity of service that is provided. For instance, in the case where a project manager is absent or unexpectedly leaves the organization, the PMO has adequate resource to ensure continued project management support is provided to the academic team thereby minimizing disruption to the project and management of the deliverables.

Although, the PMO approach offers a number of potential benefits, it is worth noting that the
project management of major consortium projects can also be undertaken via other resource models, such as through recruitment of the project manager in the academic department, or via outsourcing to an external business consultant. Each resource model will have its own pros and cons and while we have illustrated the merits of the PMO model, we do recognize that there may be instances where the other models may be more suited. Furthermore, the PMO approach is predicated on there being a sufficient need for project management services and a corresponding number of projects. This approach potentially works well for large research-intensive organizations but may be less suited to much smaller research organizations—although even in this latter case, there would still be scope for a supportive or controlling type of PMO.

Conclusions and Future Work

The competitive and collaborative nature of grants-based research and innovation projects provide a fertile ground for university-based PMO’s to flourish. This is further enhanced by the need for such projects to generate results that show clear socioeconomic value in addition to excellent scientific outputs in an efficient manner. Moreover, this means that projects increasingly consist of diverse (and international) consortia along with there being a need to demonstrate value-for-money towards public authorities and ultimately, the taxpayer. A clear-cut case therefore exists for professional project management teams to support and ensure delivery of grant-based consortium projects according to the ‘iron triangle’ of delivery, i.e. budget, time and specification. Furthermore, complex research projects increasingly require the involvement of multiple partners working in a collaborative manner and as part of a research consortium.

The case of the European Commission funded EDEN2020 project highlights how a PMO team can add value in a European research context through providing close support and working as part of the academic team that is driving forward project delivery; an effective PMO therefore works both jointly and integrally with the academic team on project development and subsequent execution. Its experience in project management, knowledge of funding rules (in this case of the EC’s Horizon 2020 program) and capacity to implement tasks such as bid management, consortium management as well as project dissemination, exploitation and communication helped the principal investigator of EDEN2020 to successfully deliver a multi-partner grant proposal and project. In doing so, the roles that the university-based PMO at Imperial College has taken up so far, clearly adhere to the PMBOK® typology on PMO’s through spanning all three types at varying levels. In the case of EDEN2020, the supporting PMO played multiple roles, with differences between the various stages of the grant submission process. At the ideation and grant negotiation stages of EDEN2020, the PMO predominantly played a supporting role. At the proposal submission stage, PMO was predominantly acting as a controlling type of PMO, whereas it has taken-up supportive, controlling and directive type roles during the implementation stage.

There are a number of benefits that can be secured through supporting complex research projects, such as those that involve the work of multiple partners, with a PMO management structure. There is continuity of service that is available to the academic team, e.g. if a project manager is not available or suddenly leaves, then the PMO team has resource available to maintain project management support until a replacement or alternative project manager is appointed. There is the
access to management best practice that is acquired by the PMO team from supporting multiple complex research projects, which enables insights and knowledge to be incrementally built up as further projects are delivered. This knowledge base can help faculty members to reduce the management risk when engaging on research consortium proposals and during the delivery stage of such projects. Along with the best practice that is generated, there can also be management processes, systems and tools that are available within the PMO, thereby allowing projects and faculty members to benefit from the learnings and experience of the team and from the delivery of previous projects. Access to a PMO management structure also provides faculty members with access to complementary resources and this includes back-off administrative staff, senior manager and director level staff, as well as other functional specialists, such as contracts managers and commercial exploitation focused staff. These complementary resources can be deployed flexibly at different stages of the project lifecycle, i.e. as and when needed, providing flexibility but without interrupting the core support provided by the project manager. Consequently, there are a range of different benefits that can be realized when supporting complex multidisciplinary research projects with a PMO management structure.

This work constitutes a first attempt to kick-start further analysis in this area. Further study will address the gaps and needs inherently identified in this paper. For instance, the EDEN2020 project is still ongoing and further analysis might be required to see how the role of the PMO evolves over the course of the project, including its role in the closure phase of the project. Moreover, future work can also focus on a further expansion and diversification of cases. Focusing on different grant programs, different sectors and examples from different countries (not necessarily confined to Europe) may provide an improved insight into the workings and merits of university-based PMOs. As such, this research is not only of relevance to those interested in the design and operations of PMO’s, but also to individual researchers and project managers involved with research grants as well as academic policy makers that aspire to improve their institution’s grant management processes and performance therein.

Authors’ Note

The authors would like to thank Professor Ferdinando Rodgriuez y Baena from the Department of Mechanical Engineering of Imperial College for his contributions as the PI of the EDEN2020 project. The authors would also like to thank Dr Radu Rautiu from Imperial College’s Programme Management Office (PMO) for his contributions to the EDEN2020 project. The views expressed in this article are personal reflections only.

About the authors

Gerben Wedekind MSc MA is a Manager at the Innovation Group of EY and previously worked as a Project Manager in the Programme Management Office (PMO) at Imperial College. He has been involved in ideation, bid submission, grant preparation and project implementation for EDEN2020.
Simon P. Philbin PhD MBA is Director of Programme Management at Imperial College where he leads the Programme Management Office (PMO). He is also a Visiting Research Fellow at Birkbeck, University of London.

Gerben Kristian Wedekind, MSc MA  
Ernst & Young  
Belastingadviseurs LLP  
Boompjes 258  
Rotterdam  
3011XZ Netherlands  
Telephone: +31 655442421  
gerben.wedekind@nl.ey.com

Simon Patrick Philbin, PhD, MBA  
Imperial College London  
Prince’s Gate 58  
London, SW7 2PG  
United Kingdom

References


Utilization of Lean Methodology to Refine Hiring Practices in a Clinical Research Center Setting

Marcus R. Johnson, MPH, MBA, MHA  
Cooperative Studies Program Epidemiology Center-Durham, Durham Veterans Affairs Health Care System – Medical Center

A. Jasmine Bullard, MHA  
Cooperative Studies Program Epidemiology Center-Durham, Durham Veterans Affairs Health Care System – Medical Center

R. Lawrence Whitley  
Cooperative Studies Program Epidemiology Center-Durham, Durham Veterans Affairs Health Care System – Medical Center

Grant Support  
The research reported/outlined here was supported by the Department of Veterans Affairs, Cooperative Studies Program (CSP).

Abbreviations

CSPEC-Durham Cooperative Studies Program Epidemiology Center – Durham  
VA-CASE VA Center for Applied Systems Engineering  
CSP Cooperative Studies Program  
ORD Office of Research and Development  
VA Department of Veterans Affairs  
VAMCs VA Medical Centers

Abstract:

Background & Aims

Lean methodology is a continuous process improvement approach that is used to identify and eliminate unnecessary steps (or waste) in a process. It increases the likelihood that the highest level of value possible is provided to the end-user, or customer, in the form of the product delivered through that process. Lean methodology has been used widely in healthcare and manufacturing settings but there is a limited amount of publicly available information on its use in research settings. The Cooperative Studies Program Epidemiology Center – Durham (CSPEC-Durham) is one of five epidemiology centers established by the Cooperative Studies Program (CSP) and serve as national resources for epidemiologic research and training in
the U.S. Department of Veterans Affairs (VA). The purpose of this project was to determine the effectiveness of utilizing the Lean methodology to identify and eliminate non-value added steps in our center’s hiring process and to increase its value to center staff.

Methods

A team comprised of representatives from each of the Center’s three operational cores was assembled: Executive Leadership/Administration, Computational Sciences, and Project Management. This team completed an A3, a tool to organize Plan-Do-Study-Act improvement processes into 9 steps, related to the Center’s interview process. A gap analysis was conducted to better understand the root causes of interview process deficiencies. Lastly, a survey was developed to constantly evaluate effectiveness, efficiency, and staff satisfaction with the revised interview process at the end of each hiring cycle. Pre-defined metrics were displayed in a color-coded dashboard.

Results

As a result of the A3, the team developed a comprehensive set of guidelines, including questions, for the interview process. These guidelines provided clarity to roles, responsibilities, and expectations for staff members participating in an interview panel. The improved interview process resulted in increased staff productivity and morale by reducing the number of work hours spent by staff on an interview process and decreasing the number of days spent on the duration of an interview cycle.

Conclusions

Overall, center staff are satisfied with interview guidelines that were developed as a result of the A3. Additional areas identified for Lean improvement include: revising the interview process for internal candidates, and improving the alignment of interview questions to the evaluation guide used to rate position candidates.

Keywords: Process Improvement; Quality; Lean; VA; CSP

Background

Lean methodology is a continuous process improvement approach that is used to identify and eliminate unnecessary steps (or waste) in a process. It increases the likelihood that the highest level of value possible is provided to the end-user, or customer, in the form of the product delivered through that process. It was developed by Toyota as part of an effort to streamline their automotive manufacturing and production processes (Teich & Faddoul, 2013). The utilization of Lean methodology has now been used widely in healthcare and manufacturing settings (Nazarali et al., 2017; Jimmerson, Weber, & Sobek, 2005; Sari, Rotter, Goodridge, Harrison, & Kinsman,
2017; Wells, Coates, Williams, & Blackmore, 2017; King, Ben-Tovim, & Bassham, 2006), as well as in laboratory science and research data collection and reporting activities (Sewing, Winchester, Carnell, Hampton, & Keighley, 2008; Lui, 2006; Ullman & Boutellier, 2008), but there is a limited amount of publicly available information on its use in research administration settings (Halkoaho, Itkonen, Vanninen, & Reijula, 2014; Schweikhart & Dembe, 2009). Given the complex nature of research administration and its numerous operational challenges (e.g., reductions in current and projected research funding opportunities, hiring skilled and professional staff, continuous regulatory and policy modifications, research participant payment models, etc.), it is paramount to identify approaches that promote efficiency and decrease unnecessary process components in this environment.

The Department of Veterans Affairs (VA) is the United States’ largest integrated healthcare system and provides comprehensive care to more than 8.9 million Veterans each year (2017b). The Cooperative Studies Program (CSP), a division of the Department of Veterans Affairs (VA) Office of Research and Development’s (ORD), was established as a clinical research infrastructure to provide coordination and enable cooperation on multi-site clinical trials and epidemiological studies that fall within the purview of VA (2014). The Cooperative Studies Program Epidemiology Center – Durham (CSPEC-Durham) is one of five epidemiology centers established by the CSP that serve as national resources for epidemiologic research and training for the VA (2017a). CSPEC-Durham is comprised of three operational core groups: Executive Leadership/Administration, Computational Sciences, and Project Management. The center has approximately 25 staff and its workforce is comprised of research investigators, project managers, statisticians, computer programmers, research assistants, data managers, medical residents/fellows, and student trainees.

The purpose of this project was to determine the effectiveness of utilizing the Lean methodology to identify and eliminate non-value added steps in our center’s hiring process and increase its value to center staff. The secondary aim was to evaluate staff satisfaction with the revised interview process at the end of each hiring cycle, as defined from the time that a position is created or becomes vacant, until the time that a potential candidate is selected for nomination to Human Resources for the position. Prior to this quality improvement project, an interview cycle, as defined from the selection of potential candidates to the selection for nomination to Human Resources, lasted roughly 30 days. Results from this project can inform efforts to utilize the Lean methodology to improve the overall effectiveness and efficiency of operational processes in a clinical research center setting.

Methods

In accordance with the VA’s efforts to create a culture of continuous improvement, CSPEC-Durham staff completed the Lean Yellow/Bronze Belt Certification in February 2016 through the VA Center for Applied Systems Engineering (VA-CASE) (2017c). The requirements for certification through VA-CASE were: attending a Lean Yellow Belt Certification Workshop, completing an online competency exam, participation in a Lean/Systems Redesign Project within the VA as a member of a project team and approval of an A3 report of the project. An A3 is a Lean
tool used to organize Plan-Do-Study-Act improvement processes into nine components.

**Defining the purpose and stakeholders**

A team comprised of representatives from each of the Center’s core groups formed to identify strategies to improve the Center’s interview process. The project began with the team deciding on the roles and responsibilities of each team member, including the project sponsor and process owner. The team then created a problem statement and determined the scope of the project, including triggers for the start and end of the process. In-scope for this project included candidates eligible for full-time positions within the Center because trainees, temporary hires and part-time employees undergo different screening and selection criteria. The process was determined to start after the selection of potential candidates for in-person interviews and stop when a nomination was submitted to the Human Resources department. These triggers were selected because Center staff had the most ownership over this part of the hiring cycle process.

After establishing the reason for action, the team developed value stream maps for the current and target state of the process. The map of the Center’s original interview process revealed staff were frustrated, specifically because the process was tiring and inefficient. These maps aided in visually identifying value adding and wasteful steps in the process. As is a common practice when value stream mapping, value adding steps received a green indicator, non-value adding, but necessary steps received a yellow indicator and non-value adding steps received a red indicator. These indicators made identifying areas for improvement more apparent. Non-value adding steps in our process included separate interviews between the candidate with Center staff and the Center director, high number of interviewers on the panel, inconsistent debriefing practices and final nominations being determined by only the executive leadership team.

**Identifying the root causes and opportunities for improvement**

After value-stream mapping, the team determined baseline and target metrics. At baseline, staff were spending an average of 28 hours per interview cycle that lasted over the course of about 30 days. Ideally, the team wanted to spend no more than 10 hours per cycle over the course of 21 days or less; aiming to decrease staff time spent on interviewing by 50% and increase staff morale.

As part of the A3 tool development process, the team also completed a gap analysis to better understand the root causes of interview process deficiencies (Figure 1). Deficiencies identified by the team included the interview format, time consumption as compared to the perceived value, and unclear understanding of the evaluation tool. These issues contributed to decreased staff morale, lost productivity and overall a frustrating experience for interview panelists. The 5-Why’s problem analysis tool was used to show cause-and-effect relationships between the perceived problems and corresponding root cause. The root causes of our Center’s problems centered around all decision makers not being together during the interview and the lack of a final debriefing by all staff who participated in the process. After determining the root causes, the team identified solutions to the process and the impact they would have on the metrics using an if/then table. For example, if all staff were included in a debriefing process, then we would achieve greater perceived value of the evaluation tool and increased staff morale. In addition, if we decreased the number of staff involved in the interview process, then we would decrease the overall staff time spent on
an interview cycle, increase staff morale and improve communication. Lastly, if we objectively evaluated the interview feedback/evaluation forms, then we would increase understanding of how the feedback/evaluation tool was utilized in the hiring decision-making process.

After the team identified potential solutions, experiments were conducted to confirm these hypotheses. It was important to determine if the changes actually contributed to the intended result. At our Center, including all interviewers in the debriefing process and developing limited interview teams greatly improved staff morale and satisfaction. Another crucial part of the A3 process was having a completion plan that clearly identified what was left to do for the project, who was responsible for reporting back to the group, and due dates. The process owner of the project updated the completion plan and ensured proper implementation of the new process.

Evaluation methods and insights

Upon completion of the A3, the team developed guidelines for creating an interview panel. These guidelines helped determine the most appropriate staff members to participate on an interview panel while taking into consideration the type of position (project management, computational sciences, etc.). The Center also implemented inclusive, final debriefings for all interview cycles. An electronic survey was developed to continuously evaluate effectiveness, efficiency, and staff satisfaction with the revised process at the end of each interview cycle. The metrics and results of each survey were displayed in a color-coded dashboard that was available for viewing by all Center staff. After each interview cycle, the average staff time (hours) and duration of the cycle were displayed in a dashboard similar to the display in Table 1. These metrics are used to measure success of the project and compare the baseline data with the target and confirmed state of the process. The staff satisfaction averages from the cycle were also displayed in the dashboard similar to the display in Figure 2. In addition, aggregated feedback of pros, cons, opportunities for improvement and general observations were shared with the Center to promote transparency and trust. The team reviewed the A3 development process at the end of the project and identified what did and did not go well and lessons learned.
Results

Baseline data and attributes of the previous hiring process revealed that the process was inefficient and burdensome for staff, with each interviewer spending an average of 28 work hours per interview cycle which lasted roughly 30 days. The gap analysis determined that problems with the interview process were related to unclear communication and evaluation methods, loss of productivity and staff dissatisfaction. The root cause of these issues stemmed from the lack of a final debriefing that would include all staff and decision-makers who participated in an interview process.

As a result of the A3 process, the team developed a comprehensive set of guidelines for the interview process. These guidelines provided clarity to roles, responsibilities, and expectations for staff members participating in an interview panel (Appendix 1). These guidelines also outlined the number of staff from each of the Center’s operational cores who should be involved in an interview panel. In addition to having ensured that interview panels consisted of representation from each of these operational core groups, panel members were also ultimately selected based on both their interest and availability to participate. After five interview cycles, the improved process resulted in increased staff productivity and morale by reducing the number of work hours spent by staff on an interview process to an average of less than four hours.
The drastic reduction can be attributed to increased efficiencies such as smaller interview panels, panelists receiving information related to the interview process and interviewee well in advance, mini-debriefs after each interview and a larger debrief after the conclusion of all interviews. However, the reduction in staff time can also be attributed to small candidate pools for some positions. Overall, there was still a significant decrease in staff time regardless of smaller (1-2) or larger (3-4) candidate pools. The average number of days spent on the duration of an interview cycle decreased to 22/41 days. These two, distinct values (22/41) are indicative of both the inclusion and exclusion of a single interview candidate from the dataset during analyses. The candidate in question lived in another state and because of that situation, a significant amount of time was spent rearranging their itinerary to travel to our center for the interview. By removing the data associated with this candidate, there was a successful reduction in the average duration of the interview cycle to 22 days. Including data into our analyses related to this candidate resulted in an increase to the average duration of the interview cycle to 41 days.

*Table 1. Average Duration and Staff Time Spent per Interview Cycle.*

<table>
<thead>
<tr>
<th>Metric</th>
<th>Baseline</th>
<th>Goal</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average staff time (hours) spent, per cycle</td>
<td>28 hours</td>
<td>10 hours</td>
<td>3.8 hours</td>
</tr>
<tr>
<td>Average Duration of interview cycle</td>
<td>30 days</td>
<td>21 days</td>
<td>22/41 days</td>
</tr>
<tr>
<td></td>
<td>Baseline or below</td>
<td>Above baseline, trending to goal</td>
<td>Goal or better</td>
</tr>
</tbody>
</table>
As displayed in the most recent satisfaction dashboard, staff are pleased with all aspects of the interview process.

![Figure 2. Staff Satisfaction Dashboard.](image)

This problem-solving process allowed our team to utilize Lean principles and tools that resulted in a more standardized interview process; reducing staff burden by eliminating wasteful, non-value adding steps. Our Center adopted a single interview model, inclusive of all stakeholders, instead of the disjointed manner in which interviews were previously conducted. We reduced the number of interviewers on the panel, implemented consistent debriefing practices and included all panelists in the final decision-making process. Lastly, the survey used to evaluate each interview cycle has and will continue to serve as a quality measure to constantly improve this process.

**Discussion**

Research administration is multifaceted and complex in nature. Therefore, the identification of strategies and approaches that increase the efficiency of the conduct of operations in this setting is critical to adequately facilitating the execution of safe, high-quality research (Lintz, 2008; Saha, Ahmed, & Hanumandla, 2011). This project demonstrates that the application of Lean methodology was effective in identifying and eliminating non-value added steps in this research center’s hiring process and increasing its value to center staff due to reductions in both the
interviewer average time (hours) spent per interview cycle and average duration (days) of the interview cycle.

There is currently a limited amount of publicly available information on the utilization of Lean methodology in a research administration setting. There are some publications that address improving efficiency but few of them report using Lean methodology to achieve that goal, as described in this manuscript. Therefore, we are unable to compare the results of this project with previous initiatives but can address some common themes that we encountered over the course of executing this strategy.

The relatively high number of hours spent by staff on an interview cycle and the number of days between the process start and end points resulted in dissatisfaction and decreased staff morale in our Center. During the gap analysis phase of the A3, the team used the 5-Why’s problem analysis tool to discover the perceived problems and root causes of our center’s interview process deficiencies. Problems included the interview format, time consumption as compared to the perceived value, and uncertainty around the value of the evaluation tool used.

Upon completion of the A3, the team developed guidelines for creating an interview panel. These guidelines helped determine the most appropriate staff members to participate on an interview panel while taking into consideration the type of position (project management, computational sciences, etc.). The Center also implemented inclusive, final debriefings for all hiring cycles. An electronic survey was developed to constantly evaluate effectiveness, efficiency, and staff satisfaction with the revised interview process at the end of each hiring cycle. The metrics and results of each survey were also displayed in a color-coded dashboard that was available for viewing by all Center staff. The team reviewed the A3 development process at the end of the project and identified what did and did not go well and lessons learned. We found that it is important to have a team comprised of diverse perspectives of the process, that key stakeholders are actively involved in the improvement process planning and that compromising is necessary during the A3 process.

There are potential limitations related to the design and methods that we used to execute this activity. First, we used the process on a relatively small number of interview cycles (n=5) and over a short timeframe of 17 months (March 2016 – August 2017). It is possible that increasing the number of interview cycles that were subjected to this approach and/or conducting this endeavor over a longer time period may have yielded different results. Secondly, CSPEC-Durham currently has a total of about 25 staff members and so this approach would need to be executed in a larger clinical research organization in order to determine its level of scalability, feasibility, and effectiveness in improving hiring practices in that setting. Lastly, this strategy may not be effective in reducing the duration (days) of the interview cycle if the interview candidate lives a long distance from where the interview would be conducted. As previously discussed, one of the interview candidates that was chosen to interview for a position lived in another state and a significant amount of time was spent arranging their itinerary to travel to our center for the interview. Including data in our analyses related to the aforementioned candidate resulted in an increase to the average duration of the interview cycle to 41 days, which was well above the average duration of the interview cycle for in-state candidates (22 days). It is also of importance to note that our recruitment and hiring process was negatively impacted for a period of almost
3 months (January 2017 – April 2017) due to the issuance of a Presidential Memorandum that suspended the hiring of Federal civilian employees (Hiring Freeze, 2017). The hiring freeze delayed our Center’s ability to advertise for a number of positions over this timeframe and also decreased the speed in which we scheduled interviews due to the initial lack of clarity that existed around this policy change.

Taking into account the aforementioned limitations, our project demonstrated several key strengths. This activity was innovative in that there is a limited amount of publicly available information on the utilization of Lean methodology in the context of hiring practices in a clinical research administration setting, as determined through a literature review. Prior applications of this methodology have been employed extensively in manufacturing and healthcare environments, as well as in laboratory science and research data collection and reporting activities, but not in a research administration setting on a formal administrative process such as hiring. Another strength of this project is that the Lean methodology facilitated the collection of input directly from the staff on both the strengths and weaknesses of our initial hiring process and that feedback was used to create a revised hiring process that increased its value to them and their overall satisfaction with it.

In summary, the utilization of Lean methodology was an effective method to identify and eliminate non-value added steps in our Center’s hiring process and increase its value to Center staff. Staff satisfaction with the revised interview process was also increased at the end of each hiring cycle. Additional work is needed to determine the effectiveness of this strategy in a larger research organization, as well as to increase its effectiveness for interview candidates that have to travel a significant geographic distance in order to attend an interview. Results from the aforementioned work could then be examined to determine the generalizability and sustainability of this model in other types of research administration settings.

Authors’ Note

This work was supported by the VA Cooperative Studies Program. The other members of the project team are as follows: Teresa Day, Kristina Felder, MPH, and Christina Williams, PhD.

Marcus R. Johnson, MPH, MBA, MHA
Assistant Director-Operations, CSP Epidemiology Center-Durham
Durham VA Health Care System
508 Fulton Street (152)
Durham, NC, 27705, United States of America
Telephone: (919) 286-0411 ext. 4247
Fax: (919) 416-5839
marcus.johnson4@va.gov

A. Jasmine Bullard, MHA
Quality Research Specialist, CSP Epidemiology Center-Durham
Durham VA Health Care System
R. Lawrence Whitley
Computer Scientist, CSP Epidemiology Center-Durham
Durham VA Health Care System

Correspondence concerning this article should be addressed to:
Marcus R. Johnson, MPH, MBA, MHA
Assistant Director-Operations, CSP Epidemiology Center-Durham
Durham VA Health Care System
508 Fulton Street (152)
Durham, NC, 27705
United States of America
Email: marcus.johnson4@va.gov

References


Appendix 1. CSPEC-Durham Guidelines for Interview Panel Members

CSPEC-Durham Guidelines for Interview Panel Members

An “Interview Panel” will be established for each “Interview Cycle”. A cycle is comprised of interviews for all candidates for a specific position/job posting including individual candidate debriefings, summary level panel debriefing of the set of candidates, and communicating the final selection. Should candidates be identified during a cycle as being more appropriate for another position, they will be included in the cycle for that other position.

Advanced phone interviews should have occurred; candidates should have been selected; and interviews should be ready to be scheduled by the time that the panel is convened. Each panel will have five team members, as follows:

Project Management Position
- Two members from the Administrative Leadership Team;
- Two members from the Project Management Team, at least one of whom should be a PM; and
- One member from the Computational Sciences Team.

Research Assistant Position
- Two members from the Administrative Leadership Team;
- Two members from the Project Management Team, one of whom should be the PM for whom the person will perform the majority of work during their first 6 months; and
- One member from the Computational Sciences Team.

Computational Sciences Position
- Two members from the Administrative Leadership team;
- Two members from Computational Sciences Team, one of whom should be the Computational Sciences Leader; and
- One member from the Project Management Team.

Other Position
- Two members from the Administrative Leadership team;
- One member from the Project Management Team;
- One member from the Computational Sciences Team; and
- One additional member from any team.

In cases where outside expertise and advice are necessary, one additional panel member may be chosen from outside of the CSPEC. However, this person must be aware of the commitments of an interview cycle and be able to complete the entire interview cycle.
Assessing Research Collaboration through Co-authorship Network Analysis

Jesse Fagan, PhD, MA
University of New Mexico

Katherine S. Eddens, PhD, MPH
Indiana University

Jennifer Dolly, CCRP
University of Kentucky

Nathan L. Vanderford, PhD, MBA
University of Kentucky

Heidi Weiss, PhD
University of Kentucky

Justin S. Levens
University of Kentucky

Abstract: Interdisciplinary research collaboration is needed to perform transformative science and accelerate innovation. The Science of Team Science strives to investigate, evaluate, and foster team science, including institutional policies that may promote or hinder collaborative interdisciplinary research and the resources and infrastructure needed to promote team science within and across institutions. Social network analysis (SNA) has emerged as a useful method to measure interdisciplinary science through the evaluation of several types of collaboration networks, including co-authorship networks. Likewise, research administrators are responsible for conducting rigorous evaluation of policies and initiatives. Within this paper, we present a case study using SNA to evaluate inter-programmatic collaboration (evidenced by co-authoring scientific papers) from 2007-2014 among scientists who are members of four formal research programs at an NCI-designated Cancer Center, the Markey Cancer Center (MCC) at the University of Kentucky. We evaluate change in network descriptives over time and implement separable temporal exponential-family random graph models (STERGMs) to estimate the effect of author and network variables on the tendency to form a co-authorship tie. We measure the diversity of the articles published over time (Blau’s Index) to understand whether the changes in the co-authorship network are reflected in the diversity of articles published by research members. Over the 8-year period, we found increased inter-programmatic collaboration among research members as evidenced by co-authorship of published scientific papers. Over time, MCC Members collaborated more with others outside of their research program.
and outside their initial dense co-authorship groups, however tie formation continues to be driven by co-authoring with individuals of the same research program and academic department. Papers increased in diversity over time on all measures with the exception of author gender. This inter-programmatic research was fostered by policy changes in cancer center administration encouraging interdisciplinary research through both informal (e.g., annual retreats, seminar series) and formal (e.g., requiring investigators from more than two research programs on applications for pilot funding) means. Within this cancer center, interdisciplinary co-authorship increased over time as policies encouraging this collaboration were implemented. Yet, there is room for improvement in creating more interdisciplinary and diverse ties between research program members.

Keywords: Interdisciplinary collaboration, co-authorship, research administration policy, social network analysis, diversity in collaboration, science of team science

Introduction

Interdisciplinary research collaboration is needed to perform transformative science and accelerate innovation (Wuchty, Jones, & Uzzi, 2007). In the past decade, there has been a growing emphasis on building collaborative, transdisciplinary scientific teams to advance knowledge creation and dissemination; so much so that the National Institutes of Health (NIH) supported the development of the Science of Team Science, a field of research dedicated to understanding the multi-level influences on the success of scientific collaboration. The goal of the Science of Team Science efforts are to investigate, evaluate, and foster team science, including institutional policies that may promote or hinder collaborative interdisciplinary research and the resources and infrastructure needed to promote team science within and across institutions (Falk-Krzesinski et al., 2011; Falk-Krzesinski & Börner, 2010; Hall, Feng, Moser, Stokols, & Taylor, 2008; Stokols, Hall, Taylor, & Moser, 2008).

In mapping a research agenda for the Science of Team Science, SciTS stakeholders have identified social network analysis (SNA) as an important methodological tool to understand and evaluate the complex dynamics of scientific collaboration (Falk-Krzesinski et al., 2011). SNA has emerged as a useful method to measure scientific collaboration through the evaluation of several types of collaboration networks (for example, Claudel, Massaro, Santi, Murray, & Ratti, 2017; Newman, 2001; 2004). Collaboration networks are represented as network graphs with researchers as nodes in the network, and ties between the nodes representing a type of collaboration, such as co-investigators on grants submitted, self-reported collaboration, or co-authorship of published scientific papers. Co-authorship networks are an objective view of one type of collaboration, and are often comprised of data easily accessible via databases such as Web of Science or those created internally to an institution to track productivity. In addition, characteristics of co-authorship networks that reflect an openness to collaboration are correlated with greater productivity and scientific impact (Bales et al., 2014; Claudel, Massaro, Santi, Murray, & Ratti, 2017; Yousefi-Nooraie, Akbari-Kamrani, Hanneman, & Etemadi, 2008).

Scientists tend to collaborate with others most like them, a phenomenon we call homophily in the
field of social network science (Evans, Lambiotte, & Panzarasa, 2011; Kegen, 2013; McPherson, Smith-Lovin, & Cook, 2001). Being of the same gender, in the same academic department, and sharing the same research interests and discipline are strong predictors of forming a collaborative tie (Kegen, 2013; Liu, Luo, & Xia, 2015; Zhang, Bu, Ding, & Xu, 2018). However, forming collaborative ties with those who are different than you (termed heterophily or diversity) results in solving complex problems (Page, 2008), producing transformative science like patent development (Claudel et al., 2017), and when this diversity contributes to a more decentralized network open to outside connections we see better scientific outputs such as publication in journals with high impact factors and higher citation rates (Yousefi-Nooraie et al., 2008). These tendencies toward homophilous collaboration can be overcome by implementing policies and structures that encourage the formation of collaborative ties between dissimilar others.

In the biomedical field, there is perhaps no greater area in need of transformative team science than that of cancer research. Cancer is one of the leading causes of morbidity and mortality in the world, and nearly 40% of men and women in the United States will be diagnosed with cancer in their lifetime (Howlader, Noone, Krapcho, Miller, & Bishop, 2016). Moreover, the number of individuals living beyond a cancer diagnosis in the U.S. is expected to reach 19 million in 2024 (DeSantis et al., 2014). The National Cancer Institute (NCI) is the largest funder of cancer research in the world. Within the U.S., the NCI provides funding and designation to academic cancer centers that may serve as “major sources of discovery into the nature of cancer and of the development of more effective approaches to prevention, diagnosis, and therapy.” The objectives of the NCI P30 Cancer Center Support Grants (CCSG) are centrally focused on fostering productive, interdisciplinary, collaborative cancer research via formalized scientific research programs, shared resources to enhance scientific interaction and discovery, developmental research funding for new priorities and collaborations, and engagement with the catchment area communities. To facilitate these research goals, the CCSG objectives include strategic planning to further the research agenda of the cancer center, efforts to coordinate cancer research training and education, scientific oversight of clinical trials, and a centralized cancer center administrative and management structure. Creating a culture of transdisciplinary collaboration that will lead to cutting-edge research in cancer centers requires leadership and innovative thinking in research administration and management.

Cancer center administration, composed of an integrated team of experienced research administrators, is responsible for providing the leadership and strategic planning that drives major priorities within a center through the creation of effective and efficient policies and initiatives. Based on a clear connection between effective organizational structure, including leadership styles that focus on inspiring transformative innovation, and the overall success of an organization or group of individuals, research administrators can promote integrative decision-making processes within team science structures. This can promote a culture of scientific collaboration and a culture of trust throughout an organization (Bateh & Heyliger, 2014; Bunton & Mallon, 2006; Ford & Randolph, 1992; Lesser & Storck, 2001; Mallon, 2006; Schnetler, Steyn, & van Staden, 2015; Siddique, Aslam, & Khan, 2011; Vaccaro, Jansen, Van Den Bosch, & Volberda, 2012).

Cancer center administration is also responsible for conducting rigorous evaluation of policies and initiatives. Within this paper, we present a case study using SNA to evaluate inter-programmatic
collaboration over time among scientists who are members of four formal research programs at an NCI-designated Cancer Center, the Markey Cancer Center (MCC) at the University of Kentucky (UK). During the 8-year time period these data represent (2007-2014), the cancer center applied for and was awarded NCI-designation through the NCI CCSG mechanism. To build the rigorous infrastructure, productivity, and evidence of interdisciplinary and transdisciplinary science needed to achieve NCI-designation, in 2009 the Cancer Center administration hired a new Cancer Center Director and began implementing strategic policies and mechanisms to encourage inter-programmatic collaboration. The CCSG application was submitted in 2012 and the Cancer Center was awarded the CCSG in 2013. We create co-authorship networks for the Cancer Center members over this 8-year period, and evaluate change in inter-programmatic collaboration in co-authoring scientific publications over time. SNA has been used to evaluate similar collaboration networks, such as co-authorship in biomedical fields (Bales et al., 2014; Claudel et al., 2017; Fonseca, Sampaio, Fonseca, & Zicker, 2016; Yousefi-Nooraie et al., 2008), collaboration on biomedical research grants in a National Institutes of Health-funded Clinical Translational Science Award (Nagarajan, Kalinka, & Hogan, 2013), and the growth of multi-center publications over time in The Cancer Prevention and Control Research Network, a network of centers jointly funded by the Centers for Disease Control and Prevention and the NCI (Ribisl et al., 2017). However, to our knowledge there is no published evidence of the use of SNA to evaluate inter-programmatic collaboration within an NCI-designated Cancer Center. Results of this study will identify areas of improvement related to co-authorship collaborations within a cancer center and the results will drive development of policy to stimulate new co-authorship collaborations.

Methods

This Institutional Review Board at the University of Kentucky determined that this study did not meet the definition of human subjects and therefore did not require IRB review.

Study Setting

The MCC is a premier cancer research center and patient care facility that operates as an integral component of UK and the UK HealthCare enterprise. Markey’s basic, translational, and clinical research efforts support the cancer center’s mission of reducing cancer mortality in Kentucky through a comprehensive program of cancer research, treatment, education and community engagement, with a particular focus on the underserved population of Appalachian Kentucky.

In July 2013, the NCI awarded a CCSG to the MCC, establishing the center’s status as an NCI designated Cancer Center. With $10 million in funding over five years, the NCI designation will help Markey further its mission and better serve the Kentucky and Appalachian Kentucky populations. The purpose of the CCSG mechanism is to drive institutional cancer research into an integrated transdisciplinary research enterprise. To support this purpose, the CCSG funds infrastructure to integrate and translate funded cancer research, and build collaboration between defined research programs. As an NCI-designated Cancer Center, Markey has applied concerted effort into strategic planning and evaluation to ensure that the requirements of the CCSG are not only met, but exceeded. The center, which has recently undergone significant expansion,
conducts research through four thematic transdisciplinary research programs: Cancer Cell Biology and Signaling (CS); Cancer Prevention and Control (CP); Drug Discovery, Delivery and Translational Therapeutics (DT); and Genomic Instability, Epigenetics, and Metabolism (GEM). Notable research successes include a robust body of seminal work in Appalachian Kentucky in recent decades in the CP Program, nationally acclaimed basic research programs in cancer biology and DNA repair and oxidative stress in the CS Program and the GEM Programs, and advanced research into translational cancer therapeutics in the DT Program. The Shared Resource Facilities provide robust state-of-the-art expertise and technology to MCC members. As the breadth and depth of the Research Programs expand, the Shared Resource Facilities (SRFs) modify their services and potentially open new SRFs to accommodate the demands of research. These facilities cover the spectrum of technical expertise needed from basic science to population-based studies, thus facilitating translation of bench work of investigators to clinical research of clinicians and population scientists. This focus encourages collaborations between SRFs to ensure that the best methods and techniques are used to reach desired outcomes.

Fostering Strategic Research Collaboration

Markey has facilitated inter-programmatic collaboration by encouraging a variety of grant applications. Researchers are encouraged to submit multi-PI R01 grants as well as other multi-project grants to the NIH. Multi-project grants facilitate collaboration by pulling in multiple primary investigators into one main umbrella project that hosts several sub-projects specific to their research objectives. Another example of multi-PI grants that facilitate collaboration are pilot award mechanisms, which require two or more members from different research programs on the application. Markey has also established a Research Communications Office (RCO) to support researchers with project management, grant applications, submitting publications, coordinating research activities, and much more. The RCO acts as a hub, receiving and editing many grant applications and publications. Due to their central nature, the RCO drives many collaborations within Markey by ensuring the appropriate scientists, clinicians, and community partners are included in a project.

Throughout the year, Markey hosts scheduled events to encourage inter-programmatic collaborations through a multitude of channels, ranging from ideological planning, building research infrastructure, and community engagement. This includes monthly Research Program Meetings, the Program and Shared Resource Leaders committee, a Seminar Series, Program Retreats, an Annual Retreat, and several research symposia. These events intentionally bring together researchers from different programs and departments who may not meet through normal daily research activity, and they increase visibility of the research conducted at Markey, ultimately stimulating ideas for collaboration.

To support this infrastructure, Markey leverages a Senior Leadership team. Over the past 8 years, starting in 2009, the Cancer Center has strategically recruited highly specialized faculty leaders. The depth and breadth of the research expertise in senior leadership gives Markey a robust repertoire of research projects that have great impact on the scientific community as a whole. Furthermore, Markey continues to strategically recruit new faculty candidates to help advance particular research areas, but with an emphasis on those with a history or interest in
transdisciplinary research and projects. Markey additionally increased research space allowing for personnel to be housed physically closer to one another, with space designed to encourage interaction and collaboration.

Evaluation Objectives

The goal of this study is to assess whether MCC Research Members (hereafter, “MCC Members”) are increasing collaboration across research programs over time, as measured by co-authorship ties. We implement multiple analytic strategies to answer this research question. First, we observe the change in network descriptives over time that reflect changes in inter-programmatic co-authorship, such as number of components, degree, degree centralization, and modularity. Second, we evaluate the dynamics of how communities or clusters of authors in the network change over time, and whether these represent a trend toward increased inter-programmatic collaboration. Third, we implement separable temporal exponential-family random graph models (STERGMs) to estimate the effect of author and network variables on the tendency to form a co-authorship tie, specifically the tendency to form a co-authorship tie with people within the same MCC Research Program, and how this changes over time. Finally, we evaluate the diversity of the articles published over time to understand whether the changes in the co-authorship network are reflected in the articles published by MCC Members.

Sample

This MCC social network analysis is based on a bibliometric network of MCC Members. The publications comprising this bibliometric network are the ultimate outcomes of grants awarded to MCC Members, where co-authorship on publications is representative of collaboration and co-funding on grants. The MCC RCO keeps an EndNote database of all publications authored by an MCC Research Member as well as data on basic demographic and academic information of each of its members, such as their rank, department, and when they became an MCC Member.

A total of 1,062 papers published in the years 2007-2014 by any of the 115 MCC Associate and Full Research Members (whose membership was approved on or before April 23, 2015) were extracted from the MCC EndNote database using a Python script. Each article was assigned an article identification number, and each MCC Member was assigned an author identification term. Non-MCC Member authors were removed from the data, as this analysis specifically looks at co-authorship within cancer center membership to better understand whether policies aimed at increasing inter-programmatic collaboration within the cancer center are effective. Separate tables were created for each publication year with columns for article ID, author ID, publication year, and publication date (day-month). For articles published in Spring/Summer/Fall/Winter issues, assigned publication date was the first day of the month in which that season begins during the calendar year (i.e. Spring - March 1, Summer - June 1, Fall - Sept. 1, Winter - Dec. 1). The same process was used for journals that produce 4 issues a year and did not have a month available.

Two articles for which no known specific publication date could be identified were dropped from the analytic sample, as was one paper that included 372 co-authors.

Characteristics of MCC Members include the MCC Research Program with which the member...
is primarily affiliated (i.e., CS, GEM, DT and CP), MCC Role or type of membership (Associate or Full Research Member), academic rank in the institution (Assistant, Associate, or Professor), home department, home college, terminal degree obtained, and gender. These variables are self-reported by the MCC Member at time of application and updated yearly. These data represent the characteristics of MCC Members as of April 23, 2015.

Network Data

The co-authorship data was treated as a two-mode network for the purposes of the descriptive analyses, and a binary one-mode network for the purposes of the inferential STERGM models. For the purposes of the descriptive analysis the networks were cumulative (a network in year Y contains data of all previous years). The data was analyzed as a matrix, Bij where the rows, i, are individual authors and columns, j, are articles. The value bij is 1 if the author i is listed as an author on article j and 0 otherwise. Each of the articles have a year and quarter attribute (such as Q1 2014, Q2 2014, etc.) and for the temporal analyses columns were filtered out if they were later than a specified year / quarter.

For the STERGM analyses we projected the two-mode matrices into a one-mode projection: A = B * BT, such that Aij = the number of times that author i and author j authored an article together. To capture the temporal trends, these networks were not cumulative and instead only considered papers which were authored within a time window of 5 quarters (e.g. 1.25 years, from Q4 2014 through Q4 2015) to allow for the long period of time that it takes for collaborations to result in published work.

The analyses were conducted using R (R Development Core Team, 2014) and igraph (Csardi & Nepusz, 2006) and the STERGM analyses were conducted using the tergm package (Krivitsky & Handcock, 2016).

Statistical Analyses

Descriptive statistics. Descriptive statistics were performed on each network including network size, number of connected components, mean degree of the network, degree centralization, and modularity. Each will be described briefly below.

Network size is the number of nodes in the network. For the two-mode analyses the network size is the count of MCC Member authors and articles. Edges, or the ties between nodes in the two-mode network, represent MCC Members authoring a paper. In the one-mode projected network, used in the STERGM analyses, when a tie exists between two authors, they have served as co-authors on at least one paper. Data are valued so that we may see how many papers two authors may co-author together over time, however this analysis focuses on the changes in co-authorship across programs over time rather than on individual author roles in this change.

Components in networks are essentially portions of the network, or sub-networks, that are disconnected from one another. In a network component there is a path from each member of the component to every other member. If there is no path between two nodes, then those nodes belong to different components. In this study, having multiple components indicates that there
are portions or sub-groups of the network that are co-authoring with one another but are not connected to other sub-groups of co-authors within the MCC.

The mean degree of the network gives us the average number of other nodes (or authors) an author in this network collaborates with. Degree centralization tells us how much of the co-authorship in this network is concentrated in just a few members (Freeman, 1978).

Modularity in this study is the degree to which researchers co-author with other researchers in their “dense group” versus people outside of their dense group. A dense group may be made up of individuals from the same or different programs, but is a group of authors who tend to collaborate. Over time this measure can show whether there is change in authors in the networks co-authoring with others outside of their core dense group of collaborators. We used the fast-greedy approach to finding module membership in the two-mode networks (Clauset, Newman, & Moore, 2004).

Longitudinal analyses. To assess whether MCC Members are increasing inter-programmatic collaboration over time we first observe the change in network descriptives such as number of components, degree, degree centralization, and modularity.

Because the co-authorship network is sparse and disconnected, we defined the clusters or communities in the network by the network component they belonged to. We then connect the communities across time using a method described by Palla et. al where the overlap between a community at Time 0 is compared to the overlap of communities at Time 1, and the communities with the greatest overlap are matched together (Palla, Derényi, Farkas, & Vicsek, 2005). Communities are also found to break apart, fuse together, fall apart, or emerge. As soon as an author collaborated on an article with another author in a different component, the two components merge. This dynamic process is represented graphically using an alluvial diagram (Rosvall & Bergstrom, 2010). Each of the 8 time points (years 2007 through 2014) in the data is represented by a vertical column divided into a number of clusters, or communities of authors who co-author together. Changes in these communities are represented by diverging and merging ribbons linking together the vertical columns and clusters at each time point.

Third, we implement separable temporal exponential-family random graph models (STERGMs) to estimate the effect of author and network variables on the tendency to form a co-authorship tie, specifically the tendency to form a co-authorship tie with people within the same MCC Research Program, and how this changes over time. STERGMs use Monte Carlo maximum likelihood to estimate the effects of chosen variables on the likelihood of tie formation or dissolution in a network. Two overall models are created to capture ties at time 2007 through 2011 and 2011 through 2014. Each model is first fit on network structural controls such as the number of edges (which is like the intercept in an ordinary least squares model), degree of at least 1 (representing a tendency against isolates), and triadic closure (the tendency for two nodes in a triad to form a tie if they are each connected to the third node but not yet to one another). These models control for the number of people available over time as well as past number of publications. In each time period there is a model for the formation of ties and a model for the dissolution of ties.

Finally, we evaluate the diversity of the articles published over time to understand whether the
changes in the co-authorship network are reflected in the articles published by MCC Members. Diversity in gender, research program, department, college, MCC role, academic rank, and informal co-authorship communities are calculated using Blau’s Index (Blau, 1977). Blau’s Index calculates the probability that two individuals taken from a dataset at random with replacement will be of different types on a given characteristic. The Blau Index ranges from 0 to 1, with values closer to 0 representing a more homogenous sample and values closer to 1 representing a more diverse or heterogeneous sample. This is calculated for each article in the dataset and an ordinary least squares regression is used to plot paper diversity over time.

Results

Markey Cancer Center Research Members

Of the 115 MCC Members as of April 23, 2015, most are male (71%), and the majority are Full Research Members (56%). Full professors make up 45% of the MCC membership, with 24% Associate Professors and 31% at the rank of Assistant Professor. Distribution of program membership is as follows: DT represent 31% of the MCC research membership, CS 26%, GEM 22%, and CP comprises 21% of the MCC research membership. MCC Members represent 26 departments from 7 colleges across the university, with the majority of members affiliated with the College of Medicine (72%) and the College of Public Health (11%).

Network Descriptives

The number of MCC Members co-authoring papers with other MCC Members grew over time, from 46 authors in 2007 to 106 (92% of membership co-authoring with at least one other MCC member) in 2014 (see Figure 1). There were nine MCC members who authored papers, but not with any other members of the MCC, and thus were isolates in the network and excluded as this analysis specifically looks at co-authorship within the cancer center, not solo authorship or authorship of papers with others outside the cancer center membership. The number of co-authorship ties increased from 133 to 1,532. The mean degree of the authors in the network—meaning the number of other authors they co-author with on average—increased over time from 1.79 in 2007 to 2.66 in 2014.
Table 1. Characteristics of MCC Member co-authorship networks, 2007 - 2014.

<table>
<thead>
<tr>
<th>Year</th>
<th># Articles</th>
<th># Authors</th>
<th>Number of Components</th>
<th>Mean degree</th>
<th>Centralization</th>
<th>Modularity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>103</td>
<td>46</td>
<td>27</td>
<td>1.79</td>
<td>0.062</td>
<td>0.93</td>
</tr>
<tr>
<td>2008</td>
<td>193</td>
<td>54</td>
<td>28</td>
<td>1.96</td>
<td>0.069</td>
<td>0.92</td>
</tr>
<tr>
<td>2009</td>
<td>305</td>
<td>62</td>
<td>29</td>
<td>2.13</td>
<td>0.060</td>
<td>0.92</td>
</tr>
<tr>
<td>2010</td>
<td>412</td>
<td>74</td>
<td>29</td>
<td>2.26</td>
<td>0.072</td>
<td>0.91</td>
</tr>
<tr>
<td>2011</td>
<td>546</td>
<td>83</td>
<td>21</td>
<td>2.41</td>
<td>0.074</td>
<td>0.90</td>
</tr>
<tr>
<td>2012</td>
<td>676</td>
<td>90</td>
<td>21</td>
<td>2.55</td>
<td>0.074</td>
<td>0.88</td>
</tr>
<tr>
<td>2013</td>
<td>857</td>
<td>98</td>
<td>13</td>
<td>2.59</td>
<td>0.065</td>
<td>0.87</td>
</tr>
<tr>
<td>2014</td>
<td>1047</td>
<td>106</td>
<td>11</td>
<td>2.66</td>
<td>0.057</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Figure 1. Four sociograms of the networks at four timepoints in 2007, 2010, 2012, and 2014. The colors indicate the different components of the network. The large circles are authors, and the smaller squares are articles. A tie between an author node and an article node indicates that an author was listed as an author on that article.
The number of connected components decreased from 26 to 11 over the 8-year period, demonstrating that there were fewer disconnected sub-networks within the co-authorship network over time. We see a fluctuation in degree centralization of the network, with an overall decrease from 2007 to the 2014 end point, meaning that in 2014 there were fewer authors who dominated the authorship ties in the network. Co-authorship was better dispersed across the network. Finally, we see that modularity decreased over time from 0.93 in 2007 to 0.86 in 2014, indicating that authors are co-authoring more with those outside their dense group over the 8-year period.

**Network Change**

The alluvial diagram in Figure 2 shows that there were initially 8 different clusters or "communities" in the initial 2007 co-authorship network, and this reduced to 3 in 2014. Communities are informal groups of MCC Members who co-author together. The zeros in the diagrams are isolated authors who have not co-authored with another MCC Member in the network (frequently because they have yet to join the MCC in the early years). Each column in the diagram represents a year of network data, from 2007 (T1) to 2014 (T8). Following the diagram from left to right, the lines indicate how authors join or leave these communities over time. Those from the “zero” community move into other communities, and the communities all change over time.

Referring to Figure 2, we see that Community 11 becomes the largest informal co-authorship community in the MCC by 2014 (T8). Community 11 starts in 2008 (T2) as a group of MCC members in the College of Public Health co-authoring together. By 2010 (T4) the community is made up of equal parts MCC Members from the College of Medicine and College of Public Health. The members of this community in 2010 (T4) come from a diverse group of departments such as Biostatistics, Epidemiology, Health Behavior, and Internal Medicine. By 2012 (T8), MCC Members from the College of Medicine dominate the community by a ratio of 4 to 1.

Over time, several other stable communities merge with Community 11 through co-authorship between community members. For example, Community 10—a small group of four researchers from Pharmacology and Toxicology/Cancer Biology—exist for three years before merging with Community 11. Community 12 is a group of three researchers from Toxicology/Cancer Biology and one from Internal Medicine, and they join Community 11 after five years. Some new communities emerge over time, like Community 17, a group of two researchers from Biochemistry and Toxicology/Cancer Biology.
Figure 2. Change in communities in the co-authorship network from 2007 (T1) to 2014 (T8). Communities labeled “0” in the first seven columns represent authors who have not yet co-authored with another MCC Member.

STERGM results are presented in Table 2. Controlling for structural characteristics of the network, ties in the network at time point 1 were significantly less likely to be formed by Associate Professors as compared to Assistant Professors (-0.65, s.e. 0.27; p<.05), and likely to be formed within the same academic department (1.37, s.e. 0.29; p<.001) and within the same MCC Research Program (1.25, s.e. 0.25; p<.001). There were no significant predictors of tie dissolution.

Controlling for structural characteristics of the network, ties in the network at time point 2 were still significantly less likely to be formed by Associate Professors as compared to Assistant Professors and likely to be formed within the same academic department, but both of these effects were weaker than at time 1 (See Table 2). Research Program continues to have a significant effect.
on tie formation, however there is a more precipitous drop in the strength of this effect from 1.25 to 0.60, showing greater co-authorship between programs rather than within programs. There were no significant predictors of tie dissolution.

Table 2. Results of STERGM formation models for structural controls only and author characteristics.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>First half</th>
<th>Second half</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Formation</td>
<td>Dissolution</td>
</tr>
<tr>
<td>Structural controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>edges -7.99 (0.46)***</td>
<td>2.05 (0.87)*</td>
<td>1.09 (0.36)**</td>
</tr>
<tr>
<td>degree -0.54 (0.14)***</td>
<td>0.16 (0.25)</td>
<td>0.37 (0.18)*</td>
</tr>
<tr>
<td>Triadic closure 1.53 (0.15)***</td>
<td>0.78 (0.25)**</td>
<td>0.89 (0.18)***</td>
</tr>
<tr>
<td>Author characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associate Professor Rank -0.65 (0.27)*</td>
<td>0.05 (0.43)</td>
<td>-0.39 (0.17)*</td>
</tr>
<tr>
<td>Professor Rank -0.05 (0.20)</td>
<td>0.31 (0.36)</td>
<td>-0.09 (0.13)</td>
</tr>
<tr>
<td>Gender Male 0.52 (0.29)</td>
<td>-0.59 (0.51)</td>
<td>0.12 (0.18)</td>
</tr>
<tr>
<td>Same Rank 0.12 (0.27)</td>
<td>-0.26 (0.42)</td>
<td>0.05 (0.19)</td>
</tr>
<tr>
<td>Same Gender -0.31 (0.34)</td>
<td>0.10 (0.60)</td>
<td>-0.09 (0.23)</td>
</tr>
<tr>
<td>Same Department 1.37 (0.29)***</td>
<td>-0.10 (0.50)</td>
<td>1.20 (0.23)***</td>
</tr>
<tr>
<td>Same College -0.10 (0.29)</td>
<td>0.56 (0.44)</td>
<td>-0.18 (0.19)</td>
</tr>
<tr>
<td>Same Program 1.25 (0.25)***</td>
<td>-0.28 (0.40)</td>
<td>0.60 (0.17)***</td>
</tr>
<tr>
<td>AIC 944.6</td>
<td>238.2</td>
<td>2835</td>
</tr>
<tr>
<td>BIC 972.4</td>
<td>283.1</td>
<td>2863</td>
</tr>
</tbody>
</table>

*** p<.001, ** p<.01, * p<.05
**Paper Diversity**

We evaluated each co-authored paper in the network on measures of diversity. As shown in Figure 3, the diversity of published articles increased over time with every measured attribute—program, role, department, rank, college, and informal community membership—with the exception of gender. The results of an OLS regression of paper diversity over time is shown beneath the title of each variable in Figure 3 (e.g. Program diversity increased by 0.01 units per year, and this increase was significant at $p < 0.001$). The Blau Index for gender decreased, non-significantly, over time.

*Figure 3. Change in diversity (Blau Index) of papers authored by MCC Members, over time ($^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$).*

[Click here for larger image](#)
Discussion

Over the 8-year period, we found increased inter-programmatic collaboration among MCC Members as evidenced by co-authorship of published scientific papers. MCC Members collaborated more with others outside of their research program and outside their initial dense co-authorship groups. Co-authorship was better dispersed through the network over time, with fewer authors dominating co-authorship ties. This inter-programmatic research was fostered by policy changes in Cancer Center administration encouraging interdisciplinary research through both informal (e.g., annual retreats, seminar series) and formal (e.g., requiring investigators from more than two research programs on applications for pilot funding) means. While inter-programmatic co-authorship of papers is not the only outcome of interdisciplinary collaboration within a cancer center, this is one metric that can be used to determine whether specific activities implemented by the cancer center to increase interdisciplinary collaboration are successful.

Some level of homophily is still driving the formation of new co-authorship ties. Being in the same department and in the same research program significantly drive tie formation, yet the effect of same research program decreased over time as inter-programmatic co-authorship ties grew. However, by observing changes in diversity of published papers over time, we found that heterophily or diversity increased, providing evidence that more collaboration occurred across programs, roles, ranks, departments, colleges, and informal co-authorship communities over the 8-year time period. The greatest increase in diversity occurred in diversity of program, reflecting the success of programs in place to improve this interdisciplinary research. There was a decrease in diversity for gender, indicating that over time authors collaborated more within their same gender, consistent with literature on gender homophily in co-authorship ties (Hâncean & Perc, 2016; Gallivan & Ahuja, 2015; Wang & Erosheva, 2016). These findings support most literature demonstrating that scientists tend to collaborate with others like them, but that this tendency toward homophily can be disrupted by implementing policies encouraging interdisciplinary collaboration.

Co-authorship in this cancer center became more distributed across the network over time, meaning that there were fewer instances of co-authorship concentrated in a just a few MCC Members as the network grew and increased inter-programmatic ties. The alluvial diagram in Figure 2 demonstrates that small, informal groups of co-authors existed throughout the years, but these groups became interconnected through co-authorship, increasing collaboration across informal as well as formal groups within the MCC. Increasing diverse collaboration ties and creating a more decentralized network has been shown to improve productivity and increase high-impact science (Yousefi-Nooraie et al., 2008).

The increase in inter-programmatic co-authorship ties in this study is an important indicator of improved interdisciplinary collaboration for this cancer center. One explanation for the increase in total number of publications and observed inter-programmatic collaboration between the years proceeding 2013 and after is that the MCC obtained NCI designation and CCSG funding in 2013. NCI designation better formalized and strengthened policies that were put in place to enhance collaborations. For example, financial support—via the designation—was used to provide additional pilot funding that required inter-programmatic collaboration. Not only is
interdisciplinary science responsive to the objectives and goals of the NCI CCSG program, it is a requirement for an NCI-designated cancer center to move into comprehensive cancer center status, the next goal in designation for the MCC. Comprehensive cancer center status would allow for greater research support and structure to truly relieve the burden of cancer not only in Kentucky—where we find six of the 10 counties with the highest cancer mortality rates in the country, and where the greatest increase in cancer mortality between 1980 and 2014 occurred (Mokdad et al., 2017)—but also for breakthrough research that will contribute to cancer research nationwide. The community that the MCC serves in Appalachian eastern Kentucky is one of the most socioeconomically oppressed areas of the United States. Transformative cancer research that is translated from the basic science MCC Research Programs to implementation in the clinical programs and out through the CP Program into the statewide community have the potential to not only make a tremendous dent in the cancer problem in Kentucky, but may be generalizable to other socioeconomically depressed communities in the nation and the world, narrowing the disparities in cancer outcomes between those with access to opportunities for good health and those who are underserved and marginalized.

Within this cancer center, interdisciplinary co-authorship increased over time as policies encouraging this collaboration (detailed in the section titled “Fostering Strategic Research Collaboration”) were implemented. Yet there is room for improvement in creating more interdisciplinary and diverse ties between MCC Members. Our findings demonstrate that MCC Members tend to form co-authorship ties within their department, research program, and gender. Additionally, Associate Professors are less likely than Assistant Professors to form co-authorship ties. Prior research suggests that strong leadership that breaks down barriers that inhibit interdisciplinary research can influence the effectiveness of team science that leads to enhanced interdisciplinary collaborations. Leaders can focus on intentional team building wherein an emphasis is placed on including diverse, high functioning team members, integrating disciplines that share common experiences, aligning goals, and focusing on creating opportunities for increasing the geographic proximity of team members (Committee on the Science of Team Science, Board on Behavioral, Cognitive, and Sensory Sciences, Division of Behavioral and Social Sciences and Education, & National Research Council, 2015).

For the MCC, one solution to achieve these parameters may be for Cancer Center administration to establish a formal mentorship program within the Cancer Center matching junior investigators with a committee of senior scientists representing diverse research programs, departments, and gender. Mentoring programs have been found to be successful in generating collaborations that focus on new research initiatives, grant submission, and publications (Luke, Baumann, Carothers, Landsverk, & Proctor, 2016; Vogel et al., 2014).

Another approach may be to build formal inter-programmatic scientific teams around solving specific problems in cancer research, using pilot funding to stimulate collaborations, which is a known facilitating factor that enhances team science (Vogel et al., 2014). Establishing teams of scientists with diverse ranks and experience also improve institutional attitudes toward supporting innovative research (Vogel et al., 2014). Having a foundation of successful scientists working with junior faculty conducting high-risk research could provide a sense of security for institutions that may otherwise be reluctant to support high-risk, high-reward research. These
interdisciplinary research opportunities contribute to job satisfaction as much as salary and job security (Grimwade & Park, 2003; Okamoto & Centers for Population Health and Health Disparities Evaluation Working Group, 2015; Park, Grimwade, Cohen, & Jaffe, 2003). While an existing strategy of the cancer center is to recruit talented scientists who are open to or have a history of interdisciplinary and transdisciplinary collaboration, implementing policies that encourage this work may help to retain these scientists as well, particularly those who are looking for an environment that encourages breakthrough science.

While co-authorship of published papers is a strong objective measure of one type of collaboration, there are limitations to this approach. It takes time for an inter-programmatic collaboration between MCC Members to result in a publication, particularly given the time taken for developing a grant application, obtaining funding, and disseminating results. Other measures of collaborative ties including co-investigators on submitted or funded grants or self-reported collaboration may be useful to broaden the definition of inter-programmatic collaboration in this cancer center. We may also learn more from collecting and analyzing additional characteristics of the MCC Members, as will be described below in areas of future research. As a case study in one NCI-designated Cancer Center, the results may not be generalizable to other institutions. However, given that the CCSG funds 69 NCI-designated cancer centers across the United States, all with similar administrative and research core structures, the policies implemented to improve interdisciplinary collaboration may work in these other cancer centers as well.

To better understand how cancer center administrators can improve interdisciplinary research, next steps will include looking in greater detail at what other factors among MCC Members may contribute to or hinder inter-programmatic co-authorship. Are there specific departments, programs, colleges or authors who are more successful at inter-programmatic collaboration? If so, what might we learn from their success? While the data we currently have allow us to explore additional variables, we may enhance our understanding through qualitative interviews or surveys with MCC Members on additional variables such as research interests, preferred method of collaboration (e.g., in-person, email, video call), or location where they work most often. Spatial proximity plays a definite role in collaboration. A recent evaluation of co-authorship and co-invention ties at Massachusetts Institute of Technology (MIT) revealed that there was a distance limit on collaboration among MIT researchers for both co-authorship and invention (Claudel et al., 2017). Being in close physical proximity was a strong predictor of having a co-authorship or co-invention tie. Inventions were created among collaborators housed within a close distance of one another (e.g., the same building) while co-authorship ties tended to form within same departments or within a discipline, which sometimes spanned buildings. In addition, productive invention requires more diversity in ties; it needs to be interdisciplinary. We argue that the breakthrough science that will transform cancer research requires the type of creativity and innovation of inventions. Therefore, the creation of diverse, interdisciplinary collaborations might be facilitated by co-locating MCC Members in environments that encourage creative interaction.

We may also learn what type of research fosters interdisciplinary collaboration by examining the content of papers that are representative of highly collaborative co-authorship. Using modern text analysis methods, such as topic modeling, the content of the articles and abstracts could
be analyzed to find what kinds of research lends itself to cross-boundary collaborations. Finally, for a cancer center to achieve the Comprehensive Cancer Center designation from the NCI it must demonstrate interdisciplinary collaboration not only within the cancer center, but across institutions. Future studies may evaluate the inter-institution collaborations of MCC Members.

**Conclusion**

Policies that encourage interdisciplinary collaboration among research members of a cancer center are successful as measured by co-authorship of scientific papers. Social network analysis is a useful method for evaluating collaboration over time, particularly the growth and change in co-authorship networks. Implementing mentorship and pilot funding policies that strategically improve cross-disciplinary collaboration may be a useful approach for resisting the tendency for scientists to collaborate with similar others, improving the diversity of scholarly output and creating the breakthrough science needed to reduce the burden of cancer in the U.S.

**Authors’ Notes**

This research was supported by the Research Communications Office as well as the Biostatistics and Bioinformatics and the Cancer Research Informatics Shared Resources of the University of Kentucky Markey Cancer Center, funded by the National Cancer Institute Cancer Center Support Grant (P30CA177558). Dr. Eddens’ contribution was supported in part by a Building Interdisciplinary Research Careers in Women’s Health grant (#K12 DA035150) from the Office of Women’s Health Research, administered by the Department of Obstetrics and Gynecology of the College of Medicine, University of Kentucky. At the time the research was conducted Dr. Eddens was an Assistant Professor in the Department of Health, Behavior & Society, College of Public Health, University of Kentucky, and a member of the Markey Cancer Center Cancer Prevention and Control Program. Dr. Fagan was a doctoral candidate in the Department of Management, Gatton College of Business and Economics, University of Kentucky. Dr. Vanderford is supported by the University of Kentucky’s Cancer Center Support Grant (NCI P30CA177558) and the Center for Cancer and Metabolism (NIGMS P20GM121327).

**Jesse M. Fagan, PhD, MA**
Visiting Assistant Professor
Anderson School of Management, University of New Mexico
1924 Las Lomas Rd NE
Albuquerque, NM 87106, United States of America
Ph: 303-917-5653
Email: aftersox@gmail.com

**Katherine S. Eddens, PhD, MPH**
Assistant Research Scientist
Indiana University
Network Science Institute
Bloomington, IN, USA
Jennifer Dolly, CCRP
Shared Resources Facilities Coordinator
Markey Cancer Center, College of Medicine, University of Kentucky
Lexington, KY, USA

Nathan L. Vanderford, PhD, MBA
Assistant Professor, Department of Toxicology and Cancer Biology
Assistant Director for Research, Markey Cancer Center
Director of Administration, Center for Cancer and Metabolism
College of Medicine, University of Kentucky
Lexington, KY, USA

Heidi Weiss, PhD
Professor, Department of Surgery, College of Medicine
Professor, Department of Biostatistics, College of Public Health
Associate Director, Shared Resource Facilities, Markey Cancer Center
Director, Biostatistics Shared Resource Facility, Markey Cancer Center
Markey Cancer Center, College of Medicine, University of Kentucky
Lexington, KY, USA

Justin S. Levens
Data Management Specialist
Markey Cancer Center, College of Medicine, University of Kentucky
Lexington, KY, USA

Correspondence concerning this article should be addressed to:
Jesse M. Fagan, PhD, MA
Visiting Assistant Professor
Anderson School of Management
1924 Las Lomas Rd NE
Albuquerque, NM 87106, United States of America
Email: aftersox@gmail.com

References


Research Administrators Should Contribute to Improving Faculty Hiring Practices

Nathan L. Vanderford, PhD, MBA
University of Kentucky

As research administrators in academic settings, much of our work is driven by the faculty we serve. Our work is validated and we feel more fulfilled when our faculty are successful. And, importantly, the successes of our faculty bring us more work (i.e., job security!). Oftentimes, we build good professional and sometimes personal relationships with our faculty and we often care deeply about them. The bottom line is that our faculty are important to us.

As research administrators, we know that recruiting faculty can be an arduous venture requiring precise scheduling and pages of paperwork, but what do we know about how faculty search committees operate? Should we care? I believe we should care and further, I believe that we can contribute to improving faculty hiring practices.

As it turns out, faculty hiring practices are a bit contentious. First, significantly more PhDs graduate than there are faculty positions available (Roach & Sauermann, 2017; Schillebeeckx, Maricque, & Lewis, 2013). The surplus of PhDs looking for jobs and the tight funding climate that has persisted for quite some time has created a super competitive situation for the faculty positions that are available. Exceptionally qualified PhDs are missing out on obtaining faculty positions because the market is so competitive.

In a recently published study in Nature Biotechnology, my colleague, Dr. Charles Wright, and I investigated the hiring practices of a faculty search committee at the University of Kentucky (Wright & Vanderford, 2017). Our findings included that a candidate’s research program area, grant funding history, publication history and quality, and perceived academic prestige (such as the institution of training for a candidate and/or the reputation of a candidate’s mentor) played significant roles in the hiring committee’s evaluation. Important to note is that many of these qualities lie in the realm of perceived academic social status.

Our study and others like it have raised concerns in the scientific community about biases in faculty hiring practices. The credentials that hiring committees are using to evaluate candidates can lead to exclusion of certain groups of individuals which then curtails diversity among faculty ranks. As such, there are calls to change faculty hiring practices in a way that will promote more diversity. For example, Montana State University in Bozeman recently implemented a multi-tiered strategy in which hiring committee members participated in unconscious bias training and received information on recruiting diverse candidates prior to screening candidates. Once implemented, the number of female faculty hires increased (Smith, Handley, Zale, Rushing, & Potvin, 2015).
This leads me back to my question at the onset of this article: can we, as research administrators, improve faculty hiring practices? I believe we can and I challenge you all to think of ways you can contribute to this at each of your institutions. Look for opportunities to voice your opinion on how your institution hires faculty. Consider novel ways that could reduce the biases that currently exist. Could you help implement a method for screening faculty applicants in a “blinded” fashion that would aid in mitigating the social status bias? Do you have an idea for increasing the number of underrepresented minority faculty on your campus?

I challenge us all to contribute to this important endeavor. Diversity in our organizations is important for a number of reasons including enhancing competitiveness and excellence and retaining exceptional talent (Gibbs, 2014). Our concerted efforts will pay dividends to the composition of faculty at all of our institutions now and for many years to come.

Correspondence concerning this article should be addressed to:
Nathan L. Vanderford, PhD, MBA
Ben F. Roach Building, 800 Rose Street, CC140
Lexington, KY 40536-0096
Phone: 859-323-2622
Email: nathan.vanderford@uky.edu

References


SRAI’s Mission is to develop, define and promote international best practices in research management, administration, knowledge transfer and growth of the research enterprise.

SRAI is Knowledge
SRA International offers training and continuing education in every facet of research administration. Whether you are looking for SRA International Certificate Program, CPEs, CLE’s and Educational Credits, SRA International offers year-round face-to-face meetings and online webinars that will meet your professional development needs.

SRAI is Collaboration
SRA International is the worldwide community of research administrators and managers that work together to improve professionally and learn from each other. Through the online community of over 5,000 active members in over 40 countries, you will have access to experts from universities, hospitals, government agencies, foundations, the private sector.

SRAI is Excellence
SRAI’s globally-recognized education program provides the most up-to-date, relevant and consistent educational opportunities. Relationships with sister organizations and strategic partners afford members access to research administrators of ability and ambition around the world.

JOIN TODAY - VISIT WWW.SRAINTERNATIONAL.ORG
SRAI membership is an essential investment in your future at every stage of your career.