

Application of project management tools and techniques to support nursing intervention research

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ABSTRACT

Nursing research involves much planning and attention to details, yet novice and seasoned nurse researchers often overlook the day-to-day operations required to conduct research studies. Project management is a set of iterative steps that can facilitate the process of conducting nursing research. In this paper we aim to provide an overview of project management and identify ways in which its specific principles and strategies may be applied to facilitate nursing research. Here we give an overview of our current longitudinal study using a Solomon four-group design and illustrate how we applied strategies and tools from the project management literature. In addition, we offer descriptions and illustrations of several other project management tools that could have been used in specific phases of this research project. We encourage nurse educators and researchers to familiarize themselves with the principles of project management and consider using them in future studies.

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What is known on this topic?

The Centers for Disease Control and Prevention [CDC] identify project management principles and tools for best practices.

- Researchers in multiple disciplines and many countries claim that project management principles facilitate and enhance the research process.
- Checklists and algorithms have previously been identified as useful project management tools for nursing research.

What this paper adds?

- Illustrations of various tools and techniques to facilitate the management of nursing research.

- Applications specific to a longitudinal study using a Solomon four-group study design.
- Details about budget incorporated into the design and planning phase of nursing research.

Application of Project Management Tools and Techniques to Support Nursing Intervention Research

Nurse scientists receive extensive preparation during their PhD programs regarding the planning of rigorous scientific studies through coursework that covers research design, qualitative and quantitative methods,

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and theory development, among other important topics (Henly et al., 2015; Wyman & Henly, 2015). Ideally, PhD students will also have opportunities to work directly with faculty on research projects in order to apply the concepts they are learning in class to a real world setting prior to undertaking their dissertation work and beginning a program of research as junior faculty. Nonetheless, across PhD programs, and even within PhD programs, the extent of content related to managing the myriad details of the study plan, a research team, and unexpected challenges that are inevitable, as well as opportunities for real-world implementation of research can vary. The same can be said for the support resources available for newly minted nurse scientists who are beginning their programs of research as junior faculty.

Even with the best of preparation, PhD students and junior faculty are novices at implementing research studies and managing research teams. Therefore, a quick reference for how to handle such complicated and evolving matters can be of service to any novice or experienced nurse scientist responsible for preparing future nurse scientists. One framework that can be particularly useful in ensuring the smooth implementation of a research study comes from the discipline of project management; namely, principles and strategies from the PMBOK® Guide published by the Project Management Institute (PMI, 2017). Given the extensive length of the PMBOK® Guide, the intensive time commitment required to master its content and successfully pass the project management professional exam, and the relative rarity with which nurse scientists have a project management professional certification themselves or can afford to hire one as a project coordinator given the high salaries they command for such specialized expertise in the business world, a quick reference with basic tips for project management can prove valuable for any nurse scientist who wants to ensure a smooth launch of a research project or who might need to course correct for projects that are not being implemented to their full potential. As such, the purpose of this paper is to extract useful tools and techniques from the field of project management and apply them to an intervention study we implemented using a Solomon four-group (S4G) design. While we offer these tools in the context of our intervention study, these concepts can be applied across a wide variety of research designs and study team configurations.

Overview of Design and Intervention

In the remainder of this paper, we will discuss the general process of nursing research as we applied it to the development and execution of a longitudinal intervention study of homeless youth. We will provide a brief description of the study as it was proposed and is being conducted followed by a more detailed description of ways in which we applied project management concepts from the PMBOK® Guide (PMI, 2017), or ways

in which we could have improved our study had we applied such concepts.

Phase One: Conceptual

The first phase of the nursing research process is generally referred to as the conceptual phase in which the principal investigator (PI) and research team identify the problem, review the appropriate literature, select a conceptual or theoretical framework, and propose a research design to answer research questions or test research hypotheses (Polit & Beck, 2017). We are currently conducting an intervention study using a S4G design (Flannelly, Flannelly, & Jankowski, 2018). The intervention is based on a positive psychology theoretical and conceptual framework (Markus & Nurius, 1986).

Using this positive psychology framework, our intervention is designed to meet homeless youth where they are as individuals and provide information concerning effective communication, goal setting, staying healthy, and decreasing health-risk behaviors. The intervention consists of six modules or conversations delivered by graduate research assistants (GRAs) with the aid of images and words presented via laptop computer. The intervention facilitators incorporate basic principles from Motivational Interviewing (Miller & Rollnick, 2013) and follow a manualized program developed specifically for this population. Manualization of the intervention assures that we maintain intervention fidelity throughout the study (Rew, Banner, Johnson, & Slesnick, 2018). We did not apply PMI strategies or techniques during this phase of the intervention study because the members of our research team who were responsible for the conceptual phase had not yet been introduced to project management or the PMBOK® Guide (PMI, 2017).

Phase Two: Design and Planning

The second phase of the nursing research process is that of design and planning. In this phase, we selected our research design, considering our purpose and making decisions that would influence the internal and external validity of the study. In this phase we also planned our intervention protocol, selected the appropriate population, developed a sampling plan, selected appropriate measures for theoretical variables, developed a plan for the protection of human subjects, and developed our budget. Each of these steps was or could have been facilitated by applying strategies and/or tools from the PMBOK® Guide (PMI, 2017).

Research Design

We selected the S4G design because of previous experiences with interventions in the target population and to control for sensitization that might occur with pretesting. The S4G design is one of three true experimental designs, as identified by Campbell and Stanley (1963), and controls for all threats to internal validity as well as for the interaction of testing and intervention, which is a threat to

external validity. In this design, participants are randomized to one of four groups: (a) pretest + intervention; (b) pretest + control condition; (c) intervention with no pretest; or (d) control condition with no pretest. The design as we modified it to include additional longitudinal findings is depicted in [Figure 1](#).

In selecting this design, we used expert judgment, a PMBOK® Guide technique, led by two PIs (hereafter referred to as multiple principal investigators (MPIs) and the co-investigator given their extensive knowledge, training, and experience. As in other nursing studies, our design was based on our specific aims, hypotheses, and research questions. Our decision to have MPIs was driven by the assumption that this design would require a relatively large sample and the aims would, therefore, be more easily met with two geographic sites for participant recruitment and intervention delivery. Hereafter these will be referred to as the “primary site” and the “secondary site.”

Protocols for Intervention

Given that homeless youth, ages 18 to 24 years, are vulnerable to adverse health outcomes related to risky sexual behaviors and substance use, we developed a brief intervention that was based on a positive psychology paradigm ([Markus & Nurius, 1986](#); [Seligman & Csikszentmihalyi, 2000](#); [Shogren, Lopez, Wehmeyer, Little, & Pressgrove, 2006](#)). We selected this approach because of its focus on positive youth development ([Benson & Saito, 2001](#)) rather than emphasizing deficits and problems associated with being homeless. The intervention and issues related to its fidelity are described in detail elsewhere ([Rew et al., 2018](#)) and are beyond the scope of this paper. We had pilot-tested several key aspects of the intervention using a group format in an earlier study ([Rew, Powell, Brown, Becker, & Slesnick, 2017](#)) and found that this population was receptive to the messages, but we encountered many challenges with convening groups. Thus, in developing protocols for the current study, we further pilot-tested the current content using a face-to-face individual intervention and determined that this approach was satisfactory to the population. By implementing two pilot studies, we were able to address issues we believed we might encounter in the larger study. For example, we knew that we had only a few hours each week when we could encounter and work with these adolescents because of the limited time the drop-in centers (i.e., services organization) were open to offer

services to these homeless youth at the primary site. This influenced our decision to develop a brief protocol that required minimal staff time to implement, thus making it translatable.

Although we identified and planned for issues encountered during the pilot studies, there were other problems that were not identified nor considered such as, drop-in center closures. Several techniques from the PMBOK® Guide, may have helped us to uncover potential problems that we did not discover during the pilot studies. These qualitative techniques include assumption and constraint analysis and root cause analysis. We could have used a root cause analysis tool such as a fishbone diagram depicted in [Figure 2](#). Root cause analysis would have provided a brainstorm session to identify main causes in the process of recruitment and generate factors that contribute to the main causes that warrant further investigation ([PMI, 2017](#)).

Population

The focus of our intervention study is the homeless youth population. In our proposal for funding the study, we defined the homeless as individuals who reside “in a shelter or on the street or living independently because they had run away, been pushed out, or drifted out of their family of origin” ([Haldenby, Berman, & Forchuk, 2007](#), p. 1232). We selected this population because the MPIs both had programs of research that focused on these youth who are greatly underserved, understudied, unprepared for adulthood, and profoundly vulnerable to several adverse health conditions. We further focused on homeless youth between the ages of 18 to 24 because we knew that this age group faced particular challenges owing to their lack of education and social skills as well as their high rates of engagement in risky behaviors (e.g., substance use and risky sex; [Rosenthal, Mallett, Milburn, & Rotheram-Borus, 2008](#); [Thrane, Chen, Johnson, & Whitbeck, 2008](#)).

Sampling Plan

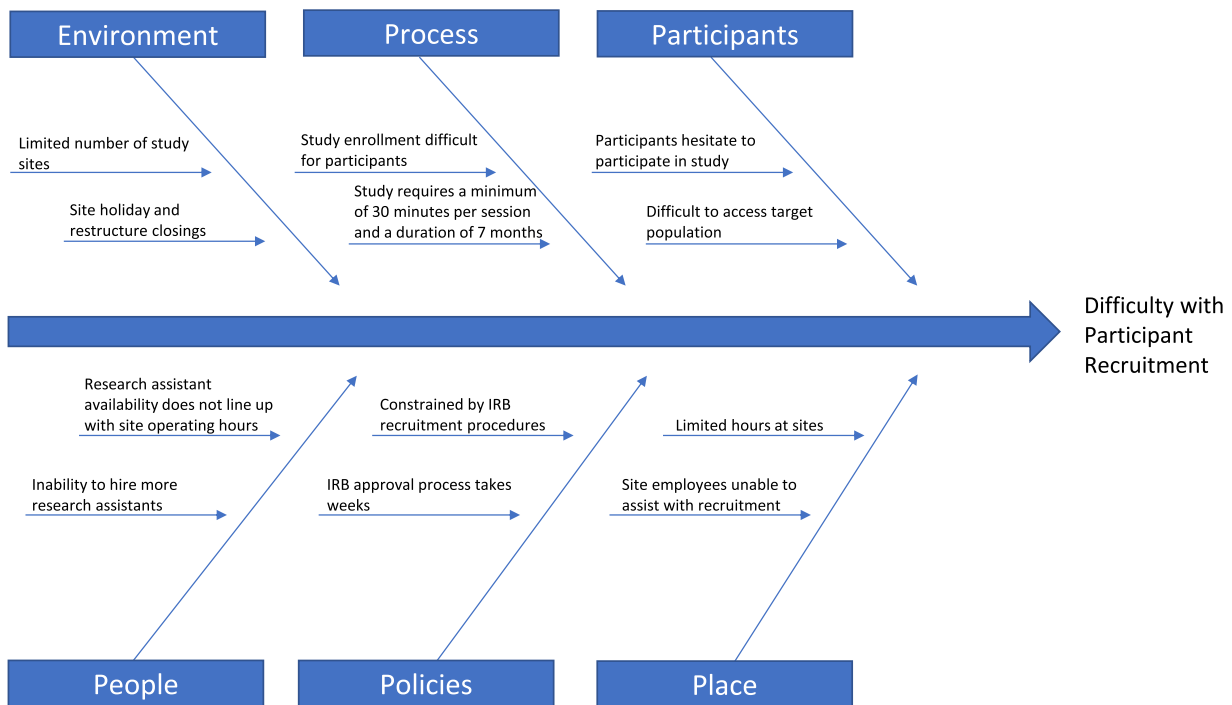
All researchers need to consider certain elements when developing a sampling plan. In our study, we considered the requirements for our research design (S4G with repeated measures) and the number and type of specific aims we had to meet (i.e., four). Using PMBOK® Guide’s technique, expert judgment, again, we anticipated from our previous experience and other investigators in this field, that retention of the sample could be difficult. While writing our proposal, we

Randomized Group	Conditions and Testing Pattern					Group Designation
	Pre-test	Intervention	Post-test	3-mo. post-test	6-mo post-test	
Group 1 (R)	Pre-test O ₁	Intervention X	Post-test O ₂	3-mo. post-test O ₃	6-mo post-test O ₄	R O ₁ X O ₂ O ₃ O ₄
Group 2 (R)	Pre-test O ₅	Control	Post-test O ₆	3-mo. post-test O ₇	6-mo post-test O ₈	R O ₅ O ₆ O ₇ O ₈
Group 3 (R)	No pre-test	Intervention X	Post-test O ₉	3-mo. post-test O ₁₀	6-mo post-test O ₁₁	R X O ₉ O ₁₀ O ₁₁
Group 4 (R)	No pre-test	Control	Post-test O ₁₂	3-mo. post-test O ₁₃	6-mo post-test O ₁₄	R O ₁₂ O ₁₃ O ₁₄

Note. R = randomized; X = intervention condition; O = observation; mo. = month; measurement of variables.

From "Intervention fidelity and facilitator training" by Rew, Banner, Johnson, and Slesnick, 2018, Western Journal of Nursing Research. Reprinted with permission.

Figure 1 – Solomon four-group design for possible selves intervention for homeless youths.



Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK(R) Guide), Sixth Edition, Project Management Institute Inc. Used with permission.

Figure 2 – Fishbone diagram to identify challenges in participant recruitment.

conducted a power analysis and determined that in addition to a second site that we had already identified in another large city, we would need to tap all the possible areas where homeless youth gathered in our primary site.

As the project unfolded, we encountered some difficulties recruiting our projected sample size in this primary site—a common challenge in collecting data, particularly from understudied and underserved communities. A tool sometimes used by project managers to troubleshoot issues is a spider web diagram depicted in Figure 3. We could have used a spider web diagram early on to brainstorm ideas about where to access more of this population. It is a very quick and easy way to write down facts and ideas that branch out from the center, leaving endless possibilities. The PMBOK® Guide (PMI, 2017) currently recommends mind mapping, which reflects the common ground as well as differences in understanding or generating new ideas. Mind maps are made up of color, words, and pictures to address more complex problem solving and are similar to using a spider web diagram.

Measures

The measures we used to operationalize the many constructs examined in this study were identified in our proposal for funding and then transformed into a data collection plan to be used throughout the study. When we created the data collection plan, we used the

PMBOK® Guide's expert judgment technique (PMI, 2017). Through our review of the extant literature on this population and our previous experience with them, we determined that the best approach was to use an interviewing method to obtain quantitative data. Based on this knowledge, we decided to use research electronic data capture (REDCap) hosted at the primary site (Harris et al., 2009). This approach would be the most efficient and secure way of collecting and archiving the data. We could have used the PMBOK® Guide's alternative analysis technique during the decision-making process (PMI, 2017). This technique would have facilitated a discussion of any and all alternatives, weigh the pros and cons, and determine the best solution.

After implementing all of the scales in this electronic program, we were able to orient our GRAs to collect data by asking various questions by individual interviews thus reducing the chances that some participants might not answer all questions. This decision prevented many of the analytic issues related to missing data. This decision also allowed us to keep all the data collected in one secure electronic repository.

When designing and planning the selection of data collection methods or tools it is important to determine who will be responsible for different tasks and when each task will be completed. Although we created a high-level schedule of key aspects of the study, we could have devised a visual timeline with tasks and duration for all study activities to ensure completion

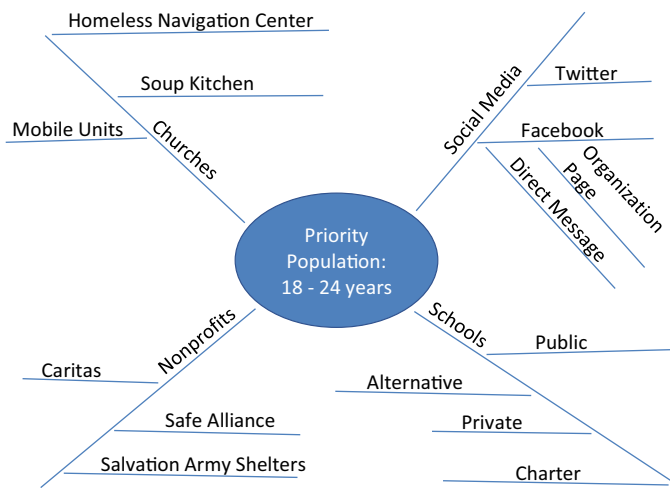


Figure 3 – Spider web diagram as brainstorming tool.

of the required tasks and outline expectations for GRAs. *PMBOK® Guide’s* schedule management process defines activities that are sequenced with the required resources (people, equipment, and supplies), the duration of each activity and is monitored and controlled throughout the project depicted in Figure 4 (PMI, 2017). A schedule management plan would have helped us determine if our assumptions were feasible given our resources and ensure staff complied with design requirements.

Protection of Human Rights

This study of homeless youth involves a particularly vulnerable population whose rights must be protected. As outlined in our proposal to the funding agency, we planned for numerous ways to protect the privacy, confidentiality, and safety of our participants. In

addition to submitting our research proposal to the institutional review boards of both universities, we developed a data and safety monitoring board (DSMB), which consisted of two senior research faculty from different disciplines at the host university. The purpose of this DSMB was to meet annually and review the policies and procedures of our protocol to ensure that all participants had been consented correctly and that the data were being collected and stored such that participants’ privacy and confidentiality were maintained and that the data were kept securely on a single server. The DSMB’s annual report was included in the annual report to the funding agency. In addition, because this was an intervention study that included collecting data on drug and alcohol use, we obtained a Certificate of Confidentiality from the National Institutes of Health to provide further protection against

Task	Assignee	Period		Days	Year					Notes
		Start	Finish		2016	2017	2018	2019	2020	
In Intervention to Promote Healthy Behaviors in Homeless Youth		04-01-2016	03-31-2020							
Obtain IRB Approval	PI	04-01-2016	04-30-2016	21	█					
Obtain Certificate Confidentiality	PI	04-01-2016	04-30-2016	21	█					
Set up Database	PI/Project Coordinator	04-01-2016	04-30-2016	21	█					
Order Equipment/Supplies/Print Materials	Project Coordinator	04-01-2016	04-30-2016	21	█					
Hire and Train Staff	PI/Project Coordinator	04-01-2016	09-30-2016	131	█					
Recruit Participants	Research Assistants	05-01-2016	10-31-2018	653	█	█	█			
Recruitment Kick Off	Research Assistants	05-01-2016	05-31-2016	22	█					
2016 Summer	Research Assistants	06-01-2016	07-29-2016	43	█					
2016 Fall	Research Assistants	08-01-2016	12-16-2016	100	█					
2017 Spring	Research Assistants	01-02-2017	05-31-2017	108		█				
Administer Intervention	Research Assistants	06-22-2016	05-31-2019	768	█	█	█			
Demographics/Screen/PreTest/\$15	GRA 1									
Module 1 and 2	GRA 2									Dependency: Must complete Demo/Screen
Module 3 and 4	GRA 2									
Module 5 and 6	GRA 2									
Post Test 1/\$20	GRA 3									Dependency: Must complete modules 1-6
Post Test 2/\$25	GRA 3									
Post Test 3/\$30	GRA 3									
Fidelity Checks	PI/Project Coordinator	07-29-2016	05-31-2019	741	█	█	█			
Document Lessons Learned	Project Coordinator	08-01-2016	03-31-2020	957	█	█	█	█		
Data Safety Monitoring Board Meetings	PI, DSMB Team, Project C	01-15-2017	01-15-2020	783	█	█	█			

Figure 4 – Gantt chart sample study schedule.

the loss of the participants' confidentiality and to further ensure the veracity of their responses to sensitive questions about their substance use.

We monitored the GRAs' activities and data collection efforts throughout the project to ensure the safety of the participants and to minimize the risk of adverse outcomes. We did not use the participants' names along with their data. Rather, we connected the repeated measures to each participant through the use of a unique code number developed from the state (primary or secondary site) in which the participant enrolled in the study, their date of birth, and their order of enrollment in the study. A separate list of these identification codes along with information about how to contact the participant was kept in a secure online repository and locked in a file cabinet in the university research lab (Figure 5). The GRAs accessed the contact information as needed via a secure electronic connection and repository, and they used project-owned cell phones to communicate with the research participants to ensure that we maintained confidentiality and retained participants.

Budget

In planning our study, we used top-down estimating that was informed primarily by expert knowledge from the two PIs (MPIs), one from each of the two research sites, who had previous experience conducting intervention studies with this population (Figure 6). The MPIs first reviewed the National Institutes of Health's (NIH's) Allowability of Costs/Activities within the Cost Consideration section of its policy (National Institutes of Health, 2019). NIH's Cost Consideration policy helps researchers to differentiate and understand direct and indirect costs and how to handle both.

Once we identified our top-level budget numbers for our direct expense categories, amounts were allocated to individual functions to create a detailed budget. Within each category we identified tasks that would need to be completed throughout the study. We began with a general category of personnel, then we estimated how much time it would take for various types of personnel to complete the tasks associated with the study and what that would cost. For example, we allocated a budget for the MPIs and we concluded that 20%

to 30% of their time would be covered to oversee the work for the duration of the study.

The PMBOK® Guide offers two strategies to facilitate the budgeting process: top-down estimating and bottom-up estimating (PMI, 2017). The bottom-up method requires looking at the steps needed to carry out an individual project and associates a cost to each step. If the bottom-up technique would have been used the team could have discovered a few tasks that had potential fees associated. One of the tasks that incurred additional fees was background checks at one of the drop-in centers. We did not initially know background checks had to be done by one of our community partners at the primary site. If we would have listed onboarding tasks, we could have identified background checks performed by our community partner and planned for the possible risk of our project having to fund this requirement.

Phase Three: Empirical

The empirical phase of nursing research is that of collecting data from the research participants. This phase generally consists of two major tasks: collecting data and then preparing the data to be analyzed. This phase typically comprises the greatest amount of time and is the phase in which many of the strategies and tools of project management were vitally important.

Data Collection

Using our S4G design with repeated measures, we had to devise a plan for random assignment of participants to intervention or control condition as well as to pretesting or no pretesting. We developed a randomization chart to be used at each of the universities involved in this study (Figure 7). This chart is described in detail in a previous publication (Rew et al., 2018), but it consisted of a sequence of computer-generated random numbers from 1 to 300 for each site paired with an enrollment order such that each time an individual would volunteer to be in the study. A research assistant, who was blind to the randomization chart, would first collect demographic data from the participant, then consult the randomization chart and assign them to one of four conditions: (a) pretest and intervention, (b) pretest and control, (c) no pretest and intervention,

Contact Information											
Primary GRA	TX ID #	Interv/Control	Refer to as	Notes	Contact Info.	Interven. Needs	Recording Consent	Due/Next	GRA Name	Type Contact	Week of 11/4
Sally	TX01	Interv	She/her	10.31 Needs to complete P1	555-666-7777	yes	yes	11.9.19	Sam	phone	
Bill	TX02	Control	They/them	P1: schedule in 3 weeks	222-333-4444	No	Yes	11.9.19	Sally	phone	

Legend: TX ID # = participant identification number; Interv/Control = intervention or control condition; Info = information; Interven. = intervention; GRA = graduate research assistant. P1 = first post-test

Figure 5 – Contact information form used in an intervention study of homeless youth.

The overall project is estimated first, and individual tasks are apportioned from it. You start from the **top** of the pyramid and work downwards.

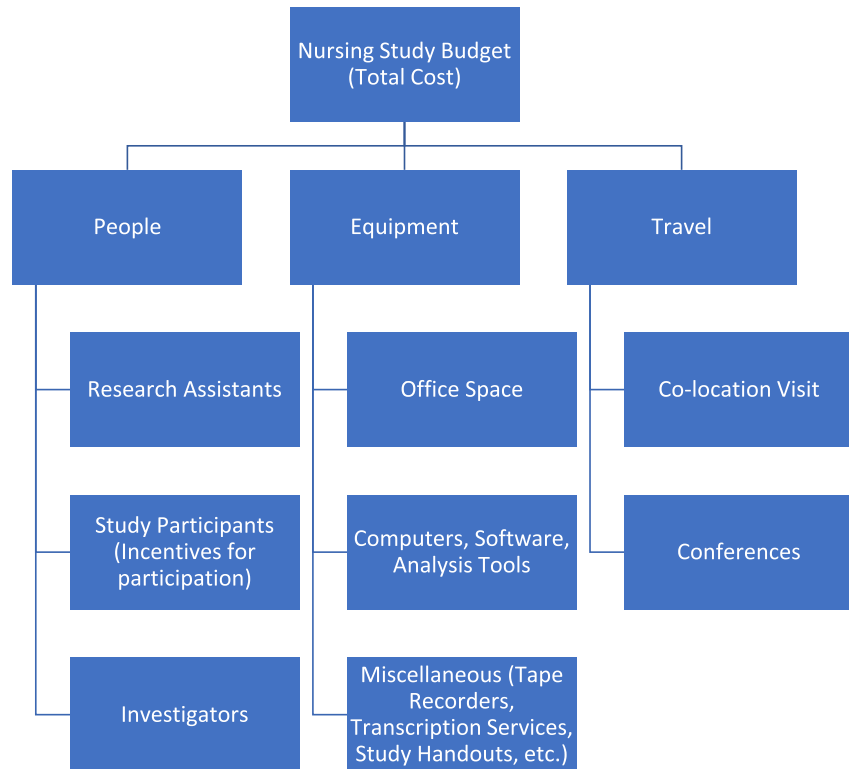


Figure 6 – Top down estimating to determine study costs.

or (d) no pretest and control. After determining the condition to which the participant was to be assigned, a research assistant would then collect pre-test data (i.e., the operationalized measures of study constructs) from those in the first two conditions. These data were collected using a laptop computer or iPad. Participants’ responses were coded directly into the REDCap database for the study.

The randomization chart was developed for this study by the first author and is similar to a Gantt chart used in project management. One version of a Gantt Chart is provided in Figure 4. Gantt charts are used for planning projects of all sizes and are a useful way of showing what work is scheduled to be done in a

specified sequence and time. Gantt charts provide a detailed dashboard of project status, dependencies, tasks, budgets, and more (PMI, 2017). The randomization chart developed for this study provided a view of the condition the participant was assigned to and the ability to mark the completion date for each task for that specific condition. If we had used the Gantt chart we could have monitored incentives (i.e., gift cards) in one document instead of creating additional excel spreadsheets to log and track incentives. Similarly, with a Gantt chart we could have more easily shown when the first post-test should have been given relative to the intervention.

Enrollment Order	R Group	Modules 1 – 6	Time 1	T 2	T3	T4
1	1	• • • • • •	Date	Date	Date	Date
2	4	X X X X X X	None	Date	Date	Date
3	3	• • • • • •	None	Date	Date	Date
4	2	X X X X X X	Date	Date	Date	Date
5	3	• • • • • •	None	Date	Date	Date
6	2	X X X X X X	Date	Date	Date	Date
7	1	• • • • • •	Date	Date	Date	Date
8	4	X X X X X X	None	Date	Date	Date

Note. R Group = randomized groups (Groups 1 + 2 complete pretest; 3 + 4 do not complete pretest; 1 + 3 receive intervention; 2 + 4 receive services as usual); • = received intervention sessions; X = received services as usual. Time 1 = pre-test; T2 = first post-test; T3 = 3-month post-test; T4 = 6-month post-test.
 From "Intervention fidelity and facilitator training" by Rew, Banner, Johnson, and Slesnick, 2018, Western Journal of Nursing Research. Reprinted with permission.

Figure 7 – Randomization of participants to Solomon four-groups in possible selves intervention for homeless youths.

The study was carried out in two large public universities and the two PIs each faced the challenge of hiring and training graduate students as GRAs throughout the study. This entailed developing orientation materials and monitoring human subject protection education throughout the life of the study. Specific to the primary site, each semester GRAs rolled off the project as they graduated from their respective programs and we hired new GRAs. Due to the turnover, we trained new staff every semester; this required face-to-face meetings to orient graduate students to the study and to train and role play the intervention with them. We then instructed them to review online training videos, listen to voice recordings of interventions provided by experienced GRAs, and participate in on-the-job training with qualified GRAs. Training materials were updated with lessons learned on a regular basis. A living *lessons learned* register was provided to all GRAs via a secure online repository. The *lessons learned* register was a subsidiary document to the overall *lessons learned* report.

Creating a *lessons learned* register is a PMBOK® *Guide* technique that was used throughout this project to document the knowledge gained over the course of the project that detailed how the study events were addressed or might be addressed in the future (PMI, 2017). For example, we learned we could not depend solely on our community partners to recruit new participants due to limited staff, drop-in center closings and seasonal decrease in visitors to the drop-in center. Although we brainstormed recruitment strategies such as distributing flyers and engaging with homeless youth at various locations throughout the city, we could have used PMBOK® *Guide* brainstorming tools or techniques such as the spider web diagram (Figure 4) or nominal group brainstorming (PMI, 2017)

We also developed an additional study inspired by our *lessons learned* efforts. We wanted to capture *lessons learned* about what worked and what did not work from the GRAs before they rolled off the project. Consequently, we developed a qualitative study wherein the departing GRAs answered a series of open-ended questions about their experiences in maintaining intervention fidelity.

Data Preparation

Before data can be analyzed in the next phase of nursing research, it must be transformed through a process of coding, which occurred during the empirical phase. Each item of data collected from the participant was given a variable name that was coded and maintained in a secure online repository and a binder (code book) kept in the research lab. Notes about reverse coding, etc. were kept in this format.

Monthly or quarterly inspections of the data collected enabled the PI at the primary site to identify data entry errors. Based on the PMBOK® *Guide's* quality control inspection technique, examination of the *work product* can determine if it conforms to the documented standards. Applying this technique, we were able to catch

minor errors, such as duplicate responses to scale items and missing numbers in unique identity codes.

Phase Four: Analytic

The fourth or analytic phase of nursing research includes the statistical analysis and interpretation of data collected and prepared in the previous phase. This phase can be broken down into two steps: (a) data analysis, and (b) interpretation of the findings.

Data Analysis

All data collected and analyzed for this ongoing study are quantitative and will be analyzed using IBM SPSS version 26. Data from the secondary site is captured in the electronic data capture (REDCap) hosted at the primary site. The advantage of using this electronic strategy is to avoid errors associated with data entry from paper-pencil survey. The data will be evaluated for accuracy, missing data, out-of-range values, and violation of statistical assumptions. If such assumptions are violated, the data will be transformed or alternative analyses will be conducted. When appropriate, internal consistency reliability for all data collected by established scales will be computed and a Cronbach's alpha of 0.70 or higher will be considered acceptable. Plans will be developed to deal with missing data. This occurrence has been minimized throughout the study by periodic checks of the data and continuous reminders given to the GRAs to monitor their own data collection procedures to ensure that all data are collected. These checks are very similar to a PMBOK® *Guide* technique called a quality audit. A quality audit is conducted by an external team or person that may include but is not limited to: identifying all nonconformity, gaps, and shortcomings or sharing good practices introduced or implemented in similar studies (PMI, 2017). We could have used one of the most common quality improvement tools called Plan-do-check-act (PDCA). PDCA is a cyclical process in which one identifies the problem(s), tests possible solutions, studies the results, and then implements the best solution. Yet, rather than going through the PDCA cycle, we chose to use expert judgment due to the paucity and simplicity of the mistakes discovered.

Interpretation of Findings

In this step, we will interpret the results of our statistical tests to answer the research questions and test the hypotheses identified before data collection began. We do not plan to apply specific project management tools at this step because this effort requires the investigators' understanding of the findings in light of a broader knowledge of the literature about our population and the theoretical framework that guided the development of our intervention.

Phase Five: Dissemination

The fifth and final phase of nursing research is dissemination. This phase consists primarily of communicating

the findings from the study to other researchers, clinicians, facilities where data were collected, and the funding agency. This dissemination usually consists of published abstracts and articles as well as podium and poster presentations at professional meetings. It is also advisable, particularly in community-based research involving vulnerable populations, to share results with the community, such as community agencies and the participant population.

Closing of the Project

When we prepare to close out the study, we will apply PMBOK® *Guide* techniques to finalize all activities (e.g., terminate cell phone service, capture final lessons learned, archive all related documents to be used as historical data, and perform team members' assessments of their participation in the project). It is critical to run a debriefing session to hear and understand feedback from team members about what went well, what did not, and how it could have been improved (PMI, 2017). Once lessons learned have been captured and documented, it is important they be stored along with all other relevant documents for retrieval and use as historical data. Prior to storage, the documented data will be reviewed and analyzed to identify actions that could be taken to strengthen any weak areas of knowledge and implementation. Once the information is archived, the planned work is complete and the MPIs will sign off the project and the study can be closed. The feedback and lessons learned that we review in this final phase will be used to plan the next study in the research team's programs of research.

Discussion

Designing, planning, and conducting research are essential to the development of a professional discipline such as nursing science. Project management, pragmatic information about how to conduct successful research in all of its details, is often missing in the everyday running of a research study. Difficulties in health research projects are rarely due to methodology, but to the management of the day-to-day details that are insufficient or problematic (Usherwood, 1996). The CDC, therefore encourage researchers to apply the principles of project management; moreover, they provide web-based information and tools for best practices (CDC, n.d; Payne et al., 2011).

Researchers from around the world emphasize the advantages of applying project management principles and skills to various research projects (Howarth, Probyn, & Maz, 2017; Pant & Baroudi, 2008; Riol & Thuillier, 2015). Researchers in Brazil, for example, argue that conducting academic research (as in the pursuit of a PhD) would be facilitated by applying the principles of project

management outlined in the PMBOK® *Guide* (Mustaro & Rossi, 2013). Similarly, Farrell, Kenyon, and Shakur, (2010) noted that much had been written about the need for randomized, controlled trials as the "highest level of evidence" to guide clinical practice (2010, p. 78); however, they also noted that very little had been written about how to manage these trials. These researchers further noted that clinical trials had many aspects that were similar to those of business projects and argued that the steps in project management as outlined by the PMI should become a standard training requirement for conducting clinical trials. Researchers in cardiac research from Iran echoed Farrell et al. (2010)'s concern that managing clinical trials is complex, yet little knowledge about how to do this well could be found (Goodarzynjad & Babamahmoodi, 2015).

As Mitchell and Jones, (2004) noted, although many textbooks have been written about nursing research, "researchers have continued to neglect the practical issues required to sustain clinical research in action" (p. 42). In the present article, we have identified and illustrated several strategies and tools used by project managers that could be used to improve the processes of nursing research. We believe that nurse educators should spend more time teaching graduate students and novice researchers about the principles and strategies of project management to facilitate the writing of research proposals and to enhance all phases of conducting nursing research. Nurse educators and senior researchers would do well to familiarize themselves with the principles and strategies of project management and become acquainted with the PMBOK® *Guide* (PMI, 2017). At the organizational level, faculty could be provided with support (e.g., financial support, protected time) to take a course offered in person or online in project management. This would serve not only to help their research projects and teams run as efficiently as possible (thus yielding the most rigorous data possible for whatever study design they are using), but also to help prepare the next generation of PhD-prepared nurses to employ these techniques in their research studies.

Conclusions

In this paper we described actual and potential applications of strategies and tools described in the PMBOK® *Guide* in an ongoing longitudinal intervention study. In particular, we provided examples of brainstorming, lessons learned, expert judgment, using a fishbone diagram to conduct a root cause analysis, using a spider web diagram for brainstorming, estimating budget with a top-down process, and developing a Gantt chart to depict the order for project tasks. We noted, as have others, that the details inherent in having a nursing research project run smoothly, on time, and within budget can be assured by applying principles of project management as detailed in the PMBOK® *Guide*. We encourage nurse educators and researchers alike to

familiarize themselves with these tools and techniques and consider using them in future projects.

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