Synthesizing Existing Evidence and Leveraging Expert Opinions to Develop a University, For-Profit, and Not-For-Profit Organization Partnership Model to Address Health Professions Education Gaps through Simulation-Based Education

by

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The above committee determined that the thesis is acceptable in form and content and that a satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate during an oral examination. A signed copy of the Certificate of Approval is available from the School of Graduate and Postdoctoral Studies.

ABSTRACT

Healthcare providers in rural and remote (R&R) areas of Canada do not have the same access to skills development and maintenance opportunities as those in urban areas. Simulation-based education (SBE) is an optimal technique to allow healthcare providers to develop and maintain skills. However, SBE is mainly limited to universities or hospital-based research laboratories in urban areas. The purpose of this thesis was to develop a partnership model between university research laboratories, for-profit organizations, and not-for-profit organizations to diffuse SBE into R&R communities. Phase A aimed to identify the problem and present a solution through an editorial paper. Phase B consisted of a scoping review to understand the current landscape of literature. Phase C was a qualitative descriptive study interviewing stakeholders to understand their perspective experiencing the partnership process. All three phases were consolidated to create a partnership model to deliver simulation solutions to R&R healthcare settings.

Keywords: healthcare provider training; simulation-based education; rural and remote; partnership model; health professions education

AUTHOR'S DECLARATION

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SAMYAH SIRAJ

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LIST OF ABBREVIATIONS AND SYMBOLS

3D	Three-dimensional
AM	Additive manufacturing
CFPC	College of Family Physicians of Canada
CME	Continuing medical education
CFIR	Consolidated Framework for Implementation Research
EDI	Equality, diversity and inclusion
EDR	Educational design research
FPO	For-profit organization
HALO	High acuity low occurrence
HPE	Health professions education
iKT	integrated knowledge translation
JBI	Joanna Briggs Institute
KU	Knowledge user
NPO	Not-for-profit organization
PHSR	Public health systems research
PI	Principal investigator
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
R&D	Research and development
R&R	Rural and remote
SBE	Simulation-based education
SBHPE	Simulation-based health professions education
ScR	Scoping review
SRQR	Standards for reporting qualitative research
SWOT	Strengths, weaknesses, opportunities, threats

Chapter 1: Introduction

1.1 Problem Statement

1.1.1 Magnitude of the problem

The right to health is a fundamental right which all individuals are entitled to. It is the economic, social, and cultural right to a universal minimum standard of health (Ghebreyesus, 2017). When looking at this right through the lens of health professions education (HPE), which includes doctors, nurses, and other allied health professionals, all healthcare providers should be competent, and therefore have access to optimal training resources to develop and maintain competencies (Ghebreyesus, 2017). According to Reason's Swiss cheese model, an improved standard of HPE can be explained as filling in one hole in the system that would lead to a stronger healthcare system (see Appendix A) (Perneger, 2005). More specifically, as it applies to healthcare in general, the Swiss cheese model suggests that the system's defenses against failure, such as patient harm, are modeled as a series of imperfect barriers, represented as slices of cheese. The holes in the slices represent weaknesses in individual parts of the system and these holes are dynamic in size and position across the slices. The system as a whole permits adverse events when holes across all slices momentarily align. HPE can be considered one of these slices in the healthcare system and minimizing the number and sizes of the holes in this slice, through improved educational models and technologies, must be the focus of researchers, educators and practitioners embedded in this field.

In rural and remote (R&R) areas of Canada, healthcare providers, such as physicians and nurses, may not have the same access to skills development and maintenance opportunities as those in urban areas due to factors such as distance from urban centers and cost (Williams et al., 2020). The inexperience and lack of training for healthcare providers is one factor that has impacted Canadians who present with poor health and medical emergencies in R&R settings (Bosco & Oandasan, 2016). The College of Family Physicians of Canada (CFPC) highlights the need to develop contextual competencies of providers to practice in R&R clinical settings, notably because there is limited access to specialized resources in those areas (Bosco &

Oandasan, 2016). The CFPC recognizes the need to reform HPE due to the significance the level of education, in relation to training and competencies, has on adequately serving the health needs of the population (Bosco & Oandasan, 2016). Thus, a shift is being made towards a competency-based curriculum in medical education to ensure healthcare providers and trainees acquire experience in diverse learning and work environments to aid them in responding to the health care needs of the communities they serve. This will allow healthcare providers to give more comprehensive care and have more advanced procedural skills to reflect their broad scope of practice and broad range of clinical procedures. To improve R&R education programs, one of the objectives that the CFPC has identified is to develop tools to increase access to clinical training, with one such tool being simulation technology (Bosco & Oandasan, 2016). Healthcare providers and trainees who practice in R&R areas require more opportunities to develop and maintain their clinical competencies, especially those required for high acuity, low occurrence (HALO) events. HALO events are procedures that healthcare providers rarely perform, but require a time-sensitive response when they do occur. As such, healthcare providers need to be adequately trained to perform these procedures, and skills training maintenance mechanisms put in place, as they cannot be predicted, and they may be the only person who can perform the procedure without the ability to ask questions (Chiniara et al., 2013). Simulation is one way of providing hands-on experiences to healthcare providers and trainees for HALO skills; however, the costs of simulators are one barrier that R&R practitioners face.

Simulation-based education (SBE), defined as a replication of a real task (or patient encounter) for the purpose of training or assessment for quality improvement, is proven to be a key aspect of HPE (Hamstra et al., 2006). Complementary to many other pedagogical approaches, such as didactic teaching and clinical placements, SBE serves as an optimal tool to allow healthcare providers to develop and maintain skills and can be used for assessment and evaluation without endangering the safety of a patient (Asghar et al., 2021). However, due to the high cost of SBE related to technologies used (e.g. simulators), skilled simulation technologists, and training infrastructure (e.g. simulation laboratories), it is limited to well-resourced educational systems (Goudie et al., 2019).

As it relates to the availability of technologies, the advent and reduced costs of Industry 4.0, brings promise of improved availability of affordable simulators globally. Industry 4.0 is considered the fourth revolution in manufacturing through its use of emerging technologies that deeply integrates business and engineering processes to make production flexible, efficient, and sustainable in a way that maintains high quality and low cost (Machado et al., 2022). Industry 4.0 is continuously evolving and enabling sustainable manufacturing through augmented simulation, additive manufacturing (AM), and similar technologies to create a positive impact in the production and distribution of its technologies (Machado et al., 2022). Three-dimensional (3D) printing is the most known form of AM, a computer-controlled process that creates three dimensional objects. 3D printing technologies are a useful tool in medical training and healthcare due to its customizability to fit any context and the reduction of costs in production (Kholgh Eshkalak et al., 2022). In R&R areas, healthcare providers and trainees practice clinical skills on cadavers or animal parts, such as pig feet, in authorized hospitals and educational institutions, which are costly to maintain and not reusable, or by using costly simulators (DiMaggio et al., 2010). AM techniques are an economic solution that moves away from the use of animal products to a more ethical, sustainable method for training. Developing simulators in a research laboratory can help reduce costs locally (Barth et al., 2022), internationally (Micallef et al., 2021), in low- and middle-income contexts (Goudie et al., 2019), and in R&R contexts (Bishop et al., 2019; Sivanathan et al., 2022). However, the Industry 4.0 augmented development and fabrication of simulators are currently limited mainly to university or hospital-based research laboratories in urban areas of developed countries, and are rarely diffused to R&R settings, where they can create a greater impact.

To date, there are no specific SBE-focused partnership models that address how Industry 4.0 augmented simulation technology can make its way from university research laboratories into the HPE system. Partnerships are a formalized relationship consisting of a joint effort to achieve mutual goals where each partner's roles and responsibilities are clearly outlined (Global Hive, n.d.). The working definition established by the World Health Organization (WHO) for the African Partnerships for Patient Safety programme is used to define the term 'partnership' for this thesis. The programme defines partnership

as a “collaborative relationship between two or more parties based on trust, equality, and mutual understanding for the achievement of a specified goal. Partnerships involve risks as well as benefits, making shared accountability critical” (WHO, 2009). This definition draws from existing literature that define the term ‘partnership’ to incorporate key building blocks, which are complete interdependence, mutual accountability, a collaborative relationship, and shared power, into the working definition (WHO, 2009). Establishing a partnership between relevant organizations can facilitate the process of delivering simulators that are developed in research laboratories to hospitals and educational institutions in R&R parts of Canada to train healthcare providers. Making SBE available to communities in need can improve health outcomes through its link to healthcare provider training (Turkot et al., 2019).

1.1.2 Importance and Impacts

Public health systems research (PHSR) is a growing focus in Canada that looks at financing, delivery, and impact of public health services (Kothari et al., 2014). One of the top six priorities of PHSR in Ontario is partnerships and linkages. This priority highlights the importance of partnerships between various sectors (i.e., healthcare providers, educational institutions, community-based organization, government, etc.) to improve the performance of the public health system (Kothari et al., 2014). Establishing partnerships between different sectors, such as university research laboratories, for-profit organizations (FPOs), and not-for-profit organizations (NPOs), can improve capacity building of healthcare providers and knowledge exchange within that healthcare system. The findings from this research support the Institute of Population and Public Health’s mandate to improve individual and population health through the application of knowledge and partnerships with public health stakeholders (Canadian Institutes of Health Research, 2021). This goal is achieved by producing low-cost innovative solutions to improve health outcomes and address inequalities in healthcare to bridge the gap in healthcare education in R&R contexts. That is, by using simulation and related technology, feasible solutions can be developed to train healthcare providers to support the delivery of the highest achievable standard of care in R&R parts of Canada.

1.1.3 Background

To date, no single partnership model has been proposed to address the gap articulated in this thesis, however, the literature highlights characteristics of partnerships between a university research laboratory and NPOs that can be used to develop partnerships specific to the research question. The literature identifies the importance of developing strategies to improve the competencies and skills of healthcare providers in R&R areas. For example, Walsh et al. (2019) highlights a gap that exists in healthcare between community hospitals and academic medical centers, wherein there is a need for solutions that can allow academic medical centers to share their knowledge and resources with community hospitals. The CFPC identifies the need to create opportunities for policy makers, health education administrators, rural communities, physicians, universities, and other healthcare providers to collaborate and create a process to provide solutions to rural education and practice as part of the social accountability framework (Bosco & Oandasan, 2016; Soles et al., 2017). Soles et al. (2017) urges that collaboration and coordination among these stakeholders is necessary to provide support for the medical education system and to develop an integrated strategy to allocate resources for rural and remote health in Canada. Methods using SBE have shown great potential for improving care provided, however, community hospitals lack access to such programs (Walsh et al., 2019).

The literature also suggests that partnerships or collaborations in healthcare are a great way to address the HPE gaps in rural communities and increase the capacity of healthcare systems. Jones (2009) suggests that establishing a collaboration between a university and a local rural hospital is optimal for addressing continuing education needs of rural paramedics and nurses. The use of simulators can help to better meet the needs of lifetime learners and a relationship between a university and rural hospital can allow both organizations to utilize their resources in a more innovative and efficient manner. The twinning partnership model is an example of a model used to guide the collaboration between a university situated in a low-income country and a university in a high-income country (Busse et al., 2013). The use of this model is seen as an effective strategy for partnerships between institutions that focus on local stakeholders to guide the partnership, as it effectively creates equitable relationships and builds sustainable health systems

through a collaborative approach (Busse et al., 2013). However, this model does not have a specific SBE or technology component as part of the partnership.

In the area of simulation-based nursing education, a collaborative practice model is used to establish Practice-Education partnerships between universities and hospitals to address budgetary constraints and insufficient clinical learning experiences. This model highlights the development of the partnership being attributed to the shared mission, dedicated nurse leaders, supportive administration, and innovative thinking, which produced a hospital-based simulation laboratory and a multi-institutional simulation experience. Due to the prohibitive cost of high-fidelity manikins, the expense is shared between the two institutions through this partnership (Senger et al., 2012). The limitations of this model in relation to the identified gap is the sole focus on student nurses and the absence of a manufacturing process to produce simulators.

The models described have several gaps in relation to their fit with the need to promote diffusion of simulators from resource-rich, academic research laboratories to R&R-based NPOs and hospitals. Specifically, these models do not have SBE and/or simulation technology as a focus of the partnership. Those that describe partnerships in the area of simulation training do not address the production/ manufacturing component for physical simulators whereby physical simulators used for training could be produced and delivered to NPOs and the healthcare sector (Busse et al., 2013; Senger et al., 2012; Walsh et al., 2019). Additionally, they provide limited to no information on funding with regards to how to fund the production of the simulators or how funding can be acquired.

In summary, the existing partnership models are rooted in knowledge translation and primarily deal with pedagogy, and not technology that supports the simulation pedagogy. More specifically, they lack two major components that are specific to simulation technology: a) production/ manufacturing, and b) funding.

1.1.4 Proposed Solution

The purpose of this thesis was to develop a model to build partnerships between university research laboratories, FPOs, and NPOs in R&R parts of Canada to improve diffusion of Industry 4.0 augmented simulation technology to the healthcare sector.

Healthcare providers practicing in R&R areas were engaged in this study to represent the healthcare sector and group of healthcare providers that this model aims to target. The following research question was used to meet the goal of the overall study: How can a university research laboratory, FPO, and NPO collaborate to deliver SBE to the healthcare sector? This overarching question was addressed in two phases, each guided by separate but related subquestions:

1. What are existing partnership models, or components of a model, that outline how a university research and laboratory can collaborate with a FPO and NPO to deliver technological solutions to the healthcare education sector?
2. What are the stages of building and sustaining a partnership between a university research laboratory, FPO, and NPO with a focus on SBE?

The following overarching research objectives were achieved by completion of the phases in this thesis study:

1) Assess the landscape of current models.
2) Develop a model for university, FPO, and NPO SBE partnerships.

Chapter 2: General Methods

2.1 Theoretical Underpinnings

Global partnerships between university research laboratories, FPOs, NPOs, and various healthcare sectors have become increasingly common and relevant today with the increase in knowledge within the healthcare field and the need for knowledge translation to communities that can benefit most from the information. Several factors, such as having shared goals, actively involving stakeholders throughout the partnership process, and having a funding stream need to work together to ensure the successfulness and sustainability of a partnership. Integrated knowledge translation (iKT) has been identified as a key component to establishing successful partnerships for a collaborative research and development process. An iKT approach emphasizes a mutual learning relationship throughout the research and development process to enhance and produce research findings that are directly related to knowledge users (KUs) (the target audience) (Gagliardi et al., 2016). This collaborative approach to generating knowledge allows for the ongoing interaction between researchers and KUs as an ideal way to address complex healthcare issues. The KUs in this thesis belong to four stakeholder groups: 1) Academic institutions, FPOs, NPOs and the healthcare sector. By involving these four key stakeholder groups, a democratic process can be fostered in this study to co-create knowledge that is beneficial to all stakeholders (Jull et al., 2017).

Combined with iKT in this thesis is educational design research (EDR). EDR is an approach used to develop practical solutions in real world contexts collectively with stakeholders. It employs an iterative process to address complex educational problems to create usable knowledge relevant for educational practice (McKenney & Reeves, 2012). The five defining characteristics of EDR are: 1) theoretically oriented, 2) interventionist, 3) collaborative, 4) responsively grounded, and 5) iterative. The three core phases of the generic model are 1) analysis and exploration, 2) design and construction, and 3) evaluation and reflection. The theoretical contributions of EDR enable the researcher to understand the phenomenon in question and contribute to a body of knowledge that can be used by other researchers and KUs. EDR provides practical contributions by way of developing solutions and making improvements to problems of practice through

empirical research (McKenney & Reeves, 2012). Solutions produced through the EDR approach are meant to be implemented and adopted in real world settings, hence the purpose of co-creating solutions with KUs to produce effective and feasible results.

2.2 Guiding Research Framework

Both iKT and EDR are approaches that aim to improve collaboration and innovation in various fields. Both share some features, but also make their unique contributions when building a partnership model. IKT focuses on integrating knowledge generated from research into practice, policy, and decision-making. Its unique contributions to a partnership model include bridging the gap between researchers and KUs by involving them in the research process, and ensuring that outcomes are relevant, applicable, and actionable in real-world settings. IKT aims to promote ongoing communication and collaboration between researchers, practitioners, and other stakeholders, and enhances the likelihood of research findings being implemented and having a positive impact. EDR is an approach commonly used in educational research and other fields to develop and refine innovative solutions, including partnership models. Its unique contributions to building a partnership model include emphasizing iterative design and development of interventions or solutions through multiple cycles by incorporating feedback and insights from stakeholders (or KUs) to refine and improve the model over time. EDR focuses on context-specific solutions that address real-world challenges and are adaptable to changing circumstances and generates both practical outcomes and theoretical insights that contribute to the field's knowledge base.

In summary, iKT emphasizes integrating research findings into practice, while EDR focuses on iterative design and development of solutions. Incorporating elements from both approaches can lead to a more robust partnership model. A hybrid framework is necessary for this thesis as we are developing a model that strides two fields: 1) healthcare innovation and 2) education, making our work interdisciplinary research. Interdisciplinary research helps identify new approaches to address complex issues by combining perspectives from more than one field. Interdisciplinary research integrates knowledge from each field with team members learning from one another, as opposed to multidisciplinary research where members of a team work in silos and within the

boundary of their discipline (Healy et al., 2022; NFRF FNFR, 2022). In the case of this thesis, iKT and EDR are combined into one framework to address the research question by integrating perspectives and knowledge from both disciplines where individuals are contributing ideas to the entire project to develop the solution.

The hybrid approach in this thesis explores the early phases of both iKT and EDR. Figure 2.1 illustrates the hybrid research framework combining iKT and EDR. The problem identification phase consists of investigating the problem and identifying a solution by employing in-house expertise and examining the literature to shape our understanding of the problem and context. The knowledge synthesis phase is carried out through a literature review to gain theoretical inputs, provide a scientifically relevant angle to the problem, and determine the gap in research that needs to be further explored. Following the problem identification and knowledge synthesis phase, a solution to the problem is determined and a process can be devised to explore and achieve the proposed solution. The exploration and design phase involves exploring the solution with stakeholders and applying ideas to construct the solution using a prototype approach. The final phase, piloting and evaluation, applies empirical testing of the solution constructed in the previous phase to study various elements, such as feasibility, local viability, soundness, and long-term impact. IKT and EDR were integrated in this thesis study by engaging the stakeholders at various points of the research process to develop a unique partnership model that caters to the demands of all stakeholder groups and can be applied in real-world settings.

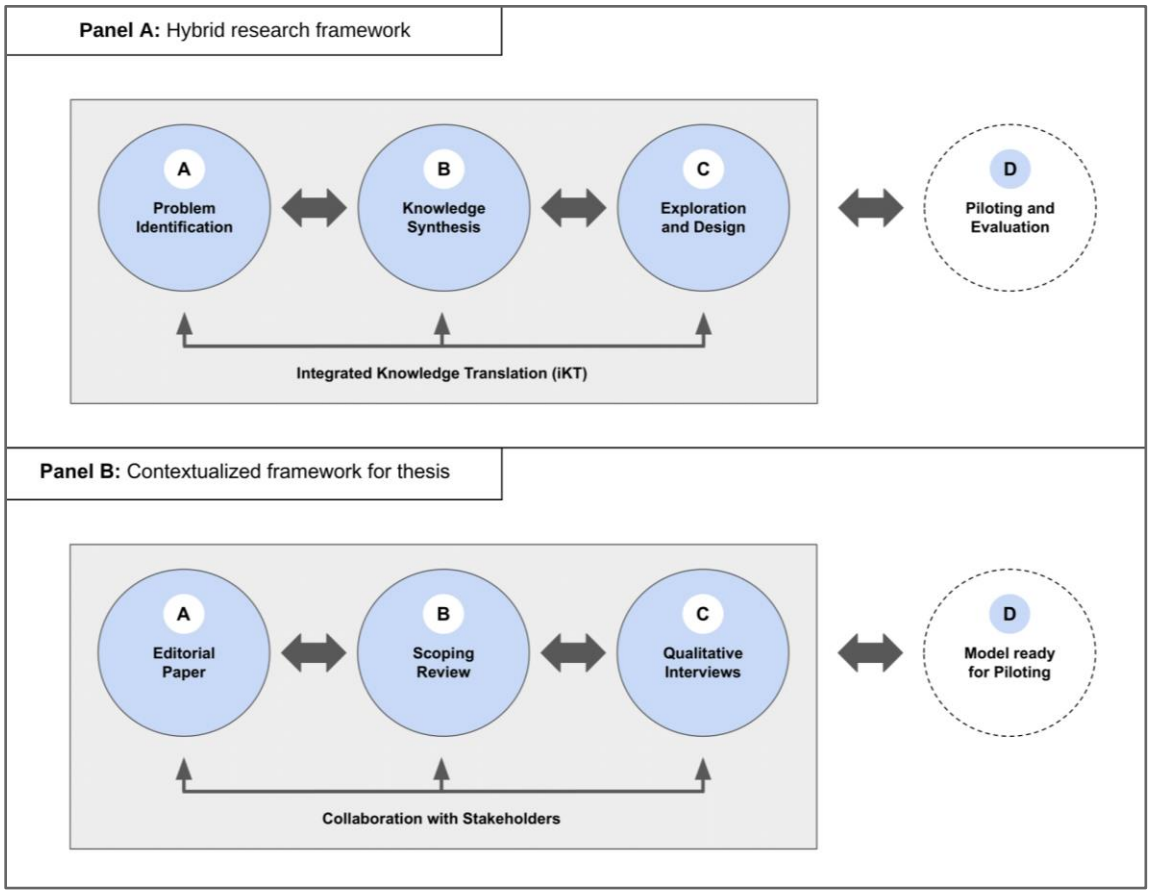

Figure 2.1: *Panel A shows a graphic representation of the hybrid research framework applying the educational design research approach and integrated knowledge translation principles to inform the course of this thesis. The circles represent the core phases of the process, while the arrows indicate the iterative and flexible process. IKT feeds into each phase of the framework to ensure KUs are engaged throughout the research process. Phases A to C are completed within this thesis.*

The current thesis deals with phases A to C of the hybrid research framework. Phase A, problem identification, was accomplished through an editorial paper to identify the problem, causes of the problem, and to present a solution (Chapter 3). Phase B, knowledge synthesis, was achieved through conducting a scoping review to understand what has already been done to solve the problem and identify the gap that needs to be further researched (Chapter 4). Phase C, exploration and design, was achieved through a qualitative descriptive study whereby stakeholders were interviewed to understand their perspective experiencing the phenomenon in question, which was then used to build the structure of the partnership model (Chapter 5). Phase D, piloting and evaluation, was not

completed in this Master's thesis study, however, can be continued as part of a PhD study.

2.2.1 Problem Identification

The problem identification phase focused on providing an understanding of the research problem and understanding the constraints within which the solution would be established. An editorial paper was written and published in the Cureus Journal of Medical Science as a perspective piece on the topic (Chapter 3) (Siraj, Brunton, et al., 2023). The problem identification phase was guided by three central questions: 1) What do we know about the problem? 2) What do we know about the context? 3) What do we know about the stakeholder needs? (McKenney and Reeves, 2012). The editorial paper detailed the context and constraints to provide a holistic understanding of the problem and situated the solution within the context to align with the needs of the KUs. The editorial paper was written in collaboration with members from the four stakeholder groups: academic institution, FPO, NPO, and healthcare, to shape our understanding of the problem and propose a solution that integrated the needs of each stakeholder group. This phase concluded with a descriptive and explanatory problem statement and a long-range goal to be achieved through this thesis study.

2.2.2 Knowledge Synthesis

Through a review of literature, the knowledge synthesis phase in this thesis explored how others have experienced the identified problem and examined how the problem was addressed. The first study of this thesis was a scoping review that aimed to understand the existing literature and identify if a model existed that outlined how a university research laboratory can collaborate with a FPO and NPO (Chapter 4). The research subquestion that was explored in this study is: What are existing partnership models, or components of a model, that outline how a university research laboratory can collaborate with a FPO and NPO to deliver technological solutions to the healthcare education sector? The research subquestion for this scoping review had two objectives:

1. To identify partnership models that can be adapted to our research context.

2. To identify strategies that can be used in a stage of the model in relation to a partnership (stakeholder engagement, research and development, funding, manufacturing, evaluation, reporting).

The scoping review applied the five stages of Arksey and O'Malley's (2005) methodological framework for conducting scoping studies: 1) identify the research question, 2) identify relevant studies, 3) select the studies, 4) chart the data, and 5) collate, summarize and report the results. The Joanna Briggs Institute (JBI) Manual for Evidence Synthesis' scoping review chapter and the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist was used to guide and report the findings of this scoping review (Aromataris & Munn, 2020; Tricco et al., 2018). FPO and related terms were not included in the search strategy as preliminary searches indicated limited results with the inclusion of the term. To broaden the scope of results, the group of terms was removed. Components of the models that are relevant to the partnership process and address the research gap, and strategies that can be used in the different stages of the partnership process were reported. A scoping review protocol was published detailing the procedure used to perform the scoping review (Chapter 4.1) (Siraj et al., 2023a). The results from the scoping review were used to inform data collection efforts in the exploration and design phase (Chapter 5), and to build the partnership model.

2.2.3 Exploration and Design

During the exploration and design phase, the work was informed through the perspective of stakeholders to explore and map the solution, and construct a prototype partnership model. The second study of this thesis was a qualitative descriptive study to develop a partnership model between university research laboratories, FPOs and NPOs to address gaps in HPE using SBE (Chapter 5). Qualitative descriptive research seeks to discover and understand a phenomenon, a process, or the perspectives of the people involved with the aim of providing an in-depth understanding of the phenomenon (Bradshaw et al., 2017). The research subquestion that was explored in this study is: What are the stages of building and sustaining a partnership between a university research

laboratory, FPO, and NPO with a focus on SBE? The research subquestion for this qualitative descriptive study had three objectives:

1. To understand the different stages in the partnership process specific to the research aim.
2. To identify strategies used in each stage of the partnership process.
3. To recognize the facilitators and barriers that may exist during the partnership process.

The qualitative descriptive approach aligns with the hybrid research framework as it relies on the input from experts with different knowledge backgrounds and perspectives to provide information on the partnership process and involves them throughout the study process. As such, the data acquired from this qualitative descriptive study informed the development of the partnership model created from analysis of participants' experiences. Four key stakeholder groups were identified as being able to provide expert knowledge and experience regarding the central phenomenon: 1) university research laboratories, 2) NPOs, 3) FPOs, and 4) the healthcare sector. These groups were used as a criterion for selecting participants for the study. Data was collected virtually through individual semi-structured interviews. The standards for reporting qualitative research (SRQR) checklist was used to guide and report the findings of this study (O'Brien et al., 2014). Results from the data analysis process were presented in the form of themes and rich descriptions. Findings from the scoping review and the qualitative descriptive study were consolidated in Chapter 5 and presented in the form of a visual model with a description of each stage of the model.

Chapter 3: Problem Identification - Developing a Partnership Model to Address Gaps in Rural Healthcare Provider Training Using Simulation-Based Health Professions Education

[Verbatim as published in the Cureus Journal of Medical Science]

3.1 Background

Healthcare providers practicing in rural and remote (R&R) areas of Canada experience challenges in providing quality care that addresses the diverse healthcare needs of its rural population, including the technical skills needed for high-acuity low-occurrence (HALO) procedures, which are clinical procedures that are rarely performed yet, when needed, need to be done urgently (Bosco & Oandasan, 2016). One factor that impacts the level of care provided is the suboptimal access to state-of-the-art education in R&R settings. It is considered a vital societal need to educate healthcare providers to prepare them for R&R practice. Barriers to accessing state-of-the-art continuing medical education (CME) for R&R area physicians include the cost of both travel time and time away from medical practices during current times of shortages, in addition to the financial burden of traveling to often distant academic centers to access CME (Bosco & Oandasan, 2016).

A reform to health professions education (HPE) is necessary to respond to challenges in the delivery of healthcare services as the level of training and competencies of healthcare providers correlates with them being able to adequately serve the population's health needs (Bosco & Oandasan, 2016). A shift towards a competency-based curriculum in HPE is suggested to ensure learners are able to acquire experience in diverse learning and work environments to aid them in responding to the healthcare needs of the communities they serve. This will allow healthcare providers to give more comprehensive care and have more advanced procedural skills to reflect their broad scope of practice and a broad range of clinical procedures (Bosco & Oandasan, 2016). The College of Family Physicians of Canada (CFPC) highlights that specialized resources are limited in R&R areas of Canada and recognizes that providers need to focus on

developing contextual competencies through relevant learning opportunities to practice in R&R clinical settings (Bosco & Oandasan, 2016). Using innovative, flexible methods to educate healthcare providers and prepare them for practice in R&R communities can create a stable health workforce (Bosco & Oandasan, 2016). One of the objectives to improve rural education programs identified by the CFPC is to develop tools that can help increase access to clinical training, with one such tool being simulation technology (Bosco & Oandasan, 2016).

Simulation-based health professions education (SBHPE) is the use of a simulative aid to replicate clinical scenarios for educational purposes and is an adjuvant to clinical training (Al-Elq, 2010). SBHPE is a training strategy that has the capacity to significantly benefit healthcare providers by addressing healthcare needs in a practically and clinically relevant manner with immediate application in clinical practice (Al-Elq, 2010). A simulator is a device that allows the user to reproduce a phenomenon under test conditions that is likely to occur in real-world situations (Al-Elq, 2010). Simulators in the context of HPE allow a learner to practice specific technical "procedural" skills, especially skills that cannot be easily practiced on patients, such as suturing and inserting chest tubes, through multiple repetitions in a controlled environment, which can be synchronous or asynchronous. The learner can receive feedback from experienced mentors to improve and correctly advance their competency in a skill without endangering a patient (Al-Elq, 2010). Realistic and commercial simulators are often prohibitively expensive (Al-Elq, 2010). Although these simulators can be incorporated into primary healthcare settings to improve learners' competence and increase patient safety, the cost of such technology is not practical for all rural hospitals and not-for-profit organizations (NPOs) to sustain. A more affordable and sustainable solution, such as 3D-printed simulators, is needed to integrate SBHPE into rural education to support healthcare provider training.

One of the policy considerations suggested by the CFPC is to apply a pan-Canadian approach by creating opportunities for policymakers, physicians, rural communities, academia, and other healthcare providers to collaborate and support the development of rural education and practice (Bosco & Oandasan, 2016). Establishing partnerships

between university research and innovation centers, for-profit organizations (FPO), and NPOs to develop and distribute simulators to R&R healthcare providers can help reduce costs and address gaps in HPE (Machado et al., 2020). Integrating these stakeholders in a sustainable collaborative process through developing a sustainable business model that focuses on meeting consumers' needs can have positive social and economic impacts (Machado et al., 2020).

3.2 Current Gap

Industry 4.0 is considered the fourth revolution in manufacturing through its use of emerging technologies that deeply integrate business and engineering processes to make production flexible, efficient, and sustainable in a way that maintains high quality at a low cost (Machado et al., 2020). The emergence of Industry 4.0 allows for the manufacturing of affordable and sustainable three-dimensional (3D) printed simulators through a flexible and efficient production process (Machado et al., 2020). Simulators developed using 3D-printed and silicone technology have the capacity to be adapted to accommodate the needs of the provider based on the clinical skill they intend to practice (Al-Elq, 2010). The method of customization using additive manufacturing techniques allows for a reduction in the cost of producing the simulator (Machado et al., 2020). However, Industry 4.0 tools to develop simulators are currently limited mainly to university or hospital-based research and innovation centers in urban areas, which if diffused to R&R settings can create a more significant impact.

To date, there are no specific partnership models with a focus on SBHPE that address how Industry 4.0 augmented simulation technology can make its way from university research and innovation centers into R&R settings. Existing models in the current literature have several gaps in addressing how simulators can be diffused from resource-rich university research and innovation centers to NPOs and hospitals in R&R areas. Specifically, the models lack a focus on SBHPE and simulation technology as a central element of the partnership as they primarily deal with pedagogy. Those with a simulation training component do not address the process of manufacturing the simulators that would be produced and delivered to R&R healthcare providers. In addition, limited literature can be found that discusses the funding stream that covers the

cost of producing the simulators, how funding can be acquired, or how financial responsibilities are distributed amongst partners. An example of a partnership model that comes close to addressing the identified gap is the twinning partnership model, which is used to guide the collaboration between a university situated in a low-income country and a university in a high-income country (Busse et al., 2013). Building a twinning partnership follows a six-stage approach: (1) build a partnership; (2) develop a work plan; (3) implement the program; (4) monitor outcomes (process, impact); (5) evaluate the results; (6) and disseminate the information (Busse et al., 2013). This model outlines an effective process to implement collaborative programs between academic institutions and local NPOs through effective relationship building among partners and by creating a sustainable approach to meet the partners' needs. This model is seen as an effective strategy for partnerships between institutions that focus on local stakeholders to guide the partnership, as it emphasizes building long-term relationships where partners equally contribute to find mutually beneficial solutions (Busse et al., 2013). The limitations of this model concerning the identified gap are that this model does not have a specific SBHPE or technology component as part of the partnership and therefore provides limited information on the manufacturing process of the simulators. More specifically, the twinning partnership model does not guide on issues fundamental to technology development, funding, and intellectual property management that are fundamental to the diffusion of simulation technologies from urban to R&R settings.

3.3 Proposed Solution

Public health systems research (PHSR) is a growing field of research in Canada that aims to examine the financing, delivery, and impact of public health services (Kothari et al., 2014). PHSR follows the philosophy of an integrated knowledge translation (IKT) approach whereby both researchers and decision-makers are engaged throughout the entire research process in a collaborative approach to produce relevant research findings (Kothari et al., 2014). One of Ontario's top six PHSR priorities is partnerships and linkages, which emphasizes the importance of creating and mobilizing partnerships between various sectors (i.e., healthcare providers, educational institutions, community-based organizations, government, etc.) to improve the performance of the public health

system (Kothari et al., 2014). This can be achieved by focusing research on understanding techniques to build partnerships across different sectors and evaluating the partnership outcomes, as achieved by the twinning partnership model. Prioritizing the establishment of multi-institutional partnerships between university research and innovation centers, FPOs, and NPOs can improve the capacity building of healthcare providers and knowledge exchange within the public health system (Kothari et al., 2014). Multi-institutional partnerships are an innovative approach to gather and optimize the use of resources from multiple institutions to provide quality educational opportunities to R&R healthcare providers (Bosco & Oandasan, 2016). To improve rural HPE and address the gaps in existing partnership models, the proposed solution is to develop an SBHPE-focused partnership model between university research and innovation centers, FPOs, and NPOs to improve the diffusion of Industry 4.0 augmented simulation technology to the R&R Canadian healthcare sector.

Developing a partnership model in the context of creating and delivering simulators to R&R healthcare organizations creates a win-win-win situation for each stakeholder involved. NPOs and hospitals in R&R communities benefit from building partnerships to increase accessibility to feasible simulators to provide adequate and continuing training to healthcare providers. The benefit to academic and research institutions is the opportunity to conduct interdisciplinary research. Research that is truly interdisciplinary and that is well suited for simulation in the R&R context is one that englobes individuals from different fields, who contribute ideas while, in the process, learning from and about each other. In doing so, they integrate their knowledge and adapt their methods from different disciplines, creating a synergy of knowledge and a synthesis of methodological approaches. Therefore, they are not working in silos and are trying to push the boundaries of methods, techniques, etc., beyond their home disciplines while discovering new pathways to mobilize technology (Healy et al., 2022). FPOs benefit from this process by allowing a shift towards a social enterprise model. A social enterprise is a business with specific social objectives that serve its primary purpose. Such businesses seek to maximize profits while concurrently maximizing benefits to society, and the profits are principally used to fund social programs. Becoming a social enterprise benefits FPOs due to the taxation benefits whereby the FPO can shield itself from some taxes through their

societal contributions. In addition, FPOs are able to tap into the academic sector, which provides them access to limited research and development (R&D) funding opportunities that can reduce or completely cover R&D costs. FPOs can also gain new business pathways by testing new markets inexpensively by engaging in low-risk, partner-driven, and low-cost partnerships.

Establishing a partnership between relevant organizations can facilitate the process of delivering simulators that are developed in a research laboratory to hospitals and educational institutions in communities that lack the resources. Developing simulators in a research laboratory using 3D printing technologies is an economical solution that helps reduce manufacturing costs and provides a sustainable SBHPE training approach (Machado et al., 2020).

3.4 Conclusion

The use of Industry 4.0 augmented simulation technology creates a path to develop feasible solutions to train healthcare providers in support of delivering the highest achievable standard of care in R&R parts of Canada. Producing low-cost, sustainable simulators addresses HPE gaps for R&R healthcare providers by providing them with the opportunity to increase their proficiency in clinical skills, in turn, strengthening rural medical practice. Developing a model to establish a partnership between relevant organizations to improve the diffusion of simulators will strengthen rural medical education and improve capacity building in the healthcare system.

Chapter 4: Knowledge Synthesis

4.1 Scoping Review Protocol: Identification of a partnership model between a university, for-profit, and not-for-profit organization to address health professions education and health inequality gaps through simulation-based education: A scoping review protocol

[Verbatim as published in PLOS One]

4.1.1 Introduction

The field of health professions education (HPE) recognizes that all healthcare providers should be competent and have access to optimal training resources to develop and maintain competencies (Institute of Medicine Committee, 2003). Healthcare providers in rural and remote (R&R) areas of Canada, more specifically physicians and nurses, may not have the same access to skills development and maintenance opportunities as those in urban areas due to factors such as distance from urban centers and cost (Williams et al., 2020). The inexperience and lack of training for healthcare providers is one factor that has impacted the quality of care received by Canadians in R&R settings (Bosco & Oandasan, 2016). One example is a lack of training on technical skills used to perform high-acuity low-occurrence (HALO) procedures. HALO procedures are rarely performed clinical procedures that are required to be performed urgently when needed (Bosco & Oandasan, 2016). Having limited training on how to perform HALO procedures can affect the health outcomes of a patient in emergency situations and in locations where accessing additional health care services is difficult. The College of Family Physicians of Canada (CFPC) highlights the need to develop contextual competencies of providers to practice in R&R clinical settings and recognizes the need to reform HPE due to the significance the level of education, in relation to training and competencies, has on adequately serving the health needs of the population (Bosco & Oandasan, 2016). To improve rural education programs, one of the objectives that the CFPC has identified is to develop tools to increase access to clinical training, with one such tool being simulation technology (Bosco & Oandasan, 2016).

Simulation-based education (SBE) is defined as a replication of a real task (or patient encounter) for the purpose of training or assessment of quality improvement and is proven to be a key aspect of HPE (Hamstra et al., 2006). SBE serves as an optimal technique to allow healthcare providers to develop and maintain skills and can be used for assessment and evaluation without endangering the safety of a patient (Asghar et al., 2021). The use of additive manufacturing allows for the improved availability of affordable simulators through a flexible, efficient, and sustainable production process that maintains high quality and low cost (Machado et al., 2020). The most known form of additive manufacturing is three-dimensional (3D) printing. 3D printing technologies are a useful tool in medical training and healthcare due to its customizability to fit any context and the reduction of costs in production (Kholgh Eshkalak et al., 2020). However, the development of simulators using additive manufacturing and 3D printing technologies is currently limited mainly to university or hospital-based research laboratories in urban areas of developed countries, and are rarely diffused to R&R settings, where they can create a greater impact (Williams et al., 2020; Habti et al., 2021; Siraj et al., 2022). Siraj et al. (2022) and Barth et al. (2022) report on the positive outcomes of using SBE and 3D printing technologies to train students and healthcare providers using simulators to learn and improve hands-on clinical skills. Developing simulators in a research laboratory using 3D printing technologies can help reduce costs and address gaps in HPE for R&R healthcare providers (Barth et al., 2022).

An example of a simulator developed in a university research laboratory includes a 3D printed/silicone simulator to train on the intraosseous (IO) access skill, where a hole is drilled into the proximal tibia bone to deliver fluids and medication into the bone marrow (Sivanathan et al., 2022). The material cost to manufacture a simple IO simulator is $12.66 CAD and costs $53.89 CAD to manufacture an advanced IO simulator. When compared to a commercially available IO similar that retails for $414 USD, the simulator developed in the laboratory is produced at a fraction of the cost (Sivanathan et al., 2022). Another example is the development of a cost-effective cricothyroidotomy simulator for emergency medicine simulation training. Cricothyroidotomy is a procedure that allows for tracheal intubation in life-threatening situations (Doucet et al., 2017). The material cost of developing this anatomically accurate simulator using 3D printing technology is

$3.63 CAD (Doucet et al., 2017). The cost of developing the simulator is covered through research and development funding whereby the research laboratory designs, prototypes and conducts research in the areas of validity, acceptability, feasibility and efficacy/effectiveness (Sivanathan et al., 2022; Doucet et al., 2017). Once the research and development process has concluded, the healthcare system requires these simulators to be manufactured to address their training needs, however, there is no mechanism or model to facilitate this process.

Public health systems research (PHSR) is a growing focus in Canada that looks at financing, delivery, and impact of public health services (Kothari et al., 2014). One of the top six priorities of PHSR in Ontario is partnerships and linkages. This priority highlights the importance of partnerships between various sectors (i.e. healthcare providers, educational institutions, community-based organization, government, etc.) to improve the performance of the public health system (Kothari et al., 2014). Establishing partnerships between different sectors, such as university research laboratories, for-profit organizations (FPOs), and not-for-profit organizations (NPOs), can improve capacity building of healthcare providers and knowledge exchange within that healthcare system. To date, there are no specific SBE-focused partnership models that address how 3D printed simulation technology can make its way from university research laboratories into the HPE system, especially in the R&R context. Establishing a partnership between relevant organizations can facilitate the process of delivering simulators that are developed in the laboratory to hospitals and educational institutions in R&R parts of Canada to train healthcare providers. A multi-institutional partnership can help overcome logistical challenges experienced by one sector, such as manufacturing the simulator, by pooling resources to provide simulators to R&R healthcare providers in a way that is beneficial to all partners (Institute of Medicine Committee, 2003; Siraj, Brunton, et al., 2023). Making SBE available to communities in need can improve health outcomes through its link to healthcare provider training (Turkot et al., 2019). Therefore, the purpose of this scoping review is to understand the existing literature and identify if a model exists that outlines how a university research laboratory can collaborate with a FPO and NPO.

4.1.2 Protocol Design

The methodological framework introduced by Arksey and O'Malley (2005) will be used to guide this scoping review by adhering to the five stages of the framework: 1) identifying the research question, 2) identifying relevant studies, 3) study selection, 4) charting the data, and 5) collating, summarizing and reporting the results. The scoping review will be conducted and reported in adherence with the JBI Manual for Evidence Synthesis' scoping review chapter (Aromataris & Munn, 2020), and the PRISMA-ScR Checklist (Tricco et al., 2018). This study does not require ethics approval as the scoping review methodology involves reviewing and collecting data from publicly available materials.

4.1.2.1 Stage 1: Identifying the research question.

The purpose of this scoping review is to understand the existing literature and identify if a model exists that outlines how a university research laboratory can collaborate with a FPO and NPO. The research question developed based on this purpose and in consultation with the research team is: What are the existing partnership models, or components of a model, that outline how a university research laboratory can collaborate with a FPO and NPO to deliver technological solutions to the healthcare education sector? Preliminary searches suggest that there is no specific model that is focused on this type of partnership. Therefore, comparable models will be chosen that can provide information for the creation of a new model specific to the research question. To accomplish this, the specific objectives of the scoping review are 1) to identify partnership models that can be adapted to support ways a university research laboratory can collaborate with a FPO and NPO to deliver SBE solutions to healthcare providers in R&R settings, and 2) to identify strategies that can be used in a stage of the model in relation to a partnership.

4.1.2.2 Stage 2: Identifying relevant studies.

Five literature databases will be searched for this scoping review: Ovid MEDLINE, PsycINFO, Scopus, Web of Science, CINAHL. Concepts derived from the research question will be used to form the free-text codes for the search strategy on Ovid

MEDLINE which will then be translated to the four remaining databases. Keywords such as “academic institution”, “partnership”, “not-for-profit”, “simulation”, and “healthcare” and synonym terms will be used. The free-text codes will be combined with database-specific controlled subject headings to form the search strategy on the five published literature databases. The free-text and controlled subject heading codes used for the search strategy on Ovid MEDLINE are shown in Appendix B. Limitations will be placed on the search engines for the time frame and the article language to ensure only relevant articles appear in the results.

Grey literature will be searched on the following databases to mitigate the possibility of limited results from published literature. The following grey literature databases will be searched: Grey Matters (CADTH), OpenGrey, and Google Scholar. In addition, the reference list of relevant articles will be manually searched to identify new articles that address the research question. The time frame for the search will be 2000 to 2022, as simulation officially became an area of scientific inquiry aiming to standardize its use in HPE after 2000 to reduce the number of medical errors occurring by healthcare providers (Institute of Medicine Committee, 2000). The search strategy has been developed in consultation with a health science librarian as per PRESS guidelines (McGowan et al., 2016).

4.1.2.3 Stage 3: Study selection.

The citation management software Endnote 20 will be used for initial screening to organize the selected articles and remove article duplicates. After refining the search query, the results will be imported to the EPPI-Reviewer software for screening and selection. Screening of the articles will follow a two-step screening process. The first step will be to screen titles and abstracts to determine the eligibility of each article. Publications will be excluded if the title or abstract does not meet the inclusion criteria. The second step will be a full-text screening of articles that have passed the first step and only relevant articles will be included in the review. Reporting of the study selection will be done using the PRISMA flow diagram. Study designs that will be accepted for the review are scoping and systematic reviews, surveys, case studies, systematic reviews, mixed methods studies, and commentaries/ program evaluations. Articles will be selected

using specific criteria for inclusion and exclusion, to ensure the articles address the specific research question. The inclusion and exclusion criteria have been chosen to account for the relevance of the article to the context of the question and to find articles that could address or provide information on the proposed gap. The inclusion criteria include the need for the article to describe a partnership model or framework, involve both academic institutions and not-for-profit organizations, focus on post-secondary education, and have a simulation/technology component. The exclusion criteria include articles that focus on kindergarten to grade school (secondary education), editorial articles, conference abstracts, posters, or dissertations and articles not published in English. The eligibility criteria may change depending on the search results and relevance of the studies.

4.1.2.4 Stage 4: Charting the data.

The data will be extracted and charted using the EPPI-Reviewer software. The following key elements will be extracted from the articles: author details, country of origin, study objective/purpose, study design, technology developed, participant characteristics, sentences defining 'partnership model' or 'collaboration model', and key findings related to the research question.

4.1.2.5 Stage 5: Collating, summarizing and reporting the results.

In accordance with the purpose of this scoping review, potential models that address the research question will be reported. If no model is identified, models that come close will be presented and characteristics of the model that can contribute to the development of a new partnership model will be summarized. Quantitative and qualitative data will be summarized descriptively in text and presented in tables and graphs where appropriate. Components of the models identified from selected articles that are relevant to the partnership process and addresses the research gap will be synthesized and grouped as themes. Strategies identified from the selected articles that can be applied in the different stages of a partnership process will be classified as subthemes under the themes created.

4.1.2.6 Quality assurance.

Endnote 20 is the citation management tool that will be used to organize articles after executing the search strategy and to create references for selected articles (The EndNote Team, 2013). Following this, the EPPI-Reviewer software, a web-based software program used to manage and analyze data in literature reviews will be used to screen and select articles (Thomas et al., 2022). Two reviewers (SS & BM) will participate in the screening and data extraction process. Both reviewers will independently screen the title and abstract of a subset of the search results (10%) to assess the eligibility criteria and perform a quality check. Both reviewers will then meet to discuss their ratings and refine the eligibility criteria as needed. Disagreements will be resolved by a third reviewer where needed. Following this exercise, one reviewer (SS) will screen the remaining references with any questions checked by a second reviewer (BM). During the charting stage, data will be extracted from 100% of the studies by one reviewer (SS), and from two random samples of 5% each by a second reviewer (BM) to ensure charting quality.

4.1.3 Dissemination

Results of this scoping review will provide an understanding on the extent of existing literature on diffusing simulators to R&R areas for healthcare provider training through a multi-institutional partnership. Additionally, the results will help identify the gaps in knowledge to establishing and sustaining a partnership that has a SBE focus. The results of this scoping review will be relevant and informative for various stakeholders: academic bodies, researchers, NPOs, simulation technologists, and healthcare providers, as a partnership addressing the identified research gap can be mutually beneficial to all stakeholders involved. In relation to dissemination, findings from this scoping review will be submitted for publication to a peer-reviewed journal.

4.1.4 Strengths and limitations of the study

- This scoping review will be the first to examine literature to identify a partnership model that focuses on implementing SBE practices, especially in the Canadian R&R context.

- The identification of articles will be done through five published literature databases, three grey literature databases, and snowball references.
- Based on preliminary searches, there is no model that specifically addresses the research question. Therefore, comparable models will be chosen that can provide information for the creation of a new model specific to the research question.

4.2 Scoping Review: Identification of a Partnership Model between a University, For-Profit, and Not-For-Profit Organization to Address Health Professions Education and Health Inequality Gaps through Simulation-Based Education: A Scoping Review

[Verbatim as submitted to PLOS ONE]

4.2.1 Introduction

Health professions education (HPE) is a field that recognizes the need for all healthcare providers to be competent and be able to develop their proficiency through access to optimal training resources (Institute of Medicine Committee, 2003). Simulation plays a critical role in the context of HPE by providing the learners with hands-on experiences in a safe environment. Rural and remote (R&R) healthcare providers in Canada and around the world, such as physicians and nurses, have limited access to simulation resources that allow them to develop and maintain skills compared to those in urban areas for reasons such as cost and distance from urban centers (Williams et al., 2020). The quality of care thereby may be partially impacted by this inequity in access to simulation training resources in R&R communities (Bosco & Oandasan, 2016). The College of Family Physicians of Canada (CFPC) recognizes the importance of providers practicing in R&R settings to develop contextual competencies in order to adequately serve the needs of the communities they work in. To reform HPE for R&R providers, the CFPC highlights the need to develop tools, such as simulation technology, to improve access to clinical training and improve rural education programs (Bosco & Oandasan, 2016).

A key aspect of HPE is simulation-based education (SBE), which is to replicate a real task or patient encounter for training or quality improvement purposes (Hamstra et al., 2006). SBE allows healthcare providers to improve their competency in clinical skills without risking patient safety and is an optimal technique used for assessment and evaluation within a controlled environment (Asghar et al., 2021). Recognizing that availability and access to simulation technology, such as simulators, in the rural and remote context may be limited by costs, logistics and ethical considerations, stakeholders such as regulatory bodies, program directors, researchers, innovators and learners need to look for modern solutions to develop sustainable access to simulation.

Three-dimensional (3D) printing is an emerging field that promotes the improved availability of high quality simulators produced at a low cost, and developed using a flexible and sustainable manufacturing process (Machado et al., 2020). However, barriers exist in diffusing 3D-printing technology to R&R settings as they are currently limited primarily to universities and hospital-based research centers in urban areas (Habti et al., 2021; Siraj et al., 2022). Through the use of 3D printing technologies, simulators can be co-developed by researchers and end-point users (e.g. R&R doctors) in a research laboratory at a reduced cost, addressing HPE gaps for R&R healthcare providers (Barth et al., 2022).

When co-developing simulators in academic research labs, the development cost is expensed using research and development funding, which covers the cost to design, prototype and conduct validity, acceptability, feasibility and efficacy/effectiveness research (Sivanathan et al., 2022; Doucet et al., 2017). After the initial co-development and test of efficacy, the simulators need to be manufactured and supplied to healthcare institutions to train healthcare providers, however, no mechanism or model currently exists to facilitate this process.

Partnerships and linkages is one of the top six priorities of public health systems research in Canada, which recognizes the need to establish partnerships between different sectors to improve public health system performance (Kothari et al., 2014). These sectors include educational institutions, healthcare providers, community-based organizations, and private sector organizations. Creating and mobilizing partnerships between university

research laboratories, not-for-profit organizations (NPOs), and for-profit organizations (FPOs) can facilitate knowledge, intellectual property, and physical assets exchange, and improve capacity building within the public health system. Establishing a partnership to facilitate the process of manufacturing simulators in an academic research laboratory and distributing them to hospitals and R&R healthcare institutions can improve healthcare provider training, in turn improving health outcomes of the Canadian population (Turkot et al., 2019).

To date, no specific partnership model exists that focuses on SBE and addresses how 3D printed simulators can be moved from university research laboratories to HPE settings, primarily in R&R settings. As such, the purpose of this scoping review is to explore the existing literature to identify if a model exists that describes the process of university research laboratories collaborating with a NPO and FPO within the healthcare sector.

4.2.2 Methods

This scoping review was conducted following Arksey and O'Malley's methodological framework for scoping studies (Arksey & O'Malley, 2005). The framework details five stages that were applied to this study: identify the research question, identify relevant studies, select the studies, chart the data, and collate, summarize and report the results. The scoping review chapter of the JBI Manual for Evidence Synthesis and the PRISMA-ScR Checklist was used to guide and report the findings of this scoping review (see Appendix C) (Aromataris & Munn, 2020; Tricco et al., 2018). A protocol was published detailing the process of this scoping review and the search strategy prepared in accordance with PRESS guidelines (Siraj et al., 2023a; McGowan et al., 2016).

The objective of undertaking this scoping review was to examine current literature and identify an existing partnership model involving university research laboratories, FPOs, and NPOs focused on SBE. The research question explored through this scoping review was: What are the existing partnership models, or components of a model, that outline how a university research laboratory can collaborate with a FPO and NPO to deliver technological solutions to the healthcare education sector? The objectives of this

scoping review were to identify existing partnership models that can be adapted to our context, and to identify strategies that can be applied to a SBE partnership.

4.2.2.1 Search Strategy.

The search strategy was carried out on five literature databases: Ovid MEDLINE, PsycINFO, Scopus, Web of Science, and CINAHL, using a combination of free-text codes and controlled subjecting headings to capture key concepts derived from the research question (see Appendix B). Limits were placed on the search engines for the article language, limiting it to English language articles, and for the time frame, focusing the search on articles published between 2000 to 2022. This time frame was chosen because simulation became an official area of scientific inquiry after 2000 to standardize its use in HPE with the aim of reducing the number of medical errors caused by healthcare providers (Institute of Medicine Committee, 2000). Grey Matters (CADTH), OpenGrey, and Google Scholar were also searched to explore grey literature, in addition to a snowball search of relevant articles included in the study through a manual search of the reference list.

4.2.2.2 Article Selection.

Articles were assessed using specific inclusion and exclusion criteria to select articles that addressed the research question. Articles were included if they described: 1) A partnership strategy, model, or framework, 2) Involved both an academic institution and not-for-profit organization, 3) Focused on post-secondary education, and 4) Discussed strategies that could apply to a SBE partnership. Articles were excluded if they focused on kindergarten to grade school, were published as an editorial, conference abstract, poster, or dissertation, and were not published in English. A two-step screening process was used to screen the articles. After the initial organization and removal of duplicate articles on Endnote 20, the refined search results were imported to a review software, EPPI-Reviewer. Articles were first screened by title and abstract to determine eligibility using the inclusion and exclusion criteria. This was followed by a full-text article screening where relevant articles were selected for the review. Figure 4.1 illustrates the screening process in a PRISMA flow diagram detailing the identification, screening, and inclusion of articles from the databases and other methods. Two reviewers

(SS & BM) participated in step one of the screening process to review titles and abstracts to perform a quality check and assess the eligibility criteria. Both reviewers independently screened a subset of articles (30 articles) using the inclusion and exclusion criteria. Both reviewers met to discuss their ratings and refine the criteria, with disagreements resolved by consensus or a third reviewer. One reviewer (SS) then screened the remaining articles for both steps of the screening process to identify the relevant articles and data extraction.

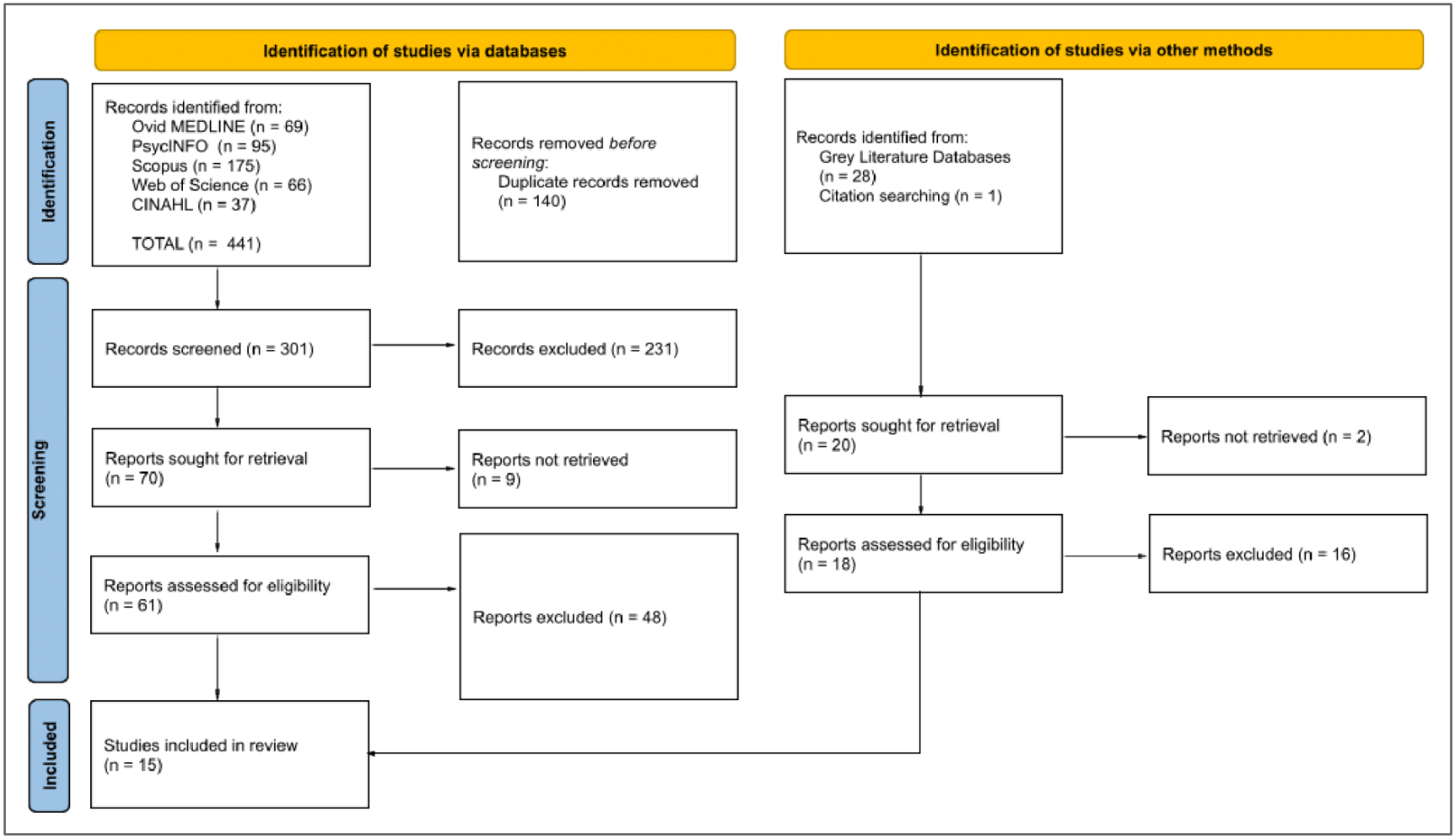

Figure 4.1: *A PRISMA flow diagram of the search and screening process.*

4.2.2.3 Data Extraction and Synthesis.

One reviewer (SS) extracted data from all the studies and a second reviewer (BM) charted the data from a random sample of four articles to ensure charting quality. The data was extracted and charted on EPPI-Reviewer and the following information was extracted from the articles: publication year, country of origin, study design, participant characteristics, professions, study aims/objectives/purpose, technology developed, sentences discussing the partnership or collaboration model used, partnership strategies, and key findings related to the research question. Quantitative and qualitative data has been summarized descriptively in text and presented using tables. The qualitative data has been synthesized using themes and subthemes to align with the review objectives (Pollock et al., 2023). Potential models that can be adapted to the research context have been reported along with characteristics of models that can be applied to a SBE partnership. Strategies that can be used to facilitate the partnership process have also been reported.

The Cochrane Handbook for Systematic Reviews of Interventions states that at least two authors should independently select studies for eligibility and participate in data extraction to minimize the likelihood of errors (Lasserson et al., 2023). As such, two reviewers participated in the screening and data extraction process to ensure that appropriate articles and information relevant to the research question were selected and reflected in the findings of the scoping review. A health science librarian was also consulted to assist in developing the search strategy used to conduct the scoping review. Additionally, the review team consisted of an experienced team member with expertise in systematic and scoping review methodology (GB) who was consulted throughout the process of conducting the scoping review, as recommended by the Cochrane Handbook (Lasserson et al., 2023).

4.2.3 Results

The search resulted in 441 articles being identified from the five published literature databases and 29 from other search methods. After removal of duplicates, 301 articles were screened by title and abstract and 79 articles were collectively assessed for

eligibility at the full-text screening stage. A total of 15 articles passed eligibility screening and were included in the review.

4.2.3.1 Study Characteristics

The publication year for the selected 15 studies ranged from 2007 to 2022, with the majority (n=11) published in the last 10 years. The country of origin for 11 of the included articles was the USA, among which three of the studies were conducted in collaboration with another country (Table 4.1) (Busse et al., 2013; Cancedda et al., 2014; Greece et al., 2019; Kerry et al., 2020; Liu et al., 2022; Magwood et al., 2012; Miller et al., 2012; Olson et al., 2011; Payne, 2014; Taro et al., 2016; Youn et al., 2019). A further two studies were conducted in Canada (De Civita & Dasgupta, 2007; Yan et al., 2018), one in Bangladesh (Ashraf et al., 2015), and one in the Netherlands (De Vrueh & Crommelin, 2017). Case study was the most common study design identified (n = 3) (Liu et al., 2022; Payne, 2014; Yan et al., 2018), followed by multi-stakeholder dialogues (n = 1) (Ashraf et al., 2015), descriptive inquiry (n = 1) (De Civita & Dasgupta, 2007), review (n = 1) (De Vrueh & Crommelin, 2017), mixed methods study (n = 1) (Greece et al., 2019), descriptive review (n = 1) (Kerry et al., 2020), project report (n = 1) (Magwood et al., 2012), and innovation report (n = 1) (Taro et al., 2016). Five articles did not describe or were unclear on the study design (Busse et al., 2013; Cancedda et al., 2014; Miller et al., 2012; Olson et al., 2011; Youn et al., 2019).

Author (Year)	Country of Origin	Study Design	Participants	Professions	What was the research intended to achieve?	Technology Developed	Partnership/ collaboration model used
Ashraf et al. (2015)	Bangladesh	Multi-stakeholder dialogues (MSDs)	Industry, University/ Academic, Community (NPO/NGO), Healthcare Institution, Government, Other	Researcher, Faculty/ Professor, Government Leaders, Not described/ Unclear	Increase stakeholder engagement in policy making and implementation (scale up) of a national Information and communication technologies or eHealth/mHealth strategy	information and communication technologies (ICTs), eHealth/ mHealth	Not described/ Unclear
Busse et al. (2013)	USA and Ethiopia	Not described/ Unclear	University/ Academic, Community (NPO/NGO), Healthcare Institution	Physician, Nurse, Faculty /Professor, Student/ Resident	Describe the stages of a twinning partnership in the context of a collaboration between an American university and an Ethiopian-based university/hospital and NPO to strengthen emergency medicine in Ethiopia; understand if the twinning partnership was effective in training emergency medical professionals in Ethiopia	No technology/ simulation was developed or used in this partnership	Six-phase twinning partnership model
Cancedda et al. (2014)	USA and Rwanda	Not described/ Unclear	University/ Academic, Community (NPO/NGO), Healthcare Institution, Government	Physician, Nurse, Faculty /Professor, Student /Resident, Government Leaders, community health workers, allied health professionals	Strengthen formal educational and in-service training programs for local health professionals in Rwanda	No technology/ simulation was developed or used in this partnership	Health service delivery framework
De Civita & Dasgupta (2007)	Canada	Descriptive inquiry	University/ Academic, Healthcare Institution, Government	Physician, Nurse, Researcher, multidisciplinary diabetes management team, Project managers, decision makers	Re-examine the implementation experiences previously reported by the developers of a diabetes management pilot program in Montreal, focusing on identifying potentially important process factors that could effectively increase adoption and sustainability	A diabetes software/ computer system was used; No simulation was developed or used in this partnership	Diffusion of innovations theory
De Vrueh & Crommelin (2017)	Netherlands	Review	Industry, University/ Academic, Community (NPO/NGO), Healthcare Institution,	Researcher, Not described/ Unclear	Provide an understanding on the role of Public Private Partnerships (PPPs) in facilitating precompetitive multi-stakeholder collaborative research	No technology/ simulation was developed or used in this partnership	Multi-stakeholder collaborative research

Author (Year)	Country of Origin	Study Design	Participants	Professions	What was the research intended to achieve?	Technology Developed	Partnership/ collaboration model used
			Government, Other				model/PPP model
Greece et al. (2019)	USA	Mixed Methods Study	University/ Academic, Community (NPO/NGO), Healthcare Institution	Researcher, Faculty/ Professor, Public Health Agencies	Develop a practice-based teaching (PBT) framework to design, implement, and evaluate the PBT pedagogical approach with the intent to help prepare master of public health graduates for successful application of public health competencies in their careers	Learning management systems (LMS) software applications (not a primary component of the partnership)	PBT STEPS framework
Kerry et al. (2022)	USA, Malawi, Tanzania, Uganda, Eswatini and Liberia	Descriptive Review	University/ Academic, Community (NPO/NGO), Healthcare Institution, Government	Physician, Nurse, Faculty/ Professor, Student/ Resident, Government Leaders, Midwives	Help strengthen existing professional health education systems and care delivery by collaborating with partner countries to meet their immediate and long-term professional human resources for health needs	The establishment of simulation labs (not a primary component of the partnership)	Global health service partnership model
Liu et al. (2022)	USA	Case Study	University/ Academic, Community (NPO/NGO)	Researcher, community stakeholders	Describe a successful community-academic partnership, the process of collaboration and lessons learned from the partnership, which used a community-based participatory research (CBPR) approach	No technology/ simulation was developed or used in this partnership	Not described/ Unclear
Magwood et al. (2012)	USA	Project Report	University/ Academic, Community (NPO/NGO), Government	Physician, Researcher, community partners, health services research methodologist, biostatistician	Activate a community of informed learners who are committed to the transformation and improvement of health outcomes for disparate communities	No technology/ simulation was developed or used in this partnership	Center for Community Health Partnership (CCHP) Model
Miller et al. (2012)	USA	Not described/ Unclear	University/ Academic, Community (NPO/NGO)	Researcher, community partners	Inform research-to-practice links for researchers looking to translate evidence-based programs (EBP) to community settings,	No technology/ simulation was developed or used	Not described/ Unclear

Author (Year)	Country of Origin	Study Design	Participants	Professions	What was the research intended to achieve?	Technology Developed	Partnership/ collaboration model used
					and community-based organizations considering implementing an EBP	in this partnership	
Olson et al. (2011)	USA	Not described/ Unclear	Industry, University/ Academic, Community (NPO/NGO), Healthcare Institution	Physician, Not described/ Unclear	Describe a successful collaboration for continuing medical education	No technology/ simulation was developed or used in this partnership	Not described/ Unclear
Payne (2014)	USA	Case Study	Industry, University/ Academic, Community (NPO/NGO), Healthcare Institution	Researcher, Not described/ Unclear	Share the lessons learned using the Translational Research Informatics and Data Management (TRIAD) project example on how academic institutions and NPOs can license and commercialize technologies to achieve technology sustainability outside of traditional grants and contracts	TRIAD Grid	Not described/ Unclear
Taro et al. (2016)	USA	Innovation Report	University/ Academic, Community (NPO/NGO), Healthcare Institution	Physician, Surgeon, Researcher, Student/ Resident	Share a process for global health partnerships and provide a basic model for interdisciplinary and international partnerships between academia and medical institutions	No technology/ simulation was developed or used in this partnership	Global Surgery Partnership
Yan et al. (2018)	Canada	Case Study	University/ Academic, Community (NPO/NGO), Government	Researcher, Other	Understand the role of NGOs in cross-sector social partnerships, specifically using the Poverty and Employment Precarity in Southern Ontario (PEPSO) Research Partnership as a case study	No technology/ simulation was developed or used in this partnership	cross-sector social partnerships
Youn et al. (2019)	USA	Not described/ Unclear	University/ Academic, Community (NPO/NGO)	Researcher, mental health providers	Inform on the implementation strategies of a cognitive-behavioural theory program using a CBPR partnership framework between an academic institution and an NGO	No technology/ simulation was developed or used in this partnership	CBPR/ community-based implementation framework

Table 4.1: *Characteristics of articles included in the study.*

4.2.3.2 Participant Characteristics.

Participants in each study included a combination of industry, university/academic, community (non-profit organization/non-governmental (NPO/NGO), healthcare institution, government and/or others. The combination of university/academic and community (NPO/NGO) was common across all 15 articles, with the addition of healthcare institutions in ten articles, government in seven articles, industry in four articles and other organizations in two articles. The professions of individuals involved in the partnership varied in each article depending on the research being conducted and the type of partnership (see Table 4.1 for participants and professions for each article).

4.2.3.3 Aims.

Four articles shared a similar research aim, focused on increasing the training capacity through an in-service training program partnership between stakeholders (Busse et al., 2013; Cancedda et al., 2014; Kerry et al., 2020; Taro et al., 2016), and two articles described the use of a university-community partnership for researchers to translate evidence-based programs to the community (Miller et al., 2012; Yan et al., 2018). A number of articles had similar purposes to describe a type of multi-stakeholder partnership within different contexts, such as understanding the role of public-private partnerships (PPPs) to facilitate collaborative research (De Vrueh & Crommelin, 2017), describing a successful community-academic partnership to improve data management and analysis (Liu et al., 2022), developing a community-academic partnership using community-based participatory research (CBPR) principles to improve community health (Magwood et al., 2012), describing a successful interorganizational collaboration for continuing medical education (Olson et al., 2011), and understanding the role of non-governmental organizations (NGOs) in cross-sector social partnerships (Yan et al., 2018). The remaining articles had unique research aims that did not overlap. One article focused on addressing eHealth implementation challenges through collaboration and knowledge exchange (Ashraf et al., 2015), while another article aimed to examine the use of diffusion of innovation theory (DIT) for a diabetes management program (De Civita & Dasgupta, 2007). One article aimed to describe how to apply a practice-based teaching

(PBT) framework (Greece et al., 2019), and one article intended to share lessons learned from the Translational Research Informatics and Data Management (TRIAD) project to commercialize a prototype technology (Payne, 2014).

4.2.3.4 Key Findings.

Of the 15 articles selected for this scoping review, 10 articles had no technology or simulation component being studied or developed in the partnership (Busse et al., 2013; Cancedda et al., 2014; De Vrueh & Crommelin, 2017; Liu et al., 2022; Magwood et al., 2012; Miller et al., 2012; Olson et al., 2011; Taro et al., 2016; Yan et al., 2018; Youn et al., 2019). Information and communication technologies (ICTs), and eHealth/mHealth was the technological focus of one study (Ashraf et al., 2015). A diabetes software system was briefly mentioned in one study, and no simulation was developed or used in the partnership (De Civita & Dasgupta, 2007). One study identified the use of a learning management system software application, however, it was not a primary component of the partnership (Greece et al., 2019). Similarly, the establishment of simulation labs was listed as an outcome of a partnership, but was not described in detail or was a focus of the partnership (Kerry et al., 2020). One article had a technological focus to the research, describing the development of the Translational Research Informatics and Data Management (TRIAD) Grid, a research-oriented data management and sharing infrastructure, however, no partnership model/framework was described (Payne, 2014).

The partnership model/framework described in the articles fell within two categories: 1) Partnership models/frameworks, 2) General frameworks. Category one, partnership models/frameworks, described specific stages or steps within the model/framework that detailed a process to forming and conducting a partnership and/or strategies that can be used throughout the partnership. Category two, general frameworks, described theoretical or conceptual frameworks that were used to underpin the study and provide an understanding for the approach taken within the study. Articles with frameworks that fell within category two also provided strategies that can be used throughout the partnership process. Partnership models/frameworks that were described were the six-phase twinning partnership model (Busse et al., 2013), a multi-stakeholder

PPP model (De Vrueh & Crommelin, 2017), the PBT STEPS framework (Greece et al., 2019), the global health service partnership (GHSP) model (Kerry et al., 2020), the center for community health partnership (CCHP) Model (Magwood et al., 2012), and the global surgery partnership (GSP) (Magwood et al., 2012). No partnership model/framework overlapped, however, there was some similarity in the approach taken, with variations depending on the research context. General frameworks that were described were the health service delivery framework used to leverage training and research collaborations (Cancedda et al., 2014), the DIT framework used to understand the process of adopting novel technologies (De Civita & Dasgupta, 2007), cross-sector social partnerships as an underpinning process used to deal with complex social issues (Yan et al., 2018), and a community-based implementation framework emphasizing equitable partnerships between community members (Youn et al., 2019). Principles from the CBPR framework were also highlighted as underpinning the research in three articles (Liu et al., 2022; Magwood et al., 2012; Youn et al., 2019)). Five of the 15 articles did not describe any partnership model/framework that was used to guide the partnership (Ashraf et al., 2015; Liu et al., 2022; Miller et al., 2012; Olson et al., 2011; Payne, 2014).

No SBE partnership model was identified that outlined how a university research laboratory can collaborate with relevant stakeholders to deliver technological solutions to the healthcare education sector. Several partnership models/frameworks that were mentioned in the literature did not describe the process or stages of the model in-depth and did not have enough information to easily replicate the partnership process (Ashraf et al., 2015; Kerry et al., 2020; Magwood et al., 2012; Taro et al., 2016; Yan et al., 2018; Youn et al., 2019). The models/frameworks that did provide guidance on how to execute the partnership did not align with the context of the intended research (Cancedda et al., 2014; De Vrueh & Crommelin, 2017; Greece et al., 2019).

However, one article described a partnership model that details stages relevant to the research context, the twinning partnership model (Busse et al., 2013). The model details six stages of a twinning partnership between academic institutions and community organizations to collectively share resources and knowledge in a peer-to-peer relationship to produce technological and economical solutions. The six phases are: 1) initiate a

partnership, 2) develop a shared work plan, 3) implement the program, 4) monitor outcomes, 5) evaluate results, and 6) disseminate information (Busse et al., 2013). The twinning partnership model is useful in conducting a partnership between academic institutions and NPOs. The limitations of this model with regards to the identified research gap are the lack of a simulation component, and specifically simulation technology, as the central focus of the partnership. As such, the model does not describe the process of manufacturing simulators and how to navigate issues that are essential to technology development, such as funding and intellectual property, and ultimately diffusing the simulation technology to R&R settings.

Partnership strategies that can be used to facilitate the partnership were also explored. These strategies included what to do before, during and after the partnership. Several strategies described in the articles overlapped. After analysis of the literature, five themes of stages relevant to the partnership process, and 13 subthemes of strategies that can be applied in the different stages were revealed. Table 4.2 presents a detailed account of the subthemes categorized under each theme.

Themes	**Subthemes**	**No. of Studies**	**References**
Engaging Partners/ Establishing the Partnership	Building on existing relationships; Identifying appropriate stakeholders	7	Ashraf et al., 2015; Busse et al., 2013; Cancedda et al., 2014; De Civita & Dasgupta, 2007; Greece et al., 2019; Olson et al., 2011; Taro et al., 2016
	Conducting a needs assessment	5	Busse et al., 2013; De Civita & Dasgupta, 2007; Greece et al., 2019; Miller et al., 2012; Youn et al., 2019
	Clear communication of, common goals, shared vision, benefits, and purpose	6	Busse et al., 2013; De Civita & Dasgupta, 2007; De Vrueh & Crommelin, 2017; Liu et al., 2022; Olson et al., 2011; Taro et al., 2016
	Clear division and definition of roles and responsibilities; expectation setting	8	Busse et al., 2013; De Civita & Dasgupta, 2007; Greece et al., 2019; Liu et al., 2022; Miller et al., 2012; Olson et al., 2011; Taro et al., 2016
	Developing a shared work plan with clear objectives, goals, indicators/deliverables, outcomes, budget, and timeline; having a	9	Ashraf et al., 2015; Busse et al., 2013; De Civita & Dasgupta, 2007; De Vrueh & Crommelin,

	contract or memorandum of understanding		2017; Greece et al., 2019; Liu et al., 2022; Magwood et al., 2012; Olson et al., 2011; Taro et al., 2016
Acquiring Funding	Acquiring funding from government, partnered organizations, grant programs, private donations, commercialization of technology	4	Cancedda et al., 2014; Kerry et al., 2020; Liu et al., 2022; Payne, 2014
Implementation	Open and frequent communication with partners through face-to-face meetings, conference calls, regular work plan meetings, emails; formal and informal communication; having a digital file sharing tool	7	Busse et al., 2013; De Civita & Dasgupta, 2007; Greece et al., 2019; Liu et al., 2022; Miller et al., 2012; Olson et al., 2011; Taro et al., 2016
	Involving key opinion leaders and clinical champions to support adoption of the partnership	2	De Civita & Dasgupta, 2007; Olson et al., 2011
Monitoring and Evaluation	Use of a monitoring and evaluation framework; establishing a performance measurement system with measurable targets for each partner; formative and summative evaluation plan	4	Busse et al., 2013; De Vrueh & Crommelin, 2017; Miller et al., 2012; Olson et al., 2011
	Quality improvement evaluation for the process and outcome of the partnership	6	Busse et al., 2013; Cancedda et al., 2014; De Civita & Dasgupta, 2007; Greece et al., 2019; Olson et al., 2011; Taro et al., 2016
	System for data collection and documentation; quantitative measures of productivity (activities, deliverables) collected using validated, quantitative reporting forms and qualitative measures of program outcomes assessed through a series of internal and external evaluations; feedback from partners	5	Busse et al., 2013; Greece et al., 2019; Kerry et al., 2020; Miller et al., 2012; Youn et al., 2019
Dissemination	Communicating results with partners; sharing achievements and lessons learned	2	Busse et al., 2013; Greece et al., 2019
	Strategic plan to disseminate results through reports, conference presentations	5	Busse et al., 2013; De Civita & Dasgupta, 2007; Greece et al., 2019; Olson et al., 2011; Youn et al., 2019

Table 4.2: *Overview of themes and subthemes.*

The stages that can be used for a SBE partnership that were derived from analysis of the articles are: 1) engaging partners/establishing the partnership, 2) acquiring funding, 3) implementation, 4) monitoring and evaluation, and 5) dissemination. These stages are considered fundamental to fulfilling a successful partnership in the healthcare sector. The first stage, engaging partners and establishing the partnership, is described as the process

of communication with appropriate stakeholders and building the relationship to commence the partnership. This stage involves identifying the needs of each partner, communicating and aligning the vision and purpose of the partnership to benefit all partners, and dividing the roles and responsibilities for each partner with a clear work plan to guide the partnership activities (Ashraf et al., 2015; Busse et al., 2013; Cancedda et al., 2014; De Civita & Dasgupta, 2007; De Vrueh & Crommelin, 2017; Greece et al., 2019; Liu et al., 2022; Magwood et al., 2012; Miller et al., 2012; Olson et al., 2011; Taro et al., 2016; Youn et al., 2019). The second stage, acquiring funding, is necessary to actuate the partnership and requires a funding source or the collection of funds to carry out the objectives of the partnership (Cancedda et al., 2014; Kerry et al., 2020; Liu et al., 2022; Payne, 2014). The implementation stage that follows requires consistent communication with partners to ensure the plan is on track and to hold the partners accountable (Busse et al., 2013; De Civita & Dasgupta, 2007; Greece et al., 2019; Liu et al., 2022; Miller et al., 2012; Olson et al., 2011; Taro et al., 2016). This may involve the participation of opinion leaders and champions to support a successful implementation of the partnership (De Civita & Dasgupta, 2007; Olson et al., 2011). The monitoring and evaluation stage is necessary to improve the process and outcomes of the partnership through an evaluation plan by collecting data using key indicators and feedback from partners (Busse et al., 2013; Cancedda et al., 2014; De Civita & Dasgupta, 2007; De Vrueh & Crommelin, 2017; Greece et al., 2019; Kerry et al., 2020; Miller et al., 2012; Olson et al., 2011; Taro et al., 2016; Youn et al., 2019). The final stage, dissemination, is key to sharing the knowledge and lessons learned from the partnership to inform individuals who can utilize this knowledge within their own context (Busse et al., 2013; De Civita & Dasgupta, 2007; Greece et al., 2019; Olson et al., 2011; Youn et al., 2019). The five stages provide a general process to carrying out a multi-institutional partnership. In addition, one article describes the process of an academic institution and NPO licensing and commercializing a technology. The article describes the process of moving technology from the research laboratory to the market in a climate where there is difficulty acquiring funding and grants for a project (Payne, 2014).

4.2.4 Discussion

This scoping review is the first to examine the literature to identify a partnership model that focuses on the diffusion of simulators from research labs to community healthcare organizations, which is especially necessary in Canadian R&R settings. Answering the research question is significant as it pertains to finding a solution to HPE gaps for R&R healthcare providers. The overarching purpose of the articles included in the study was to improve community health outcomes, whether it be through improving health education programs or learning from previous multi-institutional partnerships. Physicians were the most common healthcare professionals identified in the articles, along with surgeons, nurses, residents, midwives and/or other allied health professionals. These professionals were involved in projects that aimed to improve healthcare education and/or health outcomes (Busse et al., 2013; Cancedda et al., 2014; De Civita & Dasgupta, 2007; Kerry et al., 2020; Magwood et al., 2012; Olson et al., 2011; Taro et al., 2016). The healthcare focus of individuals involved in the partnerships suggests a need to provide tailored training tools and resources. Few studies described international collaborations between two or more countries; where this did occur, they were primarily between resource-rich and low-income countries, highlighting the importance of knowledge and resource exchange to address disparities in healthcare training and service delivery (Busse et al., 2013; Cancedda et al., 2014; Kerry et al., 2020).

No existing partnership model was identified that involved university research laboratories and NPOs where the aim was to deliver simulation solutions. Of those identified, the model that came closest to describing a partnership process that can be useful in developing a SBE partnership model was the twinning partnership model. However, this model lacks a simulation component and consequently the necessary details to manufacture and facilitate the process of distributing simulators to R&R areas (Busse et al., 2013). The articles provide relevant information that can be used to guide the process from beginning to end of a SBE partnership. The five themes and 13 subthemes derived from the literature identify stages and strategies that can be used as a template to structure the process of a SBE partnership, with the need to contextualize the

information and process to fit the research context and add the necessary elements to detail the process of manufacturing and distributing the simulators.

4.2.4.1 Principles of the Partnerships.

A successful multi-institutional partnership in the healthcare context has been identified as being guided by key principles that are rooted in integrated knowledge translation (iKT) and CBPR. Several articles discussed iKT and CBPR principles as an integral part to executing a successful partnership. These principles include producing mutually beneficial solutions, grounding the partnership in shared principles, building long-term relationships, and involving all partners in the decision making process to establish a shared vision, co-learning, co-ownership, and co-leadership. In addition, it is important to establish mutual respect, trust, and understanding, prioritize reciprocity and bilateral innovation, and allow partners to take an active role in supporting the creation of new knowledge (Busse et al., 2013; Cancedda et al., 2014; De Civita & Dasgupta, 2007; De Vrueh & Crommelin, 2017; Liu et al., 2022; Magwood et al., 2012; Miller et al., 2012; Olson et al., 2011; Youn et al., 2019). These guiding principles are key to producing and enhancing research findings that are directly related to the knowledge users (KUs) (i.e. healthcare providers and administrators). This collaborative approach to generating knowledge is an ideal way to address complex healthcare issues and improve the delivery of healthcare services (Gagliardi et al., 2016).

4.2.4.2 Gaps in the Research.

In relation to a SBE partnership model aiming to diffuse simulators from university research laboratories to hospitals and NPOs, existing models have several gaps in the purpose and process of the partnership. The identified models do not focus on simulation technology being the purpose of forming the partnership and primarily discuss the overarching process without examining the various stages of the partnership in detail. Due to the lack of a simulation technology component, the research and development process of the simulators is not described. The articles that do include a type of simulation technology do not use a physical training model and therefore do not include any information on the manufacturing process. In addition, few articles briefly discuss the sources of funding for their project, however, the process of acquiring funding to expense

the production of the simulators or for general project management is not discussed. As such, there is a need to create a new model that addresses these gaps and incorporates the diffusion of simulation technology to the healthcare sector to address training gaps in HPE (Sivanathan et al., 2022; Turkot et al., 2019). The aim of the intended model will be to detail the partnership process of developing simulators in a research laboratory and partnering with FPOs and NPOs to manufacture and distribute the simulators to healthcare providers to improve rural medical education. Alternative to partnering with FPOs, another approach to solving the manufacturing gap is to incorporate the element of crowdsourcing into a SBE partnership model whereby stakeholders can mobilize resources and infrastructure from community members to manufacture simulators (Clarke et al., 2023a, 2023b).

4.2.4.3 Specific Limitations.

The purpose of this scoping review was to identify an existing partnership model that detailed the collaboration between academic institutions, FPOs and NPOs to deliver simulation solutions to the healthcare sector. The limitations in this review are largely a result of additive manufacturing being an emerging field, with 3D printing being the most common form, and consequently limited publications available on the diffusion of simulation technologies. To ensure the search was not too restricted and to allow for a sufficient number of articles to be identified to examine the literature, FPOs were not included in the search strategy. Therefore, not all partnership models that were identified through the scoping review included FPOs as a stakeholder in the partnership, resulting in no models being able to encompass all the necessary perspectives in the partnership process. Thirteen studies that were included in the scoping review were conducted outside of Canada. As such, the information presented in the articles do not entirely apply to Canadian partnerships and need to be adapted to fit the Canadian context. Non-English articles were also excluded from the review, reducing the scope of literature that address the research question.

4.2.5 Conclusion

SBE is a key component of HPE used to provide training to healthcare providers and is crucial in increasing the training capacity of R&R healthcare providers. The results

of this scoping review identify a clear gap in the literature pertaining to the existence of a SBE partnership model. Currently, no model exists that facilitates a partnership between academic institutions, NPOs, and FPOs to produce simulators for healthcare provider training. The twinning partnership model is the most comparable model that can provide detail on general partnership stages that can be integrated into a SBE partnership model involving the appropriate stakeholders. Several components and partnership strategies used in existing models have been identified that can be incorporated into a SBE partnership model. Further research is necessary to identify the process of research and development, and manufacturing of the simulators in order to incorporate the process into a SBE partnership model. This will require collaborative research with key stakeholders involved in the partnership process to inform the creation of a new partnership model that will be used to deliver simulation solutions to R&R healthcare settings.

Chapter 5: Exploration and Design - Developing a University, For-Profit, and Not-For-Profit Organization Partnership Model to Address Health Professions Education Gaps through Simulation-Based Education: A Qualitative Descriptive Study

[Verbatim as submitted to the Journal for the Society of Simulation in Healthcare]

5.1 Introduction

Health professions education (HPE) is a field that acknowledges the importance of ensuring equitable access to optimal training resources and competency of all healthcare providers (Institute of Medicine Committee, 2003). However, in rural and remote (R&R) areas of Canada, healthcare providers may encounter challenges in accessing skills development and maintenance opportunities as compared to those in urban areas. These challenges stem from factors such as geographical distance from urban centers and financial constraints (Williams et al., 2020). Simulation-based education (SBE) involves replicating real tasks (or patient encounters) for training, assessment, or quality improvement purposes, and is a crucial component of HPE (Hamstra et al., 2006). The use of SBE is an important component to addressing teaching curriculum gaps as it allows healthcare providers to acquire clinical skills and confidence through hands-on training that may be difficult to obtain otherwise, in a comfortable and monitored environment without the concern of patient safety (Siraj et al., 2022). Developing tools using simulation technology is an objective of the College of Family Physicians of Canada (CFPC) to improve healthcare provider training in R&R areas and allow providers to develop competencies that will support them in delivering quality patient care (Bosco & Oandasan, 2016). However, the high cost associated with SBE limits its widespread availability, primarily restricting it to research and innovation centers in urban areas of developed countries, with limited access in R&R settings (Goudie et al., 2019). The limited availability and access to simulators in R&R areas can be attributed to costs, logistical challenges, and ethical considerations. Therefore, it is critical for various stakeholders including researchers, innovators, regulatory bodies, program directors, and learners to explore innovative solutions to ensure sustainable access to simulation technology for all healthcare providers.

A cost-effective solution can be achieved by using three-dimensional (3D) printing to produce simulators through a sustainable and efficient manufacturing process (Machado et al., 2020). By leveraging 3D-printing technologies, researchers and healthcare providers can co-develop simulators in a research laboratory where the academic institution finances the development using research funding, thereby reducing the cost of production (Siraj et al., 2023a). The funding supports designing, prototyping, and conducting research on validity, efficacy, and acceptability. However, no model exists to facilitate the process of mass producing and delivering the simulators to R&R healthcare providers following the research and testing phase.

In Ontario, one of the top priorities of public health systems research (PHSR) is partnerships and linkages, which advances the need to foster partnerships among different sectors to enhance the performance of the public health system (Kothari et al., 2014). Partnerships between relevant organizations, primarily academia, the not-for-profit sector, healthcare, and industry play a pivotal role in bridging the gap in HPE and aligning with the PHSR priority to improve capacity building within the healthcare system. Leveraging cost-effective innovative solutions using simulation and related technology to train healthcare providers can support the delivery of the highest achievable standard of care in R&R parts of Canada.

Currently, no SBE partnership model exists that facilitates the diffusion of simulators from university research laboratories into the broader HPE system. A scoping review conducted by Siraj et al. indicates a gap in literature on models that facilitates partnerships between academic institutions, not-for-profit organizations (NPOs), and for-profit organizations (FPOs) specific to developing simulators for training (Siraj et al., 2023b). Existing models lack a simulation technology focus and do not address the research and development, and manufacturing process that is required to produce the simulators.

The purpose of this study is to develop a model to establish partnerships between university research laboratories, FPOs and NPOs to improve the distribution of simulators in R&R parts of Canada for healthcare provider training. The research question is: What are the stages of building and sustaining a partnership between a

university research laboratory, FPO, and NPO with a focus on SBE? The objectives of the study are: 1) to understand the different stages in the partnership process specific to the research aim, 2) to identify strategies used in each stage of the partnership process, and 3) to recognize the facilitators and barriers that may exist during the partnership process.

5.2 Methods

The methodological orientation that was used to underpin this study is qualitative descriptive methodology. Qualitative descriptive research seeks to discover and understand a phenomenon, a process, or the perspectives of the people involved. Some of the philosophical underpinnings of qualitative descriptive methodology are that it is an inductive process which can paint a picture of the phenomenon and provide knowledge for the development of a theoretical framework, it is subjective whereby each participant has their own perspective that equally matters, and it is designed to help describe and develop an understanding of a phenomenon (Bradshaw et al., 2017). A key characteristic of the qualitative descriptive approach is the active involvement of the researcher during the research process by becoming part of the phenomenon through direct communication with the participants (Bradshaw et al., 2017). Qualitative descriptive research aims to provide an in-depth understanding of a phenomenon through literal description followed by analysis and interpretation of the meaning that people attribute to events. The experience is depicted from the viewpoint of the participants in plain language through rich descriptions by focusing on the Who, What, Where, and Why of the experience (Bradshaw et al., 2017; Sandelowski, 2010).

The qualitative descriptive approach was chosen as the underpinning of this study as it seeks to inform the creation of a partnership model by gathering information from participants who have direct experience with the process under investigation. As in the social constructivism paradigm of the interpretive framework, this research approach relies on the participants' view of the phenomenon where the theory is inductively developed. By using general, open-ended questions, the participants are able to construct their own meaning of the process. In applying this paradigm, the researcher "positions

themselves" in the research and acknowledges that their interpretation of the findings originates from their own personal experiences (Creswell & Poth, 2018).

The principal investigator (PI) (SS) is a female who holds a Bachelor of Health Sciences in Public Health and is a graduate student working towards her Master of Health Sciences degree. She has acquired experience in key areas related to the study through her participation in a university research laboratory, maxSIMhealth. The research laboratory has a long-standing research history in SBE and an established partnership with an NPO to support the delivery of healthcare provider training using 3D-printed simulators in the context of R&R practice. The PI has also previously researched about the partnership process pertaining to the research aim in her undergraduate studies. Through these experiences, she has developed an understanding of the partnership process, which has shaped her interpretation of the phenomenon and acknowledges that her prior experiences may influence analysis of the data. The PI has used rich descriptions and quotes to report the study findings to stay close to the surface of the data and mitigate bias in the study results. The standards for reporting qualitative research (SRQR) checklist was used to guide and report the findings of this study (see Appendix D) (O'Brien et al., 2014).

5.2.1 Participant Selection

Purposeful sampling was used to select participants to ensure that they have the required knowledge and have experienced the process being studied. Additionally, the snowball sampling method was used by gathering information from previous participants about individuals they can identify that were suitable to inform the research question (Creswell & Poth, 2018). Participants were approached via email by the PI to participate in the study using the email listed on the website of the institution or organization they are associated with, or through the email provided by an informant of this study. Four key stakeholder groups were identified as being able to provide expert knowledge and experience regarding the central phenomenon: 1) university research laboratories, 2) not-for-profit organizations, 3) for-profit businesses, and 4) the healthcare sector. These groups were used as a criterion for selecting participants for the study. Participants were included in the study if they spoke English, identified from one of the four stakeholder

groups, and had participated in a partnership that involved at minimum, two of the four following groups: academic institutions (universities or colleges), NPOs, FPOs, and hospitals. No criterion was placed on the role of the participant within their organization due to the unique roles within each organization pertaining to the partnership. Individuals were excluded if they had not participated in a partnership with the above-mentioned groups and if their work did not have a Canadian focus. Participants were recruited and interviewed until data saturation was reached. Saturation occurs in the data collection and analysis stage when the new data produced provides little to no new information, and the research question has been sufficiently answered (Guest et al., 2020). Following the initial phase of data collection and snowball recruitment, a total of 16 individuals participated in the study. Table 1 lists the distribution of participants per stakeholder group.

Stakeholder Group	**Number of Participants**
Academia/University	5
For-profit organization	4
Not-for-profit organization	4
Healthcare	3

Table 5.1*: Distribution of participants based on the stakeholder group they represent. Note: Many participants identified and applied their experience from more than one stakeholder group. The primary stakeholder group they belong to is reported.*

5.2.2 Data Collection

Data was collected virtually via Google Meet through individual semi structured interviews that were scheduled for 1 hour. The PI facilitated the interviews with participants and was accompanied by a note taker (KC). The interviews were audio and video recorded with the permission of the participants to allow for verbatim transcripts to be prepared for each interview. Field notes were written by the note taker in each interview and the PI used the process of memoing to note down ideas during the data collection process that would help in understanding the data. The data was stored on a secure Google Drive folder that was only accessible by the research team and on the PI's password-protected laptop. The interviews were guided by the central research question

and open-ended interview questions (refer to Table 5.2 for a complete list of questions from the interview guide). Following each interview, verbatim transcripts were prepared and anonymized by assigning participant codes and removing any identifiers. Transcripts were shared with participants via email to review and provide additional comments to incorporate member checking as a validation strategy (Creswell & Poth, 2018).

Q#	Question
1.	What stakeholder group do you represent? a. Briefly describe your role in your organization(s). b. What organizations did you partner with?
2.	Tell me about your experience in being part of a partnership between a [university, FPO, and/or NPO] to produce simulators for healthcare provider training. a. What was your organization's role in the partnership? b. What drove your organization's involvement in the partnership?
3.	How was the partnership funded? a. How was the financial responsibility to produce the simulators divided between the partners?
4.	Based on your experience, can you describe the step-by-step process of the partnership to produce training simulators for hospitals and/or NPOs. [Beginning, Throughout, End] a. How did you identify the appropriate partners to involve in the partnership? b. What methods did you use to engage with your partners? c. What did the research and development process look like? d. What was the process of manufacturing the simulators?
5.	What strategies did you use to sustain the partnership? a. How did you ensure the project objectives were being met?
6.	What facilitators (success factors) did you experience during the partnership process? What barriers did you experience during the partnership process? a. How did you overcome the barriers you experienced (mitigation strategies)? b. What benefit [did/would] your organization get from this type of partnership?
7.	Was there an evaluative component to the partnership? a. If so {or hypothetically}, how was the partnership evaluated? b. In your view, what were your organization's contributions to research? c. How were the findings disseminated?
8.	Would you like to make any additional comments? Is there anything else you would like to share?

Table 5.2: *The list of questions from the semi-structured interview guide used for the individual interviews.*

5.2.3 Data Analysis

Thematic analysis is a method used to identify patterns or themes in qualitative research and was used to analyze the data for this study (Maguire & Delahunt, 2017). The

data was read and analyzed word for word to identify themes and interpret the findings. Codes were applied to the text that was relevant to addressing the research question. After the transcripts were coded, the codes were organized and collated into potential themes that provided information to answer the research question. After the initial identification of themes, the themes were reviewed to ensure clarity on the patterns that were identified and to determine if they needed to be further classified into sub-themes. Finally, a detailed analysis was written for each theme and subtheme to convey the findings of the study in relation to the research question (Maguire & Delahunt, 2017). The data was reviewed and coded by the PI (SS) and the code assignment was reviewed by a second researcher (KC), with any disagreements resolved by a third researcher. The data was coded using the qualitative data analysis software Dedoose (Dedoose, 2021). Findings from the data analysis were shared with participants via email to allow for feedback and ensure member checking. Rich descriptions and quotes were used to report the findings of the study to stay close to the "surface of the data and events" (Bradshaw et al., 2017).

5.2.4 Ethical Considerations

Participants were provided with a letter of information and a detailed consent form to provide a comprehensive understanding of the study procedures. Participants were reminded of their choice to voluntarily participate in the study through email and at the beginning of the interview. Informed consent was obtained from each participant. The interview transcripts were anonymized to protect the participants' confidentiality and quotes were reported using participant code. Ethical approval to conduct this research was obtained from Ontario Tech University's Research Ethics Board (REB file #17177).

5.3 Study Findings

Participants shared their experience being involved in a SBE partnership from the perspective of one of the four stakeholder groups. Each participant brought a unique perspective with various types of simulations being the focus of their partnership. The data was coded to generate themes to describe the partnership process of developing 3D-printed simulators that will form the partnership model.

The role of each organization in the partnership is context-dependent and can be intertwined with the traditional role of the other stakeholder groups. It is dependent on each partners' purpose of involvement, what they bring to the partnership, and which stakeholder initiates and leads the partnership. These factors will determine how certain responsibilities are distributed. All four stakeholder groups may not be required to participate in the partnership. It is possible for partnerships to achieve their end goal with involvement from only 2-3 of the four key stakeholder groups depending on how the roles are distributed and the project's intended outcome. Participants described specific responsibilities of their organization in the partnership (Table 5.3), as well as joint responsibilities for all partners involved. The joint responsibilities primarily include developing a partnership acceptable to all partners via a contract or memorandum of understanding, developing ideas and determining what resources are needed, engaging in meaningful conversation when someone identifies a gap in healthcare training or curriculum, conducting a needs assessment of learners, educators and healthcare providers, recruiting partners from a variety of sources, seeking out grant opportunities, monitoring progress via executive meetings, identifying challenges and addressing risks (SWOT (strengths, weaknesses, opportunities, threats) analysis), and innovation research.

Academia/University
- Content expertise and pedagogy - Provide opportunity for resident and medical/graduate student research projects - Oversee research being done → bringing ideas, overseeing the process - Research and testing - Providing feedback if supporting a FPO with testing - Consultative role on the research process - Studying and evaluating how simulators are used (whether they enhance or promote learning) - Provide designing and engineering expertise to partner organizations - Supplying material used for testing - Assessing grant funds to support purchase of the simulators
Not-for-Profit Organization

- Providing faculty development opportunities - Acting as a liaison between partners where needed - Implementing a quality assurance process - Teach rural physicians how to do their own 3D printing and access training to be able to train closer to their communities - Having people on the ground that can execute ideas in hospital settings - Encourage rural research and get simulation equipment in rural healthcare facilities - To create, maintain and develop a network of individuals and organizations to help advance simulation - Can provide a captive audience at conferences to further goals of academia - Provide clinicians, biomed engineers who are interested in helping build simulators - Support community-based project that can support and improve healthcare access in rural areas
For-Profit Organization
- Supplier of simulators - Providing customer service to partners - Work with partners on research testing to improve simulator - Provide the technology and equipment to engineer and mass produce simulators - Work with partners to develop simulators to address their training gaps
Healthcare
- End-user that provides feedback on simulator - Identify clinical and educational needs and provides ideas for simulators - Alpha or beta prototype testing - Provide knowledge and expertise to improve simulators - Very large pool of healthcare providers available to take part in simulator trial

Table 5.3: *The distribution of responsibilities for each stakeholder group in the partnership. NOTE: An organization can have one or more of the responsibilities listed. Their responsibility is not fixed to what is listed under their stakeholder group but can also be what is listed under another group depending on the context of the partnership.*

Six themes and six subthemes were identified from the data analysis. The themes are: 1) partnership process, 2) funding, 3) partnership strategies, 4) facilitators, 5) barriers, and 6) evaluation. Each sub theme is categorized under a main theme, which elaborates on the experiences shared by the participants to help form the partnership model (Figure 5.1).

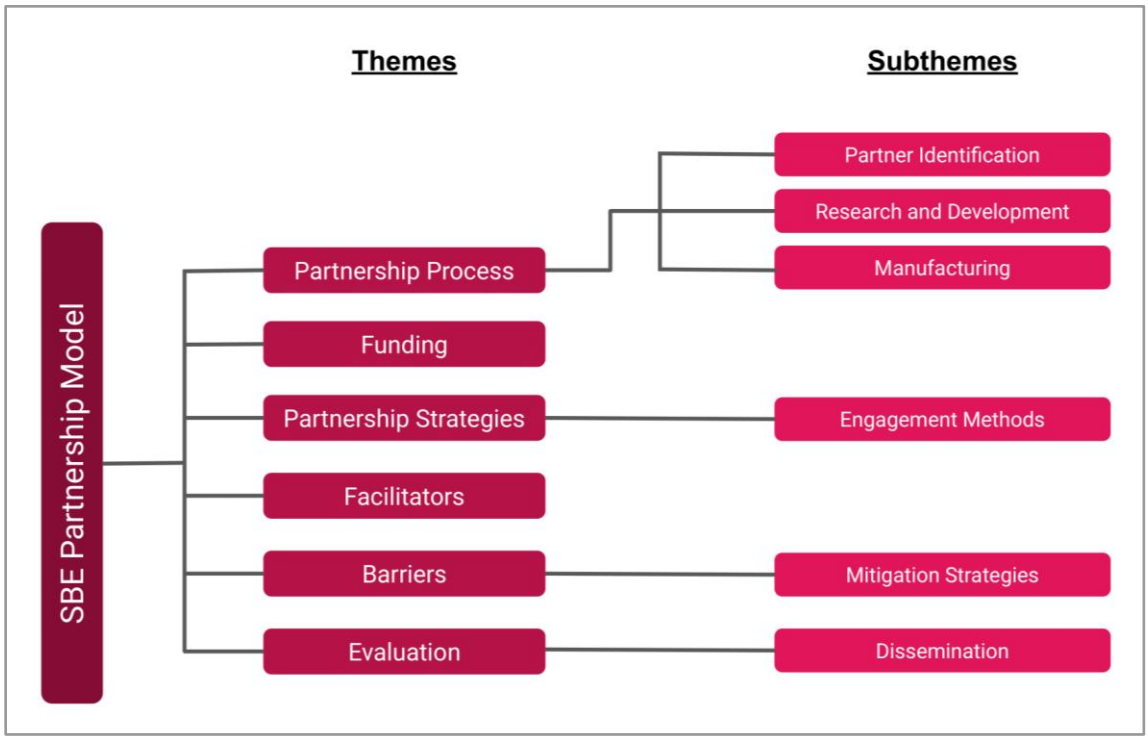

Figure 5.1*: Thematic Map: Themes and subthemes generated through thematic analysis.*

5.3.1 Partnership Process

The subthemes under the partnership process theme are partner identification, research and development, and manufacturing. The partnership process begins with identifying the need or gap. Participant 11 describes this as "either a partner coming to us and says, 'Hey can you help us with this?' Or sometimes we identify the gap or the need based on a needs assessment. It could be simply looking at the trends and the issues that we're seeing in the external landscape or even internal to us; If it's a program need or what we've identified through our learner experiences or our program experiences. And then we look for those willing partners that might want to participate." The needs assessment can be done formally through interviews, focus groups, or surveys/evaluations, or informally through conversations and meetings with stakeholders. Participant 6 highlights that organizations need to consider the following questions: "What do we need? What do we need it for? What are we teaching? What's the goal? How many do we need? How much benefit will we get from it? What's the budget? Who will pay? And where will we get it from?". The nature of the project, deliverables, and output will ultimately be driven by the needs assessment to make sure it addresses the

needs of the target population. Once the need has been identified, organizations can create a “business case” or “proposal” for the project, which includes the “purpose, what we're aiming to achieve or the objectives, how are we going to measure whether or not it's successful, and how are we going to fund it” (Participant 11). These methods will be used to support the presentation of their mission and vision in order to recruit partners. The primary organization (the organization requesting the simulators) will need to identify a funding source to fund the project prior to approaching partners or discuss with partners how to collectively source funds for the project. The primary organization can then approach potential organizations that can help them address their needs. Participant 4 emphasizes that “the key to a partnership is you can only really partner with somebody if you both have something that the other person needs [...] and you work together towards a defined shared goal”. Table 5.4 describes the various reasons each stakeholder group may participate in a SBE partnership and the benefits they receive from their participation.

Academia/University
- To conduct and produce research and knowledge - For resident and medical/graduate students to be able to produce publications and presentations - To support teaching and learning outcomes - To identify and develop sustainable simulators that support the curriculum - For student success - To provide experiential learning experiences for medical students - To improve competence and confidence of medical students in regard to training hands-on clinical skills - To identify innovate ways to prepare students in a safe environment before entering the practice setting
Not-for-Profit Organization
- To be responsive to and address the needs of the members - For decentralized learning opportunities using simulators for clinicians to practice in their own environment - Different ways to teach rural physicians - Inexpensive and sustainable training tools - To inspire research that can support rural healthcare centers - Innovative learning experiences - To improve healthcare training access in rural areas - To grow their research network
For-Profit Organization

- For brand recognition and brand awareness - An opportunity to engage with experts - Exposure to the Canadian market (educational sector and healthcare) - To leave a footprint in simulation - To meet sales quota - An opportunity to connect with new customers - To connect with people who can trial their simulators - Because of client demand - For credibility - For endorsement of their simulators by partners
Healthcare
- To obtain simulators that address current educational gaps - To meet educational objectives - To provide good healthcare and improve patient outcomes - To find solutions to deliver simulation-based education in urban, rural, and remote locations - Access to cost-effective, targeted simulators - Knowledge translation to healthcare providers - To have access to and be early adopters of the latest technology and educational opportunities - To build a platform of excellence in educating aiding increased partnerships, recruitment and retention of faculty and staff - To teach, assess and test technical and nontechnical skills external to the operating room environment - To prepare students, residents, faculty and staff for standard and emergency clinical encounters - To develop innovative approaches to simulation education

Table 5.4: *The summary of benefits and motives for each stakeholder group to participate in the partnership. NOTE: An organization may participate for one or more of the benefits listed. The outcome is not fixed to what is listed under their stakeholder group but can also be what is listed under another group depending on the context of the partnership.*

The partnership can begin with an “informal meeting” to discuss needs, goals, and define what each organization can contribute to the partnership. Conversations with partners should also discuss “ownership of devices and patents, including them within research” (Participant 8), and completing a budget exercise to ensure the project is sustainable. Regarding intellectual property rights, Participant 1 suggested publishing the simulator design ”under a Creative Commons license as openly available” so that no partner is able to “commercialize or get rich off of other people's work, but rather create something that can become publicly accessible”. Alternatively, partners could allow FPOs to sell simulators at a fraction of the cost or make it free for Canadian educators by allowing them the right to sell and market it to international customers. It is important for partners to come to a mutual understanding and agreement regarding these factors, which may require negotiation among partners. All items will be built into a formal binding

agreement. The formal agreement can be a “contract” or “memorandum of understanding” that details the expectations, accountabilities, contributions, deliverables, funding, and timelines. Participant 14 explains that they “initially signed a memorandum of understanding with [partner] and then had some negotiation and [discussions about] intellectual property rights”. The agreement should detail “a plan and be really specific with dates and deadlines” (Participant 7), and clearly defined “project objectives” agreed upon by all partners. Organizations should meet several times and have multiple recorded discussions before deciding to participate and formalize the partnership. After preliminary discussions, partnered organizations may need to submit a proposal to the leadership or legal department of their organization to approve the agreement and/or the cost of developing the simulators. Potential partners may request a “sample” of a simulator if one is available to beta test it with other members of their organization as part of a demonstration to determine its viability in addressing their training needs before moving forward with the partnership.

5.3.1.1 Partner Identification

The ‘partner identification’ subtheme describes how to identify and recruit potential partners for the project. Once the need is identified, the primary organization can promote the partnership opportunity through Listserv, social media, within professional networks, at events and conferences, and other networks. The primary organization can also reach out to professional organizations to promote the opportunity. Alternatively, the primary organization can directly reach out to organizations they would like to partner with to inform them of their need and ask for their participation in the project. This can be done through email or informal meetings and is a “consultative process”. Participant 16 explains this process by saying “we know who the players are and sometimes we're approached by those organizations with a potential project or interest and they're looking for our help, and in other cases [...] we know that we have a particular education or clinical need and we'll deliberately reach out to those organizations and say ‘Hey we're interested in partnering. This is what we want to do. Can you work with us.’”. It is important to know the organizations in the field and what they offer, and having a pre-established relationship and communications with those

organizations can facilitate the recruitment process by leveraging those relationships. “This is something that just occurs over a period of time. You know, relationship building by going to similar events together, meeting at simulation user networks, or going to industry conferences” (Participant 15). It is also important for partners to find organizations that have similar principles and goals, and whose interests align with theirs (i.e., saving lives, betterment of the healthcare system, improving education).

Once the partnership is formalized, representatives from each organization come together and begin the “working group meetings” (Participant 1). At this point, the partners can set up a “joint project management committee”, ideally with an equal number of people from all sides. If a design or prototype simulator already exists, a partner may request a demonstration or to be sent the simulator to provide initial feedback. The partnered organization can discuss within their organization to introduce the simulator to whomever will be using it and determine its usability within the organization. If a new simulator is being developed from scratch, the process will start at the beginning of the research and development stage. At this stage, partnered organizations will bring on different team members or groups within their organization to participate in the development of the simulator (ex. subject matter experts, engineers, research team). Participant 7 explains, “depending where [the first meeting] leads and which project we agree to work on, there's working sessions and in those working sessions, I could involve different teams or partners. [...] That could lead us to have multiple meetings or fewer meetings, depending on how big the project is”. The partners will then work together to achieve the accountabilities and fulfill the actions set out in the agreement. The partners will maintain ongoing communication to discuss the progress of the project and have frequent check-ins. The partners will need to determine the frequency of meetings depending on the duration of the project and the availability of the members. Meetings may be done with all partners or in smaller groups to address specific deliverables of the project (ex. subject matter experts meeting with the development team).

5.3.1.2 Research and Development

The ‘research and development’ subtheme focuses on the design and testing stage of the simulator. In some cases, a draft design may already exist, and the partnership may not need to go through all the steps in this stage, or the steps may be modified according to the context of the partnership. In this stage, the partners draft an idea for the simulator design with the development team and can use the “SWOT technique” to assist in this process. Participant 10 explains this by saying “you have a concept in your head of what you want and you talk to somebody and they start putting prototypes together. They bring them to you and you evaluate them and give feedback”. The engineers develop multiple iterations of the design before anything is printed. Appropriate “subject matter experts" (i.e., clinicians) will provide their perspective on the conception of the design to ensure that they meet the clinical requirements of the simulator. Participant 5 explains that they “worked directly with the engineers and designers and gave them feedback on how realistic [the simulator] was and what needed to change. We also did testing with resident groups and medical learners for their input on it too [through] feedback surveys and educational sessions". The prototype is then shipped or brought to the primary organization so that end users can utilize it in real time and trial the simulator to provide feedback for beta testing. Participant 3 mentions that the prototype “goes back and forth and sometimes [partner] sends different tissues or different components of a certain simulator and then we test it and give feedback”. The development team will meet with the beta testers to obtain written and verbal feedback or will collect feedback via evaluation surveys on efficacy, and its usability to improve confidence and competence. It is crucial that the simulator be “tested again and again using an evaluation system of a checklist and or global rating. Use it within an OSATS format (objective structured assessment of technical skills) in order to ensure that it's delivering the knowledge that it was proposed to do” (Participant 2). The development team will gather and review the feedback and adjust any corrections needed accordingly. This may result in multiple iteration trials and back and forth between the development team and beta testers until a final design is approved.

5.3.1.3 Manufacturing

The ‘manufacturing’ subtheme provides information on how the simulators are manufactured. The process of manufacturing the simulator is dependent on the organization responsible for manufacturing and the nature of the simulator. Some steps listed may not apply or be different depending on the context and type of simulator. Once testing is complete and the prototype has been finalized, the simulators can be mass manufactured. At this stage of the process, partners need to be cognizant of the number of simulators that need to be produced due to print time, cost of production, and storage space, and should plan accordingly. The organization responsible for manufacturing the simulators must source an adequate amount of material and parts to construct these simulators. Larger FPOs have a manufacturing chain that works systematically to produce the simulators. After the research and development stage, the development team shares the final 3D print file with the manufacturing team after which they will begin printing components of the simulators on 3D printers. Next, the simulators are constructed using an assembly line format. The supply chain manufacturers need to be trained and supervised on how to build the simulators according to the finalized blueprint designs. Participant 12 explains that “it's pretty much like an assembly line. They paint things at one station, like hand paint freckles or eyelashes or veins on the arm. Then it goes to the next station that assembles the tubing and the arm. So every process has an assembly line for manufacturing”. Intermittent quality control batches need to be pulled from the assembly line and sent to the developers for review. The simulators can then be mass manufactured and shipped to the primary organization.

After the primary organization receives the simulators, they are integrated into the teaching curriculum and are monitored to determine anticipated functionality and if it meets expected educational requirements. The simulator can be piloted in appropriate educational settings. Formal proof of concept evaluations will be completed and reviewed from in situ use. After implementation of the new simulator, the partnered organizations review the outcomes to determine “what has worked well, what hasn’t, [and] what has been the overall experience” (Participant 10). The feedback is gathered from end-users, staff/faculty, and all the partners involved. The partnered organizations set up a formal

recorded meeting to discuss the feedback. Following the implementation and evaluation, the product and partnership process is "published in a research journal" (Participant 5).

5.3.2 Funding

The source of funding is context-based and dependent on the role of each stakeholder group within the partnership. The funding may come from more than one source or method. Participants shared that the project can be "funded by the government", "research grants", "bridge funding opportunities", fundraising/charity events with the support of partners, "donors" or donations from partners, faculty budget or "internal funding" to purchase simulators for teaching, charging a rental fee based on a robin hood system (low to high rental/user rates for specific partners and groups), rent to own opportunities, or a high volume discount purchase. In most cases, the end-user purchases the simulator and can negotiate with the FPO for a discount on the simulators. Hospitals and NPOs can negotiate with FPOs to access simulators for free or at a reduced cost when offering to beta test and provide feedback on simulators. Participant 16 states that clinicians "contribute an in-kind intellectual input into the development of the products". Partners can also reinvest revenue from other sources into research and development activities or to purchase the simulators.

With regards to the financial responsibility, often it's the primary organization that is responsible for obtaining the funds to purchase the simulator, which can be sourced from any of the methods previously mentioned. Participant 4 suggests that "early on in the project, both sides [should] absorb their own costs" before formalizing the method to finance the simulators (ex. academia absorbs the cost of developing the prototypes in the research and development stage). Participant 7 emphasized that "it needs to be a win-win situation" for all partners, which includes recognizing that the private sector needs to be compensated for their contributions.

5.3.3 Partnership Strategies

Participants described various strategies that can be used to sustain the partnership and ensure the project objectives are being met. Participant 11 highlighted "communication, structure, and making sure you're doing those regular check-ins, and

adaptability and flexibility" as key strategies. Participant 1 explains one strategy being a "joint project management committee" with leads members from each partner "meeting regularly to monitor the progress and ensure the milestones of the project [are] being met". This can be done using "project plans and Gantt charts" (Participant 9). Additionally, each organization can designate a project manager to "keep the track of time, budget, [and] resources allocated" (Participant 7). Having a shared team's space as a hub for collaboration and communication to post announcements, ask questions, connect with partners, and post files is also a useful tool to facilitate communication. Several participants recognized that having an open line of communication for ongoing dialogue, regular check-in meetings and follow-ups, and being constantly responsive are important to maintaining and advancing the partnership. This can include "monthly or quarterly check-ins" post implementation. To ensure the partnership advances according to plan, participants emphasized the importance of having deliverables, setting clear expectations, project objectives, measures of success, a clear division of roles, and timelines agreed upon by all partners. As the partnership concludes, partners should celebrate any successes and acknowledge the contributions and efforts at all levels.

5.3.3.1 Engagement Methods

The subtheme 'engagement methods' summarizes the methods participants used to communicate with potential partners and maintain communication throughout the partnership. Participant 11 shares that "email communication, phone communication, meeting at conferences, and really the networking opportunities are where a lot of rich ideas come forward, not only from the academic side but we hear what others are experiencing [...] and we want to work with them to help solve those problems". The primary communication methods shared are emails, conference calls, and check-in meetings. Participant 12 lists "video chats, emails, phone calls, conferences [and] lots of on-site visits" as methods they used during their project. Check-in meetings were recommended by many participants, which can be conducted virtually, in-person, or using a hybrid format every two, four, or six weeks. Participant 2 mentioned using "an annual report" to engage partners, and having "executive meetings every spring and fall [to] discuss all aspects of finances, industry, partnership, and just keep engaged". Finally,

a project organizer or hub, such as Microsoft teams or Basecamp was recommended as a communication and project management tool.

5.3.4 Facilitators

There are several facilitators that can help move a project forward and ensure the success of the project. Participant 1 shares that “having a well-defined lead person” from each organization and “open and ongoing communication amongst all partners” as success factors for their project. Participant 16 recognizes that “in order to facilitate the partnership, there needs to be mutual reasons why people want to invest time and resources in the project. It's really important that you're able to check in with the partners and make sure that those initial drivers that encouraged the initiation of the partnership in the first place continue”. Participant 16 also shared that “there always needs to be an executive level sponsorship in whatever organizations that are there. You also need people that are on the ground that are able to actually move the projects forward. So it's making sure that you've got the right team composition, the right oversight, and the right executive support to make sure that the projects are moving forward and that people are meeting from the different organizations at the right levels, and that you've got briefings at all levels”.

Being clear about goals, expectations and outputs with partners from the beginning of the project were also described as facilitators in the partnership. Participant 4 emphasized that “a successful partnership depends on a shared goal together and a shared vision. You've got to have a visionary”. Participant 10 explains that “what makes [the partnership] successful is the ongoing communication [and] transparency. Everybody was very clear about what the goals were [...] and also shar[ed] when there were barriers or an issue had come up and how we would troubleshoot those issues, instead of trying to have something hidden. So open transparency was really important; that you build a trusting relationship between yourself and the [partner]. And accountability and meeting timelines; timelines are always really important and meeting your deliverables. And if it's not possible, giving a clear explanation as to why that deliverable wasn't met”. Additionally, defining outputs based on a needs assessment, having good champions of the project and vision within the academic institution and healthcare sector, giving

everyone “ample opportunity to provide feedback” in a timely manner (Participant 13), receiving customer support from FPOs, debriefing and reflection at the end of the project, celebrating big and small milestones and recognizing accomplishments along the way, and having an exit strategy should the project not meet the anticipated outcomes are all facilitators that can support the successful delivery of a project.

5.3.5 Barriers and Mitigation Strategies

The barriers that may appear during a project are dependent on the contextual factors that influence the partnership. Not all barriers shared by participants were able to be addressed within the partnership. Table 5.5 lists the barriers and mitigation strategies shared by participants that partners may encounter during the project.

#	Barriers	Mitigation Strategies
1	Legal departments of academic institutions disagreeing on specific clauses in the contract; Deciding who would own the intellectual property	Negotiation with partners; Be hardline about expectations surrounding intellectual property
2	Having too much flexibility in the contract process	Can allow flexibility where possible (ex. timelines); Make sure contracts are fair and reasonable and open to being revisited if circumstances change
3	Industry bias and the commercial interest of industry driving decision making	Conducting the needs assessment within the healthcare sector and with educators to define outputs
4	Waiting to receive feedback from busy rural doctors after mailing them the simulator	Sending follow-up emails to ask if they have feedback to provide; Offer small financial incentive
5	Geographical distance between partners increases response times	Utilize Zoom and other available apps to increase connectivity
6	Not enough crosstalk between researchers/clinicians and educators within the academic institutions to use simulators to train medical students and residents (remains solely for research purposes)	Need more outcomes-based testing proving that the simulators reduce negative patient outcomes, increases learner confidence, and decreases safety mishaps
7	Those who are invested in using the simulators are too busy to acquire better ones and those who purchase the simulators know little about medicine causing a disconnect; Lack of knowledge in simulation	Those who know about the simulators and are interested in purchasing it should be involved in the partnership as they know what to look for; Educating partners; A specific industry event program would allow learners to use new simulators with the developers. Educators should also attend the marketing event; Video files on the use of the simulator available to the learner and educator
8	Ownership of the project; partners with their own funding agenda and not appropriately allocating funds	Negotiation and perseverance; the focus of the partnership should be education and safety outcomes

9	A small Canadian market in comparison to other companies for international FPOs to sell simulators (lack of interest in the Canadian market)	Make it an international simulator for purchase
10	Lack of funding and competition for the same dollar	Being creative in how funding can be sourced
11	Loss of momentum if project takes too long; Loss in interest or change in the partners' driver to participate; a partner abandons the project due to alternate solution	Recognizing that the project and environment is very dynamic; readjusting priorities if needed; Good leadership paired with invested high stakeholders is imperative to success.
12	Personnel turnover leading to team instability; Lack of human resources	Well developed documentation of the project that will allow for succession of the project
13	Technology disruption - something new comes that is better than what you're doing	Recognizing the correct time to switch directions or end the project; Preparing an exit plan.
14	Having to go through multiple steps before finding a way to reach the solution	Patience and perseverance will be needed; Finding individuals who have passion vs financial interests in a project will lead it to success.
15	Poor communication and lack of timely responsiveness from partners	Acknowledge receiving an email or communication even if you don't have the answer right away; meet with partners to address concerns; open and ongoing communication
16	Management of funds by organizations that have a lot of regulations; Having to go through capital requests and various signatures before funds are released	Building trust and a good relationship with your organization's financial and capital teams to better gain your needs; Understand your organization's general accounting practices.
17	Customizing everything to each customers' need from a FPO perspective	Knowing when to say no
18	Not having the right people at the table or at the right level in the organization	Advocate for stakeholders involved in the partnership to have decision making abilities within the partnership
19	Partners not fulfilling the accountabilities and expectations set out in the agreement	open dialogue; checking in to understand why the accountabilities are not being addressed; Reference legal obligations as outlined in the memorandum of understanding should there be any misunderstanding as to obligations; Start a new team; Ensure members sign an agreement of obligation with a named term and title.
20	Time commitment	Be honest with the time commitment that will be required; Ensure meetings are well planned with an agenda and are kept to as short of time as possible; Record all meetings for reference; Have action items listed from all meetings and start with action items at the following meeting.
21	Lack of sufficient long-term planning to support organizations that manufacture their own simulators in rural areas to overcome technical issues; Lack of design capabilities in rural areas	Meet with stakeholders once project ends to create a long-term post-implementation sustainability plan; Offer a support contact number; Consider planning for short term first with the idea of hoping for long term (small steps can become large ones if the project gets some good legs.

Table 5.5: A list of barriers that may impact the partnership, and mitigation strategies to overcome those barriers.

5.3.6 Evaluation

An evaluation can be conducted throughout the project and at the end of the partnership. Evaluations throughout the partnership are a way to create an "open dialogue" and touch base with each partner to understand their experience, look at the progress of achieving the agreed upon success measures, discuss any challenges or concerns, and identify changes to the project to overcome the challenges. Depending on the duration of the project, evaluations can be conducted on a monthly or quarterly basis, or at predetermined points throughout the project. At the end of the partnership, the evaluation should be divided into two: 1) Evaluating the simulator itself and whether it meets the educational objectives, and 2) evaluating the overall partnership and the process. The overall evaluation should look at whether or not the goals of the partnership have been met and reflect on the process to achieving those goals. The evaluation can collect data through Likert scale questions to provide quantitative outputs, and through open-ended questions for subjective comments. The evaluation can be done formally or informally and includes all partners involved in the partnership. The evaluation can be conducted using "surveys", "interviews", "work group sessions", "educational sessions" with end users to evaluate the simulator, timely check-ins, accreditation, and/or auditing. Participant 1 advises that "having a third party [conduct the] evaluation [...] would probably be the most objective approach" to avoid bias. The partnered organizations should discuss the method and approach used for the evaluation based on the output they want from the evaluation and should collectively incorporate a research design into the project. At the beginning of the project, the partnered organizations should have "mutually agreed upon measures" of success and determine the metrics and key performance indicators used for the evaluation.

5.3.6.1 Dissemination

Following the evaluation of the project, partners can disseminate their findings in various ways. The most common approach is through "publications", "scholarly papers", and "conference presentations". Organizations may also choose to disseminate their findings by publishing white papers, through poster or abstract presentations, presentations at international meetings, by hosting webinars for stakeholders, internally at

executive meetings or research days, academic program meetings, organization websites, annual reports, announcements/newsletters, Listserv and social media channels. Participants have also shared that findings are disseminated when reporting to the funding organization for grants, and can be disseminated through meetings with other academic institutions, through word of mouth among professional networks, on-site visits/tours, and accreditation.

5.4 Discussion

The aim of this study was to understand the stages of the partnership process between four stakeholder groups: academia/university, FPOs, NPOs and healthcare, to develop and distribute 3D-printed simulators to improve healthcare provider training in R&R parts of Canada. Participants in this study shared their experience of being involved in a partnership that focused on identifying solutions using SBE and simulation technology to improve training and teaching outcomes for students and healthcare providers. This study is the first to investigate this topic and explore the different stages, strategies, facilitators, and barriers in the partnership process specific to this research aim. Prior research conducted by Siraj et al. examined the literature to identify existing models that involved the four stakeholder groups in a partnership to deliver simulation solutions to the healthcare sector (Siraj et al., 2023b). Findings from the scoping review indicated that no model currently exists that outlines the process of developing a partnership between the relevant organizations with a focus on SBE. However, five stages that are relevant to a SBE partnership and strategies that can be applied within those stages were derived from the literature. The themes uncovered through the scoping review are noticeable in the themes derived from analysis of the participants' experiences in the qualitative descriptive study. The similarities between the themes in both studies confirm the findings from the scoping review, and the interviews allowed for new knowledge to emerge to address the gaps identified through the scoping review. The stages and strategies from the scoping review were integrated with the findings of this study to create a SBE partnership model that addresses the gaps in literature and details the process of producing 3D-printed simulators for R&R healthcare providers.

5.4.1 SBE Partnership Model

The findings from this qualitative descriptive study informed the development of an SBE partnership model grounded within the lived experiences of participants. The findings from this study were consolidated with the findings of the scoping review conducted by Siraj et al. to construct a prototype partnership model that outlines the key stages to establishing and executing a partnership between academic institutions, FPOs, NPOs, and the healthcare sector to improve the distribution of 3D-printed simulators in R&R parts of Canada (Siraj et al., 2023b). The stages of the SBE partnership model are as follows: 1) Establishing the Partnership, 2) Research and Development, 3), Manufacturing, 4) Implementation and Evaluation, 5) and Dissemination (Figure 5.2).

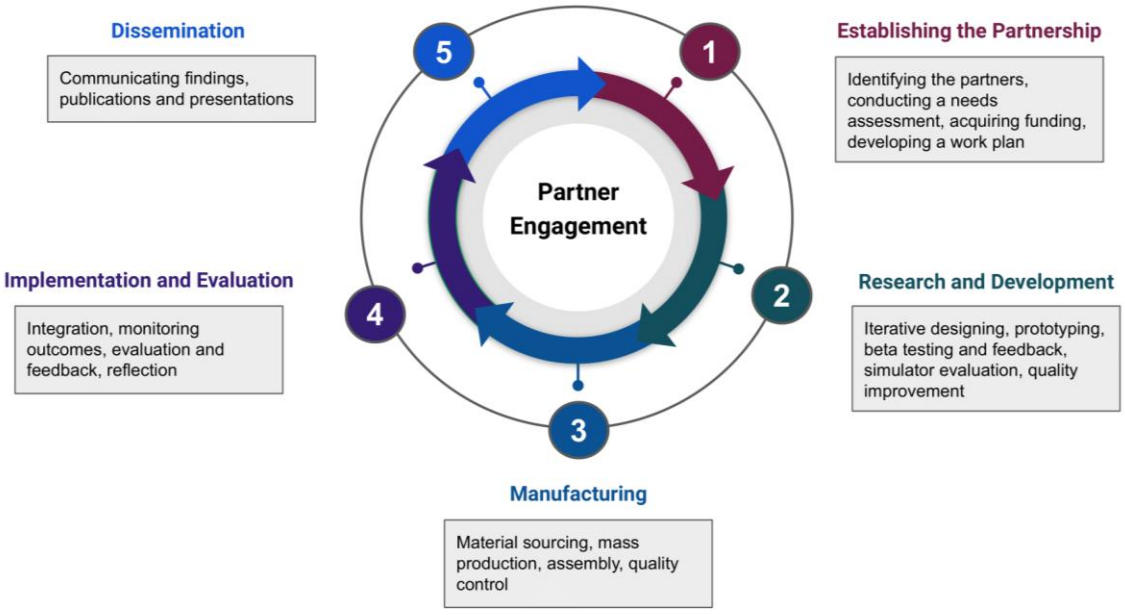

Figure 5.2: *Simulation-based education partnership model.*

Stage one of the partnership model, establishing the partnership, begins with identifying the need through a conversation with stakeholder or by conducting a needs assessment. Once the need has been identified, the primary organization can approach partners to involve in the partnership by building on existing relationships or approaching new organizations. Partners should identify their common goals, vision, benefits and purpose, have a clear understanding of each partner's roles and responsibilities, and set expectations from the beginning of the project. Also at the beginning of the project, the partners need to discuss and acquire funding to sustain the partnership. To formalize the

partnership, partners should sign a contract or memorandum of understanding that outlines expectations, clear objectives, goals, deliverables, contributions, measures of success, outcomes, budget and timelines. A key point of discussion is intellectual property that should be discussed among partners to reach agreed upon terms. This document will help guide the project and hold partners accountable to their responsibilities. A performance measurement system should be established with measurable targets for each partner to be used when evaluating the partnership. At this stage, it is important to involve key opinion leaders and clinical champions to support adoption of the partnership.

Stage two, research and development, commences after the partnership has been formalized. At this stage, partners begin working group meetings to develop the simulator design and prototype. The development team will draft an idea for the simulator with subject matter experts to ensure the design meets clinical requirements. Partners will work directly with the engineers and designers to develop the prototype by providing feedback on realism and fidelity. After a design has been finalized, the prototype simulator will be developed and sent to the end users to trial and provide feedback for beta testing. End users will provide the development team with feedback on efficacy and usability. The development team will go through multiple iterations using the feedback from beta testers to improve the simulator. The simulator will be rigorously tested in large groups using an evaluation tool to ensure they are delivering the intended knowledge. The prototype will continue to be refined until a final design has been approved by partners.

Following this, the manufacturing stage will focus on mass production of the simulator. The partner organization responsible for this task will need to source the materials to construct the simulators and train the supply chain manufacturers on how to build the simulator according to the finalized design. The manufacturer will need to be mindful of the print time and cost of production to ensure the work is being completed according to the work plan. The manufacturers will fabricate the parts or source them externally and construct the simulators using the appropriate material according to the

design blueprint. Intermittent batches will be pulled from the production line and sent to partners for quality control.

The implementation and evaluation stage will begin after the simulators have been sent to the primary organization and they have been integrated into the teaching curriculum or provider training. The use of the simulators will be monitored to determine anticipated functionality and if it meets expected educational requirements. The simulator can also be piloted in appropriate educational settings. The FPO will aim to offer help and support after implementation of the new simulator. After implementation of the new simulator, the partnered organizations will review the outcomes to determine what worked well, what did not work well, and how the overall experience was viewed. A formative and summative evaluation plan should be developed and an evaluation framework should be used to evaluate the partnership process and outcomes. The evaluation should include quantitative measures of productivity (activities, deliverables) collected using quantitative reporting tools and qualitative measures of program outcomes assessed through a series of internal and/or external evaluations, and feedback from partners. The feedback will be gathered from end-users, staff/faculty, and all the partners involved, and the partnered organizations will set up a formal recorded meeting to discuss the feedback.

The final stage, dissemination, will focus on communicating the findings, and sharing achievements and lessons learned from the partnership with partners and external stakeholders. Following the implementation and evaluation, the product and partnership process should be published in a research journal. Partners should develop a strategic plan to disseminate findings through various modes, such as through conferences, papers, newsletters, webinars, etc., to inform educators and clinicians of the resources being produced.

The central feature of the partnership model is partner engagement, which is essential from beginning to end of the partnership. This feature emphasizes the importance of open and frequent communication with partners to develop and maintain trust and transparency throughout the partnership. Partners should actively engage in face-to-face meetings, conference calls, regular work plan meetings, and emails to keep

each other informed on the progress of the partnership and to discuss any barriers or issues. Regular check-ins are key to ensuring the project remains on track and progresses with minimal hindrance and to ensure partners are on the same page as the project progresses.

To the best of our knowledge, the partnership model presented here represents a pioneering approach in the field. The SBE partnership model is different from other partnership models as its central focus is on developing 3D-printed simulators with the incorporation of FPOs as a partner. It focuses on bridging the gap between university research laboratories and healthcare settings in R&R areas, specifically addressing the delivery of simulation technology. Existing partnership models, although include academic and healthcare institutions and NPOs, do not incorporate the simulation technology that is reported in this study, and therefore do not provide guidance on the research and development, and manufacturing process to produce the simulators (Siraj et al., 2023b). The SBE partnership model shares similar principles with existing models, such as working with end users to produce mutually beneficial solutions and establishing a shared vision and trusting relationship with partners. Additionally, common features of the SBE partnership model and existing partnership models are the process of establishing the partnership, the emphasis on partner engagement throughout the partnership process, evaluation, and dissemination of the research findings (Busse et al., 2013). However, the SBE partnership model provides specific direction relevant to the research context within each stage and information on how to navigate issues related to technology development. The new stages of the partnership model compared to existing literature is the research and development stage that describes the preliminary process of designing and testing the simulator, followed by the addition of a manufacturing stage in which the simulators are mass produced. Furthermore, new knowledge that emerged from this study was the motivations of each stakeholder group to participate in a SBE partnership, the distribution of responsibilities with relation to producing simulators for the partnership, specific details on acquiring funding to produce simulators, and contextual factors that may act as facilitators or barriers within the partnership.

The establishment of this partnership model not only promotes the advancement of HPE but also aligns with the policy considerations of the CFPC aimed at enhancing medical education in rural areas (Siraj, Brunton, et al., 2023). This model, while initially designed for R&R healthcare settings, offers a versatile blueprint that can be adapted for partnerships with various organizations. Its applicability extends beyond rural areas, making it valuable for stakeholders operating in urban environments who wish to bolster healthcare education within their institutions. It's important to note that this model is not a one-size-fits-all solution; rather, it provides a flexible framework that can be tailored to suit specific contexts. Stakeholders can apply relevant stages and steps of the model to their projects and modify the approach to meet their unique requirements and project objectives. This model serves as a valuable resource for a wide range of stakeholders seeking to advance their educational objectives and address training needs within their respective organizations. Ultimately, the SBE partnership model offers an effective solution to develop cost-effective, sustainable simulators. Its primary goal is to bridge training gaps in R&R HPE by increasing access to affordable training simulators, thereby enhancing proficiency and confidence in clinical skills (Siraj, Brunton, et al., 2023).

5.4.2 Limitations

The limitations of this study stem from the lack of domestic partnerships to develop and deliver 3D-printed simulators to R&R healthcare providers. Canada is considered a significantly smaller market compared to the United States in terms of customer population for FPOs. There are fewer FPOs that work within the Canadian landscape, which make it difficult to tap into that sector. Additionally, each participant in this study had a unique experience with regards to the simulation-focused partnership that they participated in. Not all participants experienced partnerships that involved all four stakeholder groups, so their perspectives were limited, making it difficult to apply their experience to a partnership involving all four stakeholder groups. The type of simulation involved in the partnerships varied from high-fidelity mannequins to virtual simulations, to low-fidelity task trainers. This made it difficult to aggregate the findings and translate them into a process that would focus on developing 3D-printed simulators, however, we tried to stay as close to the data as possible. As a result, the partnership model was

described in a broader context, so stakeholders interested in using the model will need to apply and adapt the model to fit their context. The study included a limited number of participants that practice or work in R&R areas. As such, the model may lack some of the more specific details that address the R&R context.

5.5 Conclusion

SBE is a critical aspect of HPE used to train healthcare providers to increase their competency in performing clinical skills. R&R healthcare providers lack access to current simulation technology and continuing education opportunities. Key stakeholders were engaged in this study to understand their experience in a SBE partnership process to develop a partnership model that can facilitate the distribution of 3D-printed simulators to R&R healthcare providers. Findings from this qualitative study were consolidated to create a 5-stage partnership model to address training gaps in SBE. Future research directions for the SBE partnership model will consist of piloting the model in an appropriate educational setting to validate the process and stages of the model to ensure its feasibility and acceptability to address the research gap. The partnership model is crucial to improving access to training resources and SBE for healthcare providers in R&R areas. Application of this model to deliver simulators to R&R healthcare providers can improve rural medical education, in turn improving health outcomes in R&R communities.

Chapter 6: General Discussion

6.1 Summary

Healthcare providers in R&R communities of Canada do not have the same access to skills development opportunities to improve their clinical competencies compared to their urban counterparts. SBE is a necessary technique to allow healthcare providers to practice clinical skills to improve the quality of care they provide to the rural Canadian population. The high-cost of providing SBE has limited its availability to urban academic institutions and hospitals. 3D-printed simulators are a cost-effective solution to address HPE gaps for R&R healthcare providers. However, the knowledge and tools to produce these simulators are primarily located in university or hospital-based research centers in urban areas, and rarely diffused to R&R settings (Siraj, Brunton, et al., 2023).

This Master's thesis aimed to develop a practical solution to address the lack of CME opportunities for R&R healthcare providers in Canada by developing a SBE partnership model. To understand the partnership process between university research laboratories, FPOs, NPOs, and the healthcare sector, the following research question was explored: How can a university research laboratory, FPO, and NPO collaborate to deliver SBE to the healthcare sector? The research question was divided into two subquestions that were used to guide the studies in this thesis:

1. What are existing partnership models, or components of a model, that outline how a university research and laboratory can collaborate with a FPO and NPO to deliver technological solutions to the healthcare education sector?

2. What are the stages of building and sustaining a partnership between a university research laboratory, FPO, and NPO with a focus on SBE?

A hybrid research framework combining iKT and EDR principles was developed to guide the work in this thesis. The hybrid approach incorporated the early phases of iKT and EDR to establish a four-phase process, where the first three phases were applied in this thesis to develop the partnership model. Phase A was the problem identification phase which focused on investigating the problem to provide a clear understanding on the

issue and the contextual factors that impacted the issue. To accomplish this, I wrote an editorial paper where I examined the literature to understand the problem in greater detail and develop a clear solution that could address the problem (Siraj, Brunton, et al., 2023). I worked with members from each stakeholder group to understand their perspective on the solution and ensure the solution would address their needs. This editorial paper provided a foundation to begin the first study of my thesis, the scoping review.

In accordance with phase B of the hybrid research framework, knowledge synthesis, the scoping review allowed me to examine the current landscape of literature to understand what processes existed to address the research gap and identify what areas needed to be further explored. The objectives of the scoping review were to identify partnership models that can be adapted to our research context, and to identify strategies that can be used in a stage of the model in relation to a partnership. Findings from the scoping review revealed that no partnership model existed that focused on the development and distribution of SBE or simulation technology. Furthermore, limited research existed on the research and development and manufacturing process of the simulators, which clarified a gap that needed to be further explored. General partnership stages and strategies that could be applied to a SBE partnership model were extracted from the literature and reported in the scoping review. The identified stages and strategies were incorporated into the final SBE partnership model developed in study two, the qualitative descriptive study.

Phase C, exploration and design, was the final phase of the hybrid research framework that was applied in this thesis. The qualitative descriptive approach was used in this phase to understand stakeholders' perspectives on the partnership process, which was used to construct the prototype SBE partnership model. The objectives of this study were to understand the different stages in the partnership process specific to the research aim, to identify strategies used in each stage of the partnership process, and to recognize the facilitators and barriers that may exist during the partnership process. The research gap was explored through individual interviews with participants from university research laboratories, NPOs, FPOs, and the healthcare sector. Participants' responses were analyzed and synthesized to describe the partnership process of establishing a

partnership to develop and distribute 3D-printed simulators to R&R healthcare providers. The qualitative study reported on the different stages, strategies, facilitators, and barriers in the partnership process specific to this research aim. The findings from the scoping review and the qualitative descriptive study were consolidated to create a 5-stage prototype SBE partnership model (refer to Figure 5.2). The five stages that constitute the partnership model are: 1) establishing the partnership, 2) research and development, 3), manufacturing, 4) implementation and evaluation, 5) and dissemination.

6.2 Methodological Contributions

The methodological contributions of this thesis are evident in the development and application of a hybrid research framework created to address the gap articulated in this thesis. The research conducted in this thesis spans two distinct disciplines, education and healthcare innovation. Conducting interdisciplinary research requires the integration of knowledge and ideas from each discipline to produce research findings that are applicable to the research context. The hybrid research framework combines iKT and EDR to iteratively design and develop a solution that will be integrated into practice. IKT focuses on bridging the gap between researchers and KUs by involving them throughout the research process to co-produce knowledge that is mutually beneficial and applicable in a real-world setting (Gagliardi et al., 2016). However, the iKT approach is not widely practiced and properly understood. Gagliardi et al. (2016) reported that researchers gravitate towards using traditional methods to conduct and disseminate research, as opposed to an iKT approach. In similar yet different ways, EDR is used to develop practical solutions with stakeholders that are applicable to real world contexts. The iterative design process is used to develop and refine innovative solutions by incorporating feedback and insight from stakeholders to develop context-specific solutions (McKenney & Reeves, 2012). The principles from iKT were combined with EDR to create a new methodological approach that can be used by researchers conducting research across these two disciplines. The hybrid research framework provides direction for researchers to incorporate iKT into their work, while at the same time using discipline specific methodology to conduct research. The hybrid research framework can be used in

the early stages of developing a complex healthcare solution, as was done in this thesis to develop a unique partnership model that meets the needs of stakeholders.

6.3 Theoretical Contributions

This thesis provides theoretical contributions by way of developing a novel partnership model that advances existing knowledge and theory to address gaps in the delivery of SBE to R&R healthcare settings. The SBE partnership model explains the phenomenon that was studied in this thesis, being the partnership process between relevant stakeholders to produce simulation solutions for healthcare provider training. As determined by the scoping review, no partnership model previously existed that described this phenomenon. As such, the focus of my research was to understand the Who, What, Where, Why, and How of the process to develop a solution that answered the research question. By using qualitative descriptive research, I was able to explore and understand the perspectives of people involved in the partnership process. Doing so provided me with the necessary knowledge to develop a theory that described the process. This theory actualized as the first SBE-focused partnership model which combined existing literature with the experience of stakeholders to produce a model that can be applied in real-world settings (refer to Figure 5.2). The SBE partnership model describes the process that can be applied to establish a multi-institutional partnership focused on developing and distributing 3D-printed simulators to R&R healthcare providers. My research contributes to the existing body of knowledge by understanding the facilitators and barriers in executing a multi-institutional partnership, and through the creation of a new partnership model that guides partners through the different stages and strategies to apply when diffusing SBE from research laboratories to appropriate healthcare and educational settings.

6.4 Practical Contributions

The practical contributions of this thesis are the applicability of the SBE partnership model to address existing gaps in HPE. The model provides a mechanism for relevant organizations to operationalize to deliver cost-effective 3D-printed simulators to healthcare providers. Doing so will increase the accessibility of training tools for R&R

healthcare providers to improve their clinical competencies and support rural healthcare education. The SBE partnership model can be used by various organizations interested in establishing partnerships to address their teaching and training needs, and provides a general outline for partners to apply to their projects to achieve their intended outcomes. The model can also be applied by partners who work in urban settings and are interested in developing partnerships to further the healthcare education in their institutions. Though this model is not a 'one-size-fits-all' approach, partners can apply the general process detailed in the model and adapt it to fit their context. The model provides a general outline for partners who can apply the specific steps that are applicable to their project and can adjust the steps to achieve their project goals.

Operationalization of the SBE partnership model not only produces practical benefits for participating organizations (as described in Table 5.4), but also contributes to research and scholarship. Research contributions can be macro or micro. Macro research contributions are those that are outwardly evident and have implications for scholarship. Micro research contributions are primarily internal, for example a partner collecting and reviewing data to make improvements within their organization. Research contributions can include in-kind contributions that support the project or access to a participant pool to test the simulators. The research contributions of each of the four stakeholder groups within the partnership are listed below. Considerations when operationalizing the partnership with regards to the research contributions are also shared.

- Academia/ University: Produce publications on the partnership process and project outputs, publish research reports for data collected on the use of the simulators, and give presentations at conferences. All contributions and contributors should be listed on research papers. REB approval may be required for projects that are to be published in high value journals. Pilot projects do not require REB approval but can only report early outcomes with the idea of moving to a more formal project (a proof-of-concept approach).
- NPOs: Responsible for knowledge translation of current evidence and practices, provide background in terms of medical applicability and feedback on the

development of the simulator, produce reports and publications, and expand their research network.

- FPOs: Supply the technology that is used to collect data. The technology will depend on the simulator being created. Not all simulators are computer-based so data collection can come in a variety of styles. This would need to be decided upon during the development phase of the project.

- Healthcare: Responsible for knowledge translation. Provide the clinical perspective and experience of front-line healthcare, provide end-user feedback via in situ usability and proof of concept testing, and reporting.

When executing the partnership, key factors need to be considered to ensure successful completion of the project. Characteristics of partners that can support the partnership are being accessible, transparent, trustworthy, responsive, and committed. It is important to understand who is interested in the process, who is benefiting from the partnership, and how they are benefiting. There needs to be mutual reasons why people want to invest their time and resources in the project. The FPO that participates needs to have the appropriate technology and workflows in place to create the end products. It is also important to have an individual spearhead the project and there needs to be mutual trust between the person leading the partnership and the participating partner. Simulators need to be portable, easy to use and have any obsolete items available to purchase. They must be functional in rural settings where training is more isolated and support limited. Executive level support, making sure the right people are involved in the partnership, and having the right team composition are necessary to move the project forward. All the right players need to be present from the beginning to get a clear understanding of the problem and solution, which can be achieved with a SWOT analysis. Before establishing the partnership or during the initial meetings, partners should consider the following questions:

- What is the need? What is the gap? What are we trying to address?
- What do we need? What do we need it for? What are we teaching? What is the goal?

- What is the voice of business? What is the voice of customers? What is the voice of technology?
- How many do we need? What is the budget? Who will pay? Where will we get it from?
- How will we measure success? How will we know the project is on target?

Furthermore, when developing an evaluation for the partnership and reflecting on the partnership process at the end of the partnership, the following questions can be considered:

- What was the reason you participated in the partnership? What were you seeking to get out of the partnership?
- What went well? What didn't go well?
- Were the strategic goals of the partnership met?
- Were the timelines realistic and achievable?
- Was the frequency of meetings adequate?
- Were the relevant people always present at the meeting?
- What was the level of maturity and trust in the relationship?
- Did we reach our mutually agreed upon measures? If not, what should we have done differently?
- Were the partners' objectives met?
- Were the funds appropriately spent?
- Have the simulators met the needs of the end user?
- Are there any issues or concerns regarding the simulator?
- Has each partner met their commitment (i.e., deliverables, turnaround time)?
- How has the overall experience been?
- What did we learn?

The SBE partnership model provides general guidance on establishing a partnership between the four key stakeholder groups to facilitate the distribution of SBE to the healthcare sector. Findings from the studies indicate that the partnership process is largely context dependent. The purpose of involvement, each partners' responsibilities, the facilitators and barriers that are experienced, and the process that is followed will all

be influenced by the context of the project and the intended outcomes. Stakeholders interested in using the model should apply and adapt the model according to the context of their project. Applying the SBE partnership model in practical settings can improve access to training resources for healthcare providers in R&R areas, ultimately improving their clinical competencies and in turn, the quality of care they provide.

6.5 Strengths and Limitations

One of the limitations of this thesis was the insufficient collection of demographic information from the interview sample in the qualitative descriptive study, specifically years of experience and disciplinary background, which would provide further context and assist in analysis of the data. Additionally, purposeful sampling and snowball sampling were used to select participants for the qualitative descriptive study to ensure that participants have experienced the partnership process and have the required knowledge to inform the research question. However, future research studies can also incorporate maximum variation sampling as a method to recruit a diverse group of participants that will allow multiple perspectives regarding the process to emerge. This approach will use specific criteria to select participants with differentiating experiences regarding the criteria to maximize differences, which will increase the likelihood of the findings reflecting different perspectives (Creswell & Poth, 2018). The SBE partnership model describes a stepwise process for stakeholders to execute a SBE-focused partnership, which is reflective of the process shared by participants in the qualitative descriptive study. An iterative nature is described in the research and development stage of the model, however, the researchers recommend exploring the iterative nature of the whole model, within and between each stage, to understand the practical application and implementation process of the model.

6.6 Future Directions

In accordance with the hybrid research framework, the next stage of this research will be to execute phase D, piloting and evaluation. This stage will consist of piloting the model in an appropriate educational setting that involves the four stakeholder groups in a partnership to deliver 3D-printed simulators to R&R healthcare providers. The goal will

be to validate the process and stages of the model to ensure its feasibility and acceptability to address the research gap. This phase will incorporate formative evaluation where key stakeholders will evaluate the model to identify any issues with the methodological design and potential barriers to executing the process. The RE-AIM framework is an example of an evaluative framework that can be used to translate the theoretical partnership model into an actionable partnership model by applying the five steps of the framework: 1) Reach, 2) Effectiveness, 3) Adoption, 4) Implementation, and 5) Maintenance/ sustainment (Glasgow et al., 2019). Within the RE-AIM framework, constructs from the Consolidated Framework for Implementation Research (CFIR) can be incorporated to support the implementation step, such as the innovation adaptability construct which focuses on adapting and tailoring the partnership to fit the local context and needs (Damschroder et al., 2022). Additionally, the transportability evaluation checklist from the CIPP Evaluation Model can be used when scaling up the partnership model to assess the successfulness of the partnership's fit in a different setting (Stufflebeam, 2007). Application of the RE-AIM framework combined with the CFIR and CIPP evaluation model will help improve the probability of the model working in a real-world setting by focusing on elements that are essential to the partnership model's implementation, sustainability, and translatability into different contexts. Future research should also incorporate equality, diversity, and inclusion (EDI) into the research process to integrate considerations related to EDI into research practice and design. EDI should also be explored in future research studies related to the partnership model to incorporate EDI into the SBE partnership model to appropriately respond to local and national challenges (Social Sciences and Humanities Research Council, 2023).

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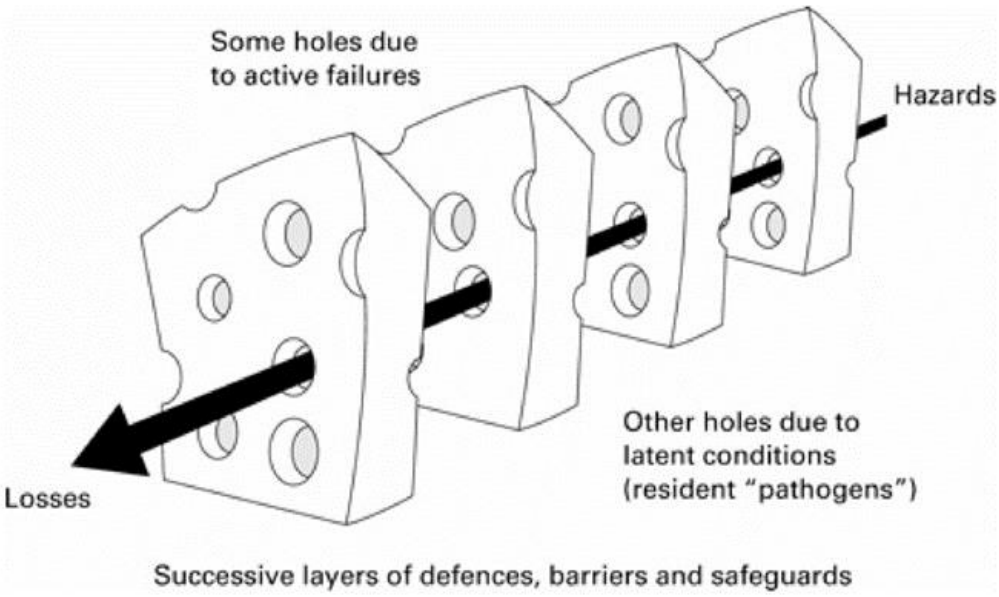
Appendices

Appendix A: James Reason's Swiss cheese model (Perneger, 2005).



Appendix B: Search strategy performed on Ovid MEDLINE for the scoping review.

Line #	Code
1	exp Universities/
2	exp *"Academies and Institutes"/
3	exp Students/
4	"academic institut*".mp.
5	"research institut*".mp.
6	universit*.mp.
7	colleg*.mp.
8	"post-secondary".mp.

9	“Post secondary”.mp.
10	1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9
11	exp Partnership Practice/
12	exp Models, Organizational/
13	exp Interinstitutional Relations/
14	exp Cooperative Behavior/
15	exp Public-Private Sector Partnerships/
16	exp Intersectoral Collaboration/
17	collaborat*.mp.
18	partnership*.mp.
19	"partnership model*".mp.
20	"partnership framework*".mp.
21	"collaborat* model*".mp.
22	"model* for collaboration".mp.
23	"model* for partnership*".mp.
24	"partnership* for collaboration".mp.
25	"collaborat* framework*".mp.
26	11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23 OR 24 OR 25
27	exp Organizations, Nonprofit/
28	"non profit*".mp.
29	"non government*".mp.
30	nonprofit*.mp.
31	nongovernment*.mp.
32	27 OR 28 OR 29 OR 30 OR 31
33	exp "Delivery of Health Care"/

34	exp Hospitals/
35	healthcare.mp.
36	"health care".mp.
37	hospital.mp.
38	33 OR 34 OR 35 OR 36 OR 37
39	exp technology/
40	exp printing, three-dimensional/
41	exp Simulation Training/
42	exp High Fidelity Simulation Training/
43	exp "diffusion of innovation"/
44	technolog*.mp.
45	simulat*.mp.
46	"simulation-based education".mp.
47	innovat*.mp.
48	39 OR 40 OR 41 OR 42 OR 43 OR 44 OR 45 OR 46 OR 47
49	10 AND 26 AND 32 AND 38 AND 48
50	limit 49 to (english language and yr="2000 -Current")

Appendix C: The PRISMA-ScR Checklist completed for the scoping review (Tricco et al., 2018).

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	**1**
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	**2**

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	**3-4**
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	**5**
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	**5**
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	**6**
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	**5-6**
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	**5**
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	**6-7**
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	**7**
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	**7**
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	**N/A**
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	**7**
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	**7-8**

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	**8-9**
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	**N/A**
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	**9-13**
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	**12-13**
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	**12-14**
Limitations	20	Discuss the limitations of the scoping review process.	**15-16**
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	**16**
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	**N/A**

Appendix D: The SRQR Checklist completed for the qualitative descriptive study (O'Brien et al., 2014).

Page/line no(s).

Title and abstract

S1 Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	1
S2 Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	2

Introduction

S3 Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	3-5
S4 Purpose or research question - Purpose of the study and specific objectives or questions	4-5

Methods

S5 Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**	5-6
S6 Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	6
S7 Context - Setting/site and salient contextual factors; rationale**	6-7
S8 Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	6-7
S9 Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	9
S10 Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	7-8
S11 Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	7-8
S12 Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	7
S13 Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	7-8

S14 Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	8
S15 Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	7-8

Results/findings

S16 Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	9-22
S17 Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	10-22

Discussion

S18 Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	22-27
S19 Limitations - Trustworthiness and limitations of findings	27

Other

S20 Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	N/A
S21 Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	N/A