Diasporans as Informants in Medical Device Design

By

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Abstract

Large gaps in contextual information exist for designers developing medical devices for low resource settings which can lead to failures in both medical device design and adoption. Over half of the world's population live under ten dollars a day and therefore can be considered as living in a low resource setting with less infrastructure, fewer trained-personnel, and less access to spare parts than developed countries. This study explores how contextual information when needed by designers in low resource setting can be provided by diasporans involved in healthcare development activities for their countries of origin. Using reflexive ethnographic and social network theories, and qualitative and quantitative enquiry, I explored the information seeking behaviour of diasporans involved in healthcare development activities for their countries of origin. A framework of information seeking behaviour and sources for accessing information that is timely, credible, and immersed in low resource settings, emerged from the research. Through this framework, designers can engage effectively with diasporans involved in healthcare development activities for their countries of origin. The framework enables designers to reflect on the information they are receiving from diasporans before utilizing it to better understand the contextual information required for successful medical device design for low resource settings.

Keywords: diasporans, information seeking behaviour, medical devices, low resources

Abbreviations

AGM: Annual General Meeting

CEO: Chief Executive Officer

CPO: Certified Prosthetist and Orthotist

DHDA: diasporan healthcare development activity

DIEM: Diasporic Information Environment Model

ENT: ear, nose, and throat

FDA: Food and Drug Administration

GI: gastrointestinal

ICT: information and communication technology

ICU: intensive care unit

ISB: information seeking behaviour

ISPO: International Society of Prosthetics and Orthotics

MBA: Masters of Business Administration

MD: Medical Doctor

NGO: non-governmental organization

PATH: Program for Appropriate Technology in Health

PT: Physiotherapist

TV: television

UK: United Kingdom

US: United States

WHO: World Health Organization

Glossary

Brain circulation –the knowledge and skills that flow back and forth between a diasporan's country of origin and country of destination via the diasporans themselves (Saxenian, 2002).

Device failure – device failures include physical failures, users being unable to use the device correctly, and failure of the device to be adopted (Aranda-Jan, Jagtap, & Moultrie, 2016).

Diasporan (for the purposes of this research) – an individual that self-identifies as living outside their country of origin, being well established in their country of destination, and maintaining active social ties to their country of origin for the purpose of healthcare development (Paris, 2020).

Diasporan healthcare development activities (DHDAs) – work that diasporans are involved in for their countries of origin to improve the healthcare in their countries of origin (Paris, 2020).

Egocentric network – a group of people, known as alters, that a particular person, known as an ego, knows (DeJordy & Halgin, 2008).

Reflexive ethnography – a qualitative research theory and methodology that can produce an analysis of reality that is outside of the researcher although they were also part of the research themselves (Davies, 2002; Hammersley & Atkinson, 1983).

Use environment – a description of the context that the medical device will be used in including: individual – socio-cultural factors; systems and structures – political, institutional, economic and public health factors; technical – industrial and technological factors; and physical – infrastructure, geographical, and environmental factors (Aranda-Jan, Jagtap, & Moultrie, 2016).

U*ser needs document* – a description of who the medical device is for, who is going to use the medical device, how the user will interact with the device, what the device will do, and the use environment (US Food and Drug Administration, 1997).

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Dedication

To Ryan, my husband, and the love of my life. We embarked on this epic journey and rode the waves of tribulation and elation together. For this I am forever grateful.

Acknowledgement

I would like to acknowledge my supervisor, Dr. Peter Bevan, committee members, Dr. Jaigris Hogson and Dr. Terry Mughan, Professor, Dr. Mary Bernard, and Program Associate, Carole Sandhu at Royal Roads University for their exceptional support during my doctoral work. Each person provided me with the guidance I needed to pursue my research. Their interest, encouragement, and insight made the process enjoyable and exciting over the many years of work it has taken to complete the program. I also want to thank BCIT for providing support for the research and my family and friends for providing encouragement over the years. Lastly, I would like to thank my participants who were very inspiring people.

Chapter 1: Introduction

Preventive, diagnostic, therapeutic, and assistive medical devices are part of the continuum of care and include devices such as vaccine delivery systems, blood pressure monitors, phototherapy systems, and prosthetic limbs. The World Health Organization recently recognized medical devices as an essential component of healthcare (World Health Organization, 2007). Health is fundamental to human development along with education and income; a long and healthy life is considered one of the key factors of the Human Development Index (United Nations, 2013). A healthy life can be dependent on access to appropriately designed medical devices. For example, without vaccinations that depend on vaccine delivery systems, people can succumb to many diseases.

Globally, many people live in areas that have low resources, defined as having less access to infrastructure, fewer trained health professionals, and a lack of medical device spare parts (Aranda-Jan, Jagtap, & Moultrie, 2016; University of Washington, 2014). In addition, research has exposed a gap in the design process of medical devices for low resource settings that leads to many failures (Aranda-Jan, Jagtap, & Moultrie, 2016). Aranda-Jan et al. (2016) conducted a systematic literature review and expert interviews regarding the design of medical devices for low resource settings and concluded a need for much more information about the context of low resource settings is required than is currently being utilized in design of medical devices specifically for these settings. Information regarding socio-cultural factors, the physical environment, technical issues, and systems is needed to understand the context that the medical device is operating in. Although understanding the context is critical for designing medical devices for low resource settings, studying the context can pose significant challenges for

designers as the task can be time consuming and costly. My research explores the potential for diasporans to provide needed context to medical device designers in a timely and cost-effective way to increase appropriately designed medical devices.

As a practicing medical device designer with a background in engineering and product development, I could see that the field was less engaged in the social sciences than in the physical sciences. However, as medical devices are an integral part of healthcare, I also understood that the field required new ways of thinking to address some of the failures of design and adoption of medical devices, especially for low resource settings. As such I embarked on a doctor of social sciences to explore the integration of this new (to me) field into my existing engineering, development, and management background.

Learning about social sciences after over twenty years in the field of engineering was a rich experience for me. I was able to take account of my perspective. This was not part of my previous educational path which focused mostly on physical sciences. While taking account of my perspective, I came to my understanding of the social world as being much more interpretivist than the physical world. This has been integrated into this research project accordingly.

For the purposes on my research, I define a *diasporan* as an individual that self-identifies as living outside their country of origin, being well established in their country of destination, and maintaining active social ties to their country of origin for the purpose of healthcare development (Terrazas, 2010). For this study, I explored the information seeking behavior of individual diasporans when engaged in healthcare development activities for their country of origin to gain an understanding of the subjective quality of the information from the perspective

of the participant. The intent is for designers to be able to utilize the framework resulting from my research to evaluate the information from diasporans in order to improve design of medical devices for low resource settings.

The following section introduces:

- concept of user needs document in the medical device design process,
- the need for a broader definition of the use environment for medical devices for low resource settings,
- the lack of time and funding for designers to sufficiently understand the user and use environment in low resource settings,
- the lack of understanding of the user and use environment leading to medical device failures in low resource settings,
- the need for new sources of information regarding the user and use environment,
- the introduction of the idea of diasporans as sources of information for designers,
- the definition of diasporans for the context of my research,
- the definition of a diasporan healthcare development activity (DHDA),
- the need to understand the information seeking behaviour of the diasporan when involved in a DHDA,
- the definition of timeliness, credibility and immersion of information and why it is important to medical device design,
- the need for a diasporan to be able to evaluate the information they obtain for their DHDAs in terms of its quality including its timeliness, credibility and immersion, and

- the need for a framework to assist a designer when evaluating information received from a diasporan involved in a DHDA

Motivation

Developing countries often lack basic life-saving medical devices, and a need exists for the design of medical devices that will work in low resource settings such as rural communities with less-developed infrastructure and fewer or less-trained personnel (Malkin, 2007; University of Washington, 2014). The initial step in the development of a medical device is the development of a *user needs document* that describes the problem to be solved (Aranda-Jan, Jagtap, & Moultrie, 2016; US Food and Drug Administration, 1997). It is critical to understand that the design process does not begin with designing; it begins with gathering information to understand the problem to be solved and the context that the problem needs to be solved in. A user needs document should describe:

- who the medical device is for,
- who is going to use the medical device,
- how the user will interact with the device,
- what the device will do, and
- the use environment

An essential concept to understand in the context of my research is that the *use environment* goes far beyond the setting that the device will be used in. Aranda-Jan et al. (2016) conducted a study to understand the necessary elements of the use environment in low resource settings that designers need to consider. According to Aranda-Jan et al. (2016), “The study provides a comprehensive contextual framework to support design practitioners to gather, compile and

analyse contextual information for the design of products for low-resource settings. The proposed framework is broad in scope to highlight under-appreciated and often neglected aspects of context, to aid decision-making at the earliest stages of product design and to avoid possible failures in 'the last mile' of getting a product to market" (p. 1). The Aranda-Jan et al. (2016) framework includes the following elements:

- individual: socio-cultural factors,
- systems and structures: political, institutional, economic and public health factors,
- technical: industrial and technological factors, and
- physical: infrastructure, geographical, and environmental factors

Medical device designers understand that they must research of all of these factors; however, it is common for designers to be unable to directly interact with users or spend enough time in low resource settings to sufficiently understand these factors which can lead to poorly designed medical devices (Aranda-Jan et al., 2016). The reasons why designers are unable to directly interact with users in low resource settings include a lack of time and funding. This lack of time and funding can lead to designers moving forward in their design process with missing or inaccurate information that leads to *device failures*. I am defining device failures widely to include physical failures, users being unable to use the device correctly, and failure of the device to be adopted. Examples of device failures in low resource settings include:

- The device cannot operate at the level of temperature, humidity or dust in the air in the low resource setting because it was designed for environments that have air conditioning (Abbas, Smith, Poluta, & Velazquez-Berumen, 2017);

- The device is used improperly because the instructions for use are not understood by the user (PATH, 2002); and
- The device is not adopted because of stigma associated with discussion of women's reproductive health issues (Chidyaonga-Maseko, Chirwa, & Muula, 2015).

Evidence for the need for designers of medical devices for low resource settings to have greater contextual understanding of the use environment is compelling. My research addresses this need by exploring a novel source of information – *diasporans* – that may be utilized by designers to gain a greater contextual understanding of the use environment.

A diasporan can be an important source of knowledge for medical device designers. Diasporans can play a role in the development of their country of origin's healthcare system through knowledge and skills that are transferred and circulated both from host to home country, as well as from home to host country (Afridi, Baloch, & Baloch, 2016). Diasporans that are working on healthcare development activities for their countries of origin may have sources of information regarding the socio-cultural factors, technical issues, the physical environment, and systems that are also required for successful medical device design.

Brain circulation is a term that has been coined to describe the knowledge and skills that flow back and forth between a diasporan's country of origin and country of destination via the diasporans themselves (Saxenian, 2002). The term is opposed to both brain drain that happens when skilled professionals leave their country of origin, or to brain gain that happens when skilled professionals arrive in their country of destination. An example of brain circulation is a project that was jointly undertaken by International Organization for Migration and several African countries including Ghana and Ethiopia. The aim was to mobilize African medical

diasporans in the Netherlands and UK to provide training and medical assistance to staff in African hospitals as well as provide internships in the Netherlands (Afridi, Baloch, & Baloch, 2016). Another successful example described by Afridi et al. in the same article is the development of hospitals in different cities in India by its diaspora (Afridi et al., 2016). Afridi et al. (2016) state, "Indian medical diaspora being the second largest diaspora of the world has achieved a remarkable success by mobilizing its members inside the home country and establishing a strong network with their home countries to transfer their skills, technology and investment by establishing corporate hospitals in different cities of India and reviving medical tourism" (p. 116). In these cases, diasporans worked with their countries of origin to provide assistance such as:

- training to personnel in their countries of origin,
- medical assistance to staff in the hospitals in their countries of origin,
- technology to the hospitals in their countries of origin,
- opportunities for medical staff from their countries or origin to participate in internships in their countries of destination, and
- investment to build hospitals in their countries of origin

These resources were only provided because of the relationship the diasporans involved had with their countries of origin thus demonstrating the value that they can bring to healthcare development in their countries of origin. Through these types of brain circulation activities, diasporans have the potential to provide useful information regarding healthcare use environments that is a critical input to the medical device development process (Aranda-Jan, Jagtap, & Moultrie, 2016). For the purposes of my study, I am looking at diasporans as a source

of unique knowledge regarding their countries of origin. As people that are socially embedded in both their countries of origin and their countries of destination, they are coming from a position of strength to the research. As people involved in the development of healthcare activities, they may have information related to many socio-cultural, technical, physical, and system-oriented factors needed by designers to develop successful medical devices for low resource settings. This puts them in a position of knowledge holders.

I am naming the healthcare-related work that diasporans are involved in for their countries of origin *diasporan healthcare development activities* (DHDAs). Diasporans participating in my research self-identified as being involved in a DHDA. DHDAs were not uniform in their organizational types. They included three different organizational types:

- non-profit-oriented,
- for profit company-oriented, and
- doctor-driven.

Participants that volunteered for the research felt that their work fit the definition of a DHDA regardless of organizational type. The activities were described by diasporans as follows:

- a non-profit that is building civil society through treatment of chronic illness,
- a charity that provides used medical devices based on hospital need,
- a company that provides prosthetic and orthotic devices,
- a company that provides emergency health evacuation services,
- a doctor providing public health educational service for their country of origin from their country of destination,

- a doctor providing radiology and general medical training services in their country of origin, and
- two doctors providing primary care in their countries of origin directly.

The range of activities considered DHDAs by the diasporans that participated in the research demonstrates the breadth of these activities.

A need exists to tap into the information held by diasporans involved in DHDAs for their countries of origin, but there is a gap in the literature regarding how such diasporans seek this information. Understanding information seeking behavior is of value to designers, as they need to assess the information they are receiving from diasporans to be able to utilize it effectively. For example, information needs to be evaluated for accuracy before it is included in the design process. If an inaccurate piece of information is included in the design process, the design may fail (Aranda-Jan, Jagtap, & Moultrie, 2016). For example, if information regarding the power voltage used is incorrect and the device is designed for a different power voltage, the device will not operate properly. A more complex example is the presence of non-Western medical/clinical practices. A medical device may not be adopted if strongly held non-Western medical practices are present as was demonstrated in the study of underutilized diagnostic technology for cervical cancer detection (Chidyaonga-Maseko, Chirwa, & Muula, 2015). Chidyaonga-Maseko et al. (2015) found that stigma regarding the discussion of women's reproductive health issues was a factor that inhibited adoption of the technology. If a diasporan has provided information to a designer regarding these issues, the designer needs to have an understanding of the accuracy of the information before they can utilize it in the design process. If the information isn't accurate at the time the designer needs to use it, it will have a detrimental effect on the design. As such, I

explored the information seeking behavior in terms of processes, experiences, and perceptions of individual diasporans when they are engaged in diasporan healthcare development activities (DHDAs) for their country of origin. This type of information is useful to medical device designers, as insight into the information seeking processes, experiences, and perceptions of diasporans will enable designers to be able to reflect on the information provided and determine how to use the information (Case & Given, 2016).

The DHDA related information provided by a diasporan to a medical device developer can come from a variety of sources, including egocentric networks, social media, media such as websites and news, libraries, information grounds such as community centers and temples, travel, and memory. An *egocentric network* is defined as a group of people (alters) that a particular person (ego) knows. Srinivasan & Pyati (2007) developed a diasporic information environment model (DIEM), which includes both local/place-based and information and communication technology enabled sources of information. The researchers argue that it is imperative to study both their local and global information sources to get a full understanding of the information they access (Srinivasan & Pyati, 2007). The DIEM includes community centres, diasporic websites (chat rooms, news sites, social networking sites, etc.), and public libraries as sources of information. I am also including travel to their countries of origin as an information seeking behaviour and their own memories as a source of information. As such I have created a novel modified version the DIEM that is more appropriate for my research study.

I am also researching the perceptions diasporans have regarding the ease or difficulty of accessing the information regarding their DHDAs. As time and cost need to be minimized,

information sources that are easier to access may be of greater value than sources that are difficult to access if the information quality is the same.

As discussed above, information from diasporans can assist in providing needed contextual information; however, it is important to understand the *quality* of the information as well. This cannot be under-estimated as missing or inaccurate information can have a devastating effect on the eventual design of a device (Aranda-Jan, Jagtap, & Moultrie, 2016). Although the work of designers is often thought of as the physical design of a device, a critical component of design is creating an accurate description of the design problem (Buchanan, 1992). The device design is evaluated on how well it solves the problem. If the problem isn't well defined, the designer will have a difficult time designing a device that solves the problem (Aranda-Jan et al, 2016). For medical devices in low resources settings, *accurate* contextual information is required to be able to develop a full description of the problem. Although diasporans may be able to provide contextual information regarding their countries of origin, designers will have to evaluate and quality of the information before using it to describe the problem. This is especially important as in today's globalized and dynamic context users and use environments can change rapidly. For example, infrastructure in low resource settings can be rapidly developing that may affect how a medical device operates. Similarly, socio-cultural issues may be changing to be more or less accepting of medical technology as is demonstrated in developed countries with respect to vaccinations (Hussain, Ahmed, & Hussain, 2018). The key is to understand the *current* situation for designers. This study begins to explore the accuracy of the information provided by diasporans by asking the diasporans themselves to characterize their information sources.

Three criteria important to medical device inputs have emerged from the literature in terms of information quality that can be studied through an information seeking behaviour study:

1) *timeliness* (Baskarada & Koronios, 2014), which is defined by how recent the information is. For example, information from memory many years ago is less timely than information from a person currently living in the medical device use environment.

2) *credibility* (Solomon, 2007), which is defined by how accurate the information is. For example, information from a medical doctor in the country of origin is likely more accurate than medical information circulating in a social media network.

3) *immersion* (Aranda-Jan, Jagtap, & Moultrie, 2016), which I am defining as how physically embedded the source of information (to the diasporan) is in the low resource setting in which the device is being used. For example, a doctor currently working in a hospital in a low resource setting represents a highly immersed source of information to the diasporan; whereas, a news story about a low resource setting that was written by a journalist in a developed country would not be an immersed source of information.

Timeliness of the information can be examined via *reflexive ethnography*. The diasporans can reflect on how timely they think the source of the information they use in their healthcare development work for their country of origin is. Currency of the information is important due to the urgency of keeping up with changes that are occurring globally in terms of healthcare, which include adoption of new technologies, strategies for increasing performance, and efforts to improve the patient experience (McCafferty, 2014). Information provided by a diasporan based on memory from many years ago might be used differently than information provided by a diasporan that has recently visited their country of origin and participated in a healthcare

development project. The former may provide insight that would need to be further verified by the designer to ensure it is still relevant and timely; whereas, the latter would more likely provide the designer with current information regarding the healthcare environment that could be incorporated into the user needs document with less verification of the information. Information regarding the user and/or use environment must be recent; therefore, information from memory and from many years ago would need to be checked to see if it is still current (McCafferty, 2014). Also, as medical devices must integrate into a particular healthcare system, it is critical to have an up-to-date understanding of it (McCafferty, 2014).

Credibility can be studied via social network and reflexive ethnography theories (Borgatti & Halgin, 2011; Hammersley & Atkinson, 1983). Understanding the credibility of the information source can assist in the evidence building process necessary to develop a robust set of design requirements in medical device design. (Alexander, Clarkson, Bishop, & Fox, 2001). Although I am treating the quality of the information as subjective, by studying the social network that the diasporan engages in for the purposes of healthcare development activities, a diasporan can reflect on the source of the information and make an informed decision regarding credibility of the information as a design input for medical device development. For example, a diasporan may have direct access to healthcare professionals in their country of origin that can provide credible information regarding the current state of the art in the region they practice in.

Immersion into the medical device use environment can also be studied via a reflexive ethnographic approach. By researching the sources of information and the information seeking behaviours of diasporans involved in healthcare development activities for their countries of origin, a diasporan can reflect on how immersed the information source and behaviour is. I am

defining immersed as being physically in the environment that the medical device is used in. For example, a diasporan that frequently travels to their country of origin as part of their healthcare development activity will be more immersed in the medical device use environment than one that participates fully from their country of destination. As such, the quality of information provided from direct observation helps to build the evidence needed for successful medical device development and may be higher and more valued as a medical device design input (Alexander, Clarkson, Bishop, & Fox, 2001).

Once a designer gathers information regarding the problem they are trying to solve through the design of a device, they apply an evaluation process to each piece of information before they include it in the user needs document. This process isn't prescriptive however it is imperative that the designer and other stakeholders review the user needs document and agree on the accuracy of the description of the problem.

Designers' Information Sources

The literature describes categories of information sources for designers developing new products as follows:

- within the enterprise or enterprise group (Internal),
- suppliers of equipment, materials, components or software (Suppliers),
- customers (Customers),
- competitors or other enterprises in the sector (Competitors),
- conferences or workshops (Workshops)
- consultants, commercial labs or private R&D institutes (Consultants), and

- universities or other higher education institutions (Universities) (Gómez, Salazar, & Vargas, 2016; Medase & Abdul-Basit, 2020).

Designers of medical devices use a complex variety of sources of information that map to these categories including:

- discussions with users and other stakeholders (Customers, Consultants),
- discussions with other designers (Internal, Workshops),
- on-site visits (Customers),
- literature reviews (Universities),
- commercial and other grey literature reviews (Competitors, Suppliers, Customers, Workshops, Consultants)
- standard reviews (Regulatory),
- patent reviews (Competitors, Universities),
- regulatory submission reviews (Regulatory),
- experiments (Internal, Customers, Workshops, Consultants, and Universities), and
- their own experience (Internal) (International Organization for Standardization, 2016; US Food and Drug Administration, 1997, 2016).

These information sources are available to designers at a variety of costs in terms of time and cost. For example, critical information sources as such discussions with users and on-site visits in the context of global health projects may involve international travel for long periods of time. As diasporans involved in DHDAs are a new source of information in the category of consultant, designers need insight into their information sources in terms of context and quality. I am conducting an information seeking behaviour study of diasporans involved in DHDAs to create a

framework for designers to use to help them evaluate the information they get from this source. Through a reflexive ethnographic analysis of all their information sources and a social network analysis of the people they work with in their DHDA I have developed a framework as follows:

1) understanding the contextual knowledge a particular diasporan, and
2) evaluating the timeliness, credibility and immersion of the information and information sources they can provide from the perspective of the diasporans themselves

The framework I have developed will assist a designer in understanding the nature of their information sources and how conducive or non-conducive they are to leading to timely, credible, and immersed information. The framework also assists a designer in understanding themes that emerged that applied to most of the participants and themes that applied to a subset of participants. Through this framework a designer can work more efficiently with a diasporan to engage with the information sources that lead to timely, credible and immersed sources of information while avoiding information sources that may not.

Thesis Statement and Research Question

In this study, I explored the information seeking behavior of individual diasporans when engaged in healthcare development work for their country of origin to gain understanding into the subjective quality of the information that they provide to medical device designers from the perspective of the participants. The outcome of the research provided guidance for medical device design on understanding the diasporan source and quality of information regarding the medical device use environment in their country of origin.

My primary study question is: *How do individual diasporans conduct information seeking processes and how does their information seeking behavior affect the quality of the information that they provide to medical device designers, particularly as it relates to timeliness, credibility, and immersion, when they are engaged in healthcare development work for their country of origin from their own perspective?*

Thus, my exploratory study was guided by the following specific research questions:

1) How do individual diasporans conduct diasporan healthcare development activities (DHDAs) and what are the local place-based and globalized information and communication technology (ICT) based, or other globally based information sources of these individual diasporans?
2) How does a diasporan's information seeking behavior affect the quality of the information in terms of timeliness, credibility, and immersion in the low resource setting from their own perspective?
3) How do individual diasporans experience and perceive their information seeking processes when engaged in DHDAs?
4) How can DHDAs be leveraged to provide useful information to medical device designers for the development of the user needs document for a medical device from the perspective of the diasporan?

Outline

The research began in 2013 and data collection was conducted in 2019. Over this period of time new literature was published to support the growing interest in the topic of improving the design of medical devices for low resource settings. I developed methodology in 2017 and 2018

to reflect and build on the current state of the published literature on the topic. The data was analyzed and synthesized in 2019 and 2020.

- Chapter 1 introduces the research topic and describes the motivation for the research. It also describes the objective of the research, the thesis statement, and the research questions.
- Chapter 2 introduces the reader to the relevant literature in a number of areas related to the research. The chapter begins with a review of the relevant design theories, diaspora theories, and information seeking behaviour theories and places the research in a combined interpretive theoretical framework. These include reflexive ethnographic and social network theoretical frameworks that the research is embedded in. The following sections then discuss medical device design, challenges of design in low resource settings, diasporans as information sources, and research on information seeking behaviour of diasporans. This chapter identifies a gap in the literature and therefore a need for the research.
- Chapter 3 discusses the research methodology of reflexive ethnographic analysis of all the information sources and social network analysis of the egocentric networks that participants access for their DHDAs. It describes the unit of analysis as individual diasporans, the recruitment strategy, the number of participants, the justification of the number of participants, the questions in the semi-structured interviews, and the data analysis methods.
- Chapter 4 gives a detailed description of each of the eight participants including their country of origin and immigration path, their diasporan healthcare development activity, their related egocentric social network, other related sources of information, and the ease and difficulty of related information seeking behaviour. This chapter also provides a number of tables and diagrams to assist the reader in understanding the participants' egocentric social network and

other sources of information in terms of importance and level and timeliness, credibility, and immersion in the low resource setting.

- Chapter 5 presents the analysis and synthesis the data collected from participants. Each research question is answered through analysis of the data. Unifying and disunifying themes were developed through the analysis of the data. Unifying themes are themes that applied to most of the participants. Disunifying themes are themes that only applied to a subset of participants. I developed a framework of unifying and disunifying themes that were either conducive or not conducive to a medical device designer obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity.
- Chapter 6 concludes the research with a summary of findings, perceived limitations of the research, proposed future research, and personal reflection.

Chapter 2: Theoretical Framework and Literature Review

In this chapter I explore the theoretical framework and supporting literature associated with information seeking behaviour (ISB) of diasporans as informants to the medical device design process. I begin with an overview of discourse on medical device design theory and explain the medical device design for low resource settings theoretical framework that this work is based in. I then present an overview of diaspora or transnational theories and explain the transnational theoretical framework that this research aligns with. Following this, I present an overview of ISB theories and explains the ISB theoretical framework that this work is based in. Lastly, I present a combined theoretical framework to situate this research in.

Following the section on the theoretical framework, I then present literature discussing the medical device design process and challenges with the design process in low resources settings. The literature clearly defines a need for designers to obtain more contextual information to design medical devices in low resource settings. It also describes difficulties that designers have in obtaining contextual information.

In the next section, I review the literature related to the central concept of this research; the engagement of diasporans involved in healthcare development activities for their countries of origin as sources of contextual information for designers of medical devices. The literature describes the characteristics of diasporans and the involvement of diasporans as sources of information in healthcare and technology development processes generally. The literature also describes the need for information to be timely and credible when being used as an input into the design process for medical devices. However, little literature exists on how to evaluate the quality of the information being provided by diasporans to designers.

In the remaining section, I review the role of information seeking behaviour studies in learning about the processes, experiences and perceptions of diasporans' involved in healthcare development activities for their countries of origin. The literature describes a variety of ways that the information seeking behaviour of diasporans has been studied and points to a relevant diasporan information environment model (DIEM). The DIEM provides a practical framework to place this research in, however I have modified it to suit the needs of medical device design for low resource settings. This modification represents the development of a new model which is fully discussed in Chapter 3.

In this chapter, I explore the reasons behind the need for cultural and contextual information for medical device developers. I demonstrate for the need for exploring the ISB of diasporans as informants to the medical device design process. If cultural and other contextual information is missing, then diasporans could provide it.

Key Design Theory Applied to Medical Device Design

Design theories and activities can be positioned in both postmodern and modern frameworks. Postmodernism is defined as a way of thinking that allows for construction of reality through different discourses and narratives (Susen, 2015). This allows for the creation of many different subjective realities. This is in contrast to Modernism, which tends towards the understanding of reality as objective and logical, with only one objective reality. The following section describes the design theory most closely aligned with the design approach that is most appropriate for medical devices for low resource settings. Medical device development requires identifying the needs of all stakeholders, understanding a wide variety of socio-cultural, technical, and physical factors of concern, and allowing for multiple solutions to complex health

problems. As such, a design theory that aligns with this process is most closely aligned with the medical device design process. Other design theories are based on design as a science (Simon, 1969) or design from a practice perspective (Cross, 2011; Lawson, 1980) and look for a theory that leads to the development of the single best solution to a problem in a logical stepwise process. As demonstrated by the variety of medical device options for a single purpose, I argue that the design theory that allows for multiple solutions to a problem solved through medical devices is more reflective of the actual process of medical device design. For example, a common medical device accessible to most people in developed countries is a home use blood pressure monitor. These medical devices are available for purchase at many drug stores and come in a wide variety of shapes, sizes and operating modes. Some are meant to work in tandem with a smart phone while others are stand-alone devices. Each device has a particular user in mind however, at their core, the problem they are solving is the measurement of blood pressure so people can monitor their blood pressure and take appropriate action if it is too high or low.

In terms of design theory, a postmodern approach would allow for a wide variety of potential solutions to solving a problem versus a modern approach to find the single best solution to a problem in a logical stepwise fashion. Buchanan's design theory aligns with a postmodern approach that aligns with current medical device design practice (1992). Buchanan introduced the idea that there is fundamental indeterminacy in design problems and that there are many potential solutions to design problems (1992).

Buchanan's approach enables problem formulation and solution to evolve together through a process of identifying the views of all participants, understanding the issues of concern, and developing potential solutions that can be explored for further development.

Buchanan's design process allows for gaining a deeper understanding of complex problems, acknowledging that there are no single solutions, and engaging all participants in the design process. This enables a deeper understanding of the context of the problem to be solved. He suggests the design of material objects (such as medical devices) as an appropriate area to apply his design theory. His emphasis on context is highly relevant to the design of medical devices for low resource settings.

Buchanan (1992) discusses the concept of placements of a design problem as follows, "Placements are the tools by which a designer intuitively or deliberately shapes a design situation, identifying the views of all participants, the issues which concern them, and the invention that will serve as a working hypothesis for exploration and development" (p. 17). For example, a blood pressure monitor can be placed in a variety of different contexts or user environments such as the home setting, the doctor's office, or a hospital ICU ward. In all user environments, the device must be used correctly to measure blood pressure. However the design of the blood pressure monitor must take into account the different users in each setting. An elderly person may be measuring their blood pressure at home at the kitchen table while an ICU nurse may be measuring the pressure of a critically ill patient in the ICU. The blood pressure monitor will have different designs to accommodate the different users and use environments. Of particular importance to this research is the identification of the views of all participants and their issues of concern including socio-cultural, technical, and physical factors in low resource settings. These can be difficult for designers to access when designing medical devices for low resource settings as will be discussed in the next section.

A Framework for Contextual Design for Low Resource Settings

In recent years, research on the design process for medical devices in low resource settings focused on the need to understand the context that the medical device will be used in. According to a review of the literature associated with the design of medical devices for low resource settings from 1987 to 2016, the publications rarely describe how the context was studied at the front-end of design (Aranda-Jan, Jagtap, & Moultrie, 2016). This lack of recognition of the importance of context led to the failure of many of the medical device design projects reviewed by Aranda-Jan et al. (2016). The need to understand context goes well beyond understanding the user of the medical device or the particular environment a medical device will be used in and expands the design context to include:

- individual socio-cultural factors,
- physical infrastructure,
- geographical and environmental factors,
- technical manufacturing, industrial, and technological factors, and
- system and structure factors including institutional, public health, political, and economic factors (Aranda-Jan et al., 2016).

A review of the literature since 2015 has demonstrated that designers of medical devices for low resource settings are starting to address contextual factors during the design phase as described by Ibrahim, Amir, Daly, & Sienko (2015) on the development of a subcutaneous contraceptive implant and Oosting, et al. (2020) on the development of an electrosurgical unit. However, the challenge remains for designers to find sources of information on contextual factors, particularly ones that are unique to low resource settings and distant from the designer

and design process. In addition to ensuring the wide range of factors are considered – as opposed to a purely technical approach – timely, credible, and immersed sources of information need to be found. Diasporans and/or bicultural people that are involved in healthcare development activities in their country of origin may be a potential source. To help explore this line of inquiry, the following section describes the relevant theoretical framework related to diasporans and/or bicultural people.

Diaspora Theories

If finding information is a challenge and diasporans are potential sources for important and relevant information for medical device developers, then understanding diaspora theories is an essential element of this research. This section outlines the relevant theories on culture related to diasporans and describes the theoretical framework that this research is based in.

Positivistic Theoretical Framework on Culture

One of the most prominent theories on culture stems from the work of Hofstede (1980). Hofstede conducted interviews and surveys regarding people's behaviour in large organizations and how they collaborated when he worked at IBM. He found that people shared a generalized set of socialization skills, which he called dimensions of national culture, that were specific to people having grown up in the same country. He then administered similar surveys to people unrelated to IBM and found that the same results occurred outside of IBM. He began to aggregate individuals having grown up in the same country as societal units. He was then able to examine national cultures rather than individual personalities (Hofstede, 1980).

This static and positivistic view of people from particular countries has permeated various academic and international business circles as demonstrated by Beugelsdijk, Ambos, &

Nell's (2020) work on measuring cultural distance in international business research, Cuypers, Ertug, & Heugens' (2018) work on lessons from Kogut and Singh cultural distance index, and Huang, Teo, Sánchez-Prieto, García-Peñalvo, & Olmos-Migueláñez' (2019) work on cultural values and technology adoption (Tung & Verbeke, 2010). However, despite widespread adoption, I caution against generalizing cultural traits, particularly with respect to diasporans involved in DHDAs. For example, a reader may assume that a particular participant embodies the national characteristics that Hofstede's research attributes to them from his research on national cultures. Individuals from a particular country may not align with these characteristics so the reader may begin their understanding of the participant incorrectly.

This research is rooted in an interpretive theoretical framework of culture as contemplated by Appadurai and described in the following section (1990, 1996). This is more appropriate as each individual participant has a unique story that cannot be placed into the constraints of characteristics of national cultures drawn from aggregate data. The uniqueness of each participant needs to be fully explored to begin to understand their information seeking behaviour.

Interpretive Theoretical Frameworks on Culture

In contrast to a positivist view, Appadurai supports an interpretive view of a diasporan or bicultural person being fluid in their identity, views, or ideas. Appadurai argues that there are no grand theories and that new theories are needed to understand diasporans and/or bicultural people. Appadurai speaks of the five "scapes" that influence the diasporan identity: ethnoscapes, the flow of people; technoscapes, the flow of technology; ideoscapes, the flow of ideas;

financescapes, the flow of capital, and; mediascapes, the flow of media (1996). This interpretive approach is the epistemological framework that this work is based in.

Globalization and advances in information and communication technologies (ICTs) have enabled diasporans to increase their interconnectedness to their countries of origin as well as to each other through the development of diaspora-specific ICT applications (Appadurai, 1996). Appadurai also introduces the concept of both mediascapes and technoscapes that have relevance to the study (1990). Technoscapes are global configurations of technology, including informational technology that moves at high speeds across the globe (Appadurai, 1990). Mediascapes include all of the information, including images, created in newspapers, magazines, television shows, and films as well as the technologies used to produce and disseminate such information (Appadurai, 1990). Mediascapes and technoscapes are dynamic and include information and communication technologies (ICTs). As an example, the term *e-diaspora* is a concept to describe diasporic groups that utilize ICTs to create specific communities (Diminescu, 2012). There are vast numbers of such communities, and they are always changing as people either join or leave. Although ICT's have had a significant impact on diasporans in terms of information sources, ICT's alone have been found to only be part of the solution for development projects that diasporans are involved for their countries of origin (Ahmed, 2018; Senior, 2016). Ahmed has found that a range of limiting factors in both destination country (i.e. ICT funding, skills) and countries of origin (i.e. ICT infrastructure, affordability) leads to initiatives by diasporans being limited by ICTs (2018). Similarly, lack of ICT development in countries of origin limit the engagement of some diasporans in development work for their countries of origin (Senoir, 2016).

Individual diasporans' mediascapes and technoscapes are part of their fluid and ever-changing information sources and impact the effectiveness, or lack of effectiveness, of development initiatives they are involved in for their countries of origin It is important for designers to understand and reflect on the fluid and ever-changing nature of ICTs that diasporans can utilize during DHDAs as they relate to timeliness, credibility, and immersion in the use environment.

Internalization of Two Cultures

Culture, for the purposes of this study, is thought of as dynamic, such that the values, beliefs, practices, images, and artifacts associated to a specific culture are subject to change over time. Researchers explain, "Psychologically, at the individual level…cultural representations include the particular values, beliefs, practices, images, and artifacts an individual associates to a specific culture." (Benet-Martinez, Lee, and Leu, 2006, p. 388). The definition of a bicultural person is that they have internalized two cultural identities, one from their country of origin and one from their country of destination, and as such it is hoped that they can provide insight into the culture of their country of origin (Brannen & Thomas, 2010).

However, it is important to understand that the cultural representation that a diasporan provides needs to be understood in terms of timeliness, credibility, and immersion in the current culture to be useful to medical device development (Aranda-Jan, Jagtap, & Moultrie, 2016). The cultural knowledge a diasporan holds from their country of origin is one of the primary reasons why diasporans are called upon to provide input into the development of technological systems (Best, Smyth, Serrano-Baquero, & Etherton, 2009). As such it is important to review the literature on the abilities of diasporans to provide cultural representations. The literature includes

acculturation theories of bicultural people and explores how the acculturation process may increase the cognitive abilities of bicultural people to provide cultural representations. The following section discusses acculturation theories of bicultural people as they relate to cultural representation.

Acculturation Theories of Bicultural People Related to Cultural Representation

The literature on the acculturation of immigrants has its roots in the work done by Bourne with "the immigrant refusing to be melted" (1916). Since then many models of acculturation have been developed and improved upon. The most influential has been the bi-dimensional model of acculturation that includes 4 quadrates that people fall into: assimilation, integration, separation, and marginalization (Berry, 1990). Other models include 3 modes of identity negotiations that individuals might use over the course of their lives: integration (a unitary multicultural identity), alternation (switching among cultural identities according to context), and synergy (new identities emerge that cannot be reduced to the sum of their parts) (Hong, Ching, No, & Chiu, 2007). People with a bicultural perspective have demonstrated more complex cognitive ability in providing cultural representations than persons with a mono-cultural perspective (Benet-Martinez, Lee, & Leu, 2006). More recent research by Jang demonstrates that bicultural people are able to effectively integrate knowledge from multiple cultural domains while working in teams with people that are monocultural which enhances team creativity (2017). The construct that diasporans or bicultural people are able to provide more accurate cultural information to medical device designers than monocultural people is of value, particularly when designing for low resource settings that designers are not familiar with. This strengthens the argument that diasporans may bring valuable insight to the problem-solving

activity that medical device designers are engaged in. The construct of culture, for the purposes of this study, is also thought to be fluid; therefore, it is the ability to describe culture, even as it changes, that is of value.

In summary, the theoretical cultural framework for diasporans and/or bicultural people relevant to this research is that identity, views, and ideas are ever changing. It is their information seeking behaviour that is of relevance to this research, and so it is not necessary to assume that diasporans have fixed identities, views, or ideas. What are important are the timeliness, credibility, and immersion of their information sources. The fluid nature of a diasporan's identity, views, and ideas may strengthen their ability to provide timely, credible, and immersed information. In order to complete the theoretical framework for this research, the next section describes the relevant information seeking behaviour theories.

Information Seeking Behaviour Theories

The design and diasporan theories that this research is situated in come from the interpretivist framework. The design theory is based on the concept that design is an indeterminate activity and that there are many solutions to a single design problem. The diasporan theory is based on a fluid view of cultural identity and that identity can change over time. In the context of this research, activities related to the development of 1) solutions to a problem (Buchanan, 1992), or 2) cultural identity (Appadurai, 1990, 1996), are fluid activities that are influenced by the context they exist in and are defined as coming from the interpretivist tradition. This is in contrast to theories that are based on the concept that there are deterministic processes to design (Cross, 2011; Lawson, 1980; Simon, 1969) and fixed national identities of diasporans (Hofstede, 1980) that are based in the positivistic tradition.

To be epistemologically consistent, the information seeking behaviour theories that this research is situated in also come from the interpretivist tradition. According to Srinivasan & Pyati, diasporan information behaviour studies need to be situated within the dynamic context of globalization (2007). Similar to cultural identity, information seeking behaviour is also dynamic and fluid and, as such, the theories it is based in for this research align with this view. Research on the information seeking behaviour of diasporans have described a diasporan information environment model (DIEM) that is well suited to the research questions (Srinivasan & Pyati, 2007).

Reflexive Ethnography Theory

A theoretical framework that describes the sources of information, and the feelings, experiences, and perceptions associated with that information seeking behaviour, is necessary to help round out the complex processes that diasporans utilize during DHDAs. Appadurai argues the need for new theory to be developed to understand the information flows of transnationals and that theories will be highly context dependent (1990). Building on Appadurai, Srinivasan & Pyati argue that reflexive ethnographic theory can be utilized as one of the underpinnings of understanding the information flows of diasporans (2007). The perspectives of the participants, with respect to their information seeking behavior during DHDAs, provide some understanding of the quality of the information particularly as it related to timeliness, credibility, and immersion in the use environment.

The reflexive ethnography theory used in this study acknowledges that I am part of the social world I am studying (Bradbury-Jones, et al., 2017; Davies, 2002; Hammersley & Atkinson, 1983). Through semi-structured interviews I collected an ethnographic account from

the participants' perspectives of the ISB they engage in while engaged in their DHDAs. However, I acknowledge that the way I interpret the interview data is influenced by my experiences as well. Similarly, the participants may also be influenced by my participation as a researcher. I have written my dissertation with this understanding as part of my approach and have added a section on my personal reflections at the end of the dissertation to give the reader some understanding of my perspectives and experiences.

Network Theory

In addition to reflexive ethnography, the theoretical framework of network theory guides the research project (Borgatti & Halgin, 2011). Network theory includes a number of related information seeking behavior theories. According to Borgatti and Halgin (2011) network theory refers to the consequences network structures, such as size and level of constraint, have on phenomenon for individuals. Network theory is of relevance to this study as the size of the network, type of people in the network, and level of connection of people in the network of an individual diasporan impacts the information that is available to them with respect to their DHDA. Understanding the connections of an individual diasporan's egocentric network can assist a medical device designer's understanding of the timeliness, credibility, and immersion of the information gained via the diasporan's egocentric network.

For example, if a diasporan has people in their network that can provide timely, credible, and immersed sources of information, designers may have found a conduit to critical information that is needed to input into their medical device design process. Conversely, if the people in a diasporan's network are based in their country of destination, they may be less valuable sources as their information may not be as immersed. As such, it is important to get an understanding of

the qualitative characteristics of the people in a diasporan's DHDA network. Most of the theories related to egocentric social networks are based in social capital and as such the following section reviews social capital theories that have relevance to this research.

Two well-known social capital theories are the theory of strength of weak ties (Granovetter, 1973) and the structural holes theory (Burt, 2004). The theory of strength of weak ties premise is that a potential source of novel ideas comes from a weak tie which is a person that is connected to a person you are connected to but not connected directly to you. This theory is of relevance to the ability for an individual diasporan to provide valuable information to a medical device designer through their egocentric network. Once a designer connects to a diasporan involved in a DHDA, they also gain the benefit of the diasporan's egocentric network which are the weak ties that are not connected to the designer directly. The idea is that, through a bridging tie, which is a person who is connected to them but not connected to other members of his or her network, a person can learn things that are not already circulating among a network known to each other (Granovetter, 1973).

The structural holes theory is related to the strength of weak ties as it argues that the more bridges or non-redundant ties, the more novel information a person can obtain (Burt, 2004; Saglietto, Cezanne, & David, 2020) This theory is of relevance to the ability for an individual diasporan to provide valuable information to a medical device designer through the connections they have that the medical device designer doesn't have. For the purposes of this study, I research the egocentric social network of individual diasporans involved in DHDAs for their countries of origin. I research their bridging ties and, as such, I measure how many non-

redundant ties they have and, hence, the potential for novel information to be circulating through the diasporan's network as per the structural holes theory (Burt, 2004).

Even though the structural holes theory come from the positivist tradition, I am using it in this research to describe part of the information environment of the research participants. It is important to understand that in the context of medical device design, the quantitative characteristics of a diasporan's egocentric social network (i.e., number of ties, how constrained or open it is, etc.) are of less significance to this research than the qualitative characteristics. In design of medical devices for low resource settings, understanding the context of the low resource setting is of paramount importance. Therefore, a single alter in a diasporan's social network may fill in a gap that the designer has and may be of greater value than a larger, less constrained social network. It is design problem specific. More importantly is for the medical device designer to look for relevant social ties to the particular problem they are trying to solve.

An example of this is a clean home delivery kit for use in Nepal (PATH, 2002). The home delivery kit includes a razor blade (to cut the umbilical cord), a plastic disc (to cut the umbilical cord on), a plastic sheet (a clean surface to deliver the baby on), three cords (to tie the umbilical cord) and soap (to wash hands before delivery). Through a diasporan working on a DHDA in Nepal, a designer may have access to a community health worker that cares for women giving birth in their community and can provide context to a designer.

In another case, a diasporan may have a much larger egocentric network that doesn't include a community health worker and as such cannot tap into this critical connection. The size of the network is irrelevant. What is relevant is the particular expertise the people in the diasporan's network has which requires a qualitative approach to determine. As such, the

description of the egocentric social network of participants includes a qualitative description of each person in their network.

In addition to the qualitative analysis, a limited quantitative analysis is also included in the description to get a measure of how much novel information may be circulating in the diasporan's DHDA-related egocentric network (Burt, 2004). The quantitative analysis may also shed light on insights for future research questions that would require a larger quantitative study of diasporans involved in DHDAs egocentric social networks to examine. For example, it may be useful to quantitatively analyze the egocentric networks of diasporans involved in different types of DHDAs. This could lead to improved understanding of such egocentric networks and assist designers in engaging with the best type of egocentric network for their particular design problem.

The following section summarizes the combined theoretical framework that this research is based on. I position design, diasporan, and information seeking behaviour theories in an interpretivist tradition as this theoretical stance has the best chance at answering my research questions in today's globalized and dynamic context.

Combined Theoretical Framework

As described by (Birkinshaw, Brannen, & Tung (2011), "The multi-faceted, contextually situated interactions that characterize today's complex cultural organizations demand a more nuanced epistemological approach rather than a predominantly positivist one" (p. 576). At the intersection of theories on design, diasporans, and information seeking behaviour, this research is situated in an interpretive epistemological framework. I am positioning the designer of a medical device for a low resource setting in the Buchanan tradition of design as an indeterminate activity

where many different solutions are possible to solve a particular problem and where input from all stakeholders is required for success (Buchanan, 1992).

This aligns with the literature on medical device design methodology that is reviewed in detail in the following sections (US Food and Drug Administration, 1997, 2016). The literature also states that designers of medical devices for low resource settings lack context and that this leads to failed designs (Aranda-Jan, Jagtap, & Moultrie, 2016). This aligns with Buchanan's design theory as well, as it is a proponent of needing to understand the complex context the device will be used in.

The involvement of diasporans involved in DHDAs as informants to provide context to medical device design for low resource settings is the area of study. I am positioning the diasporans in the Appadurai tradition of cultural identity as fluid and ever changing (Appadurai, 1990, 1996). As such, the ability to engage with diasporans as informants requires the study of their information seeking behaviour. By understanding the source of the information and the information seeking behaviour, designers can understand how to evaluate and utilize the information they receive from diasporans.

The information seeking behaviour theories most relevant to my research questions are 1) reflexive ethnography (Davies, 2002; Hammersley & Atkinson, 1983) and 2) social network theory of structural holes (Burt, 2004). The analysis of the egocentric social network of diasporans from a qualitative reflexive ethnographic perspective is of utmost importance to my research questions as this analysis gives the detailed description necessary to understand the network and its qualitative value to the diasporan. The quantitative analysis of social network theory is also provided but is of secondary importance to answering my research questions.

However, the quantitative analysis provides some insight into how likely it is that the diasporan's egocentric network is a source of novel information, as well as future research questions that can best be answered from a quantitative perspective.

In addition, the analysis, from a reflexive ethnographic perspective, of the other sources of information diasporans utilize when seeking information regarding their DHDAs is equally important for rounding out the corresponding information environment. In summary, Table 1 describes the theoretical frameworks that apply to this research. As mentioned above, the social network theory of structural holes is being applied to enable the reader to be reflexive about the structure of the diasporan social network and to ensure they explore it as it relates to a particular design problem, not in a positivistic sense.

Table 1

Theoretical Frameworks

Area of research	Theoretical Framework	Theorists
Design	Wicked Problems - Interpretivist	Buchanan, 1992
Diasporans	Culture - Interpretivist	Appadurai, 1990
Information Seeking	Reflexive Ethnography - Interpretivist	Davies, 2002 Hammersley & Atkinson, 1983
	Structural Holes - Positivist	Burt, 2004

The Intersection of Medical Device Design, Diasporans, and Information Seeking Literature

The design of a safe and effective medical device is a complex activity. The design for such a device in a low resource setting adds an extra layer of complexity particularly when that setting is not accessible to the designer (Aranda-Jan, Jagtap, & Moultrie, 2016; Malkin, 2007). The following section provides a detailed literature review of the three main concepts related to this research: 1) medical device design, 2) diasporans as an information source, and 3) the information seeking behaviour of diasporans. In order to understand the medical device design process, the concept of tapping into individual diasporans as a source of information is introduced. The need to understand the information provided by individual diasporans in terms of timeliness, credibility, and immersion is also discussed. Lastly, the information seeking behaviour literature as it relates to individual diasporans is reviewed. This is tied back to the understanding of individual diasporans as information sources for user needs development for medical devices in low resource settings.

Medical Device Design: Design Controls

The current set of practices and procedures for increasing the likelihood of developing a safe and effective medical device is referred to as *design controls.* The FDA has a specific description of design controls which is stated in their design control guidance document as (US Food and Drug Administration, 1997), “Design controls are an interrelated set of practices and procedures that are incorporated into the design and development process, a system of checks and balances. Design controls make systematic assessment of the design an integral part of development. As a result, deficiencies in design input requirements, and discrepancies between the proposed designs and requirements, are made evident and corrected earlier in the

development process. Design controls increase the likelihood that the design transferred to production will translate into a device that is appropriate for its intended use" (p. 1). Medical device design is regulated, and it is critical for designers to understand the design control process. Even though design controls were implemented in 1997 by the FDA, they are still relevant to medical device design at the time of the writing of this dissertation.

The initial step in the design control process is the development of a user needs document that outlines the problem to be solved. The next step is the development of device requirements that are called design inputs. Once the user needs and requirements have been developed, the design process can begin. The design outputs are the design drawings and other design-related documents that describe the device itself. The device is then tested to determine if it meets the requirements in verification and user needs in the validation process. At each step there is a review process. This is a simplification of the actual process of medical device design which has many more iterative steps that loop back into earlier steps in the design process; however, for the purposes of my research, this description is sufficient to demonstrate the process of describing user needs when developing the medical device specifications and requirements.

Various design methodologies may be chosen by a medical device developer within the design control process, and regulators do not prescribe which design methodology they should use (US Food and Drug Administration, 1997). The intention of implementing a design control process is to increase the likelihood that a device will be developed that is appropriate for its intended use – key to this is that the medical device functions in the context within which it is being used (World Health Organization, 2010). This is particularly challenging for medical device designers that are attempting to design a medical device for a low resource setting that is

not readily accessible to them (Aranda-Jan, Jagtap, & Moultrie, 2016). The development of a user needs document is the initial step in the design control process.

Without first-hand experience of the user and the use environment, it is difficult to develop an accurate user needs document (Shah & Robinson, 2007). Engineering knowledge and medical knowledge co-contribute to the development of medical devices and highlights the need for information regarding the user and use environment for medical device designers (Hagedorn, Grosse, & Krishnamurty, 2015; Shah & Robinson, 2007). This is because medical devices operate in medical environments and are often used by medical professionals. Designers often lack clinical and medical knowledge and as such need to access sources of medical knowledge when designing medical devices.

The challenge is even greater in low resource settings where the designer doesn't have access to the use environment or medical professionals. One source of medical knowledge for low resource settings can be individual diasporans involved in healthcare-related diaspora organizations such as Uganda Diaspora Health Foundation, Philippine Nurses Association of America, and Global Association of Physicians of Indian Origin. Diasporans in organizations such as these, as well as those that work outside the framework of organized charitable or not-for-profit programs, including individual doctors and companies, are involved in diasporan healthcare development activities (DHDAs) for their countries of origin, and they may provide much needed information and context regarding medical device users and the medical device user environment in a low resource setting (FyodorBio, 2018; Terrazas, 2010). The following section describes the importance of the development of a well-developed user needs document as

an essential part of the design control process. This is critical to understanding the motivation for this research and the need to access sources of information needed to create such a document.

Design Controls: User Needs

The first step in medical device design involves the identification of a problem or user need that will be intended to be solved through the development of a medical device. A designer may identify, for example, need for delivery of vaccines into the human body. A commonly recognized solution has been the development of syringes with needles. The identification of subsequent user needs to reduce the pain inflicted by needles and the fear they can induce in some people has led to the development of other solutions for vaccine delivery, including nasal sprays and other needle-less injectors (Mitragotri, 2006). The user need is separate from the solution, and this is an example of how a single user need can be solved in a variety of ways.

The development of a user needs document can be conducted by a variety of people in companies or other organizations, including, for example, market research staff, academic researchers, engineers, industrial designers, technologists, or business analysts (Kucklick, 2013). For the purposes of this research, anyone involved in the development of a user needs document is referred to as a *designer*. Different names exist for a user needs document as well, including concept document, design brief, opportunity document, and market research report. The term *user needs document* is used as an umbrella term for all of these potential permutations.

The user needs document is usually created by the designer as one of the first steps in the medical device development process. The user needs document includes information regarding what the medical device will do, who is going to use it, when will it be used, how the user will interact with the device, what type of procedures the device will be used for, whether the device

will be used once or reused, and what other products the device will interact with. It is important that the user needs document provide the context for the problem trying to be solved through the development and use of the medical device. It is not a description of the device itself, rather a description of the problem that will be solved through the use of the device. Many different device designs can meet the user needs described in this document and it's important to separate the user needs from the device design. Often designers do not have the medical knowledge necessary to create a robust user needs document without working with the medical users and/or patients that will be directly using the device. Designers must learn about the user needs to be able to develop a robust user needs document.

Sources of information need to be understood by designers so they can be triangulated into an appropriate set of design requirements that will meet user needs. Information can come from many sources including medical professionals, users, libraries (both online databases and physical), websites, and other designers. When a designer seeks and receives a piece of information, they must reflect on its source and make a judgement call on of the validity of the information and if they are going to include it in the user needs document. Inaccurate or missing information can lead to the failure of the medical device design so review of the user needs is a critical part of the review of user needs in the design control process (US Food and Drug Administration, 1997). The review process is embedded in every step of the design control process including the development of user needs.

Confirming that a medical device meets user needs is a critical component of the design control process. Although this seems obvious, many examples exist where the medical device meets the clinical needs but not necessarily the *user* needs. One such example was the

development of a clean home delivery kit for use in Nepal (PATH, 2002). The home delivery kit included a razor blade (to cut the umbilical cord), a plastic disc (to cut the umbilical cord on), a plastic sheet (a clean surface to deliver the baby on), three cords (to tie the umbilical cord) and soap (to wash hands before delivery). A variety of respondents were interviewed regarding the usefulness of the kit including traditional birth attendants and women who gave birth alone.

This qualitative research study found that, the kit itself was useful to the users; however, they did not understand the pictorial instructions due to low levels of literacy among the users. For example, users found the razor to be useful in cutting the umbilical cord however they also thought that the soap was meant to bathe the baby instead of for its intended use of hand washing before the delivery of the baby. Although part of the clinical needs where met, the user needs were also only partially met. A major recommendation was to improve the pictorial instructions to increase the user need to understand the use of the components in the kit. Instructions for use are considered part of the labelling associated with a medical device and are covered under the regulatory process that manufacturers must follow to be allowed to sell their medical device. In this example, more detailed understanding and documentation of the user needs regarding instructions would have been valuable for the designers to have at the beginning of the design process and may have shortened the overall device development process.

In addition to users, patients also need to be considered in the medical device design process, since many medical devices are applied to patients by healthcare personnel and, increasingly, the users may also be the patients themselves (Ward & Clarkson, 2004). For example, blood pressure monitors are now available for use in acute care, community care, and home care settings. In acute care and community care, healthcare workers use a blood pressure

monitor to measure the blood pressure of their patients. In the home care setting, however, the user is also the patient, and they may be expected to use the device on themselves. This must be taken into account as the general public has many different characteristics (e.g., greater variation in level of education) than healthcare workers, and these characteristics need to be factored into the device design (US Food and Drug Administration, 2016). Furthermore, in low resource settings, user needs also incorporate socio-cultural, technical, and physical factors that must be addressed in the development of a user needs document as described by Aranda- Jan et al., (2016).

The following section describes the challenges for designers developing medical devices to access the time and budget needed to fully develop a user needs document. This section is followed by the potential for diasporans to be informants to designers, reducing the budget and time needed by a designer to obtain the necessary information to improve a poorly developed user needs document.

Challenges

The medical device design control process is an example of leading design practices. In many countries, a clear and explicit design control process is a requirement to the medical device approval process, which is a prerequisite for marketing and selling the device (International Organization for Standardization, 2016; US Food and Drug Administration, 1997). Even with standards and regulations in place, many challenges exist with respect to full implementation of a robust design control process. The following section outlines two of the key challenges that are important to the rationale for this research: 1) limited time and budget for design, and 2) limited access to users, patients, and use environment, especially in low resource settings.

Limited Time and Budget for Design

Medical devices that are developed through an approved regulatory process that then allows them to be distributed to and used by a wide range of end-users are developed largely by the for-profit private sector. As such, there are important practical considerations for these organizations when developing a medical device. For example, for-profit private sector medical device companies fund product development either from existing cash flow or from other sources of funding such as grants, government subsidies, or private equity (Scanlon & Lieberman, 2007). Further to this, investment goes into a research and development phase before a device can be manufactured, marketed, and then sold to begin to generate cash flow from the operational phase. The challenge for a company is to ensure it can keep operating while investing in the research and development phase before it can generate enough cash flow through product sales. This results in pragmatic limits on the time available for the design process (Griffin, 1997).

As a result, medical device designers need to carefully consider the time and cost associated with the development of the user needs document. As recently as July 2017, a blog posting from a prominent medical device development contractor provides tips for gaining critical feedback from enough users to increase the odds of a successful medical device while being cognizant of the time and cost associated with getting the feedback (Syrotuck, 2017). Syrotuck underlines the need, as early as possible in the device development process, to include feedback from target users in order to ensure you go beyond the initial device inventor and designers (2017). The author also notes that the costs of getting feedback can be high and must be managed closely, as it is not advisable to fully develop a medical device with the input of a few people. The need for user feedback at the beginning of the design process is critical. The

extent of user feedback that is available to the designer, however, is in tension with the need to find faster, cheaper ways to access accurate information to apply to the user needs document that is of vital importance to the medical device design process. The following section describes how the lack of time and budget to develop design requirements is exacerbated for medical devices in low resource settings.

Limited Access to Users, Patients, and Use Environment, Especially in Low Resource Settings

Many medical device development companies develop products for use in low resource settings. A low resource setting is typically a rural or remote area in a developing country with less-developed infrastructure and fewer or less-trained personnel (University of Washington, 2014). A result of limited time and budget for design activities (imparted usually by company management that needs to ensure a medical device company can continue to be fiscally solvent and profitable) includes limited access to users and patients, particularly in low resource settings where distance may be an additional factor (Aranda-Jan, Jagtap, & Moultrie, 2016).

Many contextual categories need to be addressed when developing a medical device for a low resource setting. In addition to the technical issues, designers also need to have an understanding of 1) the stakeholders involved including users, patients, purchasers, and insurers; 2) the physical environment; and 3) the systems and structures related to the low resource setting they are designing for. A lack of access by medical device designers to users, patients, and low resource setting environments exacerbates the problem of a poorly defined user needs document, which can lead to a poorly designed medical device (Aranda-Jan et al., 2016). As such, an inexpensive, quickly accessible, and reliable source of information regarding users, patients, and low resource setting environments can increase the successful design of medical devices for low

resource settings (Aranda-Jan et al., 2016; Ibrahim, Amir, Daly, & Sienko, 2015; Oosting, et al., 2020).

Diasporans as an Information Source

Medical device designers need to have sources of information to bridge their gap in knowledge regarding medical device users, patients, and use environment (Aranda-Jan, Jagtap, & Moultrie, 2016; US Food and Drug Administration, 1997). One potential source of information is a diasporan, whom, for the purposes of this study, I am defining as individuals that self-identify as living outside of their country of origin, being well established in their new country, and maintaining active social ties to their country of origin for the purposes of healthcare development (Frehywot, Park, & Infanzon, 2019; FyodorBio, 2018; Terrazas, 2010).

Definitions and Characteristics

This study involves research with people that have a bicultural perspective. In this next section, I review the key literature that relates to the definitions and characteristics of transnational, bicultural, and diasporic people. Persons with a transnational perspective identify with two or more distinct cultures because of having internalized two or more cultures (Nguyen & Benet-Martinez, 2007). A person that has grown up in one country and moved to another country is considered to be bicultural; however, so are some Indigenous people, second- and third-generation immigrants, or someone that spends time living with someone from another country (Brannen & Thomas, 2010).

For the purposes of this study, I am working with people that self-identify as being well established in their country of destination and involved in a healthcare development activity for their country of origin. They also self-identify as having grown up in, and internalized the culture

of, their country of origin. I am limiting the participants to people that have these self-identifying characteristics as I worked with a small number of participants and limited the variation of bicultural experience to some degree. I would also like to discuss the role of memory as a source of information for diasporans during DHDAs and as such would like to have each participant having spent time during their formative years in their country of origin. Although I am limiting the inclusion criteria for the participants, there are many ways of experiencing biculturalism even for my group of participants (Brannen & Thomas, 2010). According to Hanek, Lee, and Brannen, "there is no single type of 'multiculturalism'… More nuanced examination of multicultural individuals' past experiences and psychology is needed to understand how they can better leverage their skills as global leaders" (2013).

The rise of globalization has precipitated the idea that culture is no longer a static notion tied to a particular country or place (Irani, Vertesi, Dourish, Philip, & Grinter, 2010). For some, culture is thought of more like a verb than a noun, as information flows travel ever more quickly across the globe through the use of inexpensive ICTs and travel (Shklovski, Vertesi, & Lindtner, 2014). Similarly, the perspectives of transnational, bicultural, or diasporic people are varied, and it is critical to understand that there are different ways of being bicultural. Still, persons with a transnational, bicultural, or diasporic perspective may have valuable abilities and characteristics that can be leveraged to make knowledge transfer across contexts easier, and hence facilitate global innovations, such as the development of appropriate medical devices in low resource settings (Brannen & Thomas, 2010).

For the purposes of this study, I have chosen the term *diasporan* to identify the type of person I am interested in working with as academic literature and governmental communications

have used this term to describe people that can draw upon their knowledge of their country of origin to participate in development activities for their country of origin, which is closely related to my research interest (Chikanda, Crush, & Walton-Roberts, 2015; Frehywot, Park, & Infanzon, 2019; Terrazas, 2010). For the purposes of this study, the term *diasporan* is interchangeable with *bicultural or transnational person.*

Diasporan Relationships and Communication at a Distance

Diasporans, in today's interconnected globalized world have relationships with people in different geographic locations as well as in cyberspace (Shklovski, Vertesi, & Lindtner, 2014). They are able to maintain and grow active relationships in their country of origin as well as develop, maintain, and grow active relationships in their country of destination (Shklovski et al., 2014). Through online platforms, they are also able to develop, maintain, and grow active online relationships that are not tied to a particular location, and are instead, relational (Shklovski et al., 2014). Diasporans' relationships are an important characteristic of diasporans' sources of information and influence that is of direct relevance to the study of their information seeking behavior with respect to their healthcare development activities.

Social and Economic Ties

Diasporans have social and economic ties to their countries of origin. Economic ties include the flow of capital that may, for example, be in the form of remittances or in the form of the operations of multinational corporations (Shklovski, Vertesi, & Lindtner, 2014). Social ties include the relationships they have with family; however, they may also include relationships with the wider community in their countries of origin (Shklovski et al., 2014). The ties that a

diasporan has made through their DHDA are of direct relevance to the study of their information seeking behavior.

Diasporans as Informants to Technology Development Process

Individual diasporans may be effective sources of information regarding the professional, social, technical, and other aspects of a low resource setting for medical device design (Aranda-Jan, Jagtap, & Moultrie, 2016; Liu, Hoelscher, & Yao, 2013). They may be able to help shorten the time and cost of obtaining information regarding these issues for the designer. Although no literature appears to exist on this area of medical device development, there is literature regarding the use of diasporans as informants in website development. Two publications describing diasporans engaged in design-related processes as informants highlight some of the challenges of working with diasporans (Best, Smyth, Serrano-Baquero, & Etherton, 2009; Yoo et al., 2016). According to this research, diasporans can assist website developers understand their country of origin and that this understanding would be beneficial to the design of the websites. Information was elicited from diasporans in groups via focus groups, timeline, envisioning, and co-design. In addition to the design methods and results, the researchers also described the diasporans in terms of country or place of origin and provided aggregate data on demographic information. Both sets of researchers highlighted the diversity within the groups of diasporans that they worked with and recommended that future researchers be sensitive to this diversity. Best et al. (2009) characterize part of this diversity being related to place-of-origin, time of emigration, and resettlement location (refugee resettlement programs vs. metropolitan areas). Yoo et al. (2016) also reported on participants' ideas regarding places where information was to

be disseminated and found that participants drew upon their experiences from their country of origin for ideas.

These examples demonstrate that the ideas generated by diasporans were impacted by their histories and prior experiences. Although the researchers acknowledged that the participants were diverse in terms of the histories and prior experiences and recommended that researchers be sensitive to this in future research, they stopped short of suggesting how to be sensitive to these differences. This gap in the literature is one of the motivating factors for this research project because the information seeking behaviour of diasporans provides insight to medical device designers as to how to characterize the quality of the information as an input into the user needs document.

Linking Information Quality to Information Seeking Behaviour

The differences between diasporans include their histories and prior experiences; however, they also include the sources of their information and aspects of their information seeking behaviour for the technology development projects described above (Yoo et al., 2016; Best et al., 2009). In the two research projects described above, the information sources, and information seeking behaviour, were not explored by the designers that reached out to these diasporans. By understanding the source of the information and the information seeking behaviour, designers can reflect on characteristics of the information provided. As thoroughly discussed in Chapter 1, for medical devices, three characteristics of the quality of the information are timeliness (McCafferty, 2014), credibility (Solomon, 2007), and immersion (Aranda-Jan, Jagtap, & Moultrie, 2016) of the information. These three dimensions of the information can be explored via a study of the information seeking behaviour of individual diasporans.

Need to Understand Individual Diasporans Information Seeking Behaviour

To explore the quality of the information provided by diasporans when engaged as an informant to medical device design, I posit that new knowledge needs to be generated regarding the information seeking behaviour of individual diasporans. Designers need to be able to fully understand the information they learn from various sources (US Food and Drug Administration, 1997). Some of the biases may come from characteristics that include demographics of individual diasporans, including age and gender as well as immigration history and length of time in their chosen country of destination (Bhatia & Ram, 2009). In addition, timeliness, credibility, and immersion characteristics of the information are important to understand specifically for medical device designers.

For example, information provided by an individual diasporan about an event that happened many years ago would be treated differently than information provided by an individual diasporan regarding an interaction with a user that occurred recently when they were present in their country of origin. In the former case, due to the pace of change in healthcare, a designer would need to triangulate the information before inputting into the user needs document (McCafferty, 2014). In the latter case, a designer would still need to triangulate the information but to a lesser degree as direct knowledge from users would be a more accurate source of information (Aranda-Jan, Jagtap, & Moultrie, 2016).

In addition to timeliness, the credibility and immersion of the information is important to understand. For example, peer reviewed literature is treated differently than grey literature because the peer review process produces information that has been verified by someone other than the author (Solomon, 2007). In the same way, the information learned from individual

diasporans needs to be characterized with respect to credibility and immersion so that a designer can understand how to treat it (Aranda-Jan, Jagtap, & Moultrie, 2016).

Timeliness, credibility, and immersion characteristics of the information and source are subjective and different for different medical device development projects. However, I posit that studying the information seeking behaviour of diasporans involved in healthcare development activities for their countries of origin sheds some light on the subjective quality of the information and enable designers to reflect on the information to be able to appropriately apply it to the medical device design process. The following sections discuss existing research of information seeking behaviour of individual diasporans and a diasporic information environment model that are utilized in this research.

Information Seeking Behaviour Research

Information behaviour research studies can be placed within a hierarchy of paradigm, grand theory, formal theory, substantive theory, and observations (Case & Given, 2016). Information seeking behaviour is a subset of information behaviour research. According to Case and Given:

> Information behaviour research has matured, bringing the seeker into focus, through more attention to the search process, the thoughts and emotions of the seeker, and their subsequent use of info they find or encounter (2016, p.155).

Researchers use a range of paradigms, theories, and observations including qualitative and quantitative methods (Case & Given, 2016). Research exists on the information seeking behaviour of diasporans; however, a gap appears to exist regarding focused research into the information seeking behaviour of diasporans informing medical device design.

Research on Information Seeking Behaviour of Diasporans

A review of the information seeking behaviour of diasporan research demonstrates two main areas of study: 1) local, place-based scenarios for immigrants and 2) transnational identity online for diasporans (Srinivasan & Pyati, 2007). Both areas inform the research foundation of information seeking behaviour of diasporans; however, they are generally researched and reported on separately. In an attempt to create a more holistic approach, researchers developed a diasporic information environment that integrate these foundational areas of research (Srinivasan & Pyati, 2007).

Srinivasan and Pyati suggest a model that combines both the place-based lived experience of diasporans and their globalized online information environment (2007). They developed the Diasporic Information Environment Model (DIEM) and advocate for using this model to provide more accurate and holistic information behaviour research of diasporans linking global and local contexts. The model includes a variety of research methodologies such as reflexive ethnography and social network analysis to be applied to a range of local and ICT enabled information sources and information seeking behaviours. It also includes community-based information services research and community-based action research; however, these are not relevant to this research as they are focused on providing information services for diasporans to help them navigate in their country of destination. This research is focused on an individual diasporan's information seeking behaviour during DHDAs, and as such, community-based research is not applicable. The DIEM is utilized in the development of the research methodology for the study of individual diasporans as informants to medical device design.

Diasporic Information Environment Model

This study used the diasporic information environment model (DIEM) to enhance understanding of the participants' information seeking behaviour related to their diasporan healthcare development activities (DHDAs). The literature has highlighted the use of the DIEM to enhance understanding of migrants' information seeking behaviour related to a variety of research questions (Allard, 2015; Komito, 2011; Schöpke, 2019). The research questions of these publications being explored through a DIEM were as follows:

- How does the use of new social media by two groups of non-nationals in Ireland, impact dispersed communities, and what is its relevance for processes of migration and integration (Komito, 2011)?
- How do new immigrants from the Philippines to Winnipeg identify, use, and share information during the migration process and upon arrival to Canada (Allard, 2015)?
- How do self-identified refugee communities in Greece and Germany, engage with information resources to navigate individual and community identity development during liminal phases of their refugee experiences (Schöpke, 2019)?

Although these research questions are not related to the area of design of medical devices, it's important to understand from these studies how the ISB of diasporans in each study compare and contrast to the results from this study and to discuss any gaps in the literature that this research has helped to understand. The following sections explain the theoretical frameworks of each study in terms of diasporans and information seeking behaviour. Then the study designs are discussed. Lastly the research findings are discussed.

DIEM Studies Theoretical Frameworks on Diasporans and/or Migrants

To answer these questions each researcher used transnational theoretical frameworks that highlight the need to consider both local and global interconnectedness of relations of diasporans, as well as the fluid nature of a diasporan's identity, views, and ideas (Appadurai, 1996; Bhabha, 1994; Diminescu, 2008). Similarly, a transnational framework also informed this study's theoretical underpinning and research questions of how diasporans seek information related to their DHDAs (Appadurai, 1990; Appadurai, 1996; Bhatia & Ram, 2009; Hanek, Lee, & Brannen, 2013).

DIEM Studies Information Seeking Behaviour Theories

The researchers also used information seeking behaviour theories although, in contrast to their similarity in the use of theoretical frameworks on culture, each researcher utilized different ISB theories to situate their research in. Komito (2011) drew from the social network and strength of weak ties theoretical frameworks (Granovetter, 1973). Allard (2015) drew from the sense making theoretical framework proposed by Dervin (2005). Schöpke (2019) drew from grounded theory (Charmaz, 2014; Glaser, 1978; Glaser & Strauss, 1967). My research drew from social network theory of structural holes, as well as reflexive ethnography (Burt, 2004; Hammersley & Atkinson, 1983). Researchers aligned their research with the most appropriate ISB theory to answer their research question.

Modified DIEMs of Studies

Each study utilized a unique modified DIEM to answer their unique research question. Komito (2011) utilized the research methods of reflexive ethnography and social network analysis and explored the use of mass media, social media and social networks as information

sources. Allard (2015) also utilized the research methods of reflexive ethnography and social network analysis. She explored social networks, social media, news, websites, and information grounds as information sources (Allard, 2015). Schöpke (2019) broadened out her research methods to include all four proposed by Srinivasan and Pyati (2007) including reflexive ethnography, social network analysis, community-based information services research, and community-based action research. She explored information grounds, social networks, libraries, websites, news, social media and apps including music and transportation content (Schöpke, 2019). A gap in the existing literature that my study addressed was the exploration of memory and travel as sources of information in the DIEM of my participants.

DIEM Study Designs

All studies using the DIEM utilized qualitative research methods. Each study had a unique design to answer the research question posed. Komito (2011) situated his research in Ireland. He engaged 34 participants where Poland was their country of origin and 31 participants where the Philippines were their country of origin. Semi-structured interviews were conducted three times over a two-year period. Participants were asked about their six most significant people in their egocentric social network, the communication media they used to contact people, and their other information sources.

Allard (2015) situated her study in Canada. She engaged 14 participants where the Philippines were their country of origin. Two semi-structured interviews were conducted over a 5-month period. They were asked about their migration experience, resource identification, social network and demographic information.

Schöpke (2019) engaged 19 participants that self-identified as refugees in Greece and 14 participants that self-identified as refugees in Germany. Her study expanded beyond semi-structured interviews to include surveys before the interviews to collect data about internet usage, participant observation at a variety of information grounds, and participatory action research through dance workshops. She explored her participants' information needs and goals, social networks in both physically-mediated and ICT-mediated spaces, and navigating identity shifts by engaging with information networks.

Allard (2015) and Schöpke (2019) were interested in looking at changes in ISB over time and utilized semi-structured interviews over a period of months or years. Komito (2011) conducted a single interview with participants.

Summary of DIEM Study Findings

Although these information seeking behaviour studies were exploring a range of research questions, insights on the information seeking behaviour of diasporans help to inform my study. For example, it was found that a diasporan's social network was one of the most important sources of information for all three research projects (Allard, 2015; Komito, 2011; Schöpke, 2019). This also was discussed in information seeking research of immigrants utilizing other modes of inquiry (Caidi, Allard, & Quirke, 2010). Caidi et al. examined the roles that information resources play in the everyday lives of immigrants primarily in the US and Canada (2010). They conducted a literature review of how immigrants, themselves, seek or use information in the contexts of their daily lives. They found that immigrants are most likely to ask other individuals for help as the first step when seeking information (Caidi et al., 2010).

As well, the other sources of information and information seeking behaviours were more heterogeneous without strong patterns across participants (Allard, 2015; Komito, 2011; Schöpke, 2019). This aligns well with researchers that emphasize that diasporans are a heterogeneous group and need to be studied as such (Caidi et al., 2010). Memory and travel were not included in the DIEMs of these research studies and highlights a gap in the literature that my research addressed for diasporans involved in DHDAs for their countries of origin. As such, I have developed a modified DIEM and a mixed methodology approach to understanding DHDAs which will be addressed in Chapter 3.

Chapter 3: Methodology

This research is based on a mixed methods reflexive ethnographic and egocentric social network approach. Although the majority of the methodological approach is qualitative and interpretive in nature, some limited quantitative measures are utilized as well to more fully explore and describe the nature of the diasporic information environment model of the participants of the study.

Units of Analysis

The unit of analysis in this research is an individual diasporan and their information seeking behaviour while involved in DHDAs for their country of origin. An individual diasporan involved in DHDAs is an appropriate unit of analysis for this research as medical device design involves the input of individuals with knowledge of the use environment. Also, an individual diasporan involved in DHDAs may be accessible to a medical device designer. As previously discussed in the literature review section on bicultural people, categories of people described as possibly identifying as bicultural include:

- Foreign-born people;
- Second and third generation children of foreign-born people; and
- People that live with a foreign-born person (such as a spouse).

As I worked with a small number of participants, I limited the participants to foreign-born people who self-identify as:

- Being well established in their country of destination;
- Having knowledge of country of origin and country of destination cultures (and that cultures are fluid and non-static); and

- Participating in healthcare development activities for their countries of origin.

I excluded second and third generation children of foreign-born people and people that live with a foreign-born person as I researched the memory of a person that has lived their formative years in their country of origin.

Recruitment Strategy and Number of Participants

Participants self-identified as a diasporan who are now established in their country of destination (e.g., Canada) and have experience contributing to a healthcare activity for their country of origin. This study concentrated on eight participants whose countries of origin are India (3), Ghana (1), Madagascar (1), Nigeria (2), and Panama (1). The countries were not selected specifically, rather they were the countries that participants that signed up for the research happened to be from. I purposely did not limit the countries that participants could be from as I am interested in researching diasporans as individuals, not as citizens of a particular country. Three interviews were conducted in person in Greater Vancouver, and five were conducted over the phone with participants in Saskatoon, Greater Vancouver, Abbotsford, and Michigan. The interviews took place between March and August 2019.

Participants were identified through my professional network. I have experience in the development of medical devices for low resource settings, and I identified a number of potential participants that I work with directly. I used a seed and snowball sampling technique to find eight participants for the study. Other researchers studying the information seeking behaviour of immigrants utilizing a diasporic information environment model (DIEM) also used the seed and snowball technique to find participants (Allard, 2015; Komito, 2011; Schöpke, 2019).

Semi-Structured Interviews

To maintain consistency between interviews, I followed a semi-structured interview guide (see Appendix A). The interview, which was audio recorded, was conducted face-to-face or via telephone. I also took detailed notes during the interviews. Two participants engaged in a pilot study, and another six participants engaged in the final study. No changes to the interview guide were made after the pilot study; therefore, all eight participants were included in the study.

Researchers argue that in order to understand the complexities of emergent and evolving phenomena scattered over distance and different contexts, such as the phenomenon this research explores, qualitative research methodologies that develop thick description may be more suitable than quantitative analysis alone (Birkinshaw, Brannen, & Tung, 2011). It was determined that a small in-depth exploratory study was warranted given the focus on investigating how diasporans conduct information seeking behaviour related to diasporan healthcare activities for their countries of origin, and subsequently, creating a framework for how designers could engage with such diasporans to provide missing context for medical devices for low resource settings. Utilizing a reflexive ethnographic qualitative and limited quantitative social network analysis, an initial framework was established through the in-depth analysis of eight diasporans involved in eight different DHDAs across the globe. I conducted the reflexive ethnographic qualitative analysis and limited quantitative social network analysis myself and did not utilize any research assistants in this work. This led to sufficient data to answer the research questions and provide a useful framework. Allard (2015), Komito (2011), and Schöpke (2019) also utilized in-depth interviews and smaller sample sizes in their studies of immigrants' information seeking behaviour.

Data Analysis Methods

According to the Diasporic Information Environment Model, mixed methods, including objectivist and interpretivist methods, need to be employed together to get a greater understanding of the diasporic information environment and information seeking behaviour (Srinivasan & Pyati, 2007). A reflexive ethnography and a mixed method social network analysis approach are proposed in the Diasporic Information Environments Model (Srinivasan & Pyati, 2007). I have modified the DIEM to capture a fuller understanding of the information environment of diasporans involved in DHDAs. I am including travel information seeking behaviour and the use of memory as an information source.

Modified Diasporic Information Environment Model

A fuller picture of the information seeking behavior will enable a medical device designer to better understand the timeliness, credibility, and immersion in the use environment of the information provided. See Figure 1 for a modified version of the DIEM for the purposes of this research. The differences between the original DIEM and the modified version of the DIEM are: 1) elimination of the community-based research methods as this study is focusing on individuals and 2) inclusion of travel and memory as sources of information as these are critical to understanding the information seeking behavior of diasporans involved in DHDAs.

The addition of travel to the DIEM addresses a gap in the information seeking behaviour literature on diasporans involved in development activities as the DIEM proposed by Srinivasan & Pyati (2007) doesn't include travel. Travel is an important activity that diasporans engage in when involved in development work (Abshir, 2020; Mishra, 2016; Zeleza, 2019). As such it is

worth adding as an information source and/or behaviour in the DIEM that is relevant to diasporan healthcare developemnt activities in this study.

Similarly, the addition of memory to the DIEM addressed a gap in the information seeking behaviour literature on diasporans involved in development activities as the DIEM proposed by Srinivasan & Pyati (2007) also excludes memory as an information source. Research on diasporan knowledge networks indicate that diasporans involved in such activities identify with their country of origin in a proactive way that is turned to the future rather than based on memory (Meyer & Wattiaux, 2006). It is important to understand how participants view the timeliness, credibility, and immersion of information from memory for this study.

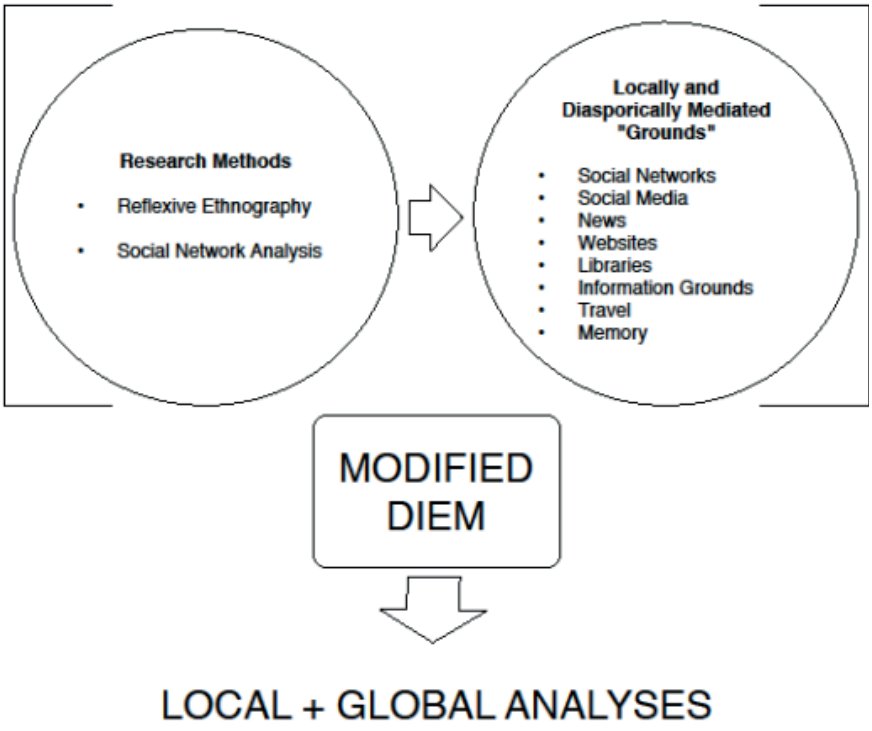


Figure 1. Modified Diasporic Information Environment Model

Reflexive Ethnographic Analysis

All of the semi-structured qualitative interview data were analyzed through a reflexive ethnographic approach (Allard, 2015; Davies, 2002; Emerson & Fretz, 2001; Komito, 2011; Schöpke, 2019). The first step involved reading through each interview in its entirety before any coding began. Initial memos were written on the ideas, themes, or issues identified for each participant. Then integrative memos that sought to clarify and link ideas, themes, and issues were developed. According to Emerson and Fretz, a reflexive ethnographic approach is in contrast to a grounded theory approach, although reflexive ethnography draws heavily on the grounded theory approach to analyzing qualitative data (2001). They explain that the difference is that the qualitative data collected cannot be "analyzed independently of the analytic processes and theoretical commitments of the ethnographer who wrote them…Said another way, from reading comes coding and written memos which direct and redirect attention to issues and possibilities that require further reading of the same or additional field notes" (p. 144).

Individual descriptions of the participants' interviews resulting from the use of a reflexive ethnographic analysis approach included: 1) immigration paths and DHDAs, 2) related egocentric social networks, 3) all other related sources of information, and 4) the ease and difficulty of information seeking related to their DHDAs.

Social Network Analysis

The egocentric social network of each participant related to their DHDA was analyzed qualitatively utilizing a reflexive ethnographic approach to capture practices, meanings, and social contexts. Detailed information was collected on the characteristics of each person that the participant worked with related to their DHDA including:

- Importance of the relationship in terms of information seeking,
- Contextual knowledge areas, and
- Geographic location.

This qualitative description of a participant's DHDA-related egocentric network is the kind of information that would be of value to a medical device designer as they would be looking for rich contextual information regarding the particular problem they were addressing. Qualitative descriptions of participants' egocentric networks were also used in other studies of the DIEMs of immigrants (Allard, 2015; Komito, 2011; Schöpke, 2019). The qualitative descriptions of participants' egocentric networks enable the researchers to get the detailed information they required to answer their research questions on immigrant identity and migration experiences. In addition to a qualitative description, a quantitative analysis was also conducted to get a sense of the opportunity for access to new ideas through the diasporan's egocentric network.

The egocentric social networks were analyzed for size, effective size, and efficiency (DeJordy & Halgin, 2008). The following section describes the mathematical equations used to calculate the quantitative measures of the DHDA-related egocentric social networks (DeJordy & Halgin, 2008). The quantitative measures calculated include:

- Size of the network = N
- Effective size of the network = EN, and
- Efficiency of the network = EF.

The first quantitative measure is the size of the network which is described as how many contacts or alters the person has in their network:

N = number of contacts in a person's network.

The redundancy of a person's alters equals the number of alters a particular alter knows in the person's network divided by the size of the network. The effective size of a person's egocentric network is equal to the number of alters they have minus the sum of the redundancy of the persons alters.

EN = N – ((# of alters A1 knows)/N + (# of alters A2 knows)/N + (# of alters A# knows)/N)

The efficiency of the network refers to the effective size divided by the size of the network.

EF = EN/N

According to Burt, the size of a person's egocentric social network is related to the chance that one of them has the resources you need (2004). Also, the effective size of a person's egocentric social network is related to the greater potential for access to new information (Burt, 2004; Saglietto, CeZanne, & David, 2020). The efficiency measure is a measure in percentage of degree of access to new information in a person's egocentric social network (DeJordy & Halgin, 2008). For the purposes of this study, the quantitative measures are one lens by which to view a participant's DHDA-related egocentric social network. Research on the relationship between structural holes and innovation have shown that higher measures of network size and efficiency increase access to novel ideas and innovation (Ozer & Zhang, 2019; Zang, 2018). However, the value of a participant's egocentric social network may be different than the quantitative analysis indicates and will be highly dependent on the nature of the design problem. For example, through a diasporan with a small inefficient egocentric network working on a DHDA in Nepal, a

designer may have access to a community health worker that cares for women giving birth in their community and can provide context to a designer. This would be highly valued from a design perspective (Buchanan, 1992; Frehywot, Park, & Infanzon, 2019). Still, the quantitative measures of size, effective size, and efficiency do provide some insight into a participant's DHDA-related egocentric social network in terms of how it performs as a source of novel ideas and this insight is worth adding to the qualitative analysis from the reflexive ethnographic analysis. As such, these measures were added to the qualitative analysis to create a holistic modified DIEM for diasporans involved in DHDAs

Chapter 4: Findings

In this chapter, the data collected for each participant is presented in detail. First, the participant's country of origin and immigration path is briefly stated. Secondly, how the participant became engaged with their diasporan healthcare development activity (DHDA) for their country of origin and the nature of the work is described. The following section presents the qualitative description of their egocentric social network with respect to their DHDA. This is followed by a quantitative description of the size, effective size, and efficiency of their egocentric social network with respect to their DHDA. The next sections provide a qualitative description of the rest of their information sources related to their DHDAs including social media (open and closed), news, websites, libraries, information grounds, travel, and memory. Then I discuss the participant's views on the ease and difficulty of obtaining timely, credible, and immersive information from the various information sources.

After the findings for each participant are described, the holistic information seeking DIEMs are described by grouping them together by type of diasporan healthcare development activity. This section highlights the findings that are relevant to designers of medical devices for low resource settings. It describes the need for a designer to create the diasporan information environment model they need for their particular medical device project, including the geographic, clinical, and contextual areas of knowledge, so they can then find a diasporan that can assist in providing the information they have identified that they need.

Participant 1

Country of Origin and Immigration Path

Participant 1 was born in Agra, India. He grew up in India and went to school there until the age of 19. He immigrated to Canada in 1965 at the age of 19 to pursue his education and obtained an MD and PhD. Initially he had planned to just do his PhD and go back. After two years, someone suggested he consider staying in Canada and becoming a Canadian citizen. The availability of scholarships and the future potential Canada held contributed to his decision to apply for citizenship. The immigration rules in Canada at that time were changing and became very favourable for Participant 1. He applied to become a Canadian and was accepted.

Diasporan Healthcare Development Activity 1 (DHDA1)

Participant 1 practiced medicine in Canada as a clinician and academic for 30 years before he really got involved in activities in India. According to Participant 1, "[I was] very immersed in Canadian way but always at the back of mind that flame was never extinguished. So I had real interest in India." In 2003 he was asked to chair a governmental advisory committee on increasing trade between Canada and India. This activity gave him an opportunity to reconnect with India and return there for a visit. According to Participant 1, "I just had a kind of awakening that there are a lot of issues where we could be engaged and most important was chronic diseases, which are so highly prevalent, so that led to formation of [DHDA1] to connect these two entities" (Canada and India, author note).

Description of DHDA1

After Participant 1's self-described awakening, he began to develop a network of people in India and Canada that had an interest in creating a healthy civil society. According to

Participant 1, “The whole purpose is to create a network of networks and the purpose is to connect these people. And I must say, though we have very specific projects and outcome focused, but really the passion is to create people-to-people connectivity to bring music to my ears so that’s really the purpose, right.” The development of the network began in 2010, and an initial conference was held that year to bring together people from India and Canada in Canada. The topics were centered on chronic illness management such as diabetes, which is highly prevalent in the South Asian population in Canada as well as in India.

Description of the Egocentric Social Network of DHDA1

Participant 1’s egocentric social network map for his diasporan healthcare development activity is shown in Figure 2. Discreet characteristics of the egocentric social network of DHDA1 are listed in Table 2 and 3. The following section qualitatively describes the network. The first person (Alter 10) Participant 1 described is one of the key members of the DHDA1 that lives in India. Alter 10 also lived in Canada, where he obtained an MBA and worked in the Canadian healthcare system. Once he married and had children, he and his family decided to return to India and raise their family close to their parents. He is currently working in healthcare in India. Alter 10 is a critical link to all other people in the network and works closely with Participant 1, particularly when Participant 1 conducts trips to India for DHDA1.

The other alters in India are described in this section. Alter 11 is a leader in quality and healthcare and is a medical doctor in India. Alter 12 is the part of another diasporan healthcare association that links healthcare professionals of Indian origin together globally and is also the medical director of one of the largest private healthcare providers. Alter 13 is a very prominent lab physician in India Alter 14 is a former dean of a medical faculty at a university in India. Alter

15 is a key person that is part of a medical research organization in India. Alter 16 is a professor of public health in India.

The alters in Canada are described in this section. Alter 1 is a long-term colleague that Participant 1 has known long before the formation of DHDA1. She holds senior healthcare and education management positions and has been instrumental in supporting and advising DHDA1. Alter 2 is another long-term colleague that Participant 1 has known long before the formation of DHDA1. Alter 2 works for a large international medical device company. Alters 3 and 4 are key members of the DHDA1 board of directors. They are key to the administration of DHDA1. Alters 3 and 4 are colleagues but are not medical professionals. Alters 5 and 6 are colleagues in senior hospital foundation and health authority management positions. Alters 7 and 8 are cochairs of the events that DHDA1 has produced in 2010 (Alter 7) and 2018 (Alter 8).

Participant 1 described the alters in his DHDA1-related egocentric social network as the very important people of a larger network of approximately 100 to 200 colleagues. All the people in his network are colleagues, and all are in either Canada or India. According to Participant 1, the people listed in his DHDA1 egocentric social network are “top of the top” and “cream of the cream”. He described them as follows: “So they’re there. So they are very high-level experts and leaders in the field…Most of them (alters on the Canadian side) have travelled to India. And also they have some connection with India in one form or another, and they themselves are involved in healthcare activity, most of them except a couple of the board members.” He also noted, “By nature I have not included some very senior people who didn’t deliver, so these are all active.” Participant 1 considers all the information provided by his alters to be very timely, credible, and immersed in healthcare either in India or Canada.

Participant 1 has known everyone in his DHDA1 egocentric social network for approximately 10 years, in some cases much longer. He makes contact with his alters six to eight times a year via all communication technologies. If he is working on a particular project, then it could be more. He also has travelled to India at least twice a year just in the context of DHDA1.

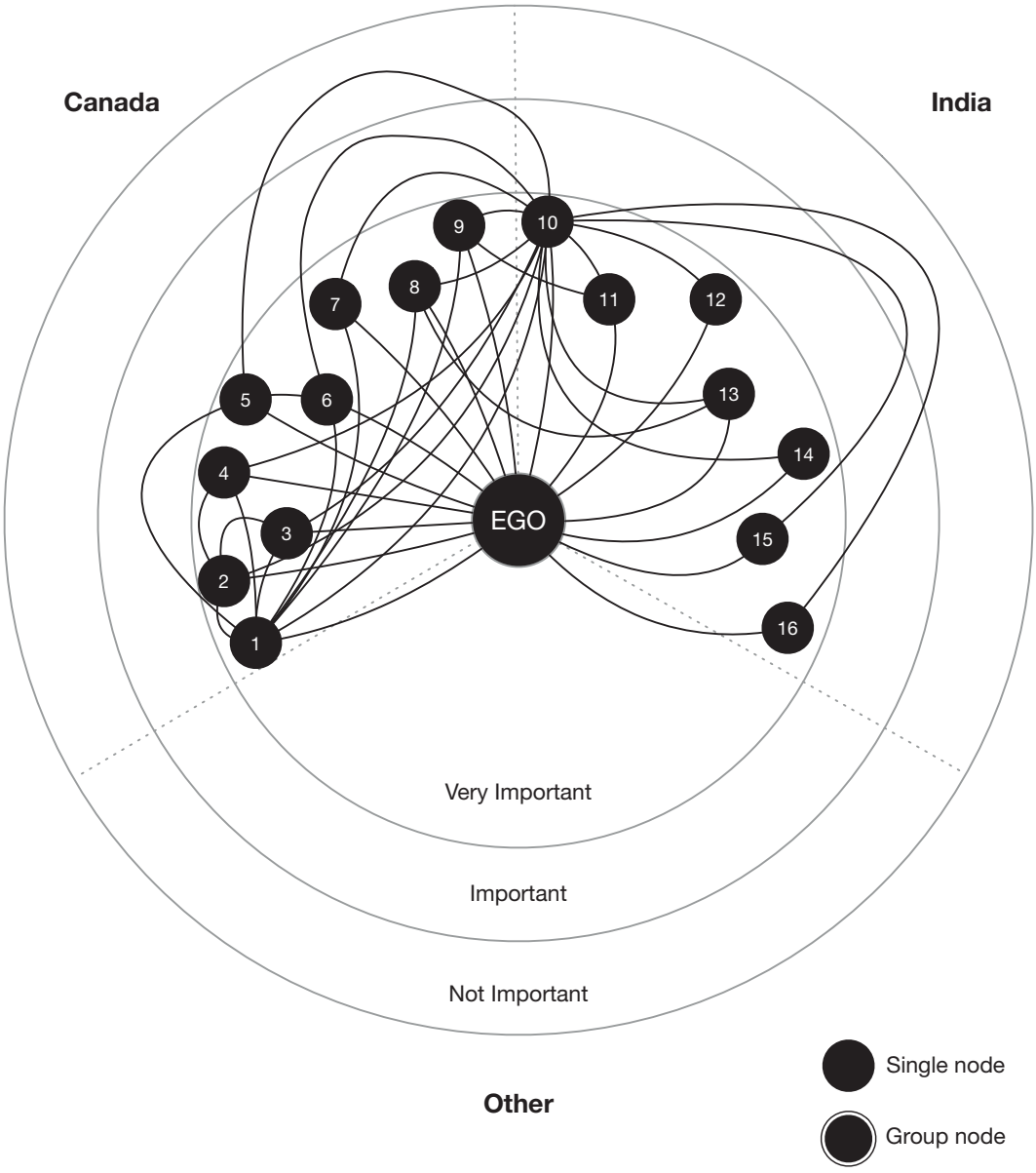


Figure 2: Egocentric social network map Participant1

Table 2

DHDA Participant 1

Characteristics of the Egocentric Social Network of Participant 1 for DHDA – I

Alter	Level of Importance	Gender	Nationality	Location	Income Level	Edu-cation	Known # of Years	Colleagues/ Friends/ Family	# Contacts/ Year	Alter Connection
1	Very Important	F	Canadian	Canada	High	High	10+	Colleagues	6-10+	2, 3, 4, 5, 6, 7, 8, 9, 10
2	Very Important	M	Canadian	Canada	High	High	10+	Colleagues	6-10+	1, 3, 4, 10
3	Very Important	F	Canadian	Canada	High	High	10	Colleagues	6-10+	1, 2, 4, 10
4	Very Important	F	Canadian	Canada	High	High	10	Colleagues	6-10+	1, 2, 3, 10
5	Very Important	M	Canadian	Canada	High	High	10	Colleagues	6-10+	1, 6, 10
6	Very Important	F	Canadian	Canada	High	High	10	Colleagues	6-10+	1, 5, 10
7	Very Important	M	Canadian	Canada	High	High	10	Colleagues	6-10+	1, 10
8	Very Important	M	Canadian	Canada	High	High	10	Colleagues	6-10+	1, 10, 13
9	Very Important	M	Canadian	Canada	High	High	10	Colleagues	6-10+	1, 10, 11
10	Very Important	M	Indian	India	High	High	10	Colleagues	10+	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16
11	Very Important	M	Indian	India	High	High	10	Colleagues	6-10+	9, 10
12	Very Important	M	Indian	India	High	High	10	Colleagues	6-10+	10
13	Very Important	M	Indian	India	High	High	10	Colleagues	6-10+	8, 10
14	Very Important	M	Indian	India	High	High	10	Colleagues	6-10+	10
15	Very Important	M	Indian	India	High	High	10	Colleagues	6-10+	10
16	Very Important	M	Indian	India	High	High	10	Colleagues	6-10+	10

Table 3

DHDA Participant 1 Continued

Characteristics of the Egocentric Social Network of Participant 1 for DHDA - II

Alter	Knowledge Source	Context	Timeliness	Credibility	Immersion
1	Travel to India	Canadian Healthcare Management & Education	Recent	High	Canada
2	Travel to India	Global Medical Device Industry	Recent	High	Canada
3	Travel to India	Canadian Healthcare Administration	Recent	High	Canada
4	Travel to India	Canadian Healthcare Administration	Recent	High	Canada
5	Travel to India	Canadian Healthcare Management	Recent	High	Canada
6	Travel to India	Canadian Healthcare Management	Recent	High	Canada
7	Travel to India	Global Health	Recent	High	Canada
8	Travel to India	Pathology	Recent	High	Canada
9	Travel to India	Healthcare Leadership	Recent	High	Canada
10	Lives in India and is Embedded in Healthcare	Healthcare Management	Immediate	High	Embedded
11	Lives in India and is Embedded in Healthcare	Healthcare Quality Leadership	Immediate	High	Embedded
12	Lives in India and is Embedded in Healthcare	Diasporan Led NGO	Immediate	High	Embedded
13	Lives in India and is Embedded in Healthcare	Lab Physician	Immediate	High	Embedded
14	Lives in India and is Embedded in Healthcare	Medical Education	Immediate	High	Embedded
15	Lives in India and is Embedded in Healthcare	Medical Research	Immediate	High	Embedded
16	Lives in India and is Embedded in Healthcare	Public Health	Immediate	High	Embedded

The following section describes the quantitative measures of the Participant 1's egocentric social network. The results are derived through the methods described in Chapter 3.

- Size of the network = 16
- Effective size of the network = 12.28
- Efficiency of the network = 0.77

The quantitative measures indicate that Participant 1's DHDA-related egocentric social network is potentially a source of many new ideas as its effective size is almost 80 percent of its size

(Burt, 2004). This indicates that many people in Participant 1's network do not know each other. This creates new knowledge pathways across the network (Burt, 2004).

Description of Other Sources of Information for DHDA1

This section describes the role of all other sources of information that Participant 1 accesses with respect to the work he is doing in his DHDA1. According to Participant 1, "Well in today's day, there's so much information so easily, right."

Participant 1 uses all electronic media to access newspapers and social media. He's always scanning what's out there for health technology information. He described the use of a specific website associated with a global organization connecting physicians of Indian origin as a group that has common interests.

In addition to his subject matter expertise, Participant 1 felt that his memory of growing up in India developed a passion for India that has played a large role in his passion for developing DHDA1. According to Participant 1, "I think more than memory I would say, maybe they are interrelated, it's the passion for India that has played a very big role in terms of…what I'm driving there, because I left it, gave a different lens on Indian values than I would have stayed. And that has played a very big role because I think for India to achieve what they're achieving they do need to know who they are. And I feel I have a different insight than what India is or what Indians are, what their values are, so that has played a role, and that is quite a critical component now in terms of building the network and bringing the change, ya."

He also mentioned textbooks and conferences in public health as sources of information. When queried about the library, Participant 1 was less enthusiastic and didn't think that the academic library has played that significant a role. According to Participant 1, "For me at least

the whole thing was designed from a practical outcome focus. So it's not the idea to publish papers, ya. It hasn't played that much role, but we do use the library for content, subject content, but that's more like let's say diet, so then, what's out there on diet, nutrition."

Information grounds also play an important role in DHDA1. According to Participant 1, "I think in our case that particular [type of place is important] because the network is created to have outcomes. And outcomes are lowering the burden of disease to create a better society; then you can't do that unless you are connected with the people directly. So we have made good use of congregations, meeting places, temples, gadwaras."

Travel also plays a critical role. Participant 1 said, "You have to travel especially within India, and you have to connect personally, this is person to person, face to face, which is very important." Participant 1 has travelled at least twice a year for the last ten years just in the context of DHDA1.

Participant 1 views these other sources of information as providing background information only. According to Participant 1, "The real action is dealing with people directly and having a specific project and working on it. So that's where the key is. All this is kind of background…So for example, we are quite active right now in leadership. So there are a lot of background I'm reading in India in terms of government, the rule changes, the medical council of India, ethics, professionalism, so that's just the background material, but the actual work is to find some partners and see how we could help them in developing leadership skills."

Ease and Difficulty of Information Seeking

The following section describes the ease or difficulty of information seeking behaviour for Participant 1. Participant 1 expressed that apps on mobile technology or on a smartphone are

the easiest to access because they are readily available and he accesses them on a daily basis. The need to connect with people directly is the most important information seeking behaviour as this is what will ultimately be responsible for an activity succeeding or not. Participant 1 feels that it isn't difficult to connect with people directly; however, it does take time. He feels that the individuals they are working with directly provide the most credible information. The biggest challenges Participant 1 stated were the ability to make a difference through follow-up and resource availability. Connecting with information sources, be they people or other, is only part of the plan for success, and follow-up and resources are required to achieve an outcome related to DHDA1. Figure 3 shows the importance ranking for the other sources of information for Participant 1.

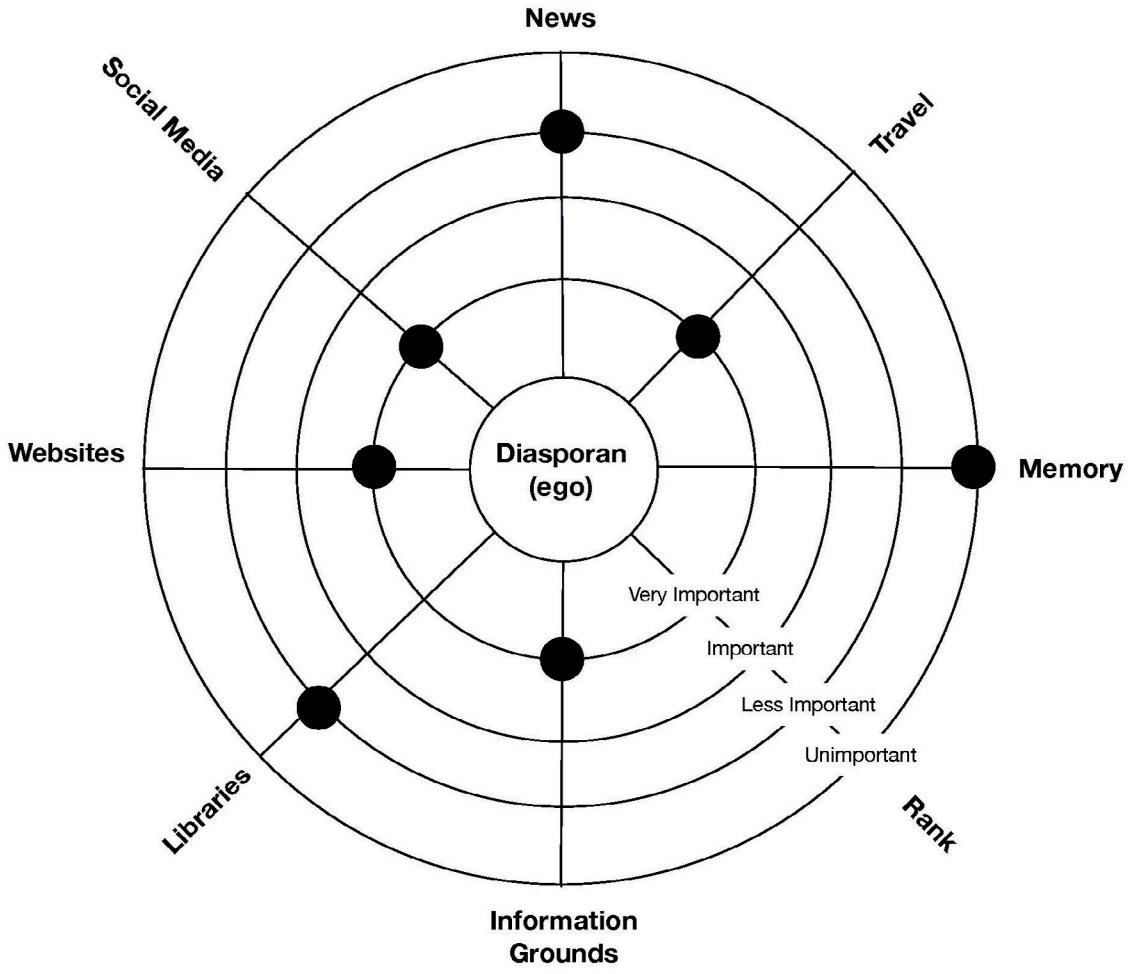


Figure 3: Other sources of information for Participant 1

Participant 2

Country of Origin and Immigration Path

Participant 2 was born in Kumasi, Ghana, in 1968. He went to primary school and college there. He then went to university in the capital city, Accra. He spent three years studying business administration in Accra, then left in 1989 and went to the UK to do his accountancy. He did his chartered accountancy in London, England, from 1993 – 1995 and became a chartered accountant. Then he worked there for three years as an accountant and then graduated in 1995 as

a fellow. He stayed there for about five or six years and then came to Canada in 2000. He landed in Toronto and started the MBA program from 2000 to 2002. After he graduated with his MBA, he moved to Vancouver and started working for a university.

Diasporan Healthcare Development Activity 2 (DHDA2)

Participant 2 became aware of a volunteer opportunity to become involved in an organization that was sending medical supplies to Ghana. In 2004, he was approached by a neurosurgeon working at a university and a fellow from Ghana and taken out for lunch to discuss the organization and their need for an accountant. When he was contacted, he said, "Yeah, why not. Let's meet for lunch." He initially served as their chair of finance. He did all the books, financial reporting at their AGMs, and day-to-day financial operations. He has been with the organization for many years and has grown into his current position as vice president. He describes his role as supporting the president in her decision-making.

Description of DHDA2

The organization Participant 2 volunteers for sends medical supplies to Ghana. This service was started by a nurse that had been on a medical mission to Ghana. She saw the need for medical supplies firsthand. She decided to take the trip to Ghana when a Ghanaian came to the hospital she worked at to do a medical observership. According to Participant 2, "Then they saw that this guy was struggling, so there might be a need to go and do something in Africa. So [the founder] went to Africa with [the Ghanaian on the medical observership]. They went to Ghana to do a needs assessment. They saw, yes, there is actual need." Upon her return, the founder recruited a team of healthcare and logistics people to begin and operate this charity. It is unique in its service as it only sends equipment that is requested by the receiving healthcare

organizations in Ghana and other neighbouring countries in West Africa such as Nigeria, Liberia, and Sierra Leone. This is an important characteristic of the DHDA2 as there are many stories about well-meaning organizations sending medical supplies that the receiving healthcare organization doesn't have the capacity to utilize. This organization ensures that the equipment and supplies that are donated have been requested by the receiving healthcare organization.

Once a healthcare organization sends its wish list, the DHDA2 attempts to gather a container load of requested equipment. The equipment is stored at a donated storage facility until a container load has been collected. A group of retired people then expertly load the container to maximum capacity in the Vancouver port, or the items are trucked to Victoria and loaded onto a container to maximum capacity. Then it is shipped to receiving ports and gets sent directly to the receiving healthcare organization that made the request. The equipment and container loading is donated by DHDA2, and the receiving healthcare organization only needs to pay for the shipping costs. In some cases, the receiving healthcare organization sends representatives to Vancouver to meet the DHDA2 team members and assist with the container loading to understand what is being shipped. According to Participant 2, "It's an end-to-end process, and it's a chain, it's well managed…I mean without a contact in Ghana, there's no way we would waste our time, just shipping and say 'Hey, who wants this?' [laughter] But definitely: one, there should be need; two, there should be targeted people; and then three, there should be somebody who definitely will be at the other end to process and to receive and to deliver."

Description of the Egocentric Social Network of DHDA2

Participant 2's egocentric social network map for his diasporan healthcare development activity is shown in Figure 4. Discreet characteristics of the egocentric social network of

DHDA2 are listed in Table 4 and 5. The following section qualitatively describes the network. The first person (Alter 1) Participant 2 described is one of the key members of the DHDA2 that lives in Canada. Alter 1 is a nurse that participated in medical missions to Ghana and saw the need first hand for medical supplies. She returned to Vancouver and recruited other people to join her to form DHDA2. In addition to Participant 2, she also knows everyone in Participant 2's egocentric social network related to DHDA2.

The other alters in Canada are described in this section. Alters 2 through 8 make up the Canadian people in the social network: Alter 2, a neurosurgeon; Alter 3, a clinical fellow; Alter 4, a radiologist; Alter 5, a shipping company; Alter 6, a trucking company; Alter 7, a storage warehouse; and Alter 8, volunteer packers. Although Alter 8 is represented as a single node, it represents approximately 15 retired people that pack the containers with expert care.

The alters in Ghana and other West African countries are described in this section. Alters 9 through 15 are people in Ghana that play a key role in the DHDA2. They range from the Minister of Health, to hospital CEOs to medical professionals. Alters 15 through 18 are medical professionals in Sierra Leone, Nigeria, and Liberia.

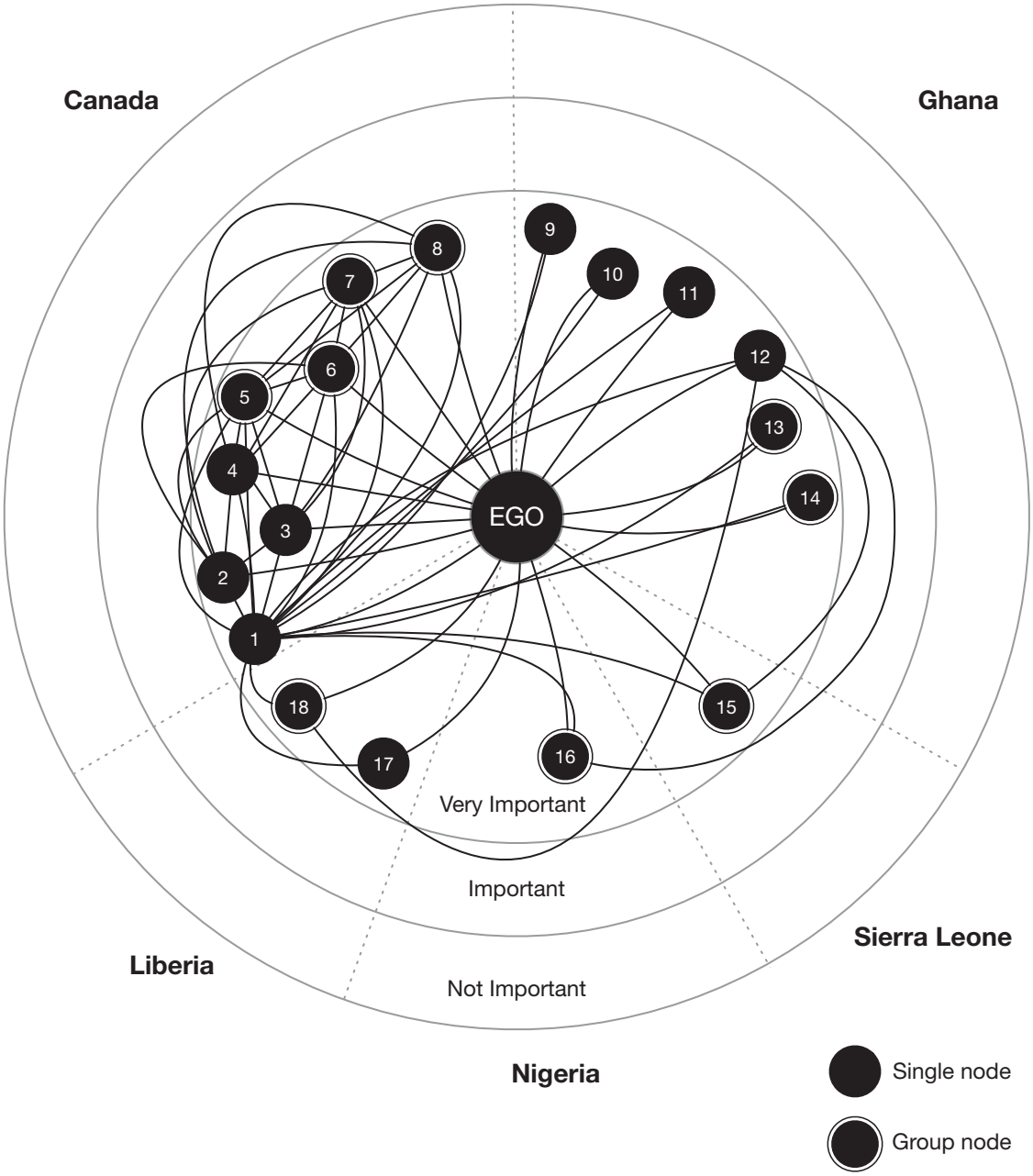


Figure 4: Egocentric social network map Participant 2

Table 4

DHDA Participant 2

Characteristics of the Egocentric Social Network of Participant 2 for DHDA - I

Alter	Level of Importance	Gender	Nationality	Location	Income Level	Edu-cation	Known # of Years	Colleagues/ Friends/ Family	# Contacts/ Year
1	Very Important	F	Canadian	Canada	High	High	15	Colleagues	On-going
2	Very Important	F	Canadian	Canada	High	High	15	Colleagues	~Weekly
3	Very Important	M	Canadian	Canada	High	High	15	Colleagues	~Weekly
4	Very Important	N/A	Canadian	Canada	High	High	15	Colleagues	~Weekly
5	Very Important	N/A	Canadian	Canada	High	N/A	15	Colleagues	~Weekly
6	Very Important	N/A	Canadian	Canada	High	N/A	15	Colleagues	~ Monthly
7	Very Important	N/A	Canadian	Canada	High	N/A	15	Colleagues	~ Monthly
8	Very Important	Multi-M/F	Canadian	Canada	High	N/A	15	Colleagues	~ Monthly
9	Very Important	N/A	Ghanaian	Ghana	High	High	15	Colleagues	~ Yearly
10	Very Important	M	Ghanaian	Ghana	High	High	15	Colleagues/ became like family	~ Yearly
11	Very Important	M	Ghanaian	Ghana	High	High	15	Colleagues/ became like family	~ Yearly
12	Very Important	M	Ghanaian	Ghana	High	High	15	Colleagues	~ Yearly
13	Very Important	N/A	Ghanaian	Ghana	High	High	15	Colleagues	~ Yearly
14	Very Important	N/A	Ghanaian	Ghana	High	High	15	Colleagues	~ Yearly
15	Very Important	N/A	Ghanaian	Ghana	High	High	15	Colleagues	~ Yearly
16	Very Important	N/A	N/A	Sierra Leone	N/A	High	6	Colleagues	~ Yearly
17	Very Important	N/A	N/A	Nigeria	N/A	High	6	Colleagues	~ Yearly
18	Very Important	N/A	N/A	Liberia	N/A	High	6	Colleagues	~ Yearly
19	Very Important	N/A	N/A	Liberia	N/A	High	6	Colleagues	~ Yearly

Table 5

DHDA Participant 2 Continued

Characteristics of the Egocentric Social Network of Participant 2 for DHDA - II

Alter	Alter Connection	Knowledge Source	Context	Timeliness	Credibility	Immersion
1	2,3,4,5,6,7,8, 9,10,11,12,13, 14,15,16,17,18,19	Travel to West Africa	Nursing	Recent	High	Canada
2	1,3,4,5,6,7,8	Travel to West Africa	Neurosurgery	Recent	High	Canada
3	1,2,4,5,6,7,8	Travel to West Africa	Clinical Fellow	Recent	High	Canada
4	1,2,3,5,6,7,8	Travel to West Africa	Radiologist	Recent	High	Canada
5	1,2,3,4,6,7,8	Canada	Shipping Company	N/A	High	Canada
6	1,2,3,4,5,7,8	Canada	Trucking Company	N/A	High	Canada
7	1,2,3,4,5,6,8	Canada	Storage	N/A	High	Canada
8	1,2,3,4,5,6,7	Canada	Volunteer Packers	N/A	High	Canada
9	1	Ghana	Public Hospital Administration	Immediate	High	Embedded
10	1	Ghana	Private Hospital CEO	Immediate	High	Embedded
11	1	Ghana	NGO CEO	Immediate	High	Embedded
12	1, 16, 17, 18, 19	Ghana	Medical Professional	Immediate	High	Embedded
13	1	Ghana	Medical Professional	Immediate	High	Embedded
14	1	Ghana	Medical Professional	Immediate	High	Embedded
15	1	Ghana	Medical Professional	Immediate	High	Embedded
16	1, 12	Sierra Leone	Medical Professional	Immediate	High	Embedded
17	1, 12	Nigeria	Medical Professional	Immediate	High	Embedded
18	1, 12	Liberia	Medical Professional	Immediate	High	Embedded
19	1, 12	Liberia	Medical Professional	Immediate	High	Embedded

Participant 2 described the alters in his DHDA2 related egocentric social network as the very important people involved in DHDA2. All the people in his network are colleagues and highly educated and/or trained for their particular role in the organization. Participant 2 mentioned that many of the alters in Ghana had become like family over the years and that the development of these very close personal relationships was key to building the organization as they received great support for making things happen in Ghana. Importantly, Participant 2 also described all the medical people in the network as being currently active in their healthcare communities so their information would be very timely and immersed in currently healthcare practice. He also said they were highly credible, “They know what they are doing.”

Participant 2 has known everyone in his DHDA2 egocentric social network for approximately 15 years except for those in other West African countries as they only came on board 6 years ago. He makes contact with his alters on an on-going basis. It is dependent on the number of shipments, but they generally do approximately 10 shipments per year.

The following section describes the quantitative measures of the Participant 2’s egocentric social network. The results are derived through the methods described in Chapter 3.

- Size of the network = 19
- Effective size of the network = 14.47
- Efficiency of the network = 0.76

The quantitative measures indicate that Participant 2’s DHDA-related egocentric social network is potentially a source of many new ideas as its effective size is almost 80 percent of its size (Burt, 2004). This indicates that many people in Participant 2’s network do not know each other. This creates new knowledge pathways across the network (Burt, 2004).

Description of Other Sources of Information for DHDA2

This section describes the role of all other sources of information that Participant 2 accesses with respect to the work he is doing in his DHDA2. He described the use of Ghana Canada Association as a way of promoting what they are doing to the Ghanaian community in Canada. And they also have their own Facebook page and website that they use as a portal for financial donations. Their website also has links to their Facebook, LinkedIn, Twitter, and YouTube accounts. According to Participant 2, they have also hired a dedicated marketing company, "They are taking that to the next level. Yep. They are doing all the different things. They came to map our activity; just like you are doing, and then they are going to just kind of do different things. They are going to have a big splash in an event, inviting key people, telling them the stories and then basically get their buy-in and they make their donation to us…they are basically taking it to the next level…promoting what we're doing, telling the story." Participant 2 described the news or social media as a secondary tool for gathering information; however, he thought that perhaps the founder of DHDA2 may utilize the news and social media to make sure she's aware of what's happening. Participant 2 did not feel that the library played any role at all.

Participant 2 described the role of other local information grounds such as local churches as very important in terms of volunteer recruitment: "Yeah. Organizations, exactly, local organizations. We use that a lot. I would say greatly, but definitely their input is quite important to us. And then, yeah, we have one of our executives whose church will come in and help out with the load…And also through the local church, I believe we tap into several volunteers who will come in to help as well. Yeah, so definitely the community help is tremendous."

Participant 2 also described the role of travel as “Huge!” According to Participant 2, “It’s huge. You know why? Because, I mean, it’s all based on travelling. It’s all connectivity. I mean, [the founder] travels quite a bit. I mean she goes for chiefly alliance, meets with top people, connects with people, and she goes for fundraising events. She goes to promote the charity. She goes on medical missions in Africa. So it’s travel, travel, travel. Definitely. Yes, it’s key…And the medical mission is huge…medical missions in Liberia, Sierra Leone, Ghana. So it’s huge. Doctors Without Borders and all those affiliates, right. They all come together. So it’s kind of great. Travel, travel, it’s kind of why I emphasize travelling. It’s a major one. So if you talk about the local people as if travel is way way higher—…A newspaper won’t do it.”

Participant 2 reflected on the role of memory and described it as important for understanding the need but that it can’t be relied upon because of the pace of technological changes: “But definitely memory, going back to where I belong and what, you know, I’ve gone through in life growing up. Brings in the need for me to appreciate what we get here. And then also appreciate how much we throw away [laughter], you know, here. So definitely it’s a big one too…We can really make that comparison and see the need for sure.” However, Participant 2 also described how things have changed: “It’s really advanced. Oh, really advanced. Yes, it’s moved forward definitely. Definitely with structure, in terms of even the equipment that they use.…I went in Ghana in 2008…I was quite impressed with the level of technology that the people are using…Things have changed and they are basically embracing technology, for sure…Because I have been back several times, right? Yes. Last time I was there in 2016, 2015, but definitely that time I went, I saw a big change.”

Ease and Difficulty of Information Seeking

This section discusses the types of information seeking behaviour that is easy and most difficult or challenging for Participant 2. The easiest place to access information was from Participant 2's own memory: "Well, I mean definitely memory's personal, right? I've got my own memory, right, so that's very [easy]." Next, information technology was described by Participant 2 as an enabler of communication, financial transactions, and information gathering and capture: "Because people are so much interested in what we can offer, so they are willing to send us their lists, their wish list. So, it's easy to get that. So, because of technology, I mean, email pops up, you know. I just get a list of things, right? And also, technology has made payment easier. I mean, just go to the bank, do a wire transfer, and boom, you get the money right at the bank. So, I would say that [information technology is] a big enabler, definitely a big enabler. Technology has really breached a gap and without that it would have been quite tough. We would have to wait and wait for the postman to deliver a letter. [laughter]… From Africa, before you know what's going on by that time, it will be obsolete. So definitely technology. We have leveraged on that. We use a lot of emails. We use a lot of phone calls. WhatsApp has been great, you know, and also cell phone, you know. Taking pictures with your phone technology-wise. You know we can just check the equipment. The people who came to interview me, they brought a very kind of tiny camera and a few cameras. You know, it was right there, and just interviewed me. So, I think technology has really, really taken us far, and it's really made information gathering and capture easy."

Participant 2 then described the most challenging issue is when there is a lack of response: "The challenging part would be when you don't hear back. When it's only a one-way

communication. At times you hit a roadblock where you can't go far because the people are not corresponding, they're not sending information." He also mentioned missing information as a challenge as well: "And also another challenge is missing information. Say I go to the bank and they send information but it's missing the address of the bank, it's missing some information, and I have to make a guess. I know this Ecobank in Liberia. I have to go and find the address, and there are only one or two. I have to make an executive guess, it may be this one. So, you know, those kind of stuff are quite difficult." Lastly Participant 2 described the challenge of not understanding the culture for other members of the DHDA2: "I'm from Ghana so definitely I understand that. [Others] can't see, you know what, because Africans are poor, if you send them old stuff, they will like it, but trust me, it's garbage. At times they dump things in Africa. You know, we don't need those things, right? They send old mattresses full of bedbugs to Africa, and it's called dumping, right? It's terrible. So, it's a challenge. It goes there, and it's there creating more problems to us, so I always tell [the founder], "You know what, these [items], just throw them away. You know, nobody wants this painting…So not understanding the culture will be a challenge. You can definitely miss the boat by not understanding the way things are done…so basically for now, actually I'm the only Ghanaian…it's something that I pride in being the only Ghanaian supporting—when it comes to discussions, meetings, I'll be able to bring a different kind of perspective, and they appreciate that. I've got an email from one honoured president. She been telling me that they can't do without you. I think because of the value that you bring to the table…I bring the local cultural piece where nobody can even think about. I say, 'Hey, think about these things.' You know, exactly, I understand that. Because that's where the hearts of the

people are, and I can understand where they are coming from, yeah." Figure 5 shows the importance ranking for the other sources of information for Participant 2.

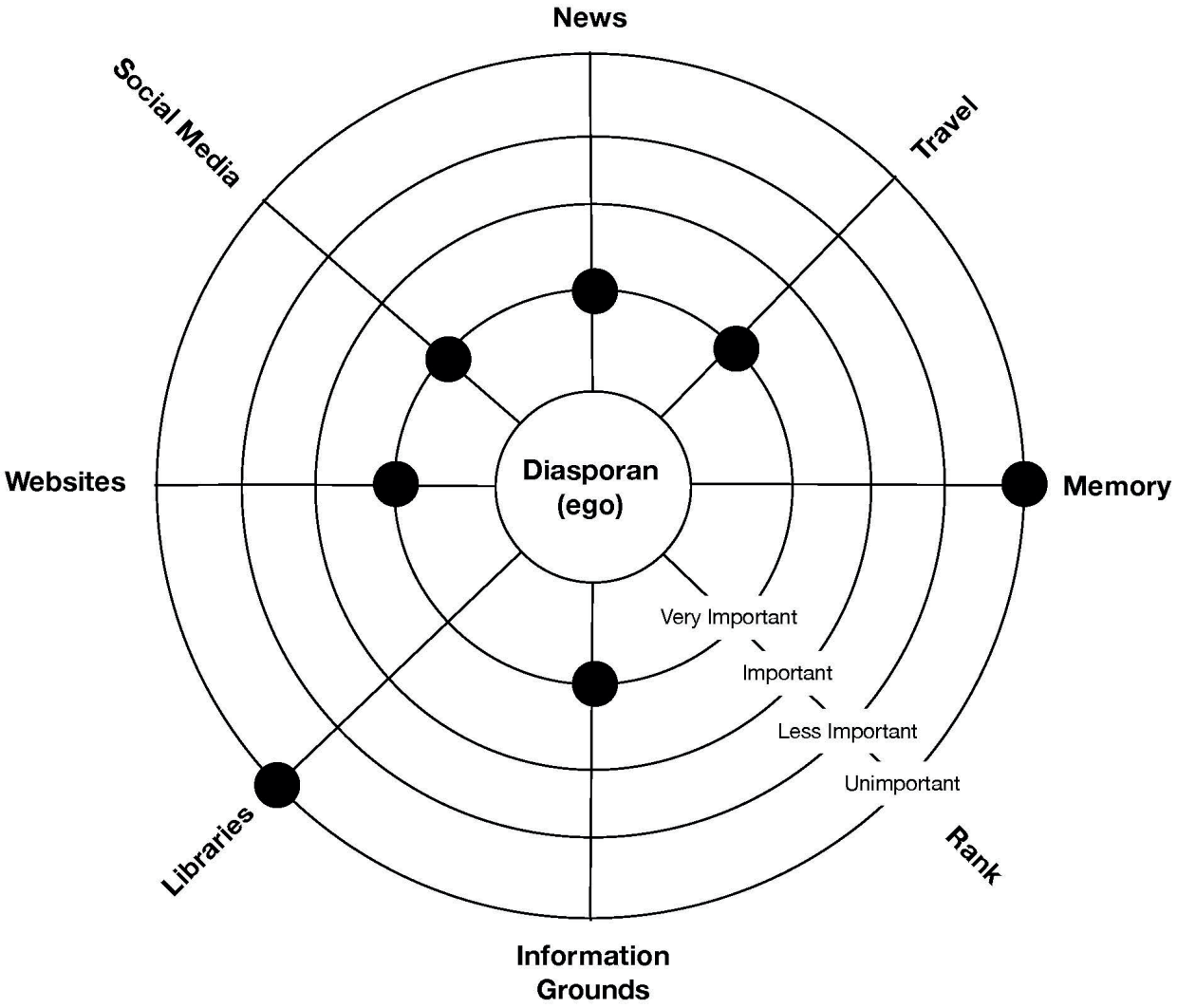


Figure 5: Other sources of information for Participant 2

Participant 3

Country of Origin and Immigration Path

Participant 3 was born at sea but was registered as being born in India. She comes from Chennai, India, which was known as Madras up until 1996. Her father was in the army, and her family moved around every two years so she grew up in locations all over the world. She considers India as her home, and that is where she moved back to after her father died unexpectedly. She finished her grade school and medical school in India before moving to England to pursue her career as a surgeon. She spent approximately nine years there, got married and became pregnant. Her husband was from Sri Lanka and was also a surgeon. They decided to immigrate to Canada in 1991 after her husband's family moved there during the civil war in Sri Lanka. They adapted to the snowy winters, raised a family in Canada, and she is still practicing medicine.

Diasporan Healthcare Development Activity 3 (DHDA3)

Participant 3 is a currently a practicing anatomical pathologist. When her children became adults, her mother, who also lived in Canada and helped to raise her children, decided to return to Chennai, India, as she didn't feel of use anymore and didn't like the winters. Participant 3 became involved in teaching a variety of medical subjects in Chennai due to her family connection: her mother and her brother both live there. She also has a close medical colleague in Canada with family in the same city, so they sometimes travel together to visit their families and teach there.

Description of DHDA3

Participant 3 teaches medical education and anatomical pathology in two different teaching institutions in Chennai. As a visiting professor, she does not receive any monetary or other benefits. She goes at least twice a year to help prepare the students for their exams in anatomical pathology. This involves the sharing of pathology slides with the patient history and diagnosis. She has contributed to a published book of these examples that is used to prepare for exams. As a visiting professor at another institution, with her Canadian colleague with family in Chennai, she conducts medical education seminars utilizing a gaming as learning strategy.

She also mentioned that things are currently changing in medical education approaches. According to Participant 3: "And right now our entire medical education is going competency by design, which is, you know, we've got to stand on our heads and you've got to see everything that every to-be doctor in training does, and you have to sign off on it, so…we have a whole big new thing coming down the pipe. In fact, it started today. It is starting today. So, in January, when I go, I'm taking a sabbatical off. I usually take about six months, and I'll be spending two or three months in the host institution and seeing—Everybody across the world is changing, so…I want to see what they do and what we do and how we learn from each other."

It is interesting to note the changing nature of medical education globally. In summary, Participant 3's DHDA3 is her work as a medical educator in her country of origin several times per year in two institutions covering both anatomic pathology and medical education topics.

Description of the Egocentric Social Network of DHDA3

The egocentric social network map related to Participant 3's DHDA is shown in Figure 6. Discreet characteristics of the egocentric social network of DHDA1 are listed in Table 6 and 7.

The following section qualitatively describes the network. Alters 1 and 2 are Participant 3's mother and brother. Although they do not play a role in her DHDA, they live in Chennai and are the reason she conducts her DHDA in Chennai, India. Alters 3 and 4 represent the people she knows at the two separate medical teaching institutions she works with in Chennai. Both institutions require a formal relationship with her as an unpaid visiting professor.

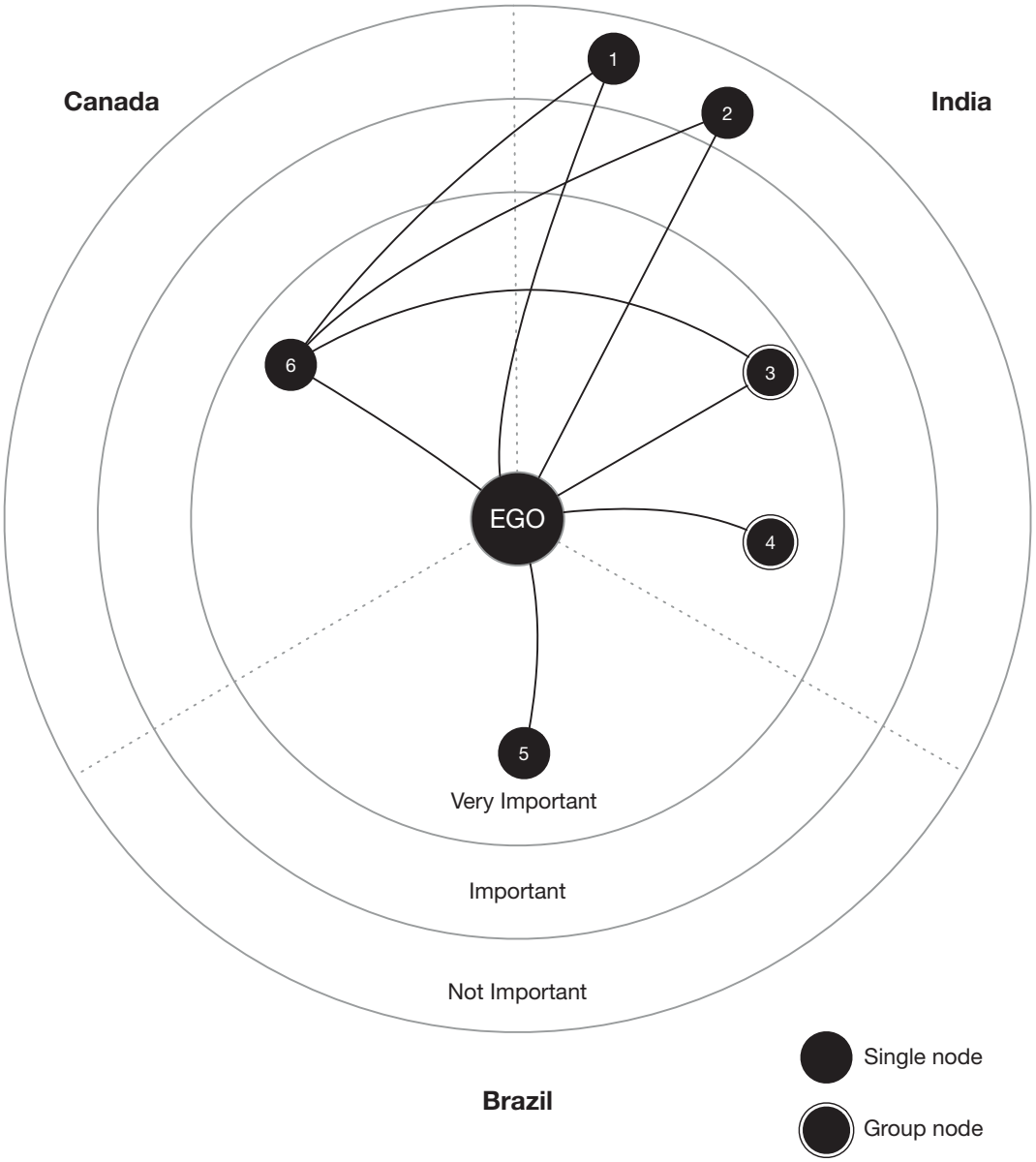


Figure 6: Egocentric social network map Participant 3

Table 6

DHDA Participant 3

Characteristics of the Egocentric Social Network of Participant 3 for DHDA - I

Alter	Level of Importance	Gen -der	Nationality	Location	Income Level	Education	Known # of Years	Colleagues/ Friends/ Family	# Contacts/ Year
1	Not Important	F	Indian	India	Unknown	Unknown	All her life	Mother	On-going
2	Not Important	M	Indian	India	Unknown	Unknown	All her life	Brother	On-going
3	Very Important	M	Indian	India	High	High	10 – 15 years	Colleagues	~ Annually
4	Very Important	M	Indian	India	High	High	10 – 15 years	Colleagues	~ Annually
5	Very Important	M	Indian	Brazil	High	High	10 – 15 years	Colleagues /became family friends	~ Annually
6	Very Important	F	Canadian	Canada	High	High	10 – 15 years	Colleagues /became family friends	On-going

Table 7

DHDA Participant 3 Continued

Characteristics of the Egocentric Social Network of Participant 3 for DHDA - II

Alter	Alter Connection	Knowledge Source	Context	Timeliness	Credibility	Immersion
1	2, 6	Lives in India	Lay Person	Immediate	N/A	Embedded
2	1, 6	Lives in India	Lay Person	Immediate	N/A	Embedded
3		Lives in India	Dean, Medical School	Immediate	High	Embedded
4	6	Lives in India	Dean, Medical School	Immediate	High	Embedded
5		Lives in Brazil	Medical Colleague/Pathology/Gastro-intestinal	Immediate	High	Brazil
6	1, 2, 4	Canadian Healthcare	Medical Colleague/Medical Education	Immediate	High	Canada

She described the structure as starting with the head of the department, followed by others in a chain of command including the relevant Dean associated with the department in the institution. Participant 3 didn't give details of her alters in the institutions as they were there mostly to ensure that the bureaucracy was in place to formalize her relationship with the

institution. She also discussed another medical colleague, Alter 5, related to her work, who lives in Brazil. Participant 3 spent one sabbatical in Brazil and did a lot of undergraduate teaching in the medical school. Alter 5 and Participant 3 were both fellows at the Mayo Clinic and developed a friendship. They are now good family friends and attend each other's children's weddings. They are part of a gastro-intestinal group that's connected to Americans that study health policy and health situations. They have been to Cuba, Peru, and other countries. Lastly, Alter 6 is the medical colleague she knows in Canada, who has family in Chennai, that she conducts medical education seminars with in India. They have travelled to Singapore together to go to medical education conferences.

Participant 3 has known everyone in her DHDA for between 10 to 15 years other than her brother and mother. Her mother, brother, and her colleague from Canada know each other. Her colleague from Canada also knows one of the institutions that she works in in Chennai, India. The other members of her network do not know of each other. According to Participant 3, the medical professionals that she has described in her network are very credible in their areas of medical expertise. The information they provide is very timely as they are actively immersed in the healthcare system.

The following section describes the quantitative measures of the Participant 3's egocentric social network. The results are derived through the methods described in Chapter 3.

- Size of the network = 6
- Effective size of the network = 4.67
- Efficiency of the network = 0.78

The quantitative measures indicate that Participant 3's DHDA-related egocentric social network is potentially a source of many new ideas as its effective size is just over 80 percent of its size (Burt, 2004). This indicates that many people in Participant 3's network do not know each other. This creates new knowledge pathways across the network (Burt, 2004).

Description of Other Sources of Information for DHDA3

This section describes the role of all other sources of information that Participant 3 accesses with respect to the work she is doing in her DHDA3. Participant 3 is part of a WhatsApp pathology group that is hosted by one of the institutions that she works at in India. The pathology slide images are all digitized and uploaded on a daily basis for students to diagnose. Participant 3 is a passive member of this group and observes the activities posted. She is sometimes asked why she doesn't actively participate in the online WhatsApp discussion by other members of the group. Participant 3 explains: "But, I'm not a big social media person. Because once you start, you have to keep going, if you know what I mean, right? I find it kinda time-consuming. I kind of look at my phone once in the morning and once in the evening, and that's about it."

It appears that pathology imaging is in a transition period both in Canada and in India. According to Participant 3: "It's mainly for the kids. For the trainees who are, you know, who have to figure out what these are. Because our exams, in Canada, the exams are already turned into digital format. Rather than real slide format. So, it's a new thing, a new, in a sense, a different kind of perception and learning, but that's the way it's going, so that we don't have to make slides. But in India we still make, it's all slides. So, I take slides, and then I'll share and leave the set with them, and they can look at it whenever they want, and they develop a little

library collection as well, right, of all my pathologies, which are, a little bit different. And, if I see anything unusual there, I bring it back. I get a slide or two of a GI b-abscess or some bug that grows there, and I don't see it very often here. Stuff like that."

The library is also an important source of information for Participant 3. She has access to Canadian university-based library databases, and she can access whatever she wants from India, including journals and papers. The WhatsApp group allows pdfs to be posted, so journals and papers are shared this way as well. This is the only social media Participant 3 uses with respect to her DHDA3. Sometimes the WhatsApp group will share Twitter links to a particular podcast that she may listen to, but the WhatsApp is the platform that is used. One noticeable difference between India and Canada is that libraries in India still carry physical books, likely because of the lack of freely available internet in India. In contrast, Canadian libraries that house physical books are almost vanishing.

Participant 3 also mentioned the use of text, email, and the internet as mediums of communication. According to Participant 3, "Emailing, internet use. It's just bread and butter now, not that I grew up with it. But it's bread and butter. And I think I am managing all right with it." Participant 3 uses credible online pathology sites such as PathologyOutlines that she knows are reputable. However, she also stated, "And sometimes just for heck of it I even read a Wikipedia entry on it. Doesn't matter. And we read it to see what it's like."

Participant 3 consumes the local news both in Canada and India. She buys five morning newspapers when she's in India and two in Canada, including the *Globe and Mail*. She also keeps in touch with the news in both countries when she's away via a Flipboard service on her phone.

Information grounds do not play a role in Participant 3's DHDA. The role of travel is critical to her DHDA, and she travels back to India twice a year to participant in teaching activities. When queried about the role of memory, Participant 3 indicated that more than memory, it's language that is important in her DHDA: "Language plays a big role. Because in the country of origin, or in Brazil or wherever people relax into the language even though you're talking in English, you know—because it's a hands-on thing. These are groups of 10, 20, 30 people sitting around a microscope. It's a very one-to-one kind of thing, right? And even in the main rapid reviews, you know, some of the questions—and then they'll make jokes, you know. And you have to be part of the crowd, otherwise—and in India, we have a lot of languages, right? I mean, we have 56 official languages, and 252 different dialects, etc. So, though languages you know—I speak half a dozen. So, the more languages you know, the better it is there. I think language is a huge connection. For me, language has always been very important."

The role of memory is not something Participant 3 taps into as a source of information because the country changes rapidly: "It's changing every time. And if you—For me to keep going back to what it was, or—everything is erased now. It's completely different. Completely different."

Ease and Difficulty of Information Seeking

The following section describes the ease or difficulty of information seeking behaviour for Participant 3. Participant 3 described her most difficult issue with information seeking in India is that the internet is not freely available in many parts. Participant 3 emphasized that there is a different type of learning happening in India compared to Canada due in part to the lack of freely available internet service in India. There you have to bring all of your teaching materials

with you such as PowerPoint presentations and video files. In Canada students all have smart phones that are connected to high-speed internet, and as a result they are checking to see if what she is saying is correct. Another challenge is the time difference between India and Canada; however, this is something that you can learn to work around and is not a hindrance. Figure 7 shows the importance ranking for the other sources of information for Participant 3.

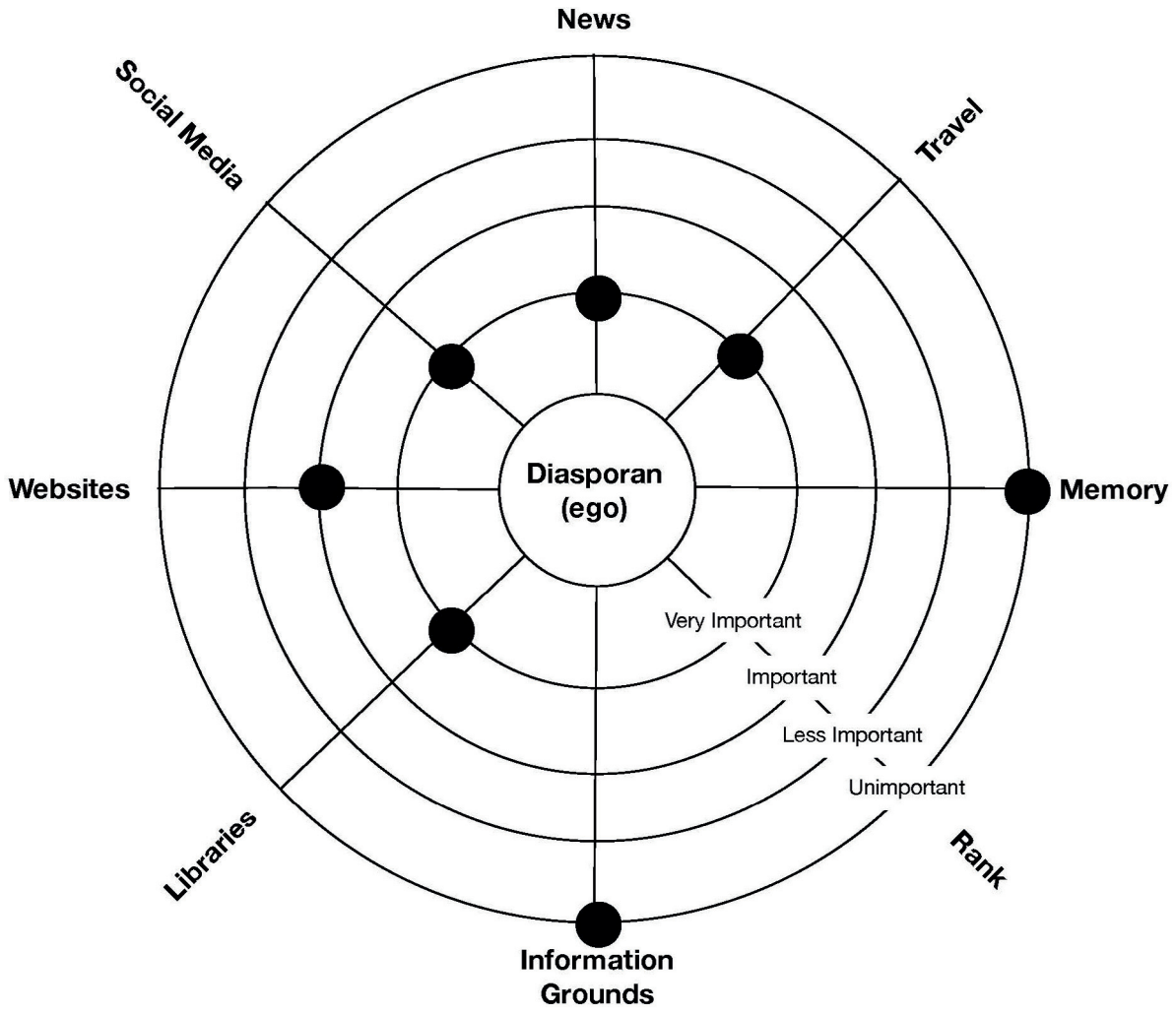


Figure 7: Other sources of information for Participant 3

Participant 4

Country of Origin and Immigration Path

Participant 4 was born to a humble family in Diego Suarez in the north part of Madagascar. She began her schooling in French. Due to changes in government, she then had to take school in Malagasy, becoming fluent in both. Although she wanted to go abroad to study,

she didn't have the financial means, and so she took courses locally in accounting, English, and other basic subjects to help her secure a job. Her first job was in a travel agency in Diego Suarez, where she worked for six years and became a manager. After having a baby in her late twenties, she quit her job to stay home and raise her daughter. When her daughter started school, she found a new job in health insurance. She met a person in her community that was working in insurance that was looking for someone to join the company. Participant 4 had developed a very strong network in her community through the travel agency, which was useful for her job in health insurance. She worked there for approximately 8 years, met her partner through that job, and moved to Canada in late 2017. She is currently studying English and applying for her permanent residency. Once she can work in Canada, she plans to start looking for employment.

Diasporan Healthcare Development Activity 4 (DHDA4)

Participant 4 started looking for work when her daughter started school. Participant 4 described the process of finding the job opportunity and getting the job offer: "So I found insurance. Someone working in insurance told me—oh, because I was really well-known from travel agency. I had all network in my little town. So, I just came like that to work with the lady. She said, 'You know what? We are looking for someone.' I am saying, 'You know, I have no idea about what is insurance stuff. I used to work in travel agency.' But, 'Do you want to learn?' I said, 'Yes, why not? Give me a little bit of time. I'm trying to do my best.' So, I got three months, like a trainer. I was alone like, you know, the book stuff. I got an interview with the boss in the capital. And the capital is Antana. Me, I was east coast, the beach coast. I went there. And then he said, 'Okay. Good!' So, yah, because I'm really—ability to talk to someone and to explain and easygoing and open, that's me. And trustworthy, honesty."

Description of DHDA4

Participant 4 described her country as being a very poor country that is deeply underdeveloped. Health insurance is not affordable for local people. According to Participant 4: "And then about government, they don't really do something good for the people. Even rich countries have everything, make everything a little bit better. No. We have little hospitals but we can be dead if we don't have any money. For example, I'm sick, I'm going to hospital, the first thing they are asking to me is 'Can you afford—can you pay?' And they say, 'I can't,' so they leave us. That's really sad, yah. That's the situation, it's really sad." The capital city has modern health diagnostic facilities if you can afford, it but that's not available at the provincial level.

The health insurance company that she worked for provides health insurance and medical evacuation services for foreigners, such as people working in mineral development or people involved in adventure travel. Through the health insurance company, Participant 4 worked with the existing private and public healthcare facilities in her province and the capital of Madagascar to provide medical services. The facilities included state-of-the-art diagnostic services only available in the capital. That company also partnered with another company to provide the medical evacuation services and the ambulance and flight services required to transport someone to one of the nearest countries with appropriate medical services to treat a serious illness or injury. Through the medical evacuation company, Participant 4 had connections to a system of people providing medivac transport services to the neighbouring regions of La Reunion, Mauritius, and South Africa as destination locations for appropriate medical care.

As part of providing health insurance, Participant 4 found herself in the position of having to also provide some level of medical services to clients with illness and injury. She

described two such cases she had to address in her role with the health insurance company. In the first case, a client with appendicitis, she called the large private medical clinic in the capital to explain her symptoms. She described her contact there as a retired military doctor practising in the capital city of Madagascar, Antananarivo. He indicated that he could provide the appropriate medical care, and Participant 4 made the arrangements to transport her client to a medical facility in Antananarivo. In the second case, a client with five hip fractures from a motorcycle accident, it was necessary to medivac him out of the country for appropriate medical care. The airport didn't have light at night, so they had to wait for the dawn before the private medical flight came in. During this time, she stayed with the client although her job did not require this of her.

Participant 4 also described her experience with the traditional medicine used in Madagascar: "They have like traditional medicine. Of course, in my country, we have a good reputation of medicinal plants, in Mada…There's a lot. A lot of people do research, yah. People look at research from abroad, they came to Mada (when I say Mada, it's Madagascar) for that because we have this resource." Participant 4 also mentioned that many local people cannot access expensive health insurance, and so they do not believe in Western medicine and like to use traditional medicine instead. However, as she has had some Western healthcare knowledge, she is cautious about using traditional medicines herself, especially if she doesn't know about the amount of a particular type that is safe to use. Participant 4 mentioned the use of essential oils as popular traditional medicines and mentioned the company HomeoPharma from Madagascar that sells a large number of products for health and wellness. She also mentioned the use of corn silk to treat urinary tract infections that her mother and grandmother informed her of. Although not

part of her formal work in health insurance, Participant 4's knowledge of traditional medicine is noted as a valuable insight into healthcare in Madagascar.

Lastly, Participant 4 discussed the visit to Madagascar by Mercy Ships, a hospital ship providing life-saving surgery in countries where surgical facilities are non-existent and/or inaccessible to local people. She did not work directly with Mercy Ships herself but spoke with members of their staff that were looking for information about a variety of topics related to living in Madagascar.

Participant 4's strong knowledge of her community and her country developed through years of work in both a travel agency and a health insurance company made her an invaluable source of information for her clients, local people in her community, as well as international visitors. Although working for a health insurance company that served foreigners would not be thought of as a traditional healthcare development activity, Participant 4 self-identified as meeting the inclusion criteria for this information seeking behaviour research study. Her knowledge of Madagascar as a person from a humble family that was born there and lived there until quite recently provided a rich source of information about many of the areas necessary to develop a medical device for low resource settings as described by Aranda-Jan et al. (2016).

Description of the Egocentric Social Network of DHDA4

Participant 4's egocentric social network map for her diasporan healthcare development activity in shown in Figure 8. Discreet characteristics of the egocentric social network of DHDA4 are listed in Table 8 and 9. The following section qualitatively describes the network.

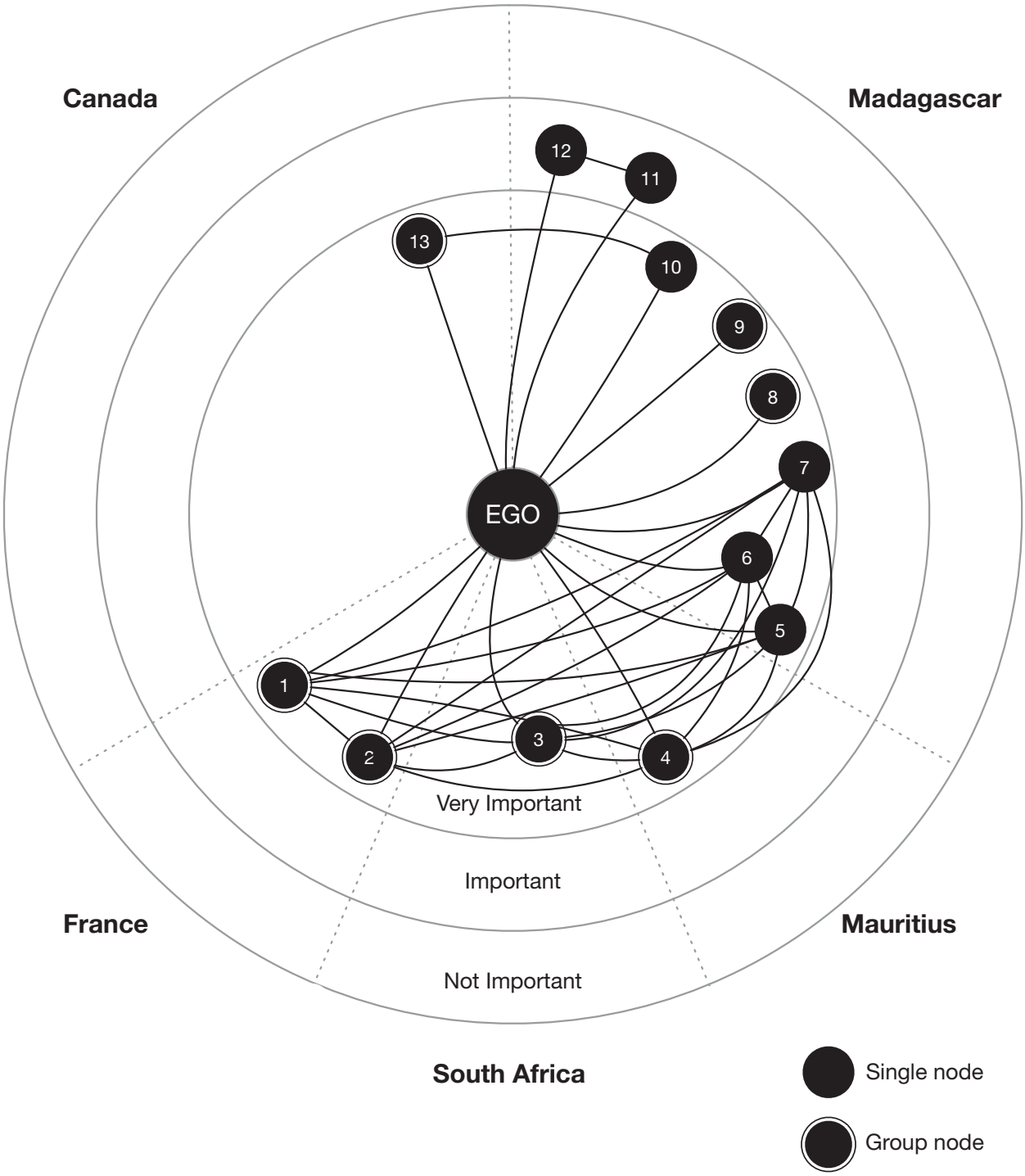


Figure 8: Egocentric social network map Participant 4

Table 8

DHDA Participant 4

Characteristics of the Egocentric Social Network of Participant 4 for DHDA - I

Alter	Level of Importance	Gender	Nationality	Location	Income Level	Education	Known # of Years	Colleagues/ Friends/ Family	# Contacts/ Year
1	Very Important	N/A	French	France	High	N/A	~10	Colleague	Ongoing
2	Very Important	N/A	French	Le Reunion	High	High	~10	Colleague	Ongoing
3	Very Important	N/A	South African	South Africa	High	High	~10	Colleague	Ongoing
4	Very Important	N/A	Mauritian	Mauritius	High	High	~10	Colleague	Ongoing
5	Very Important	M	N/A	Madagascar	High	High	~10	Colleague	Ongoing
6	Very Important	M	N/A	Madagascar	High	N/A	~10	Colleague	Once
7	Very Important	F	N/A	Madagascar	High	N/A	~10	Colleague	Once
8	Very Important	N/A	N/A	Madagascar	N/A	High	~10	Colleague	Ongoing
9	Very Important	N/A	N/A	Madagascar	N/A	High	~10	Colleague	Ongoing
10	Very Important	F	Malagasy	Madagascar	N/A	N/A	N/A	Friend	N/A
11	Important	F	Malagasy	Madagascar	Low	Low	All her life	Mother	N/A
12	Important	F	Malagasy	Madagascar	Low	Low	All her life	Grandmother	N/A
13	Very Important	N/A	N/A	Canada	High	High	N/A	Through a friend	N/A

Table 9

DHDA Participant 4 Continued

Characteristics of the Egocentric Social Network of Participant 4 for DHDA - II

Alter	Alter Connection	Knowledge Source	Context	Timeliness	Credibility	Immersion
1	2,3,4,5,6,7	Lives in France	International Medivac head office	Immediate	High	Embedded
2	1,3,4,5,6,7	Lives in Le Reunion	International Medivac flight service	Immediate	High	Embedded
3	1,2,4,5,6,7	Lives in South Africa	International Medivac flight service	Immediate	High	Embedded

4	1,2,3,5,6,7	Lives in Mauritius	International Medivac flight service	Immediate	High	Embedded
5	1,2,3,4,6,7	Lives in Madagascar	Private Medical Clinic	Immediate	High	Embedded
6	1,2,3,4,5,7	Lives in Madagascar	International Medivac – local rep	Immediate	High	Embedded
7	1,2,3,4,5,6	Lives in Madagascar	International Medivac – Capital City rep	Immediate	High	Embedded
8		Lives in Madagascar	Local Public Hospital	Immediate	High	Embedded
9		Lives in Madagascar	Local flight service	Immediate	High	Embedded
10	13	Lives in Madagascar	N/A	Immediate	N/A	Embedded
11	12	Lives in Madagascar	Traditional Medicine – lay person knowledge	Immediate	Medium	Embedded
12	11	Lives in Madagascar	Traditional Medicine – lay person knowledge	Immediate	Medium	Embedded
13	10	Office in Canada/Global seas	Surgery and healthcare training	Immediate	High	Ocean based

Participant 4 described Alters 1 through 4 as the people she worked with in France, Le ReUnion, Mauritius, and South Africa involved in the medivac company. Alter 5 is the doctor operating the large private medical clinic in the capital city of Madagascar. Alters 6 and 7 are her colleagues from the health insurance company she worked for. Alter 6 is the local representative, and Alter 7 is the person that hired her in the capital city. Alters 8 and 9 are the people at the local public hospital and local flight services. Alters 1 through 9 are all professional colleagues that she has known since she began working with the health insurance company, and she has known them for approximately 10 years. She had ongoing contact with them during her time working for the health insurance company. Alter 10 is a friend of Participant 4, and Alters 11 and 12 are her mother and grandmother. Participant 4 described her mother and grandmother as people that shared traditional medicine knowledge with her, but she stated that she had some reservations regarding their knowledge of the effective amounts of various traditional medicines. Lastly, Alter 13 represented people from Mercy Ships, the hospital ship providing lifesaving surgeries for free to the local people of Madagascar that didn't have access to surgery.

The following section describes the quantitative measures of the Participant 4's egocentric social network. The results are derived through the methods described in Chapter 3.

- Size of the network = 13
- Effective size of the network = 9.46
- Efficiency of the network = 0.73

The quantitative measures indicate that Participant 4's DHDA-related egocentric social network is potentially a source of many new ideas as its effective size is just over 70 percent of its size (Burt, 2004). This indicates that many people in Participant 4's network do not know each other. This creates new knowledge pathways across the network (Burt, 2004)

Description of Other Sources of Information for DHDA4

This section describes the role of all other sources of information that Participant 4 accesses with respect to her DHDA4.

Participant 4 does not have any social media accounts of her own. She did not mention the use of libraries as a source of health-related information. She does read the news and searches health information via social media and internet sources; however, she is adamant about checking any online information she reads with a medical professional: "Even though I checked in social media, internet, Google, I will go to see a doctor." In Madagascar, although the internet is available, according to Participant 4, "It's expensive. It's not for everybody." As a result, much of the medical information that circulates in Madagascar is done through word of mouth. For example, if a medical service provider does a good job for someone, they will get referrals. They also have pharmacies that do not require a prescription, so people also go directly to get information and medications from health professionals working at the pharmacy. Participant 4

didn't mention particular information grounds where this type of information seeking occurred but that it happened regularly during everyday interactions with the people she knew.

Participant 4 travels as often as she can. She currently needs to wait until she obtains her permanent residency status before she can travel back to Madagascar; however, she plans to do so as soon as possible to visit with her family there and her daughter who now lives in France. Travel plays a critical role in understanding the current status of things in Madagascar as the country is going through rapid change. When asked about the role of memory, Participant 4 said: "Actually, we got the new president. It was a former president but coming back. And I heard, because—Madagascar, it's hard to say it, it is corrupt country—so first of all we need to clean up this corruption. We want to move forward. That's it. Education is the base of everything, so we need to build schools, motivate the kids, the parents, send the kids to school. It's important…So [the new President] is starting to clean [up] this corruption…So it makes me happy. It makes me happy because it's like we are getting on the right track. Hopefully it will be, you know, continuing in that direction." Participant 4 mentioned following with respect to the pace of change: "Changing, yah. And my brother used to work in a course. So he stayed in Miami six months, and he went back home last month. He said, 'Wow!' I said, 'Tell me what is wow!' No one opens your luggage anymore so, unless you have something special, so he said you just go through. No one. It's forbidden now to open luggage. I saying, 'Oh, that's nice!' So, saying something's changing. I hope so."

Ease and Difficulty of Information Seeking

The following section describes the ease or difficulty of information seeking behaviour for Participant 4. Participant 4 expressed that, due to the expense of the internet in Madagascar,

the easiest sources of information are people directly. She did mention that everybody has a cell phone, but she wasn't sure what kind of information people accessed on it: "It's pretty much through people, though. It's like—how to say that? I don't know. For example, I don't know how to explain it. If I did a great job, you are my client, you are happy, so we talk. We talk, we talk. That just really there. So 'Oh yah, she's good, she did that for me. Okay, go to see her.' So, something like that. It's the same for the doctor too. If you are good doctor you did great job for people, you—some people just, 'Oh, you don't have enough money, you don't have money? Okay. Come, I'm going to help you.' Yah. But some people just reject them. Something like that. Otherwise, yah, I can see the people, everybody have like cell phone, but I don't know really if they, what kind of information. Social media maybe it's connection, maybe people, or like music stuff." Figure 9 shows the importance ranking for the other sources of information for Participant 4.

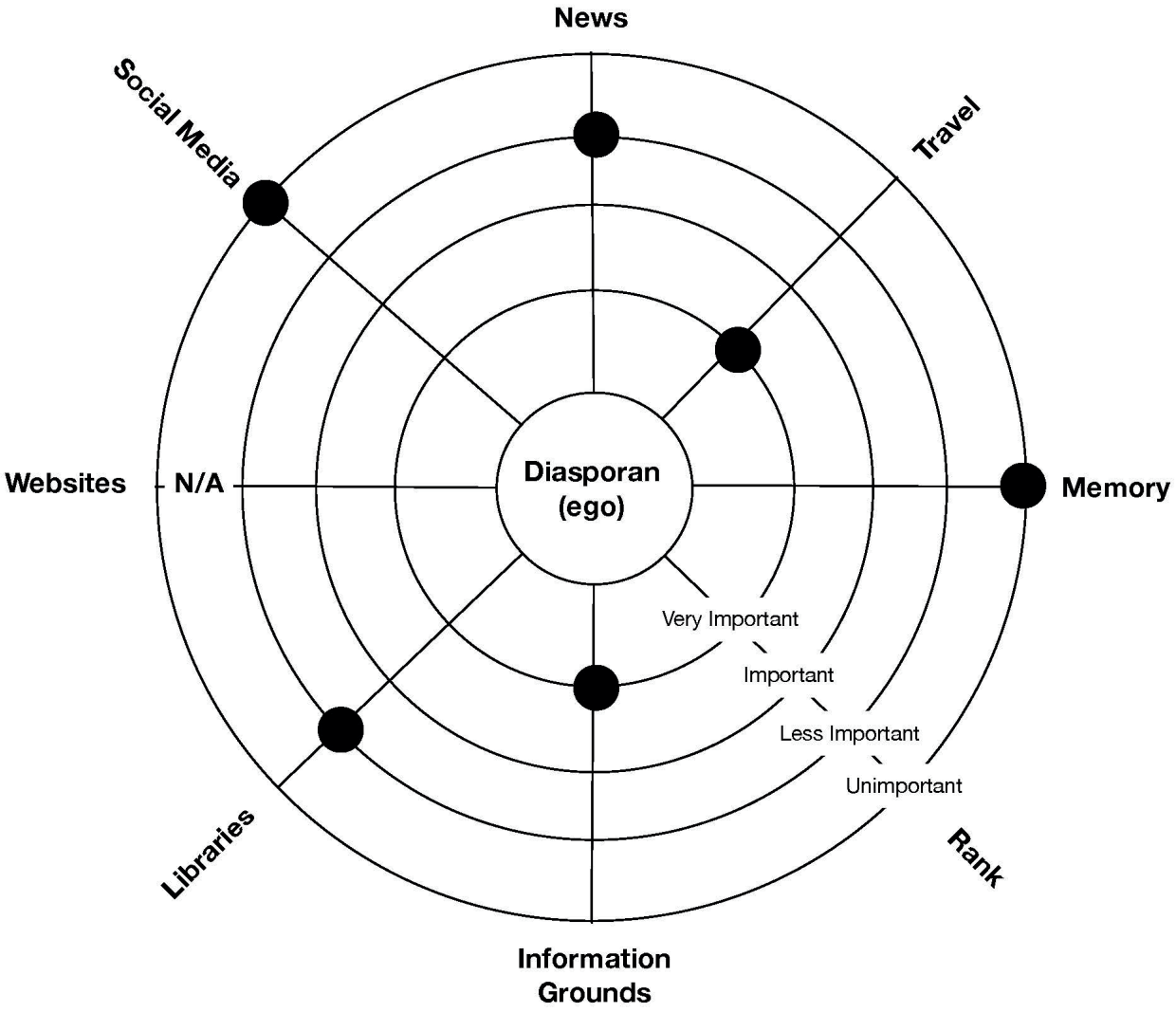


Figure 9: Other sources of information for Participant 4

Participant 5

Country of Origin and Immigration Path

Participant 5 was born in New Delhi in 1997 and lived there until he was two years old. His family then moved to the Punjab. When he was 13, his family moved to Canada. At the age of 19, he decided to return to India, to attend medical school. He has been in medical school in

India for five years and worked in a public hospital in New Delhi for three years during his training. In July 2019, he returned to Canada to begin a residency at Royal Columbian Hospital.

Diasporan Healthcare Development Activity 5 (DHDA5)

Participant 5 became involved in DHDA5 as a medical student when he returned to India to become a medical doctor and then worked in a public hospital in New Delhi. Working in a public hospital in New Delhi exposed Participant 5 to the current state of healthcare in the public healthcare system in India. Approximately 30 percent of India's population is middle class or wealthier and have access to private healthcare. According to Participant 5: "Private healthcare is good business in India." There are examples of medical tourism as well where wealthy people from Africa and other parts of the world travel to India to access their private healthcare system. This has spawned a growing medical tourism industry in India. The remaining 70 percent of the population live in lower socioeconomic conditions and do not have access to the same infrastructure as private healthcare in India. Participant 5 felt that resources and infrastructure in private healthcare in India were getting better, and the resources and infrastructure in public healthcare were getting worse. After Participant 5 completes his residency at Royal Columbian Hospital, he is considering returning to work in the public government healthcare system in India to be part of improving the public healthcare system.

Description of DHDA5

Participant 5's DHDA5 was the medical schooling he received in India followed by working in a public hospital in New Delhi when he was 19 to 24. During this time, he worked in a variety of departments, including emergency medicine, and learned a great deal about the public healthcare system in India.

Description of the Egocentric Social Network of DHDA5

Participant 5's egocentric social network map for his diasporan healthcare development activity is shown in Figure 10. Discreet characteristics of the egocentric social network of DHDA5 are listed in Table 10 and 11. The following section qualitatively describes the network. Participant 5's egocentric social network related to DHDA5 is made up of six alters. Alter 1 is Participant 5's grandfather whom he lived with during his five years of medical school and work in India. One of the reasons Participant 5 volunteered to participate in this information seeking behaviour research study was due to the health-related information seeking behaviour of his grandfather. As Participant 5 lived with his grandfather, he was able to observe his health-related information seeking behaviour in detail for a five-year period. His grandfather and his grandfather's cohort of friends would get information from social media platform WhatsApp on a daily basis and would take this information seriously. The group of elderly friends and acquaintances would share erroneous information with each other. An example of the type of information that would circulate included the advertisement of the use of a certain supplement that would eliminate the need for a knee operation. Misinformation would also be advertised in the local newspaper and on TV commercials. Another example was the promotion of the use of turmeric for a number of health conditions and different types of oil to treat pain through

infomercials on TV. From Participant 5's perspective, the health-related information circulated

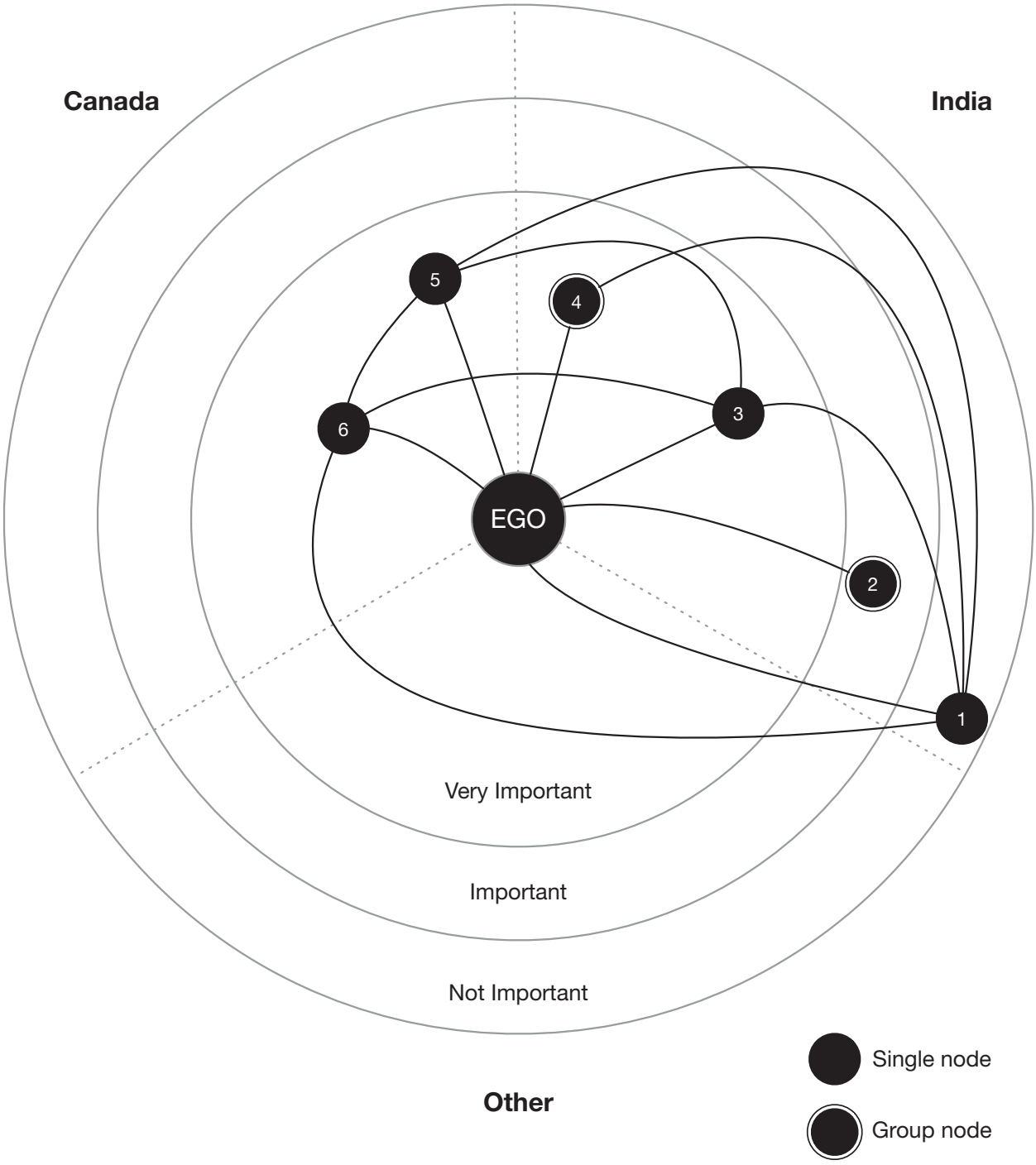


Figure 10: Egocentric social network map Participant 5

Table 10

DHDA Participant 5

Characteristics of the Egocentric Social Network of Participant 5 for DHDA - I

Alter	Level of Importance	Gen -der	Nationality	Location	Income Level	Education	Known # of Years	Colleagues/ Friends/ Family	# Contacts/ Year
1	Not Important	M	Indian	India	Unknown	Unknown	25	Family	Daily in India
2	Important	M	Indian	India	High	High	10+	Colleagues	Every work day in India
3	Very Important	M	Indian	India	High	High	10	Colleagues	Every work day in India
4	Very Important	M	Indian	India	High	High	10	Colleagues	Every work day in India
5	Very Important	F	Canadian	Canada	High	High	25	Family	Three times/ week
6	Very Important	M	Canadian	Canada	High	High	10	Family	Once a month

Table 11

DHDA Participant 5 Continued

Characteristics of the Egocentric Social Network of Participant 5 for DHDA - II

Alter	Alter Connection	Knowledge Source	Context	Timeliness	Credibility	Immersion
1	3, 4, 5, 6	Lives in India, What's App, the news	Elderly lay person	Immediate	Low – information gained from inaccurate sources that he would take seriously	Embedded
2		Lives in India	Senior Staff - preceptor	Immediate	High	Embedded
3	1, 5, 6	Lives in India	Respected family doctor	Immediate	High	Embedded
4	1	Lives in India	Colleagues – family medicine, emergency department	Immediate	High	Embedded
5	1, 3, 6	Unknown	Mother who works and teaches in healthcare	Unknown	High	Canada
6	1, 3, 5	Unknown	Uncle who is a family doctor	Unknown	High	Canada

on these platforms was actually wrong 30 to 40 percent of the time. Sixty to 70 percent of the time the information was correct but not valuable as it would promote information that was already well-known, such as eating fruit being beneficial to your health. This was somewhat frustrating for Participant 5 as he was learning about medicine and healthcare and could see that the information seeking behaviours of his grandfather and other elderly people were potentially causing harm and leading to poor choices with respect to their healthcare. From his perspective, the information was not credible although it was timely and immersed in the culture, and that this was problematic. He was curious about how to combat such misinformation, especially with elderly people in lower socioeconomic conditions. The issue is not one that is limited to Participant 5's grandfather and his particular WhatsApp group as older people across India have embraced the WhatsApp platform for connecting and sharing information.

Alter 2 represents the senior staff preceptors who are practicing physicians Participant 5 interacted with on a daily basis while working at the public hospital. They are not faculty members, but as practising clinicians, they are meant to provide one-on-one guidance to medical students. Participant 5 mentioned that he considered his preceptors to be an important source of information; however, he did not include them in the very important category. Although Participant 5 didn't elaborate, it could be because practicing clinicians in the public hospital system in Indian may have felt that their preceptor role took away from their role as clinicians in under-resourced public hospitals. As such they may not have had the time to provide detailed guidance.

Alter 3 is a very important source of information and role model in Participant 5's egocentric social network related to DHDA5. According to Participant 5, Alter 3 is in his 50s and

taught him what a family doctor is supposed to be. Alter 3 lives in India, and Participant 5 spoke to him everyday. He learned how to provide cradle-to-grave care of a family doctor from Alter 3. Although he is a colleague and not a family member, Participant 5 was closer to him than other family alters.

Alter 4 represents Participant 5's colleagues in his medical school in India. He considered Alter 4 to be a very important source of information. He spoke with his colleagues everyday, mostly learning from them in the various departments he worked in including the emergency department.

Alters 5 and 6 represent Participant 5's uncle and mother in Canada. Alter 5 is his uncle who is also a family doctor in Canada. Participant 5 considers Alter 5 to be a very important source of information and spoke to him at least once a month about healthcare issues. His uncle is an influencer of his, and Participant 5 respects his knowledge. Alter 6 is Participant 5's mother. He also considers her a very important person and source of information regarding his DHDA5. She also worked and taught in healthcare, and Participant 5 spoke to his mother approximately three times per week regarding healthcare issues.

The following section describes the quantitative measures of the Participant 5's egocentric social network. The results are derived through the methods described in Chapter 3.

- Size of the network = 6
- Effective size of the network = 3.67
- Efficiency of the network = 0.61

The quantitative measures indicate that Participant 5's DHDA-related egocentric social network is potentially a source of some new ideas as its effective size is just over 60 percent of its size (Burt, 2004). This creates some new knowledge pathways across the network (Burt, 2004).

Description of Other Sources of Information for DHDA5

This section describes the role of all other sources of information that Participant 5 accesses with respect to the work he is doing in his DHDA5. In contrast to the social media use of his grandfather, Participant 5 does find credible information on the social media platform Facebook. According to Participant 5, Facebook is used a lot in India. In particular, most of the medical pages, accounts. or groups are on the Facebook platform. Participant 5 described the use of these information sources as very valuable as a study tool, especially when studying for exams. For example, a photo would be presented and a medical student would see if they knew what the medical condition was. Participant 5 also described several websites that he used as a study guide. These included Wikipedia and Medscape. Participant 5 perceived Wikipedia as developing into a really credible tool. He also thought that Medscape provided up-to-date medical information. He used Wikipedia and Medscape sites to check knowledge he already had. He also described the use of clinical websites that only healthcare professionals had access to as a source of information on issues he didn't have existing medical knowledge about.

Not surprisingly, his experience of living with his grandfather for five years during his medical training and work in India demonstrated that the news media often had misinformation regarding healthcare. As such he does not use it himself as an accurate source of information.

Participant 5 did study at libraries in India; however, he and his colleagues did not usually access the information available in the libraries. He reflected on the differences he

observed between the use of hardcopy books in Canada versus India by doctors after finishing medical school: “People don’t tend to read (hardcopy) books here (in Canada) after finishing medical school, but people in India in healthcare do read books, even after graduation, but they would buy books as they don’t use the library.”

Participant 5 described the use of some information grounds to discuss healthcare issues in India. He and other younger doctors that were his colleagues would meet on occasion at cafes to discuss the changes happening in healthcare in India. They would discuss issues related to the rapid transition that is currently happening there in medicine. According to Participant 5, younger doctors were practicing medicine differently than the generation of doctors before them. The current cohort of medical doctors are being trained to use more diagnostic technology. According to Participant 5, the focus on the use of diagnostic technology, and the training required to utilize these resources, is changing the bedside manner of younger Indian doctors. This has resulted in a shift in medical culture, which would be discussed at cafes amongst younger doctors. Younger Indian doctors do not have the same level of patient-oriented bedside manner skills as older Indian doctors. As a result, some patients in India are unhappy with this new focus on technology, because they perceive it, as a shift away from the people skills they have become accustomed to with older Indian doctors. In some cases, there have been reports of violence against doctors. Participant 5 mentioned that some younger doctors were angry about how new doctors are being treated and have organized strikes to protest the violence against them. For Participant 5, cafes are an example of an information ground that he utilizes to discuss these issues and seek information related to Indian medical *culture*, not medical treatment, from his cohort of younger doctors.

Participant 5 discussed the role of travel as an information source for his DHDA5. Participant 5 felt that travel was a critical activity for accessing credible, timely, and immersed information. According to Participant 5, all sectors of India are in rapid transition, not just healthcare. The speed of change in society as a whole impacts many aspects of healthcare. As such, being immersed in the country is necessary to know what is currently happening. Having said that, Participant 5 also felt that, although travel was very important, a person that has travelled to India can still only provide one person's perspective. As a result, he recommends that even in this case the information provided should be independently verified before being acted upon.

Participant 5 also discussed the role of memory as an information source for his DHDA5. Participant 5 has memories from living in India until he was 13 and then from 19 to 24. His memories are as recent as the first half of 2019. Even still, Participant 5 did not think he could count on the information from memory to be credible, timely, or immersed as he felt it had too much bias and that the information would be very subjective. He felt any information from memory, even recent memory, would need to be verified before being acted upon. Figure 11 shows the importance ranking for the other sources of information for Participant 5.

Ease and Difficulty of Information Seeking

Participant 5 discusses his perception of the ease or difficulty of accessing information while in India related to his DHDA5. He first described the order in which he would try to access information related to his DHDA5 from sources that were easy to access. First, he would ask his uncle as his uncle would always be available to him to discuss issues even though he is in Canada. Secondly, he would use internet-based resources such as Wikipedia and Medscape to

check his knowledge or more detailed clinical sites only available to healthcare professionals if he is looking for information on a topic he didn't already have training on. According to Participant 5, "Because I'm young and technologically educated, it is easy for me to Google it when I'm looking for information." The third easiest source of information to access for Participant 5 is to talk to his colleagues, which he also perceived as relatively easy to do. And lastly, he would call his mother as a source of information on healthcare related topics.

Participant 5 then described the difficulties he had when engaged in information seeking behaviour. Although he described internet sites as easy sources of information to access, he also mentioned that in India he did have difficulty in accessing them when the internet connection wasn't available, "I was aware of all these up-to-date online clinical resources for doctors, but they were just hard (to access) because the internet sucks in India everywhere, yeah, so that was hard." The second hardest is finding the right book or the right resources. For example, Participant 5 said, "For orthopaedics, what's the right resource for me? I don't want to get a really fancy orthopaedic book for a person that just wants to know the basics."

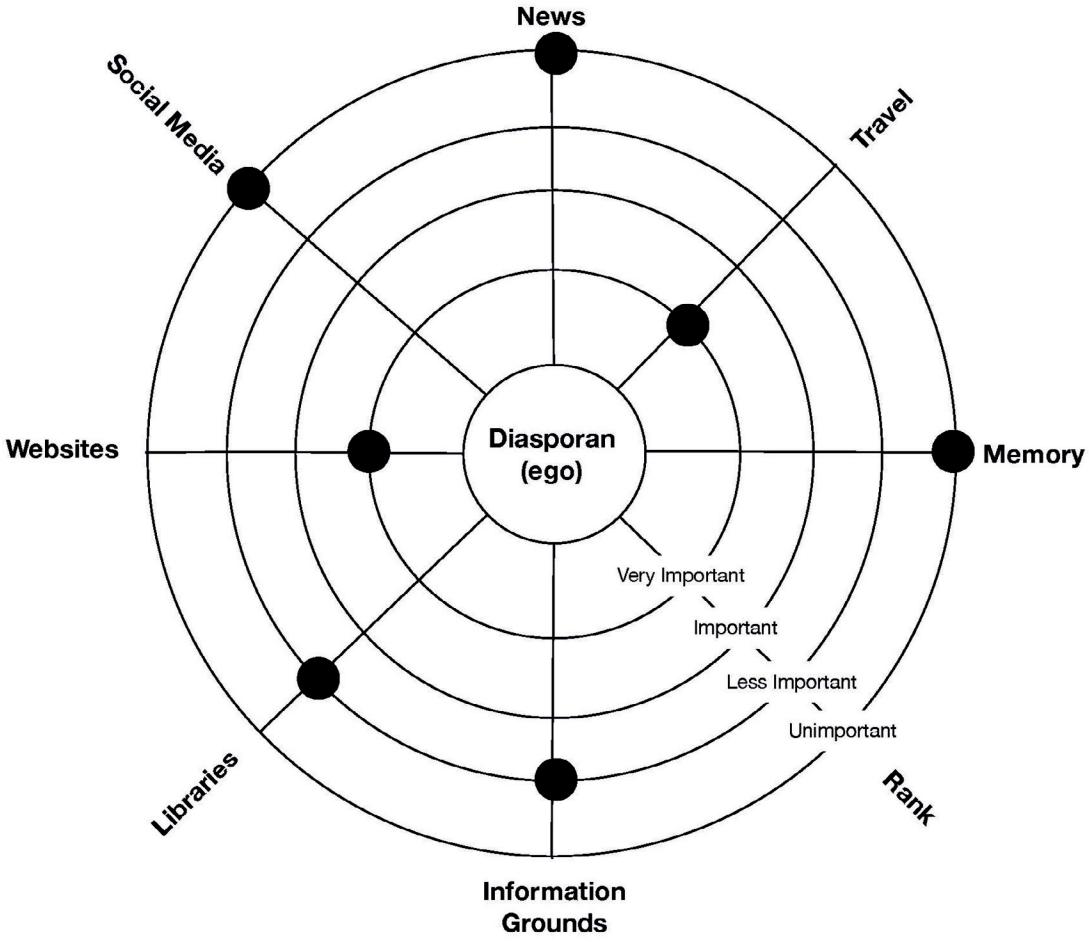


Figure 11: Other source of information for Participant 5

Participant 6

Country of Origin and Immigration Path

Participant 6 was born in the city of Lani, Nigeria, in 1979. He lived in Nigeria until he moved to Canada in 2008 when he was 29. He did his primary, secondary, and post-secondary schooling in Nigeria and completed his medical training there to become a doctor. Participant 6 worked as a doctor in Nigeria for a few years before he came to Canada as an international student and did a master's program at Simon Fraser University in Vancouver. He then worked for a short time before moving to Ottawa to conduct a PhD program. He then moved to Saskatoon in 2013 and entered his residency program. He became a Canadian citizen in 2014 and has been working as a healthcare professional in Saskatchewan since 2014.

Diasporan Healthcare Development Activity 6 (DHDA6)

Participant 6 became involved in DHDA6 when he came to Canada. His DHDA6 is a group of informal activities that range in size and scope. Participant 6 states that his strength and competencies are mostly in public health. He has a particular interest in public health, and he tends to interact with his colleagues in Nigeria that do some public health work. One example of his work is providing feedback on some of their residency projects. He also discusses the status of treatment in viral infections as he has a close colleague in Nigeria in public health that is involved in Lassa virus programing. He also has a close friend that is now a family doctor in Nigeria. They grew up together, went to primary and medical school together, and discuss medical issues on a regular basis. He also mentioned staying in touch with another colleague who works in Nigeria as well as the UK and the US. This colleague has had some research

background and has done some vaccine-related type of work. He has worked in multi-national NGOs and is a person he considers to have a global perspective he can connect to.

Another activity he also mentioned that he is involved in a WhatsApp group that has formed out of his medical school graduating class in Nigeria. Out of approximately 180 students in his graduating class, 110 have joined this closed WhatsApp group to discuss a wide variety of medical issues. He participates in two ways: sometimes actively contributing to the discussion if the topic is related to public health and sometimes simply observing the conversation to get a better understanding of other areas of healthcare that his colleagues are engaged in.

Lastly Participant 6 mentioned that he sometimes receives requests for consultation on health-related issues from his mother, father, and grandmother whom all still live in Nigeria. He makes it clear that he doesn't provide medical care to his relatives in Nigeria as he can't see them in person, but he may be able to facilitate a meeting with a colleague that he has in Nigeria.

Description of the Egocentric Social Network of DHDA6

Participant 6's egocentric social network map for his diasporan healthcare development activity is shown in Figure 12. Discreet characteristics of the egocentric social network of DHDA6 are listed in Table 12 and 13. The following section qualitatively describes the network. Participant 6's egocentric social network related to DHDA6 is made up of six alters. Alter 1 is Participant 6's colleague who works in Nigeria as well as in the UK and the US. Participant 6 considers Alter 1 to provide him with a timely, credible, and immersed perspective of global health: "There is a friend of mine who is—I think he is no longer in the country now. He said he was leaving the country earlier this year. But for the longest time he was in and out of the

country. He also, he had some research background, he's done some vaccine related type of

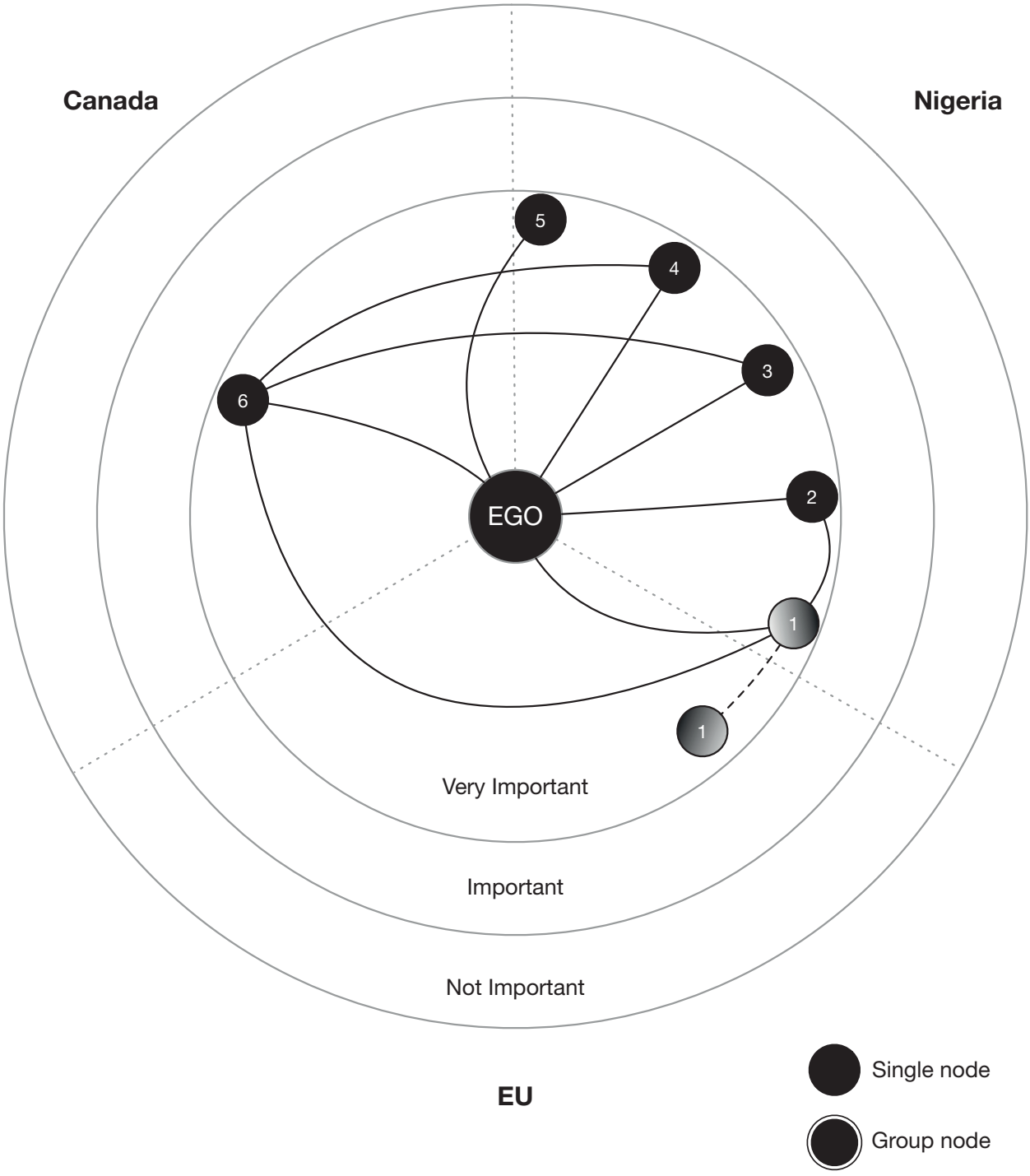


Figure 12: Egocentric social network map Participant 6

Table 12

DHDA Participant 6

Characteristics of the Egocentric Social Network of Participant 6 for DHDA - I

Alter	Level of Importance	Gen -der	Nationality	Location	Income Level	Education	Known # of Years	Colleagues/ Friends/ Family	# Contacts/ Year
1	Very Important	M	Nigerian	Nigeria /Europe	High	High		Friend and Colleague	Ad Hoc/As needed
2	Important	F	Nigerian	Nigeria	High	High		Colleagues	Once/ month(2)
3	Important	F	Nigerian	Nigeria	Unknown	Unknown		Family	Every 1 or 2 days
4	Important	M/ F	Nigerian	Nigeria	Unknown	Unknown		Family	Once a week
5	Important	M	Nigerian	Nigeria	High	High		Friend/Col league	Every 2 weeks
6	Important	M	Nigerian	Canada	High	High		Family/Col league	2-3 days/2 weeks

Table 13

DHDA Participant 6 Continued

Characteristics of the Egocentric Social Network of Participant 6 for DHDA - II

Alter	Alter Connection	Knowledge Source	Context	Timeliness	Credibility	Immersion
1	2, 6	Lives in Nigeria	Global perspective of healthcare from Nigerian and European Context	Immediate	High	Embedded
2	1	Lives in Nigeria	Virology Expert	Immediate	High	Embedded
3	6	Lives in Nigeria	Grandmother – user of healthcare system	Immediate	High	Embedded
4	6	Lives in Nigeria	Mother and father – users of healthcare system	Immediate	High	Embedded
5		Lives in Nigeria	Family physician	Immediate	High	Embedded
6	1, 3, 4	Other colleagues living in Nigeria	Ear, nose and throat specialist	Recent	High	Canada

work. He's been with a few multinational non-governmental organizations…Because I also realize that time and distance has an impact on how I do things. So he is a bit more connected to the pulse of things on the ground. He has a better understanding of what things feel like, but he's also able to see that from the view, he's spent time in Europe, he's spent time in the US. So he has a bit more global perspective compared to, no knocks to my colleagues, but if they have not worked outside of Nigeria, it impacts how things are seen. So what I may, what I may see as rather absurd, he may see as par for the course…so if I could see through his lens, it's maybe not as biased, so to speak. So I also try to speak with him."

Alter 2 is another colleague of Participant 6 that lived in Nigeria and specializes in public health. Alter 3 is a long-time family friend whom Participant 6 has gone to medical school with and is now a working family doctor that is the de facto family doctor of his parents and grandmother in Nigeria. Alter 4 represents Participant 6's mother and father, and Alter 5 represents Participant 6's grandmother. Although his parents and grandmother are not medical professionals, they do represent users of the healthcare system in Nigeria and give Participant 6 some insight into that experience as they often engage him in their health-related activities. Lastly, Participant 6 included a distant relative that recently immigrated to Canada as Alter 6 in his egocentric social network related to his work in his DHDA6. Alter 6 is the only person in Canada he mentioned, and this person knows all the other people in his DHDA-related social network except for his colleague in public health in Nigeria. He found this person to be an excellent connection back to people in Nigeria in his sub-specialty of surgery as he has only been in Canada for two years and has more recent memories that Participant 6 himself. However,

Participant 6 didn't know how accurate his information would be related to the bigger picture of healthcare in Nigeria after two years.

The following section describes the quantitative measures of the Participant 6's egocentric social network. The results are derived through the methods described in Chapter 3.

- Size of the network = 6
- Effective size of the network = 4.67
- Efficiency of the network = 0.78

The quantitative measures indicate that Participant 6's DHDA-related egocentric social network is potentially a source of many new ideas as its effective size is just over 80 percent of its size (Burt, 2004). This indicates that many people in Participant 6's network do not know each other. This creates new knowledge pathways across the network (Burt, 2004).

Description of Other Sources of Information for DHDA6

This section describes the role of all other sources of information that Participant 6 accesses with respect to the work he is doing in his DHDA6. Participant 6 stated that he does read the news about happenings back in Nigeria. He used an example of reading about news stories of lots of violence in a particular part of Nigeria, and he is sometimes able to call a colleague that is there to get their perspective of what's happening. He states: "At home, I don't take what I read on the news verbatim, I still try to query and see what I can on the ground for confirmation of the news. Similarly, if I hear of any particular issues, I am able to talk to my friends, my parents, you know, they have experience with the healthcare system, I'm trying to call or hear, find from somebody who is on the ground there is this what is their experience, is this what happens currently, or is their experience totally different?...I use the social media

primarily to inform myself and next, to probably ask more questions." Also, as mentioned in the description of Participant 6's DHDA6, a closed WhatsApp group of approximately 110 from his medical school graduating class is another source of information that he accesses. This group practices in a wide variety of medical specialties. Some of the members still work in Nigeria, and some have left to work in other countries but are still part of the WhatsApp group. As a result, Participant 6 can listen in on conversations and discussions related to areas of medicine that he is less familiar with, or he can be an active part of the discussion related to his area of expertise in public health.

Participant 6 does think the library plays a role in helping him brush up on medical topics outside of his expertise in public health. He doesn't have as much experience in acute or active clinical medicine, so he may need to read some information available through the library to be able to have a more informed conversation regarding health issues in these areas.

Participant 6 does frequent information grounds such as coffee shops with other friends from Nigeria; however, they are not in the healthcare field so their conversations are more related to how things are going. Participant 6 also doesn't travel frequently to Nigeria due to the significant distance. He's only been back once in 2015 since he arrived in Canada in 2008.

When queried about the role of memory, Participant 6 was thoughtful about his response. He said that, although he still has his memories of how things were when he was in Nigeria, he is careful not to assume that things have or haven't change, "inherent in that, [making assumptions about whether things have changed or not] I feel is an arrogance which I try not to, which I'm mindful of." So he still wants to talk to colleagues that are there to discuss the current state of the issue they are discussing in Nigeria: "Oh, okay, so things have changed, so what's the new

process? So I try to ask. Because I also realize that time and distance has an impact on how I do things." As such he feels that he must connect to others with on-the-ground experience to understand the current state of healthcare in Nigeria. Figure 13 shows the importance ranking for the other sources of information for Participant 6.

Ease and Difficulty of Information Seeking

The following section describes examples of information seeking that are easy and other examples that are difficult. At first, Participant 6 mentioned that the easiest information to get is what is available on social media, but then he questioned its validity. Upon further reflection, he stated, "And so I think getting a fair assessment of what's on the ground is talking to colleagues or giving somebody a call or sending somebody a text message of, so, what happened." When asked if it was difficult to get a response, Participant 6 said, "I think they can count on me. So, they humour me and respond to my email."

He did mention that sometimes it is difficult to access the internet and that the connection can sometime be spotty. However, he mentioned that because the country is fairly sizable and has quite a number of people, a total internet blackout is unlikely and that he has always been able to reach a few people. He can turn off the video feature of his WhatsApp platform and switch to audio only when communicating with his parents or colleagues when the internet begins to get spotty. He also mentioned that the internet infrastructure in Nigeria is there and data plans are available to those that can afford them. He said that physicians in the country are probably higher-income earners who are able to pay for their data plans.

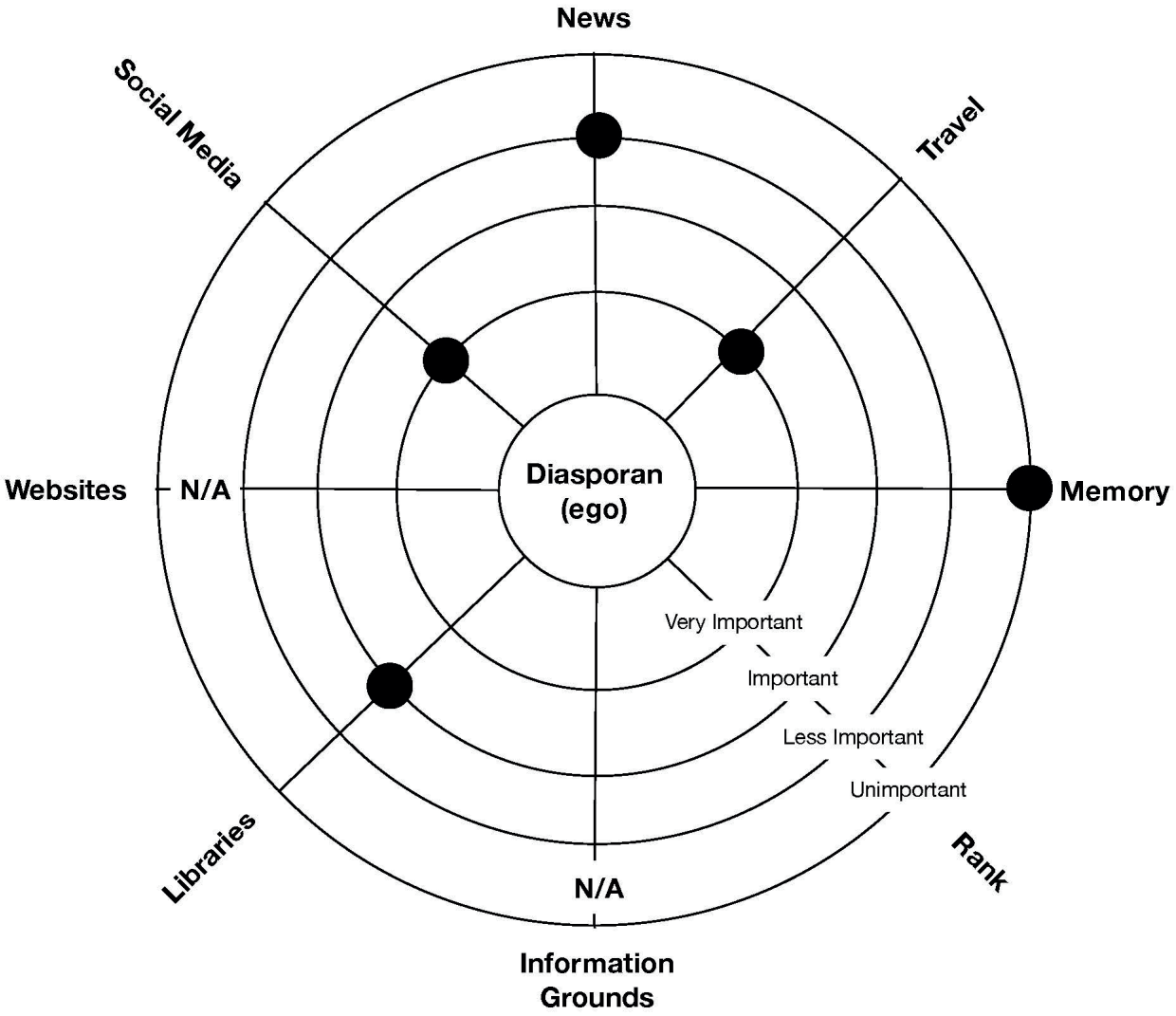


Figure 13: Other sources of information for Participant 6

Participant 7

Country of Origin and Immigration Path

Participant 7 was born in the Republic of Panama in Panama City. She was born to a large family that was impacted by the political upheaval there are in surrounding countries. During her youth she travelled considerably with her family, living in many cities and countries in Central and South America, which exposed her to their different people and cultures. After she completed secondary school, she worked in a regional hospital back in Panama. This experience attracted her to the orthopaedics profession, and a few years later, she took a three-year prosthetics and orthotics course in Argentina. She worked as a Certified Prosthetist and Orthotist (CPO) at a time when there were few women CPOs in Central and South America. She returned to Panama and worked with orthopaedic doctors and patients, particularly children, requiring a CPO. She also worked with American doctors coming from the Shriners to work with children in Panama. On a few occasions, Participant 6 travelled back to the United States with children that required surgery that couldn't be performed locally. Then she became involved in the International Society of Prosthetics and Orthotics (ISPO) and began to develop the field in Panama. In 1996, due to her excellent work in the field of prosthetics and orthotics, Participant 7 was hired by a prosthetic and orthotic company to help them build their business in Central America, South America, and the Caribbean. She moved to the United States in 1999 and continued to work with this company from the United States.

Diasporan Healthcare Development Activity (DHDA7)

Participant 7 became involved in her DHDA7 throughout her career as a CPO. Although she didn't move to the United States until 1999, she has been involved in the development of the

prosthetics and orthotics field in Panama, other countries in Central America, South America, and the Caribbean since she became engaged with ISPO. According to Participant 7: “I got involved with ISPO International, and that is who really triggered my connection with the rest of the area. I mean Central and South America, including the Caribbean. Panama was the first country in the region with a national member society, with the, you know, ISPO national member society, establishing.” In addition to her professional work as a CPO, Participant 7 also developed continuing education for other CPOs in Central and South America through ISPO. Through her work with local hospitals, the Shriners, and ISPO, she made a significant contribution to the field. Based on her work, she was hired by a prosthetic and orthotic company in 1996 and then moved to a part of the company in the United States in 1999.

Description of DHDA7

Participant 7 described her DHDA7 both as part of her work with ISPO developing the profession in Central America, South America, and the Caribbean, and as part of her work as a CPO working directly with a prosthetic and orthotic company to build their business throughout the region. She describes the work: “[The Company] became a very important partner because they facilitate my communication with everybody. I actually started pushing a lot: We need to have progress. We need to have literature. We need to have materials for PTs [physiotherapists] as well as prescrip—how do you say that—doctors. The ones who generate a prescription. And I remember during those years they were telling me, ‘[Participant 7], but the orthotists are our customers.’ Fantastic, they are your customers, but they don’t do anything if they don’t have a prescription. And, if we are dealing with, at that time, we didn’t even have access to all the programs that were globally recognized. That came years after, you know. A lot of people were

trained, they saw a six-month seminar or a year training program, things like that. And they were, they didn't really have the academic background to offer service. Then I tried to push a lot with regard to we need to establish bridges with all of these other professionals. I'm trying to level the service we provide, because you don't control the academic level of anybody…but if we can facilitate the understanding, you know, clinically and technically, then you are doing something for the service." She also described her work with ISPO: "From the association or the international society's point of view…you can belong to your local physical therapy association or your orthopedic surgeons' association, but what you deal with is orthopedic surgeons only or PTs only, or nurses, or that's it. When you join ISPO, that's for me one of the few, if not the only, international platform, professional platform, where you have a team of multi-disciplinary professionals. Including the users of orthotics, prosthetics, wheelchairs, whatever." Participant 7 was very passionate about the value in having a platform for multi-disciplinary approach to prosthetics and orthotics.

Description of the Egocentric Social Network of DHDA7

Participant 7's egocentric social network map for her diasporan healthcare development activity is shown in Figure 14. Discreet characteristics of the egocentric social network of DHDA7 are listed in Table 14 and 15. The following section qualitatively describes the network. Participant 7's egocentric social network related to DHDA7 is made up of nine alters. Alter 1 represents the people she works with at her employer, an orthotics and prosthetics company in the United States. Alters 2 and 3 represent the nurses and orthopaedic surgeons she has worked

with in the United States. Alters 4 and 5 represent the orthopaedic surgeons and

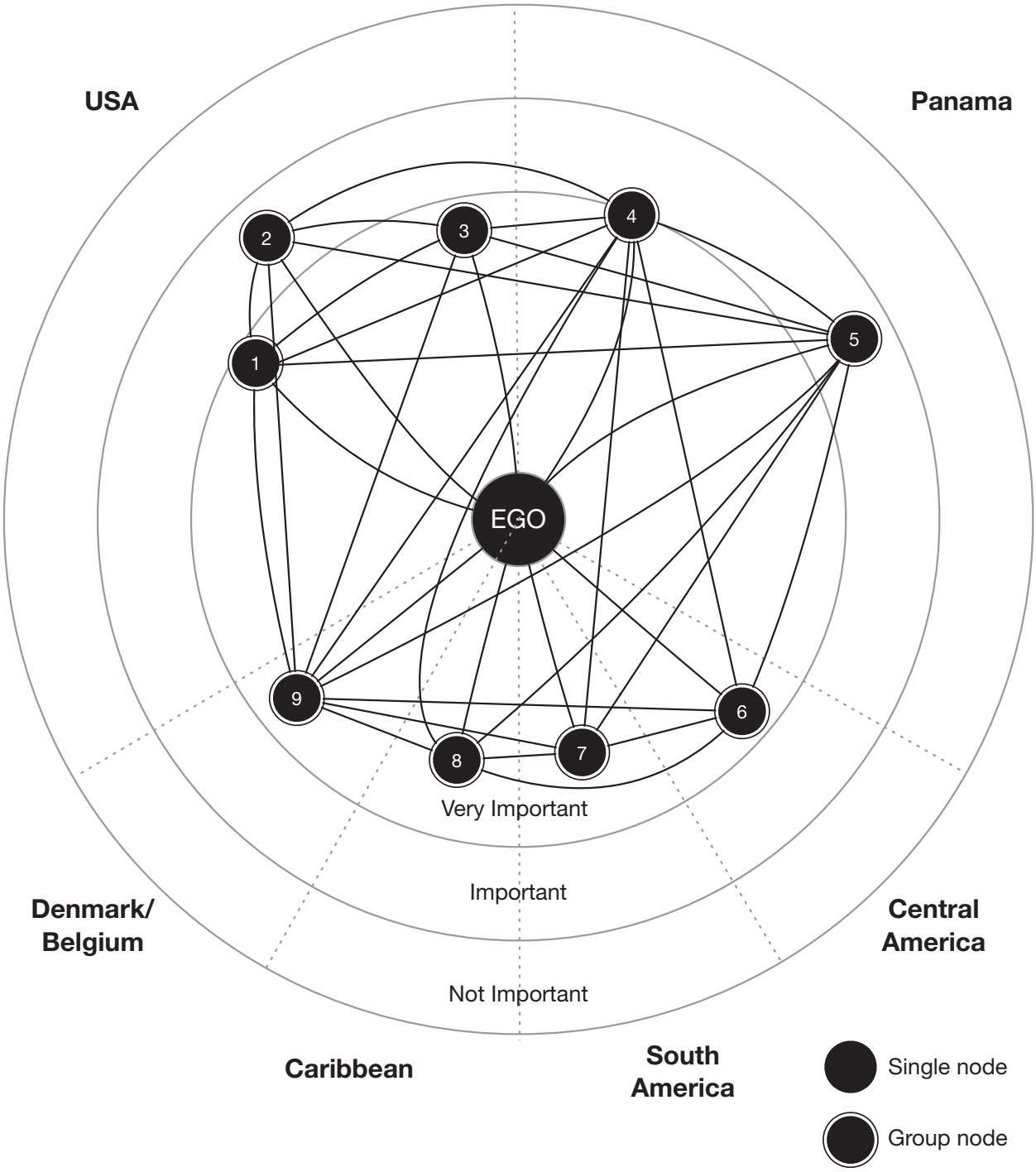


Figure 14: Egocentric social network map Participant 7

Table 14

DHDA Participant 7

Characteristics of the Egocentric Social Network of Participant 7 for DHDA - I

Alter	Level of Importance	Gender	Nationality	Location	Income Level	Education	Known # of Years	Colleagues/ Friends/ Family	# Contacts/ Year
1	Very Important	N/A	N/A	US	High	High	>30 years	Colleague	Ongoing/ Daily
2	Important	N/A	N/A	US	High	High	>30 years	Colleague	Ongoing/ Daily
3	Very Important	N/A	N/A	US	High	High	>30 years	Colleague	Ongoing/ Daily
4	Very Important	N/A	N/A	Panama	High	High	>30 years	Colleague	Ongoing/ Daily
5	Important	N/A	N/A	Panama	High	High	>30 years	Colleague	Ongoing/ Daily
6	Very Important	N/A	N/A	Central America	High	High	>30 years	Colleague	Once or twice per week
7	Very Important	N/A	N/A	South America	High	High	>30 years	Colleague	Once or twice per week
8	Very Important	N/A	N/A	Carribean	High	High	>30 years	Colleague	Once or twice per week
9	Very Important	N/A	N/A	Denmark	High	High	>30 years	Colleague	Once or twice per week

Table 15

DHDA Participant 7 Continued

Characteristics of the Egocentric Social Network of Participant 7 for DHDA - II

Alter	Alter Connection	Knowledge Source	Context	Timeliness	Credibility	Immersion
1	2, 3, 4, 5, 9	Travels there	Industry	Immediate	High	Embedded
2	1, 3, 4, 5, 9	Travels there	Nursing	Immediate	High	Embedded
3	1, 2, 4, 5, 9	Travels there	Orthopaedic surgery	Immediate	High	Embedded
4	1, 2, 3, 5, 6, 7, 8 ,9	Lives there	Orthopaedic surgery	Immediate	High	Embedded
5	1, 2, 3, 4, 6, 7, 8, 9	Lives there	Medical professional	Immediate	High	Embedded
6	4, 5, 7, 8 .9	Lives there	International medical society	Immediate	High	Embedded
7	4, 5, 6, 8, 9	Lives there	International medical society	Immediate	High	Embedded
8	4, 5, 6, 7, 9	Lives there	International medical society	Immediate	High	Embedded
9	1, 2, 3, 4, 5, 6, 7, 8	Lives these	International medical society	Immediate	High	Embedded

medical professionals she works with in Panama. Alters 6 to 9 represent the people she has worked with from ISPO in Central America, South America, the Caribbean, and Denmark. Participant 7 has known all of her alters for more than 30 years, as she has been actively engaged in the profession of prosthetics and orthotics for her entire career. She considers all of her alters to be highly credible sources of information that are timely and immersed in their countries. However, she did mention that the orthopaedic surgeons are the most important professionals related to the work she does. She explained that this is because they are the people that can prescribe a prosthetic or orthotic device. This means that they are the main source of referrals. The nurses and other medical professionals such as rehabilitation doctors are listed as important sources of information as well but not as important as the orthopaedic surgeons that she listed as very important.

The following section describes the quantitative measures of the Participant 7's egocentric social network. The results are derived through the methods described in Chapter 3.

- Size of the network = 9
- Effective size of the network = 3.0
- Efficiency of the network = 0.333

The quantitative measures indicate that Participant 7's DHDA-related egocentric social network effective size is one-third of its size (Burt, 2004). This indicates that many people in Participant 7's network know each other. This creates fewer new knowledge pathways across the network (Burt, 2004).

Description of Other Sources of Information for DHDA7

This section describes the role of all other sources of information that Participant 7 accesses with respect to the work she is doing in her DHDA7. According to Participant 7, one of the most important sources of information is gained through travel: "I will say that the travelling and visiting them, it gives me an absolutely certain information about the practice, about the level of the service, and also what is happening locally and how much there's trouble because of import taxes or whatever. Every time that I travel, it's like discovering something new, or confirming something, you know, that we are dealing with…everybody has their own perspective. Then, one of my positions is: …we [her employer] cannot make any decisions about any new markets based on somebody else's perspective. We really need to measure the potential. We know how far we can go. And really if you only know North America practice and you travel to other areas, that's why a lot of people classify many areas like 'third world' and I get really upset with the term. Because I say, 'My God! I think you need to travel a little more to really see the difference.' Because these areas, Central America, South America, and the Caribbean, and I will just, from all of this region, I will say maybe Haiti and Nicaragua are the ones that trouble a lot, but you will be absolutely surprised to see the level of service that you can find in any other place. Then it's like, you know, you need to travel to see the real situation." With respect to memory, Participant 7 stated: "Since I was a child, I have been one of those lucky humans that since very young age, we were travelling to different countries due to political asylum, etc. But that gives you also a different perspective, you know. Then you make sure, then you value, you don't take anything for granted. Then at the same time, you learn how to struggle and survive. You know, do the best with what you have. And I think that that makes a huge role.

I don't think that if you grew up and everything is so close to you, and everything is perfect, and then you will struggle more than other people when you have a minor difficulty." Although memory was useful as a way of understanding the needs, Participant 7 emphasizes the need to travel to understand the current situation.

In contrast to information sources from travel, Participant 7 feels that the news and social media are not as important and can be a waste of her time. Although she has a Facebook account, she never uses it. Participant 7 stated, "I feel like I waste my time because, I will say maybe 15 percent of the information is useful, everything else is what the people did during the weekend."

Participant 7 uses electronic modes of communication such as Skype and email on a regular basis. She prefers face-to-face communications via Skype because she feels that email communication still creates the potential to interpret the information differently than the sender intended: "Because if you think about it, I can send you something by email, and then it's based on your interpretation. How are you reading that? Then when we talk to each other: I don't understand you, could you explain? When you go a little extra with information, then the concept is clear and that's fantastic. It's not based on somebody's 'Okay, this is what I understood, and this is how I use this information.' I think that that would play the first role. You know, the person to person."

Participant 7 also described the library as an important role in her information seeking. She and her colleagues put a lot of effort into translating technical and clinical documents into Spanish, which was more important before the internet and tools like Google Translate were available. Currently the ISPO hosts a website that is available for anybody, and they are a source of new publications such as a monthly newsletter.

Participant 7 described the use of information grounds as an important information seeking place for specific situations. She described a program that she created with the Shriners through a local church in Panama to help teenagers with prosthetic limbs when they turn 18. At this time, the teenagers no longer have sponsors for their artificial limbs or orthotic braces. Participant 7 described the program: "And then one local church allowed us to use their auditorium, and every single Thursday we had a program and people—you would not believe how many people came. They were doing raffles, they were doing activities, because after that age, who is going to sponsor your artificial limbs or your body brace? Then we also tried to teach the parents, you know—this is not forever. Plus, there is a big gap, because if you don't work over there, you don't have social security coverage. Then you need to be working in order to have this—let's say—coverage, insurance. But for artificial limbs and something that is already an existing condition, you need to work at least five years before the social security can sponsor something like that. Then what happens is you are 18, Shriners gave you your new leg, perfect, but now you will not get another one until you become 23, 24 years old. Then you probably need another one before that time. That's why we started the community program and it was fantastic." Figure 15 shows the importance ranking for the other sources of information for Participant 7.

Ease and Difficulty of Information Seeking

The following section describes examples of information seeking that are easy and other examples that are difficult. Participant 7 says that the electronic sources of communication through the internet are the easiest to access. She states that the infrastructure is available; however, sometimes there are connectivity issues due to problems with power outages, but that is

not that common in her experience: “I can tell you too what happens with regard to that subject [internet connection]. If they don’t have the resources, of course the service is going to be very, very poor. Then, you know, but this is not because the service is not available. Maybe because the institution cannot afford, you know, broadband for everybody, but not because it’s not available.”

One of the most challenging issues related to information seeking for Participant 7 is cultural issues related to politics and gender. In some cases, people in positions of power do not want to make the changes necessary. According to Participant 7: “When I, for me, it was the people…a little because—or they play political or mandatory positions, you know, that nobody will tell me what I need to do or how to do my stuff, or, and that is also very much related with culture. Or a gender issue. I have been in a very difficult situation just because I’m a female. Oh yes…what happens in many cases is in order for you to change something you need to recognize, you know, what needs to be changed. And if you don’t want to recognize that, it’s like talking to a wall.”

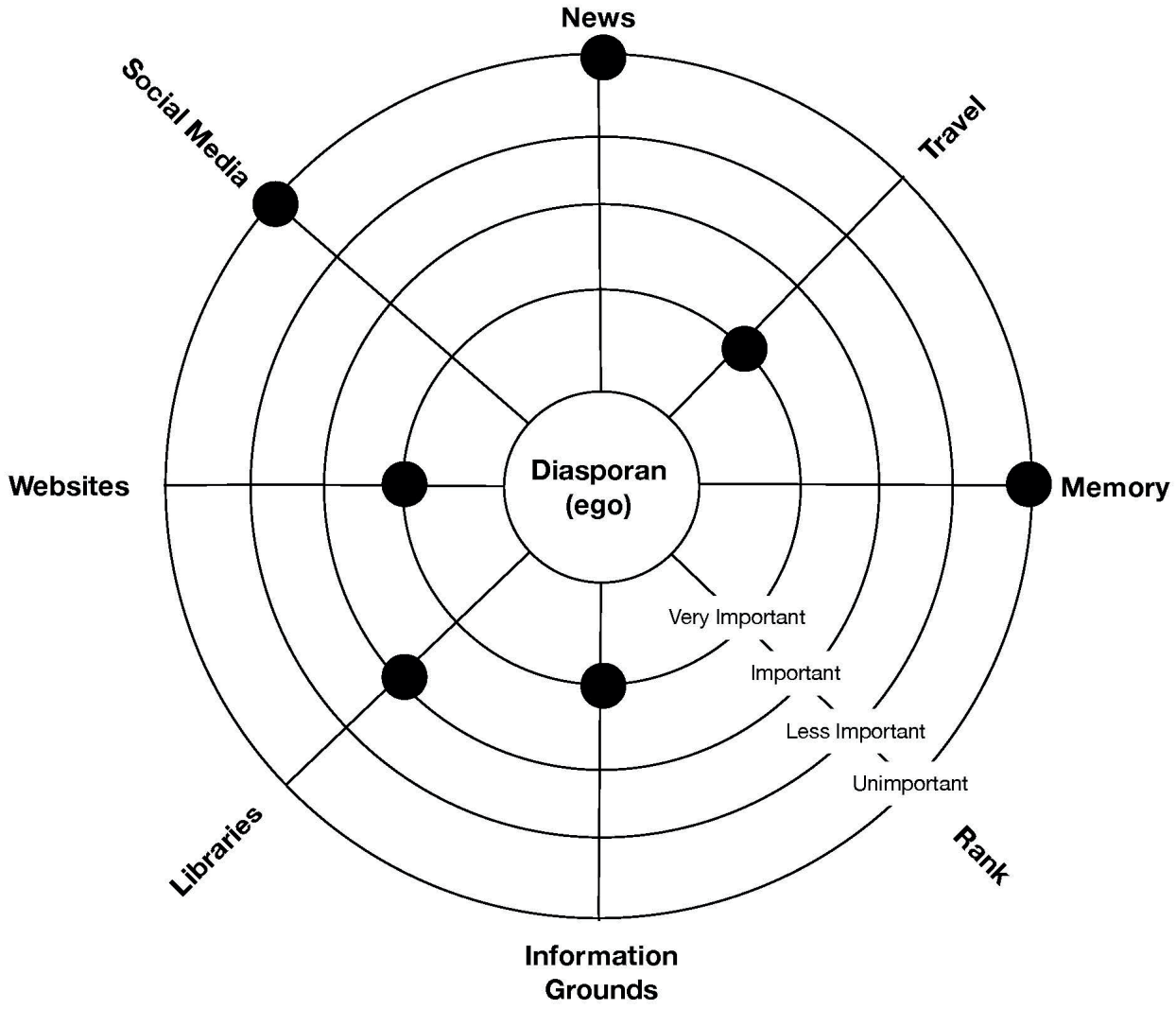


Figure 15: Other sources of information for Participant 7

Participant 8

Country of Origin and Immigration Path

Participant 8 was born in the Anambra State in southern Nigeria. She went to university at the age of 17 in a neighbouring state within the southern region of Nigeria. She graduated from medical school in 2014 at the age of 23. She completed her Housemanship in the southwestern part of Nigeria in 2016. Housemanship is an internship for one year that all

graduates take for national integration. She worked at a teaching hospital first and then moved to the general hospital. This is how Participant 8 describes her work: “There I worked in a general hospital, which is in a suburban area with so many, it’s called a confluence town. Actually, it’s where they said the war ended. That’s when the civil war in 1970 ended. So, it’s like a confluence town. People from so many places and parts of the country living there. And also, there’s a major road, so there’s really lots of accidents, lots of kidnappings, lots of shit happening there, so the job that I worked there was a very busy one and mostly in primary care; we are the first person they’ll call. It’s actually very, very, busy. You know I experienced this. And after that, I finished in 2017 November, and I went back to my place in Anambra. So now I worked in a private hospital from December to June when I now resigned, and I now came here in August 2018.” Participant 8 then explained how she immigrated to Canada in August of 2018 through an opportunity created via a MasterCard Foundation Scholarship program: “Working and studying in Nigeria, and working in Nigeria, in Nigerian hospitals, made me understand that there is a lot of problems with the health system itself, or the health policies…So I had the idea that it would be nice to go to some place that is already working out and go learn how things are being done. I’m able to bring back those plans and be able to help in the policy-making. So that is one of the major reasons why I came to the public health program here [in Vancouver, Canada].” Participant 8 had been in Canada for one year and was 28 when we conducted the interview.

Diasporan Healthcare Development Activity (DHDA8)

Participant 8 became involved in her DHDA8 throughout her career as a medical doctor in Nigeria and a student in public health in Canada. Participant 8 worked in the Nigeria healthcare system for many years and was able to see that some things were not working as well

as they could be. She has great interest in learning about public health systems that are working well and trying to bring about change back in Nigeria. Her education and work in Nigeria as a medical doctor over a 10-year period has given her experience in a wide range of medical specialties including pediatrics, surgery, and emergency medicine. She has worked in very busy primary care positions where she has worked mostly alone to support her patients as well as in teaching hospitals that have a support system of more senior doctors and professors supporting young doctors that are gaining experience. She is now doing her masters of public health at a university in Canada to gain experience that she plans to bring back to Nigeria to improve the healthcare system. After she finished describing her involvement in her DHDA8, she said, "So you see I fit the bicultural definition very well, right."

Description of the Egocentric Social Network of DHDA8

Participant 8's egocentric social network map for her diasporan healthcare development activity is shown in Figure 16. Discreet characteristics of the egocentric social network of DHDA8 are listed in Table 16 and 17. The following section qualitatively describes the network.

Participant 8's egocentric social network related to DHDA8 is made up of seven alters. Alter 1 represents her professors in her masters of public health at a Canadian university. Alters 2 and 3 represent senior colleagues and her cadre of colleagues at her teaching hospital in Nigeria. Alters 4 and 5 represent senior colleagues and her cadre of colleagues at the general hospital she worked at in Nigeria. Alter 6 represents all of her patients. Participant 8 described Alters 2 through 6 as being very important sources of information. She also worked with nurses in hospitals in Nigeria and said they were part of the team she worked with. She confirmed that all of her alters were colleagues, except for her patients. She mentioned that she had a very close

relationship with her patients and would spend considerable time discussing their health situation. Participant 8 felt that all her alters were highly credible sources of timely and immersed information.

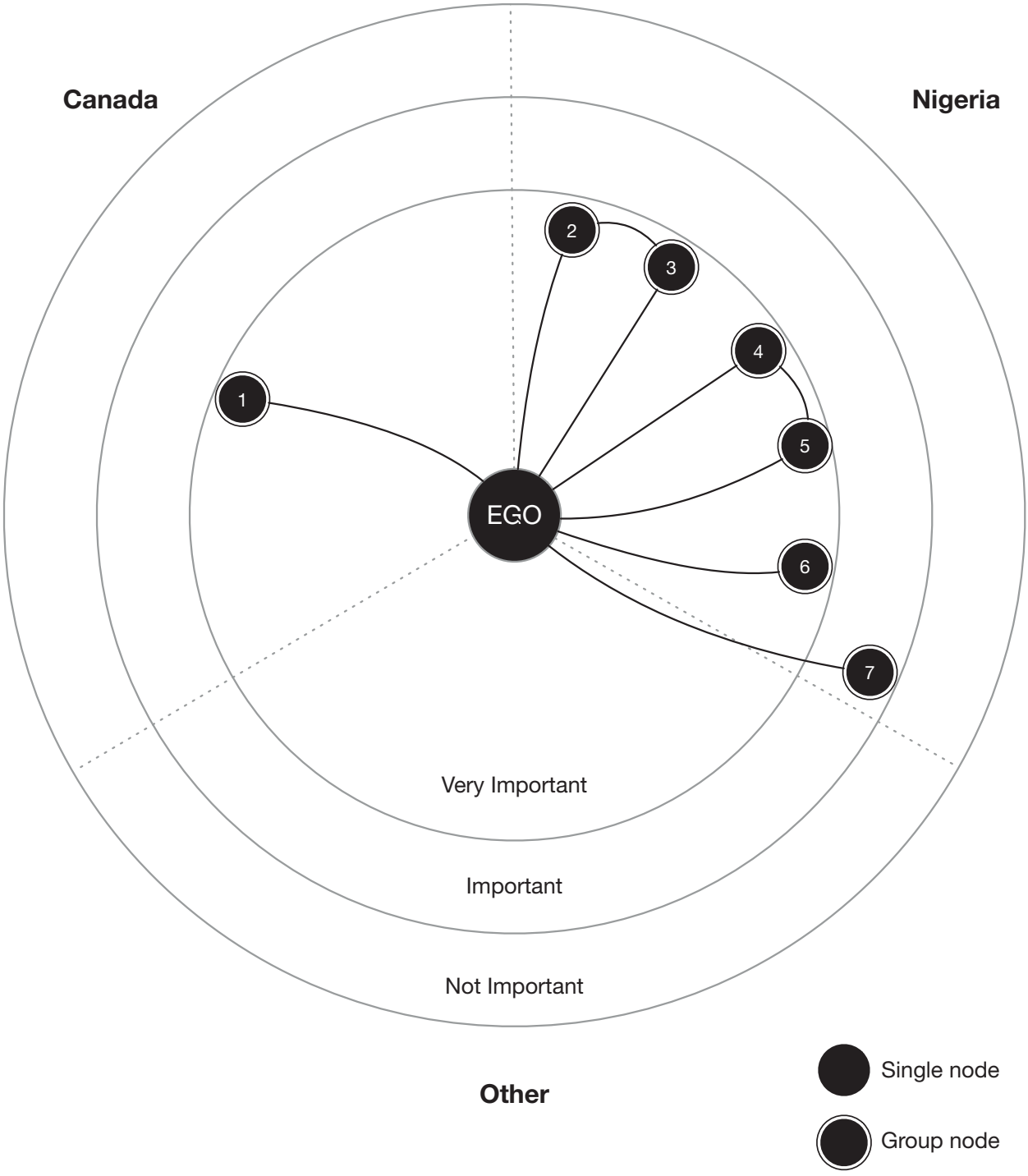


Figure 16: Egocentric social network map Participant 8

Table 16

DHDA Participant 8

Characteristics of the Egocentric Social Network of Participant 8 for DHDA - I

Alter	Level of Importance	Gen-der	Nationality	Location	Income Level	Education	Known # of Years	Colleagues/ Friends/ Family	# Contacts/ Year
1	Very Important	N/A	Canadian	Canada	High	High	1	Colleague	Every working day
2	Very Important	N/A	Nigerian	Nigeria	High	High	~6 year	Colleague	Every working day
3	Very Important	N/A	Nigerian	Nigeria	High	High	~6 years	Colleague	Every working day
4	Very Important	N/A	Nigerian	Nigeria	High	High	~5 years	Colleague	Every working day
5	Very Important	N/A	Nigerian	Nigeria	High	High	~5years	Colleague	Every working day
6	Very Important	N/A	Nigerian	Nigeria	High	High	~6 years	Colleague	Every working day
7	Very Important	N/A	Nigerian	Nigeria	High	High	~6 years	Colleague	Every working day

Table 17

DHDA Participant 8 Continued

Characteristics of the Egocentric Social Network of Participant 8 for DHDA - II

Alter	Alter Connection	Knowledge Source	Context	Timeliness	Credibility	Immersion
1		Lives in Canada	Teaching and clinical university	Immediate	High	Embedded
2	3	Lives in Nigeria	Supervisor resident doctor in teaching hospital	Immediate	High	Embedded
3	2	Lives in Nigeria	Colleagues in teaching hospital	Immediate	High	Embedded
4	5	Lives in Nigeria	Senior colleagues in general hospital	Immediate	High	Embedded
5	4	Lives in Nigeria	Colleagues in general hospital	Immediate	High	Embedded
6		Lives in Nigeria	Patients	Immediate	High	Embedded
7		Lives in Nigeria	Nurses	Immediate	High	Embedded

The following section describes the quantitative measures of the Participant 8's egocentric social network. The results are derived through the methods described in Chapter 3.

- Size of the network = 7
- Effective size of the network = 6.43
- Efficiency of the network = 0.92

The quantitative measures indicate that Participant 8's DHDA-related egocentric social network is potentially a source of many new ideas as its effective size is just over 90 percent of its size (Burt, 2004). This indicates that most people in Participant 8's network do not know each other. This creates new knowledge pathways across the network (Burt, 2004).

Description of Other Sources of Information for DHDA8

This section describes the role of all other sources of information that Participant 8 accesses with respect to the work she is doing in her DHDA8. One of the most important sources of information comes through a closed WhatsApp group. According to Participant 8, the WhatsApp group connects Nigerian doctors and provides a platform for the following: "I'm still a part of the WhatsApp group where it's a doctors group. Basically, for doctors where people can ask a problem, they have a patient, they don't know what to do about it, they can post it, put up the history, ask questions, senior colleagues, we have some professors and also all the way down to house officers. Professors in the group lecture and stuff so they can help out with the case." This is a highly valued source of information for Participant 8.

Participant 8 also mentioned an open Facebook account of a Nigerian doctor working in a rural and remote area of Nigeria. He uses this platform to post how he improvising to treat his patients in the low resource settings of rural and remote areas of Nigeria.

Participant 8 did not find that the news was a credible source of health information. She mentioned that the news may distort the facts regarding violent attacks happening in Nigeria. Sometimes the news media would under-report the violence or not report it at all; however, Participant 8 would hear about an attach via her WhatsApp group as it would report that a certain number of people that were attacked were brought to the hospital where they were working. Participant 8 used her WhatsApp group to learn about things happening on the ground or as a way to verify news stories.

Participant 8 also mentioned her use of information grounds while she was in Nigeria to provide community care education for mother and child health. She mentioned that she gave such a talk in a community centre: "Had to organize a kind of mother and child, like, talk in the community. So, where I gave a talk to the women, perhaps they would be home remedies for diarrhoea before they come, bring their child to the hospital. So all this kind of community education, community talks also important because they ask their questions and you want to be able to get information and be able to answer their questions and be able to clear their doubts."

Participant 8 hadn't had an opportunity to travel back to Nigeria; however, she felt that the healthcare system was deteriorating in Nigeria due to a rise in insecurity. She said she was able to keep in touch to a degree mostly through the WhatsApp group of Nigerian doctors she was part of. When queried about the role of memory, Participant 8 felt that since she had been in Canada and learned about the role of public health insurance through personal experience (she had had a baby in Canada in the past year), her memories of healthcare in Nigeria made her sad. According to Participant 8: "I am only coming here as an international student, I am not a citizen yet, and immediately I was expected to have a health insurance as soon as I landed. And then you

see how everything is working, you see the helicopters are taking people to hospital. You see how the hospitals are—Ok, I had my baby two months ago here—and I just had to go, myself, to hospital. Just go with the card. Just meant to go with the clothes I'll wear when I'm going back and the clothes I wear when I go. Everything was right there, down to pad and pants. But if it's in the country, if it's back home, you know how much you are going to spend if you have to go to a good hospital? Good in quotes…And it's not like we do not have the money to be able to effect these changes in the country. We do…High risk of infant mortality. It pains me somewhat, that's the truth. When you come out, it's like you cannot be able to achieve that because of partisanship and people, and lack of political will." Figure 17 shows the importance ranking for the other sources of information for Participant 8.

Ease and Difficulty of Information Seeking

The following section describes examples of information seeking that are easy and other examples that are difficult. Participant 8 described the WhatsApp group of Nigerian doctors as the most accurate and easiest source of information to get. Although the news is also very easy to obtain electronically, it does not provide an accurate description of what is really happening in real situations on the ground so Participant 8 would go to her WhatsApp group for verification or a more accurate description of what is happening.

The power and internet infrastructures in Nigeria are very good. However, access to the internet can be expensive, so it depends on how important having internet access is to you. It was a very important service for Participant 8 to have, so she had to budget enough money each month to have access to the bandwidth she wanted. Here in Canada she just uses free Wi-Fi, but that isn't the same in Nigeria.

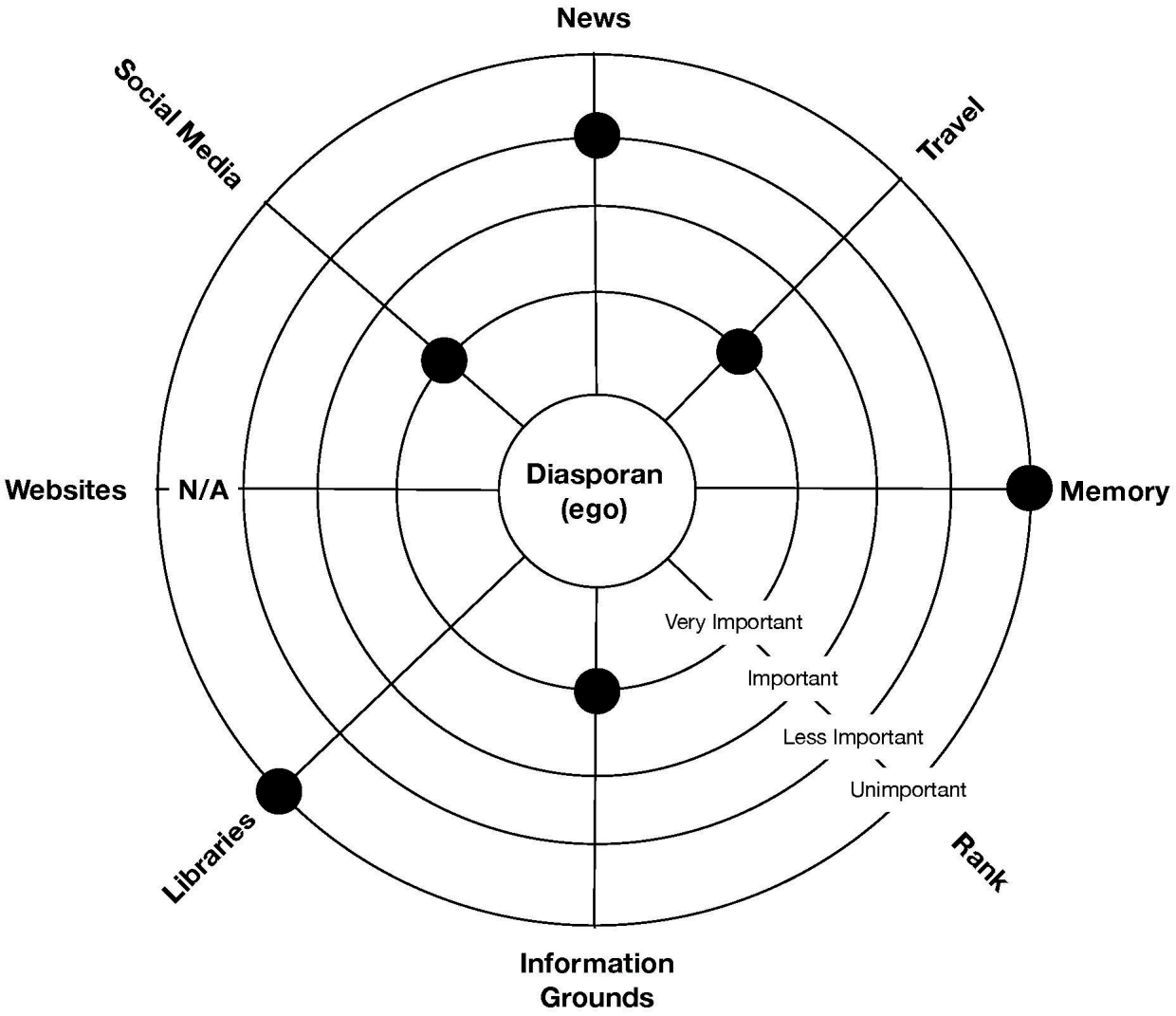


Figure 17: Other information sources for Participant 8

Unique Holistic Information Seeking DIEMs

The following section describes the DHDA-related information seeking behaviour of each participant in holistic terms. The DIEMs from this research have been grouped together accordingly to highlight some of the similarities that emerge that are dependent on the type of DHDA. The type of DHDAs that participants of this study were involved in include:

- Doctor-driven (i.e. education or clinical services)
- Nonprofit-oriented (i.e. charities)
- For-profit- oriented (i.e. companies)

The modified DIEM figures include the following information:

- The type of diasporan healthcare development activity,
- The contextual areas of knowledge,
- The egocentric social network and other information sources,
- The level of importance in terms of timely, credible, and immersed sources of information,
- The clinical area(s), and
- The geographic area.

The type of DHDA that a diasporan is involved in effects a number of characteristics of their DIEM so it is an important finding and can provide a signpost for a designer when looking for a diasporan as a source of information. The type of DHDA had an impact on the size of its egocentric social network and the number of contextual areas of knowledge. The size of a diasporans' egocentric social network can impact the ability for that network to provide sources of information with larger networks providing larger information sources. The more contextual

areas a DHDA has knowledge of the better in terms of addressing all the areas a designer must address when developing a medical device for a low resource setting. However, the remaining characteristics were not impacted by the type of DHDA. For example, the clinical areas and geographic areas did not align along DHDA type. Nor did the importance of particular sources of information.

An important finding from this research is that a designer must create their own DIEM outlining the information needs they require for their particular medical device project in terms of:

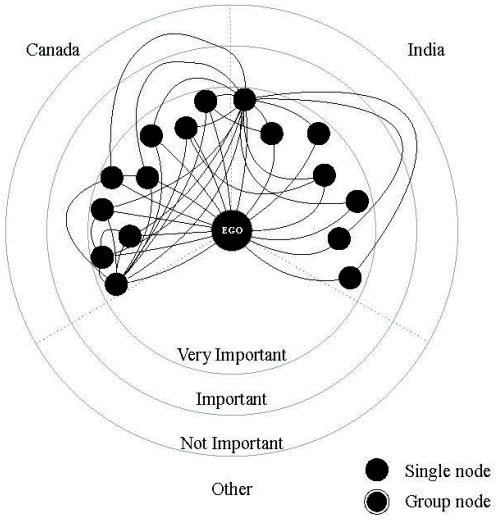
- The contextual areas of knowledge,
- The clinical area of knowledge, and
- The geographic area of knowledge.

A designer then needs to match their information needs to a diasporan involved in a DHDA that has access to these information needs. As there are many individual diasporans involved in DHDAs, as well as diasporan-driven development groups, this finding can provide insight to designers to focus on the type of DHDA, the clinical area, and the geographic area that would be the best match for their particular medical device project.

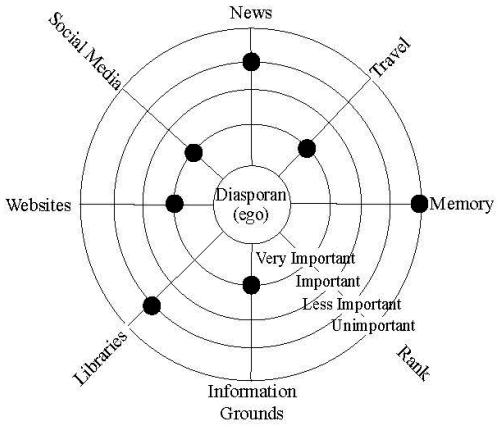
The similarities between modified DIEMs that share the same type of DHDA can be visualized in the following figures and are described in the following section. The modified DIEMs for each participant are presented in Figures 18 to 25.

Figures 18 and 19 represent DHDA1 and DHDA2 that are nonprofit organizations. The two nonprofit organizations both had egocentric social networks that were large in terms of size and effective size. However they did not share the same contextual areas. The medical device

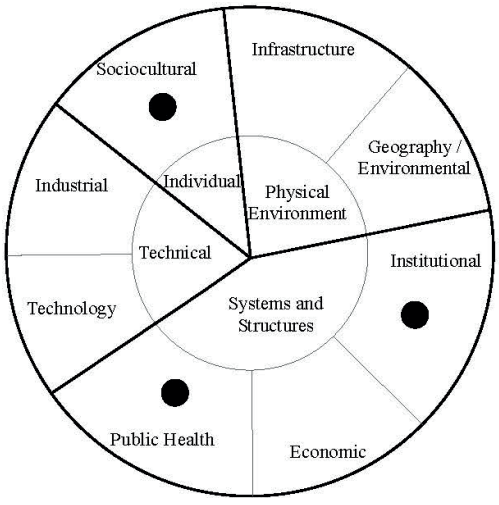
donation nonprofit covered a much wider breadth of areas. In both cases, memory and libraries were not seen as important sources of information. Information grounds, travel, social media, and websites were all identified as important for these nonprofit DHDAs. The only information source that differed in terms of importance was the news which was more important for the civil society and health related DHDA. Lastly the geographic regions for the nonprofits included India, Ghana, Nigeria, Liberia, Sierra Leone, and Canada.



Ego-Centric Social Network Map

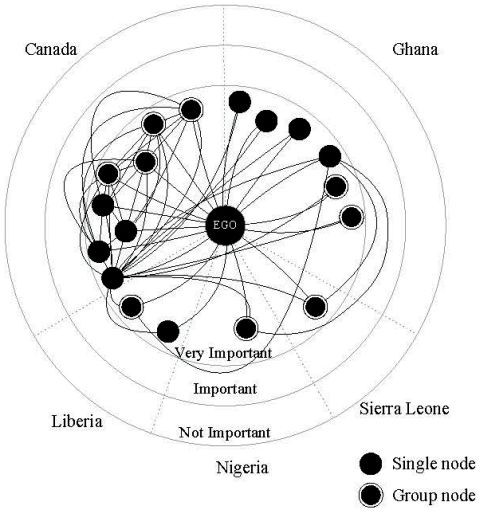


Other Information Sources

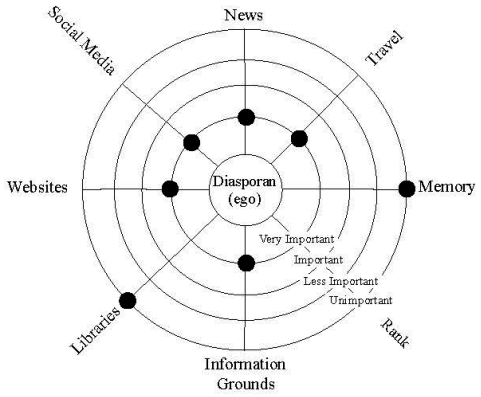


Contextual Categories for Low Resource Settings

Figure 18: Modified DIEM for Participant 1: Nonprofit-oriented DHDA



Ego-Centric Social Network Map



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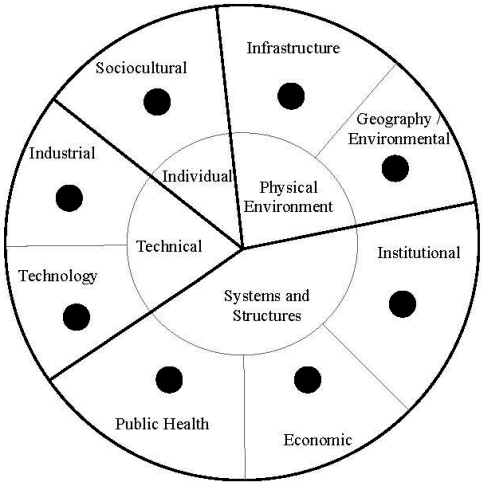
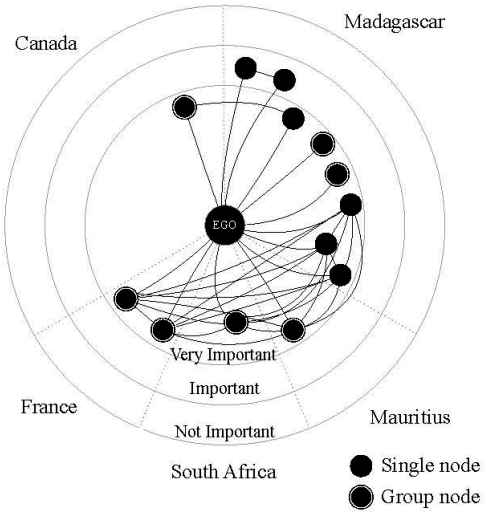


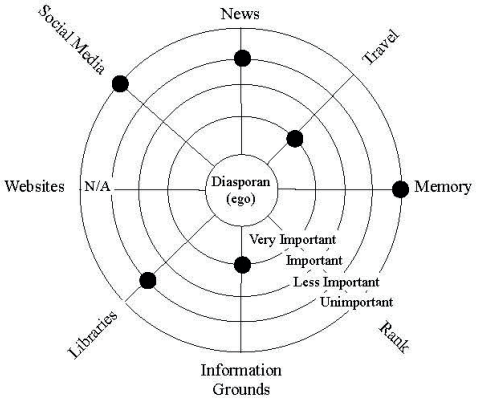
Contextual Categories for Low Resource Settings

Figure 19: Modified DIEM for Participant 2: Nonprofit-oriented DHDA

Figures 20 and 21 represent DHDA4 and DHDA7 that are for-profit companies. The two for-profit organizations both had egocentric social networks that were also large in terms of size, however the prosthetics and orthotics egocentric social network had a smaller effective size. They also did not share the same contextual areas. The health insurance for-profit DHDA covered a much wider breadth of areas. In both cases, memory, news, and social media were not seen as important sources of information. Information grounds and travel were identified as important for these for-profit DHDAs. The only information sources that differed in terms of importance were libraries and websites which were important to the prosthetics and orthotics related DHDA but not important to the health insurance related DHDA. Lastly the geographic regions for the for-profits included Madagascar, Mauritius, South Africa, France, Canada, Panama, Central America, South America, the Caribbean, Denmark, Belgium, and the USA.



Ego-Centric Social Network Map



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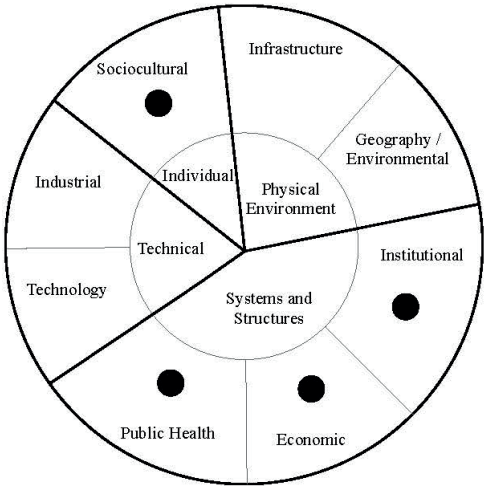
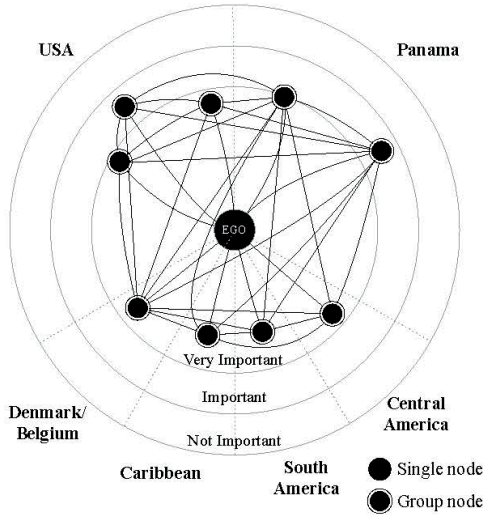
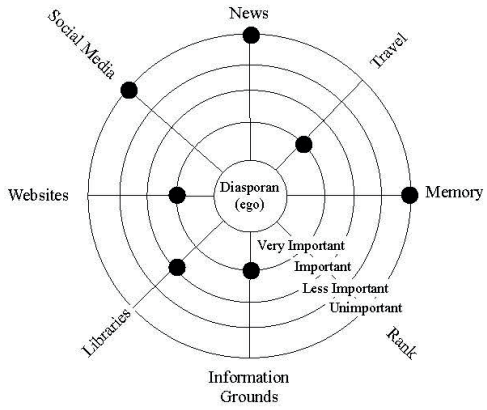


Contextual Categories for Low Resource Settings

Figure 20: Modified DIEM for Participant 4: Company-oriented DHDA



Ego-Centric Social Network Map



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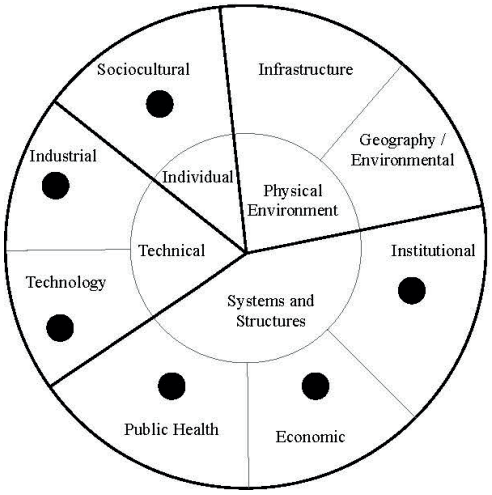


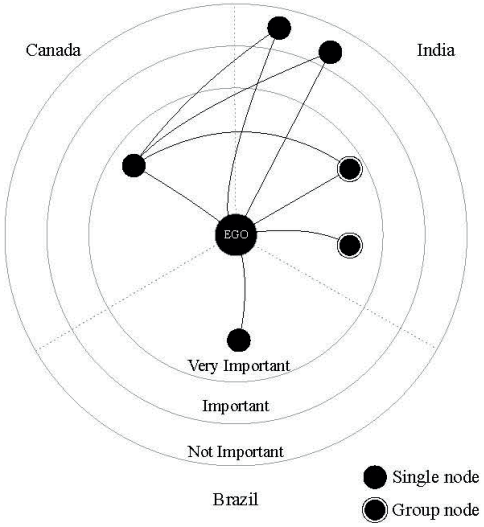
Contextual Categories for Low Resource Settings

Figure 21: Modified DIEM for Participant 7: Company-oriented DHDA

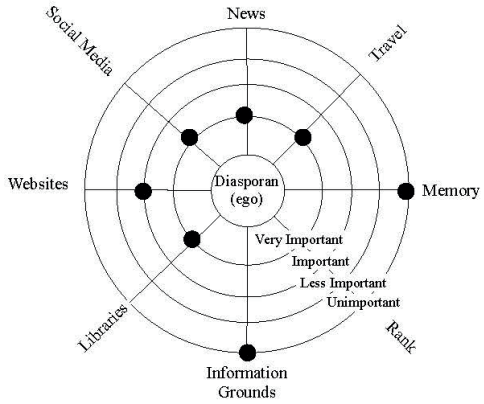
Figures 22 to 25 represent the remaining doctor-driven DHDAs. These four doctor-driven DHDAs have slightly smaller egocentric social networks. They also had the smallest number of contextual categories with a maximum of three. Not surprisingly, the contextual categories represented included public health and socio-cultural factors with three of the four DHDAs including knowledge of healthcare institutional factors. Memory was not an important source of information and travel was an important source of information for all doctor-driven DHDAs. The remaining sources of information varied as follows:

- Websites – 2 important, 2 not important
- Social media – 3 important, 1 not important
- News – 1 important, 3 not important
- Libraries – 2 important, 2 not important
- Information grounds – 1 important, 3 not important

The importance of the remaining sources of information are related to the uniqueness of the DHDA and diasporan involved. Lastly, the geographic areas covered include India, Brazil, Nigeria, European countries, and Canada.



Ego-Centric Social Network Map



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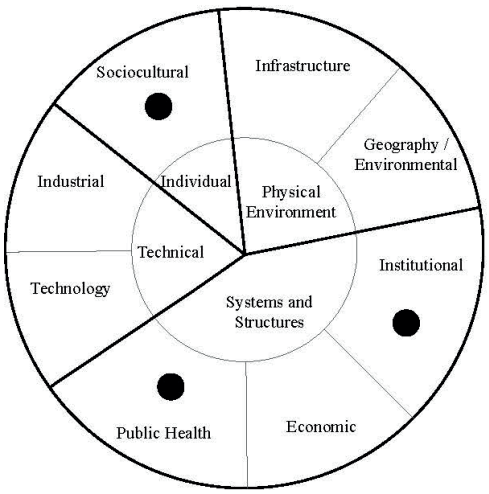
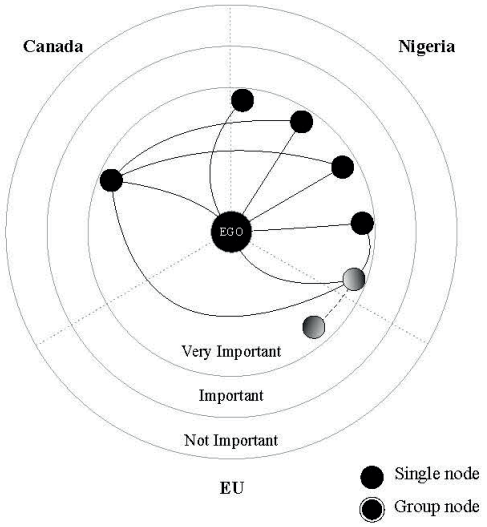
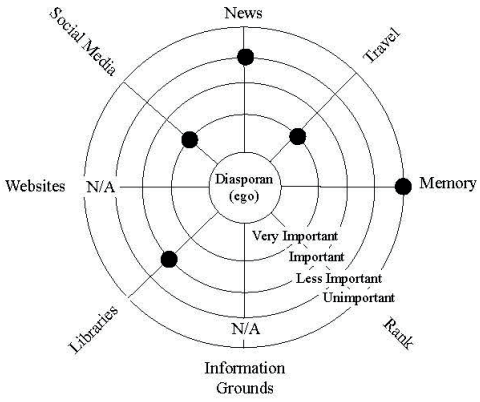


Contextual Categories for Low Resource Settings

Figure 22: Modified DIEM for Participant 3: Doctor-driven DHDA



Ego-Centric Social Network Map



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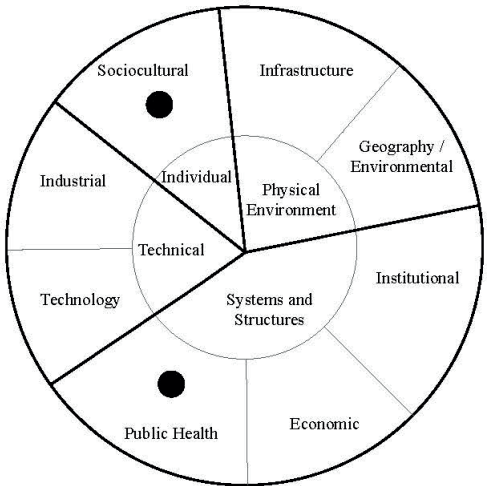
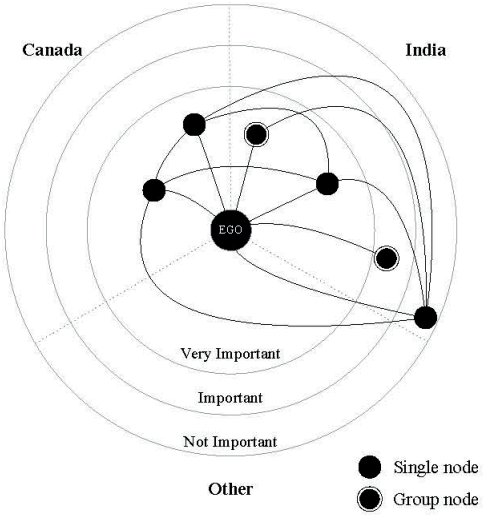
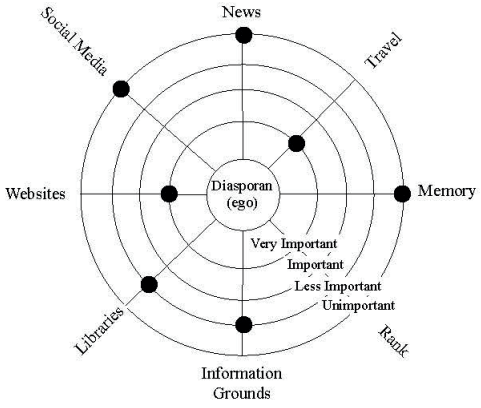


Contextual Categories for Low Resource Settings

Figure 23: Modified DIEM for Participant 6: Doctor-driven DHDA



Ego-Centric Social Network Map



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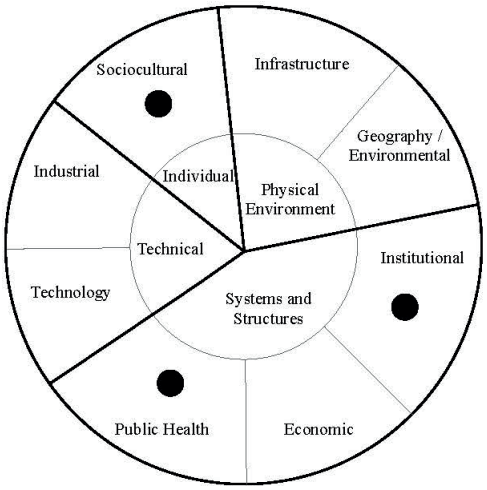
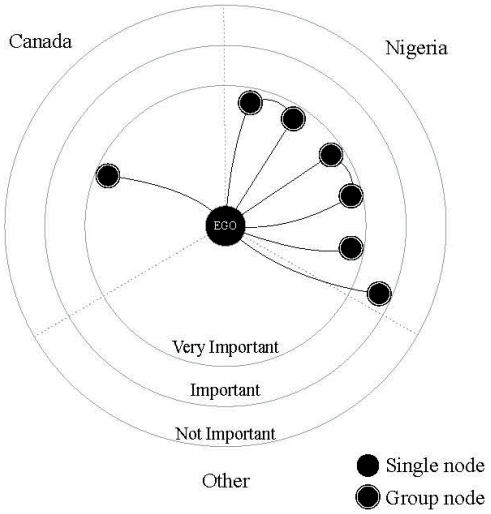
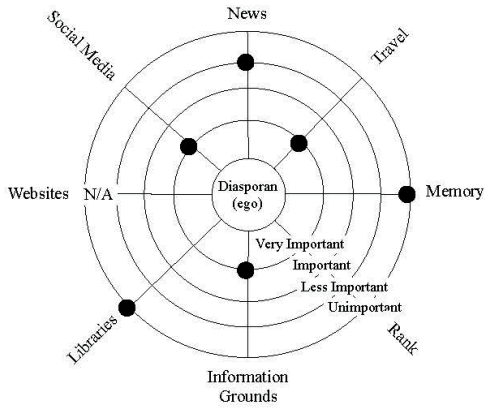


Contextual Categories for Low Resource Settings

Figure 24: Modified DIEM for Participant 5: Doctor-driven DHDA



Ego-Centric Social Network Map



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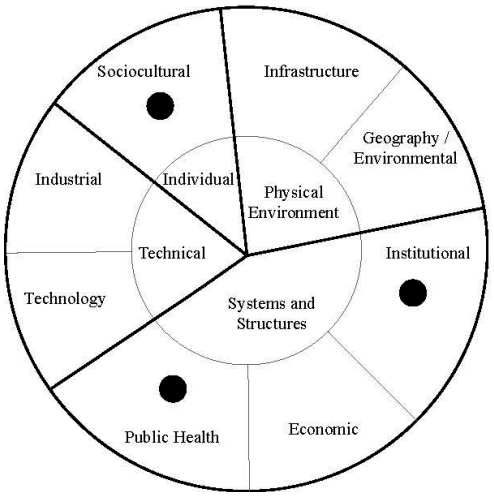

Contextual Categories for Low Resource Settings

Figure 25: Modified DIEM for Participant 8: Doctor-driven DHDA

The modified DIEM resulting from this research provides insight to designers of medical devices. By viewing a diasporan's DIEM, a designer can assess what geographical, clinical, and contextual areas they may have information about. A designer can also assess the people and other information sources that the diasporan has access to. A designer then has a better understanding of how a diasporan may be able to provide the information a designer needs to design a successful medical device for the diasporans' country of origin. Furthermore, the addition of travel and memory as information seeking behaviours and/or sources are a modification to the original DIEM proposed by Srinivasan & Pyati (2007). By including questions on travel and memory, the modified DEIM provides greater insight into the importance, or lack of importance, these sources have with respect to providing timely, credible, and immersed information. As such, the combination of this specific information is a unique contribution of the research and represents a modified Diaspora Information Environment Model (DIEM).

This chapter presents the detailed findings from this research project. The findings are presented in detail for each participant as it is important to get enough information to understand the information seeking behaviour of diasporans involved in DHDAs as it would apply to medical device design. This entails getting an understanding of the nature of the DHDA itself and the geographic reach of the work. It also entails understanding the qualitative nature of the people that the diasporan is working with and the qualitative nature of the other sources of information. By having a detailed understanding of the DIEM of the participants it is possible to map this qualitative description to the areas that could be applied to assist a designer in understanding the contextual areas needed for successful design of a medical device for a

particular low resource setting. In addition to the qualitative data, a quantitative description of the participants' egocentric social networks also provide some insight into how many novel ideas many be able to come from their network given that more efficient social networks lead to potentially more novel ideas. The following chapter provides the discussion of the findings.

Chapter 5: Discussion

This chapter discusses how the research findings answer each of the four research questions. The first section addresses research question one and research findings are placed in the existing literature related to information seeking behaviour of diasporans. I discuss how the literature informs the findings of this study, how the findings identify gaps in the literature, as well as how they confirm what exists in the literature. The holistic diasporic information environment model is presented for each participant and placed in the context of the literature related to information seeking behaviour of diasporans utilizing the DIEM.

The second section addresses the second research question and discusses how timely, credible and immersed the information seeking behaviour of participants is during their diasporan healthcare development activities (DHDAs). This section is a unique contribution to the literature as there is little published research on this specific topic. However some research is published on the information seeking behaviour of physicians that are looking for clinical information and how credible the information sources are (Aakre, Maggio, Fiol, & Cook, 2019; Daei, Soleymani, Ashrafi-Rizi, Zargham-Boroujeni, & Kelishadi, 2020). Six of the participants of this research were physicians and/or medical professionals. It is useful to compare and contrast the research from this study to the broader area of research of physicians looking for clinical information as this will shed some insight how different or similar the information seeking behaviour is between the two groups studied. This will highlight what impact being a diasporan physician has on information seeking behaviour. Therefore the research findings from question two are discussed with literature on credible sources of information physicians utilize when they are looking for clinical information.

The third section addresses the third research question and discusses the ease and difficulty of information seeking behaviour as perceived by diasporans during their DHDAs. This section is also a unique contribution to the literature as there is little published research on this specific topic. Similar to the second section, this section discusses the findings from this research in the context of the ease and difficulty of information seeking behaviour of physicians looking for clinical information (Aakre, Maggio, Fiol, & Cook, 2019; Daei, Soleymani, Ashrafi-Rizi, Zargham-Boroujeni, & Kelishadi, 2020).

The fourth and last section addresses the fourth research question and discusses how the information seeking behaviour of diasporans involved in diasporan healthcare development activities for their countries of origin can be leveraged to aid designers developing medical devices for low resource settings. This section discusses a framework to guide designers when engaging with diasporans involved in DHDAs as sources of information. The framework shown in Figure 18 describes four quadrants of information sources and behaviours. The sources above the horizontal axis are very useful, or favourable, to medical device developers. The sources below the horizontal axis are less useful, or nonfavourable, to medical device developers. The sources on the left side of the vertical axis were identified by most of the participants and were unifying. The sources on the right side of the vertical axis were identified by a subset of participants and were disunifying.

It is important to understand that the framework should not be considered static and applying for all time. It should be revisited and revised as diasporans' information seeking behaviours change over time. As information seeking behaviour is impacted by the state and accessibility of technology (both ICT and transportation) and the ability to access physically

based information sources (community centres, churches, etc.), the framework should reflect these changes as they occur. Some of the factors that can impact and potentially change information sources and behaviours of diasporans involved in DHDAs will be discussed throughout the discussion on research question four. For example, the global COVID-19 pandemic that occurred during this research has severely restricted gathering at churches, community centres, and other information grounds, as well as restricting air travel (Gossling, Scott, & Hall, 2020). However, the use of online tools for communication such as Zoom have increased dramatically (Sonis, et al., 2020).

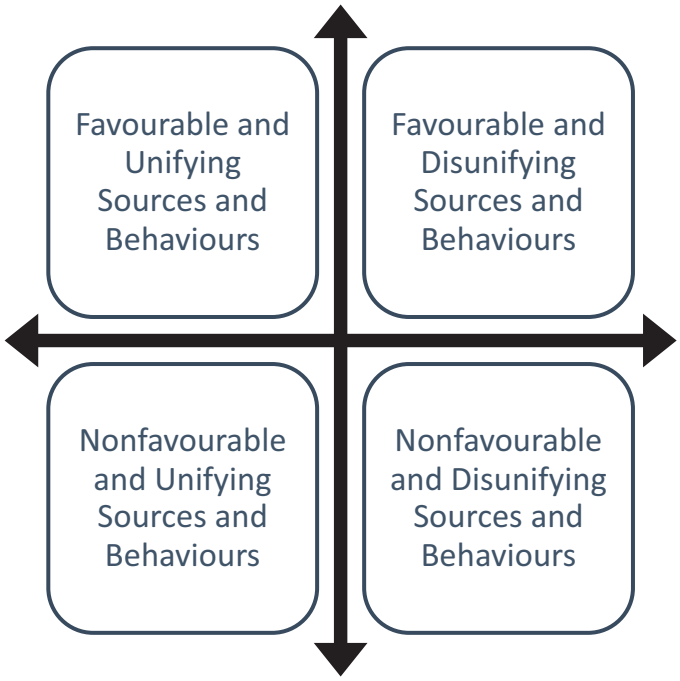

Figure 26: Framework to guide designers engaged with diasporans

Research Question 1

The first research question is: How do individual diasporans conduct DHDAs and what are the local place-based and globalized information and communication technology (ICT) based or

other globally based information sources of these individual diasporans? The following section discusses this research question.

A comparison of each participant's modified DIEM related to their DHDAs demonstrates that they are unique to each individual. It is important to note that the DIEMs are unique because it highlights the importance of trying to formulate a framework that could help medical device designers to better engage with individual diasporans. From my research, it is evident that there is variety between individual diasporans with regards to:

- Type of diasporan healthcare development activity they are involved in,
- Characteristics of their egocentric social networks,
- Contextual categories they have knowledge in,
- Geographical areas they are active in and
- Level of importance of their other information sources.

Although each modified DIEM is unique, there are some characteristics that show some significant similarities of value are discussed in the following sections.

Different DHDAs have Different Egocentric Social Network Size Range

One of the research findings is that the type of diasporan healthcare activity and the size of the egocentric social networks demonstrated the following characteristics:

- Nonprofit and for-profit organization DHDAs egocentric social network size range between 9 and 19
- Doctor-driven DHDA have smaller egocentric social networks size range between 6 and 7

As noted above, egocentric social networks are smaller in the DHDAs that represent single doctors providing clinical and/or educational services for their countries of origin. In contrast, the size of the egocentric social networks are generally larger in the DHDAs that represent organizations. This doesn't mean that doctor-driven DHDAs are necessarily less important for a particular medical device development project as each project will be unique and require unique sources of information to input into the design. For example, if the doctor-driven DHDA is in the particular clinical area that the medical device will operate in, their modified DIEM may contain highly relevant information.

The research findings align with other research on the size of egocentric networks of people more generally. Research has found that people have a close innermost layer of egos that averages to be five members (Roberts, Dunbar, Pollet, & Kuppens, 2009). The next layer out of people whom an individual contacts at least monthly averages between 12 – 15 members (Roberts et al., 2009). Similar results have also been found for communities of practice such as DHDAs (Webber & Dunbar, 2020). It is of interest to note that egocentric social networks for participants involved in doctor-driven DHDAs were somewhat smaller than the participants involved in company- and non-profit-oriented DHDA. According to Roberts et al., there is generally a negative relationship between mean emotional closeness and network size so it may be that participants involved in doctor-driven DHDAs have closer emotional connections to their DHDA related egocentric network (2009).

Different DHDAs have Different Contextual Knowledge Categories

This research also indicates that the doctor-driven DHDAs are active in a smaller number of contextual knowledge categories when compared to the for-profit or nonprofit-oriented

DHDAs. Contextual categories proposed by Aranda-Jan, Jagtap, & Moultrie (2016) that are essential for successful design of medical devices for low resource settings include:

- Public health
- Technology
- Industrial
- Sociocultural
- Infrastructure
- Goegraphy/environmental
- Institutional
- Economic

The participants involved in doctor-driven DHDAs were active in two or three contextual categories including public health and sociocultural categories. The three of the four participants involved in for-profit or nonprofit-oriented DHDAs were active in four to eight contextual knowledge categories and had more knowledge of economic categories than the participants involved in doctor-driven DHDAs. This is important for designers of medical devices for low resource settings to understand as they can focus on finding diasporans involved in the type of DHDA that will help them get the contextual knowledge they need for a particular device. For example, if a designer is looking for a guide to economic information in a particular low resource setting, they may want to focus on finding a diasporan involved in a for-profit or nonprofit-oriented DHDA rather than focusing on a diasporan involved in a doctor-driven DHDA. These findings align with the research on the need for contextual categories of knowledge to design successful medical devices for low resource settings (Aranda-Jan, Jagtap, & Moultrie, 2016).

Egocentric Social Networks Very Important Sources of Information from Professionals Regardless of Type of DHDA

Each participant's DIEM was observed to be unique; however, common across all of them is that almost all of the people in a given participant's ego were rated as important or very important sources of information for their DHDA. Also, it was a common feature across participants that most of their egocentric network consisted of professional relationships for DHDA activities. Although the type of DHDA demonstrated some differences in terms of size of egocentric social network and the number and type of contextual categories, it did not demonstrate any differences in terms of the importance of the participants' egocentric social networks or that the people in these networks are professionals. As such, a designer can approach a diasporan involved in any type of DHDA with the understanding that it is likely that the people in their egocentric social network will be professionals and have important sources of information.

The existing literature also aligned with this research in findings showing that participants considered the people in their egocentric social network as the most important source of information, regardless of research question (Allard, 2015; Komito, 2011; Schöpke, 2019). This also was discussed in information seeking research of immigrants utilizing other modes of inquiry (Caidi, Allard, & Quirke, 2010). The importance of a diasporan's egocentric social network is a major finding across this research, the related DIEM research, and other information seeking research of diasporans. Of all the types of information sources, people come through as the most important for diasporans. This cannot be underemphasized as an important finding, particularly in the context of all the other ICT-mediated information sources that have become relatively ubiquitous and easy to access with the rise of smartphones. Even though many

other sources of information including the news, social media, library databases, and websites can all be accessed very easily by diasporans via smartphones, people in their networks are identified as the most important source of information.

This finding across diasporan related information seeking behaviour research can be leveraged by medical device designers in the following ways:

- Diasporans are conduits to people of value to the medical device design process,
- The strength of the relationships between the diasporan and the people in their network can be utilized to quickly respond to the needs of medical device designers to answer questions regarding the context of the place they are designing for, and
- It would take much longer for a medical device designer to create a similar social network without the assistance of the already formed social network of the diasporan the designer is working with.

This significant finding addresses the challenges that medical device designers face in terms of lack of time and budget to fully understand the contextual categories in low resource settings. By engaging with a diasporan, a designer can reduce the time and budget needed to develop their own connections to people with similar information, hence improving their ability to develop a successful medical device for a low resource setting.

Egocentric Social Networks Lead to Probability of Novel Information

Most of the networks have efficiency scores above 70%. This indicates that the diasporan is able to provide connections to people that are not connected to each other and can therefore be sources of greater numbers of novel ideas than the networks that were more connected (Burt, 2004; Saglietto, CeZanne, & David, 2020)). The quantitative analysis of the

DHDA-related egocentric social networks of the participants demonstrate that the majority of them provide a good chance of accessing novel ideas as demonstrated by the measures of efficiency in the following table:

Table 18

Size, Effective Size, and Efficiency of DHDA-related Egocentric Social Networks

Participant	1	2	3	4	5	6	7	8
Size	16	19	6	13	6	6	9	7
Effective Size	12.5	14.8	5	9.3	3.7	4.8	3.0	6.4
Efficiency	0.781	0.788	0.833	0.716	0.611	0.806	0.333	0.918

The network efficiency size indicates of the level of connectivity of a particular area of healthcare. Healthcare areas that have networks that are highly connected may have less efficiency with respect to new ideas and may have more difficulty with change than areas of healthcare that have networks that are more efficient and more sources of new ideas. This could be an added barrier to the adoption of new medical device designs. Only one of the participants had an egocentric social network with an efficiency of less than 50%.

Diasporans have Unique Information Seeking Behaviours

The literature on information seeking behaviour of diasporans utilizing a holistic diasporic information environment model approach informed this research by presenting results that indicated that the DIEMs for all participants were unique (Allard, 2015; Komito, 2011; Schöpke, 2019). For example, although all participants in all four studies ranked people as being the most important source of information, the use of ICT and other information sources were quite varied across all four DIEM related research studies. Although a designer can be relatively

confident that the people in a diasporan's egocentric network will be an important source of information, they will have to learn about the other information sources, both ICT-mediated and placed-based, that are relevant for each diasporan that they work with as no consistent pattern was discovered in the DIEM related research.

ICT-mediated and Place-based Information Sources Importance Not Consistent

The ICT-mediated and place-based sources of information did not form any patterns with respect to level of importance overall, either in my findings, or the other DIEM-related literature (Allard, 2015; Komito, 2011; Schöpke, 2019). This is relevant to medical device designers as they will need to understanding that ICT-mediated and place-based sources of information are dependent on a particular diasporan. The designer will have to work with a particular diasporan to determine which ICT-based and/or place-based sources of information provide timely, credible, and immersed information of relevance to the particular health problem to be solved via medical device design.

Memory Not Credible, Travel Essential as a Source of Information in DIEM

Also, this research presented detailed qualitative DIEMs for each participant, including memory and travel. Although the other DIEM focused research studies didn't include memory or travel, other literature from outside of the information seeking behaviour literature show similarities to my findings.

Although the participants discussed the importance of memory as the motivator for their involvement in their DHDA, none of them were confident that they could provide timely, credible, or immersed information from memory. Similarly, research on diasporan knowledge networks indicate that diasporans involved in such activities identify with their country of origin

in a proactive way that is turned to the future rather than based on memory (Meyer & Wattiaux, 2006). This points to both research studies finding that memory of country of origin may be the driver for participation, but that their work in DHDAs or other types of diasporan knowledge networks are rooted in the present and looking toward the future. Unless a diasporan has an active connection with their country of origin, it is possible that they could provide information that is out of date to the designer. Information that isn't timely can lead to designs that don't meet the current needs of people. As such, medical device designers must understand this finding from this research so that they engage with diasporans that are actively involved in healthcare development activities, not diasporans more generally.

Travel was discussed in the literature as a characteristic of brain circulation. Brain circulation is described as the knowledge and skills that flow back and forth between a diasporan's country of origin and country of destination via the diasporans themselves (Saxenian, 2002). Brain circulation research involved healthcare development activities (Afridi, Baloch, & Baloch, 2016; Saxenian, 2002). The research on brain circulation indicated that travel of diasporans between their country of origin and country of destination was an essentail component of successful projects. This finding aligns with the finding from this research that also indicates that travel is an important information seeking behaviour to access timely, credible, and immersed information. This is relevant to designers as the finding also addresses the challenges of lack of time and budget to understand the contextual categories of low resource settings. Engaging with diasporans that are already travelling between their countries of origin and destination can reduce both the time and budget required for a designer to travel to the low resource setting themselves.

Gap in Qualitative DIEM Detail

Reviewing the literature on DIEMs identified a gap in the qualitative description of each participant's DIEM (Allard, 2015; Komito, 2011; Schöpke, 2019). In Chapter 4, I have provided rich qualitative detail of each participant's DIEM from this research as that gives readers a sense of the uniqueness of each one as well as the differences between each one. Diasporans were found to have information sources related to particular geographies. They also had different types of social networks and demonstrated a unique set of ICT-mediated and place-based information sources. This is important to medical device designers as they will need guidance to find diasporans that have the information they need to understand the context of a particular health problem in a specific part of the world (Aranda-Jan, Jagtap, & Moultrie, 2016). Unlike the other DIEM studies, I did not aggregate the data from participants from a particular country of origin or country of destination (Allard, 2015; Komito, 2011; Schöpke, 2019). For example, Allard discussed the data collected but didn't include the DIEM for each participant (Allard, 2015). After a brief description of each participant, Allard then described the participants' information seeking experiences during their immigration experience by phase and blended the responses from participants together (2015). Komito provided a description of the information seeking behaviour of his participants in terms of percentages of participants that used particular communication platforms or accessed types of information sources (2011). Similarly, Schöpke also presented aggregate results of the information seeking behaviour of their participants upon migrating, and didn't include a description of the DIEM for each participant (2019). I treated each participant as a unique person with a potentially powerful social network and other sources of information that would be valuable to a particular designer. For example, if a designer needed

to better understand the community, it would be important that the diasporan they were working with uses information grounds (such as community centres or temples) in their DHDA. Not all diasporans involved in DHDAs utilized information grounds so it is important for a designer to understand this and be guided to finding a diasporan with this type of connection (Aranda-Jan, Jagtap, & Moultrie, 2016). A designer will have to know the following characteristics of the information they are seeking from a diasporan involved in a DHDA:

- The geographic part(s) of the world they are designing a medical device for,
- The contextual categories they need to fully understand the context of the low resource setting they are designing for,
- The medical specialty the medical device is part of, and
- The type of patients, users, and other stakeholders that are involved in the medical device they are developing (Aranda-Jan, Jagtap, & Moultrie, 2016).

Once the designer has developed a good understanding of these issues, they can begin their search for a diasporan involved in a DHDA that matches these issues.

Diasporans Studied as Valuable Sources of Information vs Deficit of Information

The study of diasporans as a valuable source of information, or conduits to sources of credible, timely, and immersed information aligns with other research related to the value of diasporans as sources of information. Researchers have identified medical diaspora as underused entities in low- and middle-income countries' health systems development (Frehywot, Park, & Infanzon, 2019). Frehywot, Park, and Infanzon conducted a review of medical diaspora organizations and their findings indicated that there were 89 organizations in the US, Canada, the United Kingdom, and Australia (2019). They argue that these organizations can be utilized more

than they currently are in health systems development and listed the organizations to make it easier for individuals and other organizations to connect with them. In the context of this research study, six of the eight participants were medical diasporans and were utilizing their skills to develop health systems in their countries of origin. The other DIEM studies presented diasporans as persons looking for information to help them navigate migration processes and/or identity development processes due to migration (Allard, 2015; Komito, 2011; Schöpke, 2019). As has been argued throughout this research, designers can engage with diasporans, as valuable sources of information, to assist them with the development of medical devices which are an essential part of health systems.

Analysis of Findings of DIEM Research

This section summaries the research findings as they relate to the literature on DIEMs. It identifies areas where the results of this research align or diverge with the other research investigating the diasporic information environment model of diasporans. Through this exploration of the research, a number of areas were in alignment between the research findings and the literature:

- People in the egocentric networks of all research participants were found to be the most important sources of information regardless of research question. This is a significant finding that can reduce the time and budget necessary for designers to access necessary contextual information (Allard, 2015; Caidi, Allard, & Quirke, 2010; Komito, 2011; Schöpke, 2019), and
- The heterogeneous pattern of other place-based mediated or ICT-mediated source of information between participants indicates that designers will have to learn the pattern for

each diasporan they engage with to access the credible, timely, and immersed information they are looking for (Allard, 2015; Komito, 2011; Schöpke, 2019).

The following issue that emerged from this research diverged from the other studies utilizing DIEMs.

- Diasporans are a source of information in this research study. The other research studies of DIEMs present diasporans as having a deficit of information. This is an important turn in the literature as most information seeking behaviour research has focused on the lack of information of immigrants. Designers can learn from diasporans involved in DHDAs to help them develop medical devices for low resource settings (Allard, 2015; Frehywot, Park, & Infanzon, 2019; Komito, 2011; Schöpke, 2019).

Lastly, a gap was identified between research findings of this study and other DIEM studies as memory, travel, and rich qualitative description of DIEMs were not presented in the other studies:

- Participants expressed that memory doesn't play an important role in the information they need to work on current healthcare development activities. This significant finding emphasizes the need for designers to look for diasporans that are actively involved in diasporan healthcare development activities (Allard, 2015; Komito, 2011; Meyer & Wattiaux, 2006; Schöpke, 2019).
- Participants stated that travel is an important information seeking behaviour in diasporan healthcare development activities. This can reduce the time and budget necessary for a designer to travel to the low resource setting themselves while gaining the needed

information through diasporans already travelling there (Abshir, 2020; Allard, 2015; Komito, 2011; Mishra, 2016; Schöpke, 2019; Zeleza, 2019), and

- The rich qualitative description of DIEMs is required to be of value for medical device development purposes. This demonstrates that designers need to first understand what information they are looking for. Designers must create a diasporan information environment model that describes the information they are looking for in terms of geographic areas, clinical areas, and contextual knowledge areas. Designers can also focus on the type of diasporan healthcare development activity that can best assist in accessing the type of information they need for a particular medical device. Once they know what information they need, they can then compare that to the rich qualitative descriptive of the DIEM of a diasporan to find a match (Allard, 2015; Komito, 2011; Schöpke, 2019).

Identification of Themes from Research Question 1 Across Participants for Each Type of Source of Information

Unifying Themes

Each individual diasporan and their corresponding DHDA is unique in terms of their information seeking behaviour. None of the participants used the same pattern of information seeking behaviour with respect to local place-based, globalized ICT-based, or other globally based information sources as a whole. However, four unifying themes emerged across participants regarding the type of source of information:

- Egocentric Social Networks: Very Important
- ICT-mediated Information Sources: News Easily Accessible but Not Credible
- Memory: Not Reflective of Current State of Culture

- Travel: Valuable Information Seeking Behaviour

The following sections discuss the four unifying themes that emerged from the participants.

Egocentric Social Networks Unifying Theme: Very Important

Egocentric social networks related to participants' DHDAs showed few similarities. However, almost all of the alters that diasporans identified in their egocentric social networks were characterized as being very important sources of timely, credible, and immersed information..

Each network had at least one alter in their country of destination and multiple alters in their country of origin. Participants worked with a minimum of 6 and a maximum of 18 alters in the egocentric social network related to their DHDA. Participants involved in providing healthcare services for their country of origin as primary care or specialty physicians had networks with either 6 or 7 alters, while participants involved in nonprofit-oriented or company-oriented DHDAs had networks between 9 and 18 alters. This finding aligns with research on the social network size of people generally (Dunbar, 2014) and of communities of practice (COPs) (Webber & Dunbar, 2020). Webber and Dunbar analyzed a dataset on the size of active communities of practice in the workplace and found that COPs size is limited to approximately 40 (2020). They argue that personal egocentric social networks and professional (communities of practice) egocentric social networks have similar characteristics and argue that these are subject to the same kinds of constraint (2020). The constraints include the cognitive demands and the time required to manage large numbers of relationships and they argue that this likely influences the size of COPs in much the same way as they do the size of human social groups (Webber & Dunbar, 2020).

Each participant considered most of their alters as either very important or important to their work. Also, the majority of alters were considered highly educated professional colleagues with few alters described as family or friends. Out of a total of 482 alters described by eight participants, only 6 were listed as important and 3 as not important. Three of the eight participants described all of their alters as very important. This reveals a unifying theme that the people or organizations that participants were working with are considered to be of great value to the success of the DHDA. As such, connecting with a diasporan involved in a DHDA is likely to lead to being connected through the diasporan to a group of valuable people and/or organizations that may be of immediate value to a medical device developer. They also described multiple alters' information to be immediate in terms of timeliness, high in terms of credibility, and embedded in terms of level of immersion in their countries of origin. This finding again aligns with Webber and Dunbar's research on the number of very important or important people represented by the two innermost layers of alters in an egocentric network of people that are part of communities of practice (2020).

ICT Unifying Theme: News Easily Accessible but Not Credible

For most participants, the news was described as an easy source of information to get but not a credible source of information and is the second unifying theme. In most cases, participants described the news as either less or not important sources of information. They also indicated that the news was an easily accessible information source. Most participants stated that they independently verified any issues reported on in the news before they acted upon it. This finding aligns with research on source credibility of news outlets (Stecula, 2019). Stecula found that 700 research participants rated the legitimacy of different news outlets between 30 and 68 out of a

possible 100 points for legitimate sources (Stecula, 2019). However, Stecula also found that people that do have trust in the news may not be well equipped to separate quality information from false information (2019). For example, some respondents attributed more legitimacy to fake news outlets than traditional news sites. Also, Pennycook, Cannon, & Rand, found that prior exposure to fake news can increase subsequent perceptions of accuracy (2018). Most participants of my research study did not think the news was credible. This finding also aligns with research on diasporans and their critical stance on the news (Christiansen, 2004). Christiansen conducted an analysis of both qualitative and quantitative news consumption by immigrants in Europe and found that they had a critical stance towards news sources (2004). They may have had shared experiences as diasporans that led to this unifying theme. Their life experience of immigration to a new country and their heightened ability to describe culture may also have given them the tools needed to navigate the credibility, or lack of credibility, of news sources from both their countries of origin and countries of destination.

Memory Unifying Theme: Not Reflective of Current State of Culture

For all participants, memory was not seen as a timely, credible, or immersed source of information and is the third unifying theme. However, memory seemed to create strong emotional feelings in all participants. Each participant's answer to the question regarding the use of memory as a timely, credible, and immersed source of information regarding their DHDA yielded a different response but all agreed that their memory is not reflective of the current state of the culture in their countries of origin.

The following strong feelings were expressed when participants were queried about the role of their own memories as a source of information:

- Created a passion for making a positive change in their country of origin,
- Developed their sense of need for resources in their country of origin,
- Created a passion for learning as many languages and/or dialects as possible as this was the way to connect with the people they are trying to support,
- Reflected upon memories as being biased and subjective, even recent memories,
- Reflected upon being careful not to assume things have or haven't changed as they considered this to be a form of arrogance they wanted to avoid,
- Created a capacity to learn how to solve problems during difficult times and not take anything for granted, and
- Developed a sense of sadness when they experienced public healthcare in Canada and compared it to healthcare in their country of origin because of lack of political will, not resources.

The findings from my research on the use of memory as a timely, credible, and immersed sources of information align with other research on memory of immigrants of their countries of origin. Sequeira discusses how memory is understood as a matter of experience, recollection, communication, and social interaction (2015). As time has passed, and my participants have had many experiences and social interactions since their formative years in their countries of origin, their view of their memories as not being accurate as a source of current information aligns with this view.

Travel Unifying Theme: Valuable but Volatile Information Seeking Behaviour

Travel was one component of the diasporans' DHDA information environment that almost all participants said was important and is the fourth unifying theme. In many cases

participants described the pace of change to be rapid in their countries of origin such that travel was necessary to stay up to date on the healthcare system. This aligns with other research on the importance of travel on the development work of diasporans in their countries of origin (Abshir, 2020; Mishra, 2016; Zeleza, 2019). However, three of the eight participants had not travelled to their countries of origin as part of their DHDA since their last arrival in Canada. Although this is represented as a unifying theme, it's important to note that for a variety of reasons including cost, time, and immigration status, travel was not something all of the participants engaged in at the time of the interviews. In fact, during the writing of this dissertation, the global COVID-19 pandemic put a major restriction on air travel severely limiting the potential for DHDA related travel. The future of air travel, until a vaccine is developed for COVID-19, is uncertain and may lead to permanent restrictions as well as increased costs of travel. Therefore, although travel remains an important method for obtaining timely, credible, and immersed information in low resource settings, the characteristics of air travel being relatively accessible for the research participants during the interview period changed within one year to being severely restricted (Gossling, Scott, & Hall, 2020).

Summary of Unifying Themes

The previous sections describe the areas of commonality between the participants with respect to answering the first research question: How do individual diasporans conduct DHDAs and what are the local place-based and globalized information and communication technology (ICT) based or other globally based information sources of these individual diasporans? Each participant and corresponding DHDA was found to be unique; however, there were a few commonalities that can be highlighted as unifying themes as follows:

- Most alters were described as very important or important and the information they provided was described as immediate in terms of timeliness, high in terms of credibility, and embedded in terms of level of immersion in their country of origin. This is the first unifying theme of relevance to the study as these are the types of information sources that are necessary for successful medical device development.
- The second unifying theme of relevance to the study is the lack of credibility of information from the news. Most participants said that they would have to verify any information they learned from news sources before characterizing it as credible. In some cases, participants said that they would tap into their egocentric social networks or closed social media sites for verification.
- Diasporans that participate in healthcare development activities for their countries of origin do not think that their memories provide timely, credible, or embedded sources of information. As such, a third unifying theme is that it is not advisable to utilize information from memory alone to feed directly into a medical device design process.
- In many cases participants described the pace of change to be rapid in their countries of origin such that travel was necessary to stay up-to-date on the healthcare system. This is an fourth unifying theme of major relevance to the study as the need to be present to understand the healthcare context aligns with best practices in design methodology. It's also important to note that the ability to travel is in flux at the time of the writing of this dissertation due to the global COVID-19 pandemic.

Comparing the participants has led to the development of four important unifying themes. This suggests it is important to have an informed framework to guide medical device developers when

engaging with diasporans involved in DHDAs as a source of information for their medical device design projects. Diasporans involved in DHDAs can play an important role when their information seeking behaviour is understood and reflected upon by the medical device designer. However, indiscriminately utilizing sources of information from diasporans may also lead to errors in thinking that could lead to poor design decisions.

Disunifying Themes

When contrasting the participants' modified DIEMs, six disunifying themes emerged as follows:

- Egocentric Social Network: Unique Geographic Locations, Structures and Contextual Knowledge Areas
- Libraries: Varied Opinions on Value to DHDA
- Open Social Media: Secondary Source of Information Requiring Verification
- Closed Social Media: Valuable Source for Medical Professional Participants
- Websites: Varied Opinion on Value to DHDAs
- Information Grounds: Valuable Source if Relevant to a particular DHDA

Egocentric Social Network Disunifying Theme: Unique Geographic Locations, Structures and Contextual Knowledge Areas

The egocentric social networks of participants had a number of commonalities discussed in the section on unifying themes; however, they also have a number of dissonant characteristics of importance to understand. The egocentric social networks of participants were unique in terms

of geographic location, size, areas of contextual knowledge, and the type of DHDA and is the first disunifying theme. The variation in each characteristic is as follows:

- Geographic locations include India (3 participants), Nigeria (2 participants), Ghana (1 participant, Madagascar (1 participant), and Panama (1 participant)
- Size of network ranges from 6 to 19
- Areas of contextual knowledge include sociocultural (8 participants), public health (8 participants), and economic (3 participants)
- Type of DHDAs include doctor-driven (4 participants), nonprofit-oriented (2 participants), and for profit companies (2 participants)

This variation in the egocentric social network of diasporans involved in DHDAs requires designers to find diasporans involved in DHDAs that match the information needs that the designer has. This finding aligns with research on the emergence and effectiveness of global health networks that have formed to address global health problems. According to Shiffman et al., global health networks address a wide range of health issues, operate in a wide range of geographic regions, and are made up of a range of individuals and types of organizations (2016).

Library Disunifying Theme: Varied Opinions on Value to DHDA

The use of libraries among participants was varied, with some utilizing academic publications and books while others did not engage with the library at all. As such, the use of the library emerged as the second disunifying theme.

Three of the participants felt that the library was an important source of information for their DHDA. Three participants that were medical specialists accessed academic publications to keep up to date in their field and, in one case, to brush up on areas that they weren't expert in.

This finding aligns with the findings of research on the use of libraries in information seeking behaviour of physicians (Aakre, Maggio, Fiol, & Cook, 2019; Daei, Soleymani, Ashrafi-Rizi, Zargham-Boroujeni, & Kelishadi, 2020). Aakre et al. conducted a systematic review of studies exploring barriers to and facilitators of point-of-care information seeking of electronic knowledge resources including information in library databases (2019). One of the facilitators found was the assistance of a librarian however this was difficult at point-of-care (Aakre et al., 2019). Daei et al. conducted a systematic review of physicians' clinical information seeking behavior and found that libraries and hospital libraries were a source utilized where available (2020).

However the remaining participants either felt that the use of the library was a secondary source of information or not an important source of information with respect to their DHDA. Two participants described the use of the library as secondary in terms of information seeking related to their DHDA. One participant did go to the library for content, such as the latest research on diet and nutrition, but felt that it was secondary to the work of his DHDA that required the action of people to translate that information into a useful program on nutrition, for example. One participant described the use of the library as a place to study rather than a source of information. The remaining three participants did not feel that the library was a source of information that they accessed with respect to their DHDA. These findings align with research on knowledge translation in health. Sipido and Nagyova argue that a need exists for a multidisciplinary strategy that connects health research and achieving better health (2020). The researchers examined the barriers and hurdles to translating research results on cardiovascular diseases into implementation and found a lack of cross-disciplinary health approaches (Sipido &

Nagyova, 2020). This may explain why the majority of the participants in my research didn't find the information from the library of great importance to their work in achieving better health for people through their DHDAs.

Open Social Media Disunifying Theme: Secondary Source of Information Requiring Verification

The use of open social media, such as public pages of organizational social media sites, was varied and emerged as the third disunifying theme. Some participants utilized open sources of social media for a variety of purposes while others did not engage with social media at all with respect to their DHDA.

Some of the DHDA organizations had open social media accounts including Facebook, LinkedIn, Twitter, and YouTube. These accounts were used to provide information to people interested in their DHDAs. One participant mentioned that his DHDA organization utilized open social media accounts to facilitate donations to the DHDA organization. Another beneficial use of an open social media account for one participant was as an information source on medical treatment from a doctor in Nigeria providing medical care to patients in rural and remote areas of Nigeria.

Information gathered from open social media accounts was also described as a source of background health information or a secondary source of information. Information gathered via open social medical sites was always verified by a medical professional, according to one participant. For one participant, open social media targeted to elderly patients in India fostered misinformation and was a source of frustration. For a subset of participants, open social media accounts were not used at all. Reasons for not using open social media accounts for DHDAs included lack of accurate health information and a lack of time. These findings align with

research by Swire-Thompson & Lazer who argue that, although the internet has become a popular resource to learn about health, a large amount of inaccurate information is shared, particularly on social media sites (2020). Researchers discuss the challenges with navigating health information online and propose several strategies for improving the online information ecosystem such as improving ehealth literacy and strengthening the signal of source quality online (Chou, Oh, & Klein, 2018; Swire-Thompson & Lazer, 2020).

Closed Social Media Disunifying Theme: Valuable Source for Medical Professional Participants

Closed social media, such as a closed WhatsApp group of doctors from a particular school, presented as the fourth disunifying theme across study participants. Closed social media sites were described as a highly credible, timely, and immersed source of information for those that used them in all but one case. The closed social media sites consisting of medical professionals were cited as a very valuable source of credible, timely, and immersed information. The four medical doctors, two primary care doctors and two medical specialists, all described the use of closed WhatsApp or Facebook sites of their colleagues that they went to for information. In some cases, the members of the closed social media sites were composed of people that they graduated with. In other cases, they were composed of a range of medical colleagues from their countries of origin focused on a single medical field such as pathology. In the cases of closed social media sites of fellow graduates, the members had experience in a wide range of medical specialties. This finding aligns with research on the value of closed social media sites of medical professionals for sharing information (Chan & Leung, 2018; Ganasegeran, Renganathan, Rashid, & Al-Dubai, 2017). Chan and Leung conducted a systematic review of the literature published since 2007 to examine the the use of social network sites for communication among health

professionals (2018). They found that many different types of social network sites were used and that WhatsApp in particular was appriased as an efficient and easy to use application (Chan & Leung, 2018). Genasegeran et al. conducted a study of 307 health professionals' use of WhatsApp clinical groups and found that the majority of respondents perceived WhatsApp as beneficial to their clinical practice (2017).

Lastly, one participant described the information circulating on closed social media sites of elderly people in his country of origin, including his own grandfather, as spreading misinformation about health treatments. The use of closed social media in this circumstance led to the spread of poor-quality health information that wasn't credible although it was timely and immersed. This finding aligns with the research by Swire-Thompson & Lazer (2020) and Chou, Oh, & Klein (2018) on the challenges that online misinformation causes in public health.

Swire-Thompson and Lazer explored how individuals interact with health misinformation online and proposed a number of strategies to address health misinformation including: 1) improving ehealth literacy; 2) using the internet as a collaborative tool with physicians; and 3) strengthening the signal of source of quality online (2020). A viewpoint by Chou et al. discuss the necessity to determine when and how to intervene in misinformation on health due to the negative consequences it can have on people health (2018).

Websites Disunifying Theme: Varied Opinion on Value to DHDAs

The use of websites was varied and emerged as the fifth disunifying theme. Some participants discussed the use of websites as sources of information while others did not describe websites at all with respect to their DHDA.

A number of participants mentioned the use of websites for medical professionals as a credible source of information. Websites with less credible medical information was also mentioned, including Wikipedia that has been creating more credible content according to one doctor. The other use of websites was for the company-oriented or non-profit-oriented DHDA organizations that had their own websites. One participant also mentioned the use of one diasporic website that connects physicians that have left their country of origin. This was the only diasporic website mentioned by participants. One participant mentioned the use of an international medical society website as a credible source of technical and clinical information. Two participants did not mention the use of any specific websites as sources of information for their DHDAs. This finding aligns with the research by Swire-Thompson and Lazer (2020) on how individuals interact with health information online including information from websites. The researchers found that people seeking health information online utilize many sources to find content including direct to online source, online searches via search engines such as Google, and user generated content from sites such as Yelp. Due to the range in quality of health information available they suggest the need for greater ability to signal the quality of the source to the health seeker (Swire-Thompson & Lazer, 2020). A tool that signals the quality of the source of the website would be of great value to diasporans involved in DHDAs as well as designers of medical devices for low resource settings as well.

Information Grounds Disunifying Theme: Valuable Source if Relevant to a Particular DHDA

The use of information grounds was varied and emerged as the sixth disunifying theme. Some participants described activities they participated in at information grounds while others did not engage with information grounds at all with respect to their DHDA

In terms of information grounds, five participants described activities in churches, temples, community centres, and cafes. Activities ranged from community education, getting together with healthcare colleagues to discuss issues, engaging with the community, and volunteering for the DHDA. In many cases, participants felt that the interaction they had with people through their activities based in information grounds to be very important to their DHDA. The ability to discuss topics related to their DHDAs directly with people was key. This finding aligns with research on the crucial need for community participation in addressing global health issues (Marston, Hinton, Kean, et al., 2016; Marston, Renedo, & Miles, 2020).

However, three participants didn't feel that information grounds were relevant to their DHDA. Two participants were highly trained medical specialists, and one was involved in a company-oriented DHDA.

Summary of Disunifying Themes

The previous sections describe the areas of dissonance between the participants with respect to answering the first research question: How do individual diasporans conduct DHDAs and what are the local place-based and globalized information and communication technology-based or other globally based information sources of these individual diasporans? Each participant and corresponding DHDA was found to be unique with areas of dissonance that can be highlighted as disunifying themes as follows:

- The egocentric social networks of participants were unique in terms of the combination of geographic location, structure, areas of contextual knowledge, and type of DHDA,
- The library provided a source of credible medical information that was important to the medical specialists. However, not all participants utilized the library for the purposes of

their DHDAs. One cannot assume that the library is a source of information that diasporans involved in DHDAs access,

- Sources of open social media such as open Facebook pages were used to promote some DHDAs that had corresponding organizations. Open social media sites were, at best, a secondary source or background source of information that needed to be verified by participants that utilized them. Not all participants utilized open social media sites. Although open social media sites are easily accessible, not all diasporans involved in DHDAs use them, and when they do, they usually need to verify the information,
- Sources of closed social media sites for medical professionals were a very important source of information for the medical professional participants in this study. The ability to connect with a group of medical colleagues to discuss medical issues as well as confirm news reports were listed as some of the uses of these sites. However not all participants used closed social media for their DHDA,
- Similar to the library, some websites provided a source of credible medical information that was important to medical specialists. Also similar to open social media, some websites provided sources of information about the diasporans DHDAs. Also, diaspora websites were not found to be an important source of information for most of the participants. Lastly, not all participants utilized websites with respect to their DHDAs. Websites represent a wide range of information, some highly credible; however, not all diasporans involved in DHDAs find them relevant to their DHDA, and
- Information grounds were found to be either very important as a source of information for diasporans involved in DHDAs or not relevant to their DHDAs. For diasporans that

did mention utilizing information grounds, they were a rich source of interaction with people in their countries or origin or countries of destination. However, not all participants utilized information grounds with respect to their DHDAs. This is the fifth disunifying theme of relevance to the study. Information grounds can be a conduit to people of relevance to a diasporan's DHDA; however, not all diasporans utilized them for their DHDAs.

Comparing the participants has led to the development of five important disunifying themes. Similarly to the finding of important unifying themes, this also suggests it is important to have an informed framework to guide medical device developers when engaging with diasporans involved in DHDAs as a source of information for their medical device design projects. Without such a framework, indiscriminately utilizing sources of information from diasporans may also lead to errors in thinking that could lead to poor design decisions.

Research Question 2

How does a diasporan's information seeking behavior affect the quality of the information in terms of timeliness, credibility, and immersion with respect to the medical device use environment? The following section discusses this research question.

Timeliness, Credibility, and Immersion of Information Sources Themes

The following section synthesizes how participants described their sources of information with respect to their DHDA in terms of timeliness, credibility, and immersion in the corresponding low resource setting. The following unifying and disunifying themes emerged from this research:

Unifying themes

- Alters' Information: Highly Credible, Timely, and Immersed
- Travel: Very Important for Timely, Credible, and Immersed Information
- News: Not Credible, Although Timely and Immersed
- Memory: Not Credible, Timely, or Immersed

Disunifying themes

- Information Grounds: Beneficial for DHDAs Involving the Public
- Social Media: Closed Medical Professional Social Media Very Credible, Open Social Media Not Credible
- Library: Credible Medical Information but Not Relevant to All DHDAs
- Websites: Varying Degrees of Credible Sources of Medical Information

Alters' Information Unifying Theme: Highly Credible, Timely, and Immersed

The first unifying theme is that all participants had multiple alters in their countries of origin that they described as highly credible, timely, and immersed sources of information. This was a common and unifying theme that cut across all DHDAs. This finding aligns with research on the importance of people as sources of information from the diasporan information seeking literature (Allard, 2015; Caidi, Allard, & Quirke, 2010; Komito, 2011; Schopke, 2019) and the physician information seeking literature (Daei, Soleymani, Ashrafi-Rizi, Zargham-Boroujeni, & Kelishadi, 2020). As six of the eight participants were physicians or medical professionals, this is a relevant finding as well.

People that are highly credible and can provide timely and immersed information from a low resource setting are of great value to medical device designers (Aranda-Jan, Jagtap, & Moultrie, 2016). For medical device designers without contacts in the low resource setting they are designing for, connecting with a diasporan involved in a relevant DHDA could represent a connection to a valuable source of information from a pre-existing network, saving both time and money. In terms of both structural holes and strength of weak ties theories, adding a diasporan with a pre-existing DHDA egocentric social network can increase the medical device designer's network in a valuable way. According to these theories, this type of connection increases a person's access to new knowledge and ideas (Burt, 2004; Granovetter, 1973; Saglietto, CeZanne, & David, 2020).

Travel Unifying Theme: Very Important for Timely, Credible, and Immersed Information

Four participants had been travelling back to their country or origin for the purpose of their DHDA at the time of the interviews. All four participants indicated that travel was a very important part of their DHDA to remain knowledgeable about the current environment and this emerged as the second unifying theme. Reasons given by participants for travel with respect to their DHDA included medical training, gathering business intelligence, relationship building, and program development. Three participants indicated that although they didn't have plans to travel back to their country of origin in the near future, they all planned to travel there in the future. Two doctors were enrolled in educational programs in Canada at the time of the interviews, and one participant was waiting to become a landed immigrant before she could leave Canada and return with her ability to remain in Canada intact. The remaining participant was a medical specialist from Nigeria that conducted his DHDAs mostly from Canada with only

one trip back to visit his family in his country of origin a number of years ago. These findings align with research on the role of travel in aiding diasporans that are involved in development activities for their countries of origin (Abshir, 2020; Mishra, 2016; Zeleza, 2019). Travel enables diasporans to access information directly from their countries of orign which is timely and immersed. However the ability to travel can be affected by costs and immigration status, as well as by global pandemics (Gossling, Scott, & Hall, 2020).

News Unifying Theme: Not Credible, Although Timely and Immersed

The news was not considered credible by participants and emerged as unifying theme for seven of the eight participants. One participant was an avid reader of the news both from her country of origin and country of destination. She was a medical specialist providing training in her country of origin with little information regarding her medical specialty coming from the news, and so her news reading was for a more general purpose than her DHDA. Other participants felt that the news was a source of background or secondary information with respect to their DHDA, and that, at best, they would check any information they gathered from news sources. As such, the news is considered to be a source of low credibility although it is timely and immersed in the low resource setting. As discussed above, this finding aligns with research on the lack of legitimacy of the news as a source of credible information (Stecula, 2019) and more specifically, the critical stance diasporans take with the news (Christiansen, 2004).

Memory: Not Credible, Timely, or Immersed

Memory was not considered credible, timely, or immersed by participants and emerged as a unifying these for all of the participants. Most participants discussed the rapid rate of change in their countries of origin as the main reason why they couldn't depend on their memories alone

as a credible source of information. One participant stated that everything has changed in her country of origin. Other participants felt that their memories were too subjective. This finding aligns with research on the changing nature of memory over time (Edelson, Sharot, Dolan, & Dudai, 2011; Sequeira, 2015). For example, Edelson et al. utilized functional brain imaging to determine that social influence modified the neuronal representation of memory (2011). In Sequeita's work on understanding migration, memory is also discussed in terms of being influenced by the present (2015). As designers require credible, timely, and immersed sources of informaiton, this is a critical finding and should be noted by designers to ensure they do not utilize information gathered via the memory of diasporans alone. Information from diasporans' memory may be very useful, however it needs to be verified to determine if it is still accurate.

Disunifying Themes

The remaining sources of information presented in a variety of levels of credibility, timeliness, and immersion for the participants. As such they are described as disunifying themes, and medical device designers will need to work carefully with diasporans involved in DHDAs to understand their particular views on the remaining sources of information.

Information Grounds Disunifying Theme: Beneficial for DHDAs Involving the Public

Information grounds emerged as being a source of credible, timely, and immersed information from the public for three of the eight participants and emerged as the first disunifying theme. Examples included providing information to mothers on child and maternal health issues through community centres, discussing chronic disease management with people at gudwaras, and hosting information and fundraising events for children with prosthetic limbs

aging out of the healthcare system in churches. Another participant described the use of cafes as a place to discuss the state of healthcare with his medical colleagues. Participants indicated that these were places where you could find credible, timely, and immersed sources of information related to their DHDAs. These examples of the use of information grounds reveal an important conduit to a wide variety of people in low resource settings. People involved in activities occurring in information grounds include women with children, children with prosthetic limbs, people visiting gudwaras, and medical doctors. Getting access to potential medical device users, patients, and medical professionals via diasporans through events at information grounds could be of great value to medical device developers, depending on the nature of the device. The remaining five participants did not utilize information grounds as a source of information for their DHDAs and indicated that they were not an important source of information for their DHDA. This finding aligns with research on health topics that require community engagement. In these cases, information grounds are an important source of information (Marston, Hinton, Kean, et al., 2016; Marston, Renedo, & Miles, 2020).

Marston, Hinton, Kean, et al. developed a bulletin that proposed community participation, that can be facilitated in information grounds, as central to achieving the objectives of a global health strategy (2016). Similarly, Marston, Renedo, and Miles commented that community participation is critical to participation in the COVID-19 response and suggest that funds are needed to create dedicated staff and spaces to bring the public and policy makers together (2020). The challenge in the times of a global pandemic such as COVID-19 is to create a safe physical community space or information ground.

Social Media Disunifying Theme: Closed Social Media Very Credible, Open Social Media Not Credible

When queried about social media as a credible, timely, and immersed source of information, participants described a range of responses and it presented as the second disunifying theme. The first characteristic that is of significance is the difference between open and closed sources of social media. Open social media presented as a unifying theme requiring verification across the majority of study participants. For open sources of social media, only one participant indicated that they accessed an open social media page as a source of credible, timely, and immersed information. This was the Facebook page of a medical doctor providing medical care to his patients in a rural and remote area of Nigeria and sharing his experiences through his open Facebook page. The four participants that were involved in company- or nonprofit-driven DHDAs had corresponding open social media accounts to promote their organizations. In contrast to these positive usages, several participants did not have personal open social media accounts and cited a lack of time as one reason. Participants that mentioned open social media sites as sources of news or health information also indicated that they would verify the information they encountered via open social media sites.

Closed social media presented as a disunifying theme across study participants. Closed social media sites were described as a highly credible, timely, and immersed source of information for those that used them in all but one case. The closed social media sites consisting of medical professionals were cited as a very valuable source of credible, timely, and immersed information. The four medical doctors, two primary care doctors and two medical specialists, all described the use of closed WhatsApp or Facebook sites of their colleagues that they went to for information. In some cases, the members of the closed social media sites were composed of

people that they graduated with. In other cases, they were composed of a range of medical colleagues from their countries of origin focused on a single medical field such as pathology. In the cases of closed social media sites of fellow graduates, the members had experience in a wide range of medical specialties. Lastly, but importantly, one participant described the information circulating on closed social media sites of elderly people in his country of origin, including his own grandfather, as spreading misinformation about health treatments. The use of closed social media in this circumstance led to the spread of poor-quality health information that wasn't credible although it was timely and immersed.

These findings align with research on the variation in the quality of health information on social media (Chou, Oh, & Klein, 2018; Swire-Thompson & Lazer, 2020). The use of closed social networking sites by groups of medical professionals as a way to share credible and timely information was also found to beneficial by other researchers (Chan & Leung, 2018; Ganasegeran, Renganathan, Rashid, & Al-Dubai, 2017).

Library Disunifying Theme: Credible Medical Information but Not Relevant to All DHDAs

Information sources from the library presented as the third disunifying theme with respect to the credibility, timeliness, and immersion of the source. Certainly, the participants that utilized the library as a source of medical information described this information source as highly credible, timely, and immersed. However, a number of participants didn't cite the library as an important of information for their DHDA. One participant of a doctor-driven DHDA didn't feel the library was relevant to her work. Others described the libraries both in Canada and their countries of origin in a time of change with physical books disappearing in Canada as online sources of books and publications became more available. Some participants had access to high-

quality publications from any location in the world via subscriptions to databases they could access from Canada or their countries of origin. One participant used the library as a place to study but not to access information in his country of origin. These findings align with research on knowledge translation in health and the gap between health research information and their implementation in practice. Sipido & Nagyova argue that a need exists for a multidisciplinary strategy that connects health research and achieving better health (2020). Since my participants were involved in DHDAs that focused on achieving better health for people, this may explain why some participants didn't feel that the information available via the library was of value to their DHDA.

Websites Disunifying Theme: Varying Degrees of Credible Sources of Medical Information

Lastly, websites emerged as the fourth disunifying theme. Websites were used to promote the company- and nonprofit-driven DHDAs. Participants of doctor-driven DHDAs accessed highly credible, timely, and immersed sources of medical information from professional medical websites if they could access them. A number of the doctors also mentioned the use of Wikipedia and Medscape as sources of medical information that was improving; however, they would only use the information as a check against information they already knew. Other participants said they would check Wikipedia just to see what they said but did not take it seriously. These findings align with research on the variability of the quality of health information available on the internet (Swire-Thompson & Lazer, 2020).

Summary of Unifying and Disunifying Themes

The level of credibility, timeliness, and immersion of a source of information is of critical importance to understanding the medical device environment use in a low resource setting. This

section analyses the participant responses to how credible, timely, and immersed that various sources of information they access with respect to their DHDA are. The following table summarizes how participants described all sources of information with respect to credibility, timeliness, and immersion. As these characteristics are critical to the medical device design process, this is an important finding of the research. Although a definitive ranking of how timely, credible, and immersed each information source and/or behaviour didn't emerge, it is clear that the egocentric social networks is the number one ranked source. Memory and the news are the least ranked sources of credible information. The remaining sources have mixed ratings that depended on a variety of factors including:

- Ability to travel,
- Role of the public in a particular DHDA impacted need for information grounds,
- Purpose of open social media: general groups not credible while a physician working in a remote area of Nigeria discussing clinical care highly credible,
- Purpose of closed social media: medical professional closed groups leading to high credibility and closed social groups of elderly people leading to low credibility,
- Type of DHDA impacted the role of credibility of information in libraries, and
- While most website were thought of as credible sources of information, one participant was skeptical of medical sources such as Wikipedia.

Table 19

Level of Credibility, timeliness, and immersion of Information Sources

Rank	Credibility	Timeliness	Immersion
Egocentric Social Network	High – 8	High – 8	High – 8
Memory	Low – 8	Low – 8	Low – 8
Travel	High – 8	High – 8	High – 8
News	Low – 7 N/A – 1	Low – 7 N/A – 1	Low – 7 N/A – 1
Information Grounds	High – 4 N/A – 4	High – 4 N/A – 4	High – 4 N/A – 4
Open Social Media	High – 1 Low - 7	High – 8	High – 8
Closed Social Media	High – 4 Low – 1 N/A – 3	High – 4 Low – 1 N/A – 3	High – 4 Low – 1 N/A – 3
Library	High – 3 Medium – 1 N/A – 4	High – 4 N/A – 4	High – 4 N/A – 4
Websites	High – 7 High & Low – 1	High – 8	High – 8

Research Question 3

How do individual diasporans experience and perceive their information seeking processes when engaged in DHDAs? The following section discussed this research question.

Ease and Difficulty of DHDA Related Information Seeking Behaviour Themes

The following section synthesizes how participants described their experiences while seeking information related to their DHDA. Unifying and disunifying themes that emerged include:

Unifying Themes:

- Person-to-Person: Easy and Fruitful
- Access to the Internet: Available but Not Freely Accessible

Disunifying Themes:

- ICT-Mediated: Easy but Varied in Type
- Challenges of Information Seeking for DHDAs: Few but Disparate Challenges

As six of eight of the participants were physicians and/or medical professionals, it is useful to understand physicians generally describe their experiences while seeking information. For example, systematic reviews of the physicians' clinical information seeking behaviour were conducted to obtain a comprehensive understanding of the topic, including ease and barriers of use (Aakre, Maggio, Fiol, & Cook, 2019; Daei, Soleymani, Ashrafi-Rizi, Zargham-Boroujeni, & Kelishadi, 2020). As the review articles include ease and barriers of use of information sources, it is useful to compare against the ease and difficultly of use encountered by the participants of this research.

Person-to-Person Unifying Theme: Easy and Fruitful

One of the unifying themes for most participants was that one of the easiest information seeking experiences was connecting with people directly involved in their DHDA. Some participants were able to meet people involved in their DHDA directly. This face-to-face information seeking was very important to the success of the company and nonprofit-oriented DHDAs. The doctor-driven DHDAs had less opportunity to travel to their countries of origin in three of four participants. However, these doctors still described the ability to connect directly with people via closed social network apps such as WhatsApp or via phone, email, text, and

Skype as easy and fruitful. When queried about the responsiveness to requests for information, one participant described his experience as follows, “I think they can count on me. So, they humour me and respond to my email.” These interactions also led to the gathering of credible, timely, and immersed sources of information related to their DHDAs. Similarly, physicians found that colleagues that provided encouragement and support were easy to access as information sources (Daei, Soleymani, Ashrafi-Rizi, Zargham-Boroujeni, & Kelishadi, 2020).

Access to the Internet Unifying Theme: Available but Not Freely Accessible

One of the unifying themes for most participants was the lack of free access to the internet in their countries of origin. This response was the same for participants from Nigeria, India, and Panama. In general, participants stated that the infrastructure for both power and the internet was available in their countries of origin; however, they needed to purchase data plans to be able to access the internet. One participant felt the internet was poor throughout India regardless of purchasing a data plan. This was also stated by the other participant from India who mentioned that due to the lack of access to the internet in India, medical students did not have the same access to information as her medical students in Canada. One of the participants from Nigeria also noted that in Canada she could access the internet for free through free Wi-Fi available at her post-secondary institution while she would have to budget to pay for similar access in Nigeria. These findings somewhat align with findings in the literature regarding the lack of access to the internet in low resource settings (King, Pegrum, & Forsey, 2018; Literat, 2015).

King, Pegrum, and Forsey conducted a systematic review of the research into the use of open online learning technologies in low resource settings and identified a lack of regular, stable

internet connection as a continuing problem (2018). Literat discusses the implications of massive open online courses for higher education and in doing so also identified that many developing countries still struggle with poor digital infrastructures, especially in rural areas (2015). The diasporans in this study stated that the infrastructure has arrived in their countries of origin however the ability for people to access the internet is still hampered by the lack of free access.

ICT-Mediated Disunifying Theme: Easy but Varied in Type

One of the disunifying themes for participants was the use of information and communication technology mediated information seeking behaviour. All participants described the use of such technologies as being easy; however, they did not describe the same types of sources. The sources of information included email, Apps, phones (didn't specify landline or cell phone in some cases), cell phones, camera feature of cell phones, the internet, social media, the news, medical Wikipedia sites, MedScape websites, professional medical websites. Participants had the resources to be able to access information and communication technologies in both their countries of origin and countries of destination. The different sources that participants emphasized were varied and in some cases were influenced by the type of DHDA they were involved in. As such, information and communication technology mediated information seeking behaviour presented as a disunifying theme. Similarly, online credible information sources that were easy to use positively affected the likelihood of use by physicians looking for clinical information (Chan & Leung, 2018), however not all online information sources were viewed as credible (Daei, Soleymani, Ashrafi-Rizi, Zargham-Boroujeni, & Kelishadi, 2020; Swire-Thompson & Lazer, 2020).

Challenges of Information Seeking for DHDAs Disunifying Theme: Few but Disparate Challenges

Challenges of information seeking for participants include cultural issues, political issues, issues with follow-up and lack of response, missing information, and difficulty finding informational books. As such these challenges present as a disunifying theme dependent on the participant and to some degree type of DHDA they are involved in. Participants also described a wide range of unique information seeking difficulties and challenges related to their particular DHDAs. Participant 1 described the ability to make a difference through follow-up and resource availability was a challenge. Even though he had developed a very high level and strong egocentric social network with highly committed people, it was stiff difficult to create change. Although the information seeking behaviour wasn't difficult, it didn't always lead to the outcomes he desired.

Participant 2 described the lack of understanding of the cultural nuances as a challenge in terms of the success of his DHDA. Again, the information seeking behaviour wasn't difficult; however, the need for a cultural advisor to ensure the right decisions were being made was very important to the success of the DHDA. Participant 2 noted that the founder of his DHDA expressed that the success of their DHDA hinged on his cultural knowledge of Ghana. Participant 2 also mentioned that at times he found the lack of response or missing information to be a challenge for him.

Participant 3 mentioned the time change to be something that needs to be managed, but she didn't find it to be a hindrance to her DHDA work. Participant 5 mentioned that he found it difficult to find appropriate books at times. Participant 7 also described difficulties related to her information seeking as being part of the larger cultural and political landscape. She works

through out the Caribbean, South and Central America, and she has found that her gender has created communication challenges.

The most common barriers identified in the literature included lack of time, lack of information searching skills, and unawareness of accessible sources (Aakre, Maggio, Fiol, & Cook, 2019; Daei, Soleymani, Ashrafi-Rizi, Zargham-Boroujeni, & Kelishadi, 2020). These findings differ from the main barrier indicated by the participants in this research study that the internet was available but not freely accessible in their countries of origin. Diasporan participants didn't indicate many other barriers to finding information related to their DHDA. They seemed to have the time to search for information as well as the information searching skills and sources needed for their DHDAs. This may be due to the strong connections diasporans have built specifically for their DHDAs as well as the wide range of information sources including travel and information grounds in addition to egocentric social networks and other ICT-mediated information sources.

Research Question 4

How are DHDAs leveraged to provide useful information to medical device developers for the development of the user needs document for a medical device from the perspective of the diasporan? The final specific research question explores the connection between diasporans involved in DHDAs, their information seeking behaviour with respect to their DHDA, and the development of a user needs document for a medical device in a low resource setting. In addition to learning about the information seeking behaviour of diasporans involved in DHDAs on its own, this section explores how this learning can be leveraged by designers of medical devices for low resource settings.

Need for Contextual Information That Is Credible, Timely, and Immersed

As described in the literature review, the design of medical devices for low resource settings requires a contextual framework to increase the likelihood of success (Aranda-Jan et al., 2016). The contextual categories of the framework are much wider than technical or clinical. They include the following contextual categories (Aranda-Jan et al., 2016):

- Individual: Socio-cultural,
- Technical: Individual and Technology,
- Systems and structures: Public Health, Economic and Institutional,
- Physical environment: Infrastructure and Geophysical/Environmental.

Medical device designers are tasked with gathering information on all contextual categories as an initial and on-going step in the process of designing a medical device for a low resource setting (Aranda-Jan, Jagtap, & Moultrie, 2016). The information they gather must be credible, timely, and immersed in the low resource setting. A category of information that is missing or information about a category that is incorrect can result in the design of an unsuccessful medical device. The motivation for the research is to find credible, timely, and immersed sources of information in all the contextual categories that can be accessed in a timely and cost-effective manner by designers of medical devices for low resource settings.

Medical Device Designers in High and Low Resource Settings

Recent critical thought regarding engineering for development or humanitarian engineering programs exposes the potential for thinking of medical device design for low resource settings as apolitical and ahistorical (van Stam, 2016). It's important to understand that the reasons for the existence of low resource settings in many countries are rooted in both current

and historical examples of colonialism. For example, Canada has a history of colonialism that has led to a gap in healthcare, among other things, between Indigenous Canadians and other Canadians, with Indigenous Canadians receiving a lower level of healthcare services (Frohlich, Ross, & Richmond, 2006). My position is that designers exist globally, in a variety of high to low resource settings. Although my research focuses on developing medical devices for low resource settings, designers in low resource settings could also develop products for high resource settings as has been expressed by the term reverse innovation (Immelt, Govindarajan, & Trimble, 2009). Perhaps future researchers will explore the involvement of diasporans involved in DHDAs as informants to those involved in reverse innovation projects.

Engaging Diasporans Involved in DHDAs as a Source of Information

In reflecting upon sources of information regarding the contextual categories in low resource settings, individual diasporans working on diasporan healthcare development activities for their countries of origin emerged as a worthy source of study. I deliberately chose individual diasporans as my area of study rather than diaspora organizations. As a medical device designer, I am familiar with the design process and reflected on how valuable discussion with individuals are for gaining insight into contextual categories. Designers work with people directly, and as such, I felt that it was important that my research also work directly with the people that a designer might interact with.

I see a variety of ways that designers can engage with diasporans involved in DHDAs. In this research, diasporans responded to a call for participants and volunteered their time. I was fortunate that the participants gave generously of their time as it is not advisable to pay participants to participate in academic research. However, for medical device design projects, the

time commitment would likely be much higher, and as such, a paid consulting role for a diasporan involved in a DHDA would be a viable approach for an organization developing a medical device for a low resource setting. For universities with humanitarian engineering programs, a possible approach would be to create a "Diasporan in Residence" position which could be paid via an existing salary or via a separate contract. Although traditional academic research wouldn't usually be so prescriptive, I feel it's important to explicitly value the contribution of the diasporan for their work and appropriately compensate them. This role of cultural and language advisor is paid in other industries such as in the employment of Afghan diasporans by the Canadian military during their deployment in Afghanistan (Brewster, 2019). Without the guidance and information provided by Afghan diasporans, the Canadian military operation would not have been as successful (Brewster, 2019). Considering the evidence that medical device design requires cultural and a number of other contextual categories that can be provided by diasporans involved in DHDAs, their value should not be underestimated or undervalued.

Diasporan Driven Definition of a DHDA

I also deliberately designed the study so that the diasporan themselves could define what their diasporan healthcare development activity was. I didn't want to bring a preconceived idea of what a DHDA was as I didn't want to self-limit the generation of knowledge. This resulted in four different types of DHDAs that emerged from eight participants as follows:

- Nonprofit-oriented (Participants 1 and 2)
- Company-oriented (Participants 4 and 7)
- Medical specialist-driven (Participants 3 and 6)

- Primary care medical doctor-driven (Participants 5 and 8)

The activities described included:

- Developing programs to strengthen civil society through focus on chronic illness in India (Participant 1)
- Medical device donation program in Ghana, Liberia, Sierra Leone, and Nigeria (Participant 2)
- Pathology training in India (Participant 3)
- Provision of emergency medical transport services in Madagascar (Participant 4)
- Primary medical care services in India (Participant 5)
- Supporting medical resident projects in public health in Nigeria (Participant 6)
- Provision of prosthetics and orthotics products and services in South America, Central America, and the Caribbean (Participant 7)
- Primary medical care service in Nigeria (Participant 8)

The DHDAs included a wide range of organizational structures. The DHDAs occurred in, or in collaboration with, the following types of organizations:

- Nonprofit NGOs
- Charitable NGOs
- Multi-national Companies
- Academic Institutions
- Healthcare Organizations
- Ministry of Health
- Diasporan Organizations

- Gurdwaras
- Churches
- Community Centres
- International Societies

Of note, in addition to working with these organizations, a number of participants also had significant interactions with their families in terms of health-related issues. Also, the range of geographic locations included India, Ghana, Liberia, Sierra Leone, Nigeria, Madagascar, Panama, the Caribbean, South America, and Central America. In conclusion, the DHDAs represent a rich source of information from a wide range of organizations and geographic locations. It's important to note that each diasporan's DHDA was bounded by a geographical region, and as such, they would only be able to provide information to a designer for the countries they worked in. This finding compares with other literature on similar diasporan healthcare development activities (Frehywot, Park, & Infanzon, 2019; Shiffman, et al., 2016). Frehywot, Park, and Infanzon studied medical diaspora organizations and found 89 groups operating in the US, Canada, the United Kingdom, and Australia (2019). Shiffman et al. studied the emergence of global health networks (2016). Both studies found that groups were focused on a variety of geographic, clinical, and contextual areas. Similar groups were described by the diasporans participating in this research however for-profit companies were also included as DHDAs.

Recruitment of Diasporans Involved in DHDAs

In addition to understanding the type of organization a diasporan is involved in, designers will need to recruit participants. The recruitment of my participants also sheds some light on

how designers may engage with diasporans involved in DHDAs to inform their medical device designs. I used my professional network and was able to identify and recruit eight participants through an email-based call for participants. Although successful, it did take several months to recruit eight participants. To speed the recruitment of diasporans involved in DHDAs, other approaches could be employed, including contacting formal diasporan health development organizations (Frehywot, Park, & Infanzon, 2019; Shiffman, et al., 2016). Even companies could be tapped for expertise if they are not competing in the same market. Also, paying for the expertise would also speed participation.

Timely, Credible, and Immersed Sources of Information

Once recruited, diasporans were found to have very valuable connections to people and other sources of credible, timely, and immersed sources of information. For a medical device designer, this could represent a very valuable addition to their own information environment. In terms of increasing the strength of the designer's egocentric social network, the addition of a diasporan involved in a DHDA adds a node that increases their connection to weak ties. According to the theory of the strength of weak ties, this addition can improve the designer's access to important knowledge and ideas that they wouldn't otherwise have access to.

One significant finding is that the diasporans involved in DHDAs that participated in this research unanimously stated that information from their memory would not necessarily be credible, timely, or immersed and as such would need to be verified carefully before being acted upon in terms of a design decision or input. This finding aligns with literature on the changing nature of memory over time (Edelson, Sharot, Dolan, & Dudai, 2011; Sequeira, 2015). For example, Edelson et al. examined how socially induced memory errors were generated in the

brain and found through functional brain imaging that social influence modified the neuronal representation of memory (2011). In Sequeita's work on understanding migration, memory is also discussed in terms of being influenced by the present (2015). The findings from the study of the diasporans in this research adds to the body of knowledge that studies the nature of memory, in this case from the perspective of the diasporan themselves. This highlights the value that working with a diasporan that is currently involved in a DHDA for their country of origin brings. It's not just that they are a diasporan, but that they have a connection to the current contextual categories necessary for successful medical device design for low resource settings.

The other sources of information that resulted in credible, timely, and immersed information included travel, closed social media sites, information grounds, websites, and the library. Open social media, the news, and websites were cited as timely and immersed but not necessarily credible and that those sources of information required further verification before being acted upon.

Contextual Areas Covered

Another area of exploration is the range of contextual categories the participants would be able to provide information about. I defined experience with a contextual category as being an essential component of the DHDA. For example, a doctor providing primary medical care services would have knowledge of the individual socio-cultural context of their patients, as well as the public health and institutional context they worked in. However, they would not need to have knowledge of the other categories to conduct their DHDA. Participants may have been able to find information on the other categories; however, if they didn't need it for their DHDA, I limited their knowledge of it as follows:

- Individual: Socio-cultural — all participants had experience in this category as diasporans themselves, as well as through the egocentric social networks they worked with for their DHDA,
- Systems and structures: Public Health, Economic, and Institutional: all participants had experience in public health and at the health institutional level; only one had experience at the economic level,
- Technical: Individual and Technology: one participant had experience at the individual and technology level, and
- Physical environment: Infrastructure and Geophysical/Environmental: one participant had experience at the infrastructure and geophysical/environmental level.

This is an important finding as the range of contextual categories the diasporans involved in DHDAs that were participants in this research was heavily focused on the individual socio-cultural, public health, and health institutional contextual categories. This reveals that diasporans involved in DHDHs may have a limited knowledge base for a designer to tap into. A designer of a medical device for a low resource setting can supplement their information sources with the information provided by a diasporan involved in a DHDA; however, they will still have to find other sources to ensure they have an understanding of all contextual categories. This aligns with research on the structure of diaspora and other global healthcare development networks (Frehywot, Park, & Infanzon, 2019; Shiffman et al., 2016).

Frehywot, Park, and Infanzon identified the medical diaspora are an underused entity in low resource setting health system development (2019). Their research identified 89 medical diaspora organizations in the US, Canada, the United Kingdom, and Australia (Frehywot et al.,

2019). These groups ranged in terms of geographic focus, clinical focus, and knowledge of contextual areas even though they only included medical diaspora organizations and excluded biomedical engineering diaspora organzations (Frehywot et al., 2019). Shiffman et al. researched the effectiveness of global health networks and found that different networks had different levels of effectiveness (2016). In contrast to medical diaspora, global health networks involved people with a wider range of expertise beyond the medical profession, a largely elite composition, and focus on a variety of contextual areas (Shiffman et al., 2016). The variation in geographic focus, clinical focus, and knowledge of contextual areas of the medical diaspora and global health networks are also reflected in the DHDAs studied.

The recent focus on medical diaspora and emerging global health networks is of relevance to designers of medical devices in low resource settings. Designers now have current resources they can utilize when trying to find a diasporan with the relevant geographic focus, clinical focus, and knowledge of contextual areas. For example, Frehywot, Park, and Infanzon, list contact information for the 89 medical diaspora groups studied (2019). The work by Shiffman et al. also discusses factors for effectiveness of global health networks (2016). They found that their effectiveness is increased when they construct a compelling vision of the issue they are addressing and build a political coalition that includes people beyond their traditional base in the health sector (Shiffman et al., 2016). Designers can utilize these findings to improve their ability to find an appropriate diasporan to work with on their project.

Guidance Framework for Engaging with Diasporans Involved in DHDAs

All themes that emerged from answering the first three research questions are of value to the guidance framework for engaging with diasporans involved in DHDAs. The unifying themes

were issues that emerged as common to the majority of the participants. The disunifying themes emerged as a variety of responses from the participants. Although all themes require reflection by the medical device designer as a credible, timely, and immersed source of information, those with disunifying themes will require greater reflection before being input into the design process. Themes were derived by the reflexive ethnographic analysis method, as described in Chapter 3. They include the following:

- A unifying theme that is conducive to obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity. This theme explores information sources of diasporans involved in DHDAs for their countries of origin that medical device developers can be confident will lead to timely, credible, and immersed information.
- A disunifying theme that is conducive to obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity. This theme explores information sources of diasporans involved in DHDAs for their countries of origin that medical device developers may or may not have access to as the use of these sources was varies. If the diasporan did use a particular source, then it was a timely, credible, and immersed source.
- A unifying theme that is not conducive to obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity. This theme explores information sources of diasporans involved in DHDAs for their countries of origin that medical device developers cannot be confident will lead to timely, credible, or

immersed information. As such, medical device developers would have to subject the information to a high level of verification before utilizing in the design process.

- A disunifying theme that is not conducive to obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity. This theme explores a small number of information sources that participants had mixed responses to regarding the timeliness, credibility, and immersion. In these cases, a medical device developer would have to subject the information to a high level of verification before utilizing in the design process.

Figures 26 and 27 graphically depict the unifying and disunifying themes conducive to, and not conducive to, obtaining timely, credible, and immersed information from a diasporan related to their DHDA by a medical device developer. These are characterized as a favourable framework and a nonfavourable framework.

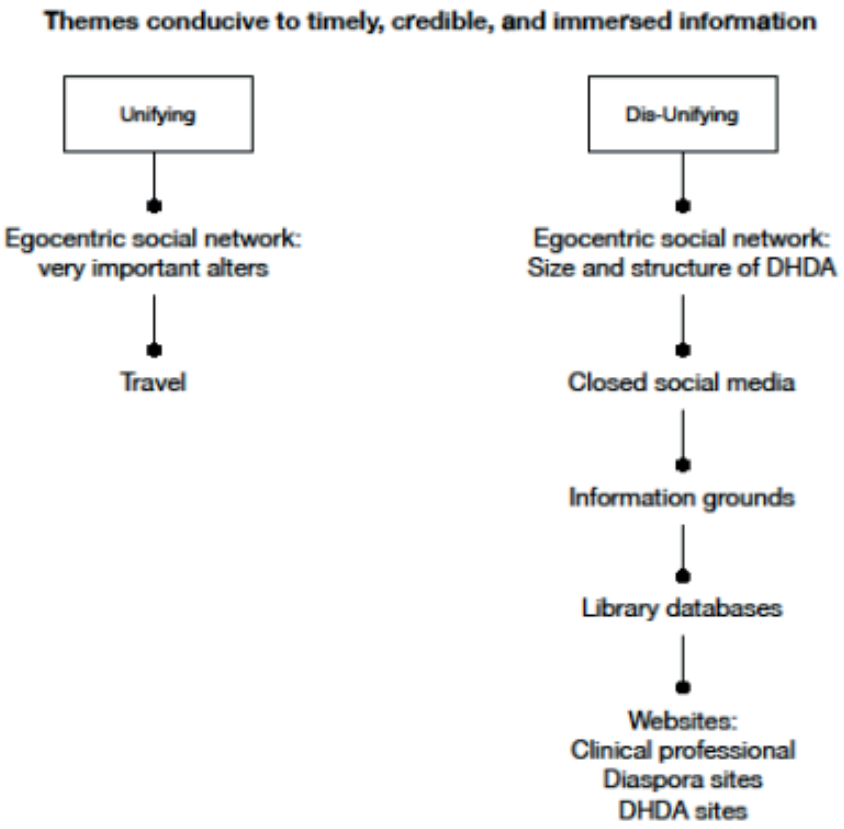

Figure 27: Favourable Framework

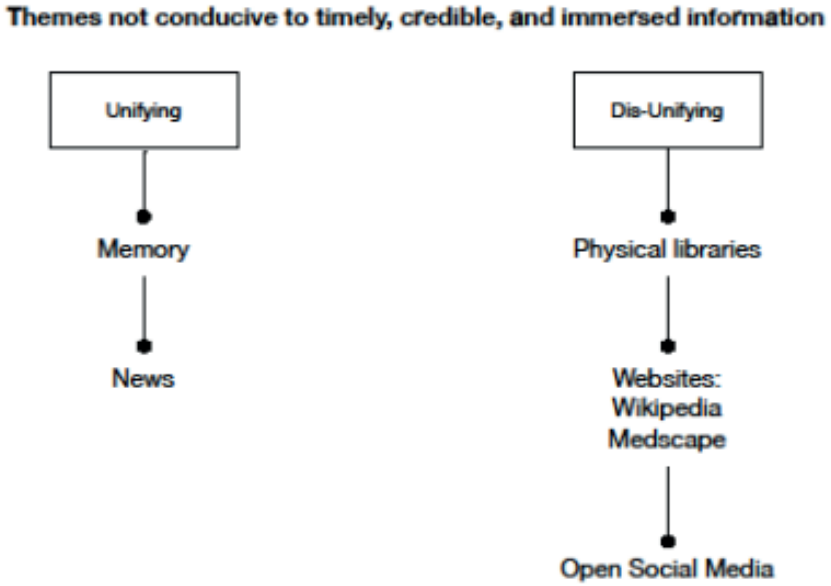

Figure 28: Nonfavourable Framework

These frameworks address the need identified by Aranda-Jan, Jagtap, and Moultrie (2016) for contextual information by providing guidance for working with diasporans involved in DHDAs as sources of contextual information. It is important to understand that these frameworks should not be considered static and applying for all time. They should be revisited and revised as diasporans' information seeking behaviours change over time. Even during the writing of this dissertation, travel, although still a behaviour that leads to timely, credible, and immersed information, was severely restricted due to the global COVID-19 pandemic (Gossling, Scott, & Hall, 2020). Similarly, access to information grounds was also restricted due to the global COVID-19 pandemic. It is anticipated that these restrictions will loosen as treatments and/or vaccines for COVID-19 develop. In this case, the ease of travel and visiting information grounds will return. The following chapter will discuss the conclusions drawn from this research.

Chapter 6: Conclusions

This chapter provides the conclusions reached from this research. Health is one of three key factors of the Human Development Index (United Nations, 2013). The World Health Organization recently recognized medical devices as an essential component of healthcare (2017). Medical devices are the inconspicuous part of healthcare that can be the difference between sickness and health. They are part of vaccination programs, provide diagnostic information, are essential to surgery, provide therapies, and replace failing human abilities. As such, a healthy life depends on access to appropriately designed medical devices.

People living in low resource settings, defined in part as having less infrastructure, fewer trained staff, and less access to spare parts, require access to appropriate medical devices. According to Aranda-Jan, Jagtap, and Moultrie, the current methods for design of medical devices are failing to address the requirements for low resource settings (2016).

Aranda-Jan, Jagtap, and Moultrie conducted a systematic literature review and expert interviews to develop a framework for contextualized design of medical devices for low resource settings (2016). This is a significant contribution to the field of the design of medical devices for low resource settings which has had many failures (Aranda-Jan et al., 2016). This comprehensive review identified four contextual categories with eight sub-categories as follows: 1) Technical: Industrial and Technological Factors, 2) Physical: Infrastructure, Geographical, and Environmental Factors, 3) Individual: Socio-Cultural Factors and 4) Systems and Structures: Political, Institutional, Economic, and Public Health Factors. They found that currently the focus on the design of medical devices for low resource settings is highly technically-oriented. Unfortunately, it is unlikely that this approach will lead to successful adopted devices. They

present a contextual framework as a tool for designers. This framework provides guidance to medical device designers particularly in the initial phases of the design process. The identification of a complete set of requirements in all contextual categories can be guided by the use of this framework. Designing a medical device that meets the comprehensive list of requirements greatly increases its likelihood of use (Aranda-Jan et al., 2016).

In comparison to the framework developed by Aranda-Jan, Jagtap, and Moultie, I identified diasporans involved in healthcare development activities for their countries of origin as potential sources of timely, credible and immersed information regarding the contextual categories needed by medical device designers (2016). The framework developed from my research connects into the Aranda-Jan et al. framework (2016) as a source of contextual information that their framework identifies as being needed. Literature exists that identify diasporans, persons with a bicultural perspective, as having valuable abilities and characteristics that can be leveraged to make knowledge transfer across contexts easier, and hence facilitate global innovations (Brannen & Thomas, 2010). In order for a designer to work with a diasporan as a source of timely, credible, and immersed information regarding the diasporan's country of origin, I identified the gap in the literature as the need to develop a framework to guide the designer on the information seeking behaviour of the diasporan. Through this framework, a designer can reflect on the information received from the diasporan to determine how to incorporate it into the development of requirements.

In order to develop a framework, my primary research question was: How do individual diasporans conduct information seeking processes and how does their information seeking behaviour affect the quality of the information, particularly as it relates to timeliness, credibility,

and immersion, when they are engaged in healthcare development work for their country of origin? This main research question was guided by four specific research questions as follows:

1) How do individual diasporans conduct DHDAs and what are the local place-based and globalized information and communication technology (ICT) based, or other globally based information sources of these individual diasporans?
2) How does a diasporan's information seeking behavior affect the quality of the information in terms of timeliness, credibility, and immersion with respect to the medical device use environment?
3) How do individual diasporans experience and perceive their information seeking processes when engaged in DHDAs?
4) How are DHDAs leveraged to provide useful information to medical device developers for the development of the user needs document for a medical device from the perspective of the diasporan?

Practical Contributions

The following section presents a summary of the practical contributions of this research. Through semi-structured interviews with eight participants the main research questions and specific research questions were answered utilizing reflexive ethnographic and social network theoretical approaches. The focus was on understanding from a detailed, qualitative perspective, the information seeking behaviour of participants. Although some quantitative measures were calculated regarding participants' egocentric social networks, it is important to understand that, from a design perspective, the qualitative characteristics of the social network is of greater

interest and value than the quantitative measures. This is because the information needed is problem dependent and may reside in even the smallest social network.

The framework that emerged identified four groups of information seeking behaviour and sources. Each grouping identifies behaviours and sources with the following characteristics:

- A unifying theme that is conducive to obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity. This theme explores information sources of diasporans involved in DHDAs for their countries of origin that medical device developers can be confident will lead to timely, credible, and immersed information.
- A disunifying theme that is conducive to obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity. This theme explores information sources of diasporans involved in DHDAs for their countries of origin that medical device developers may or may not have access to as the use of these sources was varies. If the diasporan did use a particular source, then it was a timely, credible, and immersed source.
- A unifying theme that is not conducive to obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity. This theme explores information sources of diasporans involved in DHDAs for their countries of origin that medical device developers cannot be confident will lead to timely, credible, or immersed information. As such, medical device developers would have to subject the information to a high level of verification before utilizing in the design process.

- A disunifying theme that is not conducive to obtaining information that is timely, credible, and immersed related to a diasporan healthcare development activity. This theme explores a small number of information sources that participants had mixed responses to regarding the timeliness, credibility, and immersion. In these cases, a medical device developer would have to subject the information to a high level of verification before utilizing in the design process.

Two unifying themes emerged as being conducive to timely, credible, and immersed information: 1) Participants' egocentric social networks: very important alters and 2) Participants' travel to their countries of origin. These are significant findings when viewed against the need for quick and cost-effective sources of information. Essentially, a designer could access timely, credible and immersed information via a diasporan's social network quickly as diasporans were in regular communication with their networks and considered the majority of their networks as very important sources of information. A designer could also benefit from the diasporan's existing travel by travelling with them or assigning them information seeking tasks while there and sharing the costs. These sources and behaviours can assist designers in developing a complete set of requirements regarding contextual categories in less time and with less cost.

Five disunifying themes emerged as being conducive to timely, credible, and immersed information: 1) Participants' egocentric social networks: size and structure of DHDA, 2) Closed social media, 3) Information grounds, 4) Library databases, and 5) Websites: clinical professional, diaspora sites, and DHDA sites.

The diasporans' social networks emerge as an important source of information; however, the type of DHDA, and the geographic location, size, and structure of the network is dependent on the particular diasporan. It will be important for the designer to consider what type of DHDA, the geographic location they are working in and the size and structure of the social network that will be most beneficial to the particular design problem they are designing for. Three different types of DHDAs emerged from the research: 1) Nonprofit-oriented, 2) Company-oriented, and 3) Doctor-driven. Although the sample size is too small to make any statistically significant findings, it is interesting to note that the nonprofit- and company-oriented DHDAs tended to be larger and in some cases have a greater understanding of more of the contextual categories. Doctor-driven DHDAs were very deep in the medical area of specialty and had good links to other doctors both in the same specialty and in some cases to other specialties as well. The participants were from the following geographic regions represented in this research: 1) India (3), 2) Madagascar (1), 3) Ghana (1), Nigeria (2), and Panama (1). This occurred from a general call for participants from my professional and personal network. A particular designer would need to tailor their search for a diasporan to engage with to the geographic location of the design problem.

A number of participants described their participation in closed social media groups such as WhatsApp as very important, credible, timely and immersed sources of information. The WhatsApp groups described were of medical professionals from their countries of origin that the diasporans maintained connections with. Diasporans that used these closed social media groups had very quick access to medical professionals in their countries or origin. Two mentioned that they would confirm news stories through these groups in addition to using them for knowledge

on medical practice. This source of valuable information also meets the need for timely access as well as inexpensive access from their countries of destination due to the ubiquitous nature of free wifi in Canada.

Information grounds were another source of credible and immersed information of value to diasporans and of potential value to designers. For the diasporans that engaged in activities on information grounds such as community centres, churches, cafes, and gudwaras, they were a rich source of information from people that were accessing medical services and devices. In one case, the information ground was a café in India that younger medical doctors met at to discuss the state of the practice of medicine. The participant described the discussion the young doctors were having about violence against doctors that were focusing on diagnostic technologies and losing the focus on the patient. This insight might be very useful to designers developing new diagnostics for India and demonstrates the type of information potentially discussed in informal information ground settings.

Media found on library online databases, professional clinical websites, diaspora websites and DHDA websites were all found to be sources of timely, credible and immersed information for the participants that said they used them; however not all participants used these sources or mentioned them as important sources of information for their particular DHDA. As such, a medical device designer would have to query a diasporan they were considering working with if they felt these sources of information would be essential to their design problem.

Equally insightful, two unifying themes emerged that were not conducive to timely, credible, and immersed sources of information: 1) Memory, and 2) News. Although perhaps not surprising, memory was universally rejected by participants as a timely, credible and immersed

source of information. This is a significant finding as an unreflective designer could mistakenly engage with a diasporan and try to learn about their country of origin and directly input this information into their design requirements. Due to the rapid pace of change in healthcare globally, this approach could lead to inaccurate design requirements. It could provide a false sense of accuracy in the mind of the designer. These potential outcomes could lead to more failures of medical devices developed for low resource settings. This also highlights the need for the diasporan to be actively involved in a healthcare development activity within a few years of working with a designer. Essentially the diasporan is more valuable as a conduit to timely, credible and immersed sources of information rather than the source itself.

The news also emerged as a unifying theme not conducive to timely, credible and immersed source of information for almost all diasporans. At best the news needed to be verified by a different source of more credible information by diasporans. In some cases, diasporans mentioned that they would verify news through their social networks. One participant described the news as creating more questions than answers.

Lastly, three disunifying themes emerged that were not conducive to timely, credible, and immersed sources of information: 1) Physical libraries, 2) Websites such as Wikipedia and Medscape, and 3) Open social media. Physical libraries were only mentioned by a few diasporans as sources of information. Similarly, websites such as Wikipedia and Medscape, and open social media had mixed reviews by the few diasporans that mentioned their use. As such, designers would need to reflect on the accuracy of the information provide through these sources if provided to them by diasporans. In some cases, these websites were improving as accurate

sources of medical information but the doctor's that mentioned their use utilized them to check their knowledge rather than to learn something new.

The semi-structured interviews with eight diasporans working on healthcare development activities for their countries of origin led to the development of a favourable and nonfavourable framework of information seeking behaviour for designers. By reflecting on the frameworks, designers can choose appropriate diasporans that can assist them in learning about the contextual categories needed to create a complete set of design requirements. Designers can then elicit information from the diasporans they are working with and utilize the framework to determine the level of verification needed before using the information to develop the design requirements.

Theoretical Contributions

This research indicates that the information seeking behaviour of diasporans involved in healthcare development activities for their countries of origin aligns with the theoretical frameworks that it is based on. The theoretical design framework stresses the importance of the input from a wide variety of stakeholders for successful design outcomes (Aranda-Jan, Jagtap, & Moultrie, 2016; Buchanan, 1992). The information seeking behaviour of participants revealed that they have excellent connections with a wide range of people through their egocentric social networks that could contribute to understanding the context of the low resource setting for designers. In alignment with Buchanan, participants stressed the importance of their egocentric networks above other sources of information regarding the importance of the information they provided in terms of being timely, credible and immersed. The views of participants' social networks were essential to the diasporan healthcare development activities. This research indicates that other sources of ICT-enabled or physically-based information did not form a

consistent pattern of importance for all participants. These sources were dependent on the participant and the type of DHDA they were involved in. In terms of design, these other sources of information would need to be further verified to ensure they were timely, credible, and immersed in the low resource setting to be designed for.

In terms of theoretical transnational frameworks, the research indicates that participants did not view their memory as a source of timely, credible, and immersed information. This aligns with transnational identity as being fluid and constantly changing. This research indicates that diasporans need to continually learn about the state of their country of origin as they are in a dynamic state of change. The participants reinforced this idea with their views on the need to connect with people in their countries of origin, as well as travel to their countries of origin, to have a timely, credible, and immersed source of information. ICT-enabled sources of information that were not related to direct communication with people in their country of origin were of less importance when asked about how timely, credible, and immersed they were.

Lastly, the reflexive ethnographic and social network theoretical frameworks of information seeking behaviour of the participants represented by their DIEMs were reinforced by the results of this research. As in other studies, this research indicates that people are the most important source of timely, credible, and immersed information. The addition of travel and memory to the DIEM is a unique contribution to the literature and revealed valuable insights to these sources of information and information seeking behaviour. By including memory, this research indicated that participants were not confident in the use of their memory alone as a tool to accurately represent the current cultural context of their countries of origin due to the rapid

pace of change. Also, participants were in favour of travel to their countries of origin as a method of gaining timely, credible, and immersed sources of information.

Perceived Limitations of the Research

This section reflects on the perceived limitations of the research. The methodology involved a reflexive ethnographic approach to the analysis of the data along with a quantitative measure of part of the egocentric social network data. Each methodology had some perceived limitations that are discussed.

Reflexive ethnography is one of the methodological approaches suggested by Srinivasan & Pyati when researching the information environment of diasporans (2007). The use of semi-structured interviews is a valid method for gathering data to be analyzed through a reflexive ethnographic approach (Chapter 25 of Handbook of Ethnography, SAGE 2007). However, the use of other methods of conducting ethnographic research, such as participant observation and field observation, were not used in the course of this research. This lack of more extensive ethnographic research methods has limited the data available for analysis. As such, the findings, and favourable and nonfavourable frameworks developed, are not as complete as they could be with more extensive data collected. However, the findings do provide some insight into the information seeking behaviour of diasporans. These frameworks also provide some valuable guidance to designers developing medical devices for low resource settings.

Similarly, the quantitative analysis conducted on the egocentric social networks of the participants in the research were limited to size, effective size and efficiency (a percentage measure of effective size). This was deliberately done as a more robust quantitative analysis of eight social networks would have provided little more insight into the value of the social

networks from a particular design problem perspective. This is partly due to the low number of participants. However, the size, effective size and efficiency of the social networks did reveal some insights into the nature of doctor-driven, nonprofit-oriented, and company-oriented DHDAs that may be worth further exploration. More is written on this in the next section on future research.

Lastly, the interview for Participant 5 was only partially recorded and transcribed. However I took very clear notes during the interview process and the lack of a verbatim transcription did not negatively impact the analysis.

Future Research

This research was the first step in understanding the complex nature of the information environment model of diasporans involved in healthcare development activities for their country of origin. As such there is ample room for future research as this research uncovered a rich, yet limited, understanding for a small number of participants.

First, future research could focus on repeating the research on a larger number of participants to determine if any major changes need to be made to the frameworks developed. Also, the research could be repeated at a future date to determine the effect that time is having on the findings. For example, sources of information from Wikipedia were thought to be improving so perhaps in future this source would be of more value to diasporans and designers alike. Also travel may take on a new form in future with a focus on potentially reducing air travel for sustainability purposes.

Secondly, a larger number of participants could be studied to learn more about the relationship between the type of healthcare development activity and the related egocentric social

network size, structure and composition. This research could continue to build on the early stage observation that these measures seem to be affected by whether the activity was nonprofit-oriented, company-oriented, or doctor-driven. A deeper understanding of this relationship would be beneficial to designers in terms of deciding what type of diasporan to engage. The optimal size, structure and composition of the egocentric social network could be mapped to the design problem. If more were known about the relationship between the social network and the type of healthcare development activity, potentially a more valuable match could be made between the diasporan and the designer, saving time and money. Another question that could be asked is how effective the information sources of diasporans involved in DHDAs are at providing information about the specific contextual knowledge areas identified by Aranda-Jan, Jagtap, and Moultrie (2016).

Lastly, information seeking behaviour research questions could be explored with organizations that are trying to harness the value of diasporan connections for the purposes of development more generally. For example, the European Parliament Committee of Development has committee $5.8 Million dollars over three years to develop an EU diaspora facility. They plan to develop the following: 1) a worldwide mapping of diaspora engagement; 2) capacity building and technical assistance for governments and civil society; and 3) a roster of diaspora development experts to serve as a centralized resource (https://www.devex.com/news/eu-pushes-diasporas-role-in-development-93533).

The engagement of information seeking behaviour researchers, specifically, and social sciences researchers more broadly, can be of great value to the field of medical device development for low resource settings. As the field of medical device development is highly

technical in nature, the addition of the social sciences can aid in increasing the development and adoption of appropriate medical devices for the setting it is being developed for.

Personal Reflections and Reflexivity

I met many diasporans throughout this research project. I have been honoured to work with the participants and I thank them for sharing their stories with me and agreeing to be part of my research. As discussed previously I bring a transnational theoretical framework to this research and consider culture to be fluid and ever changing for the participants and myself. As proposed by reflexive ethnographic researchers, I also acknowledge that is it critical to reflect on the interactions I had with the participants from three levels including the discourse produced through the interview, the interactions I had with the participants during the interview, and the current societal conditions that influence the interaction and the text produced (Davies, 2002). The discourse was created by the participants due to my interest in exploring their information seeking behaviour during their DHDAs and due to their participation in DHDAs.

In reflecting on the conversations, I realized that I had a feeling of affinity with all of the participants due to their participation in DHDAs. I made it clear in the beginning of the interviews how I was appreciative of their time as well as impressed by the work they were doing. Although I don't know how the participants felt about me, the conversations we had from the semi-structured interviews were respectful and led to the type of information I had intended on discovering. Three interviews were conducted in person and five were conducted over the phone. I also reflected on purposely developing the inclusion criteria so that I felt comfortable with the participants. I realized that I had very little time to develop a rapport with the participants and that I wanted to be able to connect with them quickly to be able to collect

relevant data via a single interview. As such, I purposely only included participants that self-identified as being well established in their country of destination. In this way I felt we would be on the same level from a status perspective. I felt that I may not be able to create the rapport quickly with someone not self-identifying as being well established in their country of destination. This was particularly important for the interviews that were conducted over the phone. Although I only knew one of the participants prior to the research project, six other participants were found through members of my professional network and this also created a level of trust. Only one participant, who was male, responded to a cold call and he mentioned that he was somewhat reluctant to respond but overcame this and called me back because I was a woman.

In terms of the level of societal conditions during the interviews with the participants, I reflected on the past thirty years as it has seen many waves of social change. When I began my education in engineering at the University of British Columbia in the late 1980s, I was one of three women in a class of approximately one hundred men. In 1989, the largest mass-murder occurred at L'École Polytechnique in Montreal, Canada that targeted women in an engineering program. Fourteen women were killed, twelve engineering students, one nursing student and one staff member. In addition to learning a difficult field, I was now also engaged in post-shooting activities sweeping the engineering field such as developing engineering activities in the K-12 educational system. This was partly to simply have boys and girls see that a woman could be an engineer, essentially a representation issue. In part this was also to encourage girls into engineering.

I bring this up in the context of the research participants, many of whom struggle with issues of representation and discrimination as people of colour in Canada. Although our experiences aren't the same as I am of Western European descent, I have experienced gender discrimination. As such, I understand the need to be sensitive to the participants. Even the concept of engineers in Canada working to assist people in low resource settings in other parts of the world can be wrought with discrimination if not actively reflected upon. For example, one of my engineering students from Kenya mentioned a recent example of a professor using an outdated example of need for the Maasai people to have portable chairs and had her engineering class design cardboard chairs. As her mother was Maasai, she had first-hand experience of the advances in the current Maasai culture and felt that this exercise gave her class colleagues in Canada an inaccurate view of the Maasai. She is advocating for updated examples in her engineering classes. In one of the lectures I give on global health to biomedical engineers, I bring in examples of reverse engineering to demonstrate that problems solvers exist everywhere and that solutions do not always go from developed to developing countries. In some cases developed countries are adopting solutions from developing countries as well.

This research has demonstrated to me the strength of the participants in terms of their ability to, not only thrive in their country of destination, but also to be of great value to their country of origin through the work they are doing in their DHDAs. I have been enriched by working with the participants and it is my hope that this research sheds some light on the strength they can bring to the medical device development industry.

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Appendix: Interview Guide

Definitions

The following definitions provide a description of the technical language used in the interview guide.

- Egocentric social network – the people one person has social relationships with
- Egocentric social network map – a visual representation of the people one person has social relationships with (See Appendix)
- Alters – the people in a person's social network
- Alter-alter relationship – the relationship between two people in a person's social network
- DHDA – Diasporan healthcare development activity. This is a healthcare development activity that a person from another country is involved in that is related to their country of origin.
- Measure of how constrained a social network is – how many people in a social network know each other is a measure of how constrained it is. For example, a social network where the people in it know everyone else in the network is completely constrained.

Introduction

Step 1

After an initial description of the project and anticipated outcomes, participants will be asked a number of open-ended questions regarding their history, their immigration experience and their involvement with their diasporan healthcare development activities as follows:

- *"Can you please tell me a little about where you were born and how long you lived there?"*
- *"Can you please tell me about your immigration experience? How old were you when you immigrated? What was your immigration path?"*
- *"I'm interested to learn more about your involvement with your healthcare development activities for your country of origin. Can you please describe how you are involved?"*

Once the participant has finished describing their experiences, data collection on the participant's eco-centric social network with respect to their DHDA will begin.

Egocentric social network data

The following protocol is used to collect data on participants' egocentric networks (DeJordy & Halgin, 2008):

Step 2

One name generator question to be asked to generate the network of the interviewee (ego).

- Name generator question to identify the important people (alters) in an interviewee's healthcare development project.

- *"Who are the people with whom you usually work with when engaged in your healthcare development project?"*

- Interviewees will be asked to rank the information received from each person according to their degree of importance from "very important" to "unimportant". Initially, the concept of importance will be reflected upon by the interviewee and not pre-defined by the researcher.
  - *"Can you please rank, from very important to unimportant, how important the information received from each person is to the success of the healthcare development project?"*

Step 3

Additional questions will be asked to obtain information about the characteristics of the alters, including age, gender, nationality, geographical location, income and education level.

- Interviewees will also be asked about characteristics of their relationship with their alters including duration and type of relationship and frequency of contact.
  - *"For each person in your network that is involved in the healthcare development activities can you please describe the following:*
    - *Age*
    - *Gender*
    - *Nationality*
    - *Geographic location*
    - *Income level*
    - *Education level*

- *How long have you known each other?*
- *What is the nature of your relationship (i.e. family, friend, colleague, etc.)?*
- *On average, how often do you have contact?*

Step 4

Interviewees will be asked to describe the alter-alter relationships to determine the structure of their DHDA network.

- *"Think about the relationship between the first person you described and each of the other people in the social network. For each pair, would you say they are strangers, friends or family, or colleagues?"*
- *"Think about the relationship between the next person you described and each of the other people in the social network. Again, for each pair, would you say they are strangers, friends or family, or colleagues?" Note: this question will be repeated until all alters-alter relationships have been discussed.*

- The alter-alter relationship measure will either be present or absent. This will determine how constrained the network is.

Step 5

Interviewees will be asked additional questions about how people in this network help them understand the context of their healthcare development project.

- Each of these questions will determine how their alter has obtained information regarding the healthcare development project.
  - *"For each person you listed, how do you think they obtained their knowledge regarding the healthcare development project? Some options include the*

following: they live there, they travelled there within the last year, they communicated with someone from there recently via electronic communication, they saw it on the news, etc."

Step 6

Utilizing VennMaker (or equivalent) software or physically via paper and pen, the network map will be drawn by the researcher during the interview. The location, gender and other characteristics of each alter will be shown.

Semi-structured qualitative interview data on egocentric social network

Step 7

Immediately after the development of the network maps, qualitative interviews will be conducted with participants.

- Respondents will shift from being observed to becoming observers that will help to ensure *their* perspectives are being reflected in the data collected. They will first be asked to verify the accuracy of their social network with respect to their healthcare development project.
- Semi-structured, open-ended questions will be asked as follows:
    - *"How does each person in your DHDA network contribute to helping you understand the local context of your healthcare development project?*
    - *How important are they in terms of the timeliness (e.g., was it recent knowledge or from long term memory); credibility (e.g., how did the*

diasporan view the credibility of the person providing the information); and immersion (e.g., how involved in the project or healthcare intervention was their network contact) of the information they provide you with?

Data collection on other information seeking behaviour

Semi-structured qualitative interview data

Step 8

Next, semi-structured, open-ended questions will be asked regarding other information seeking behavior outside of their network.

- Semi-structured interview questions will query interviewees about the role of other sources of information with respect to their development healthcare projects. In addition to the categories suggested by Srinivasan & Pyati, participants will be asked about the role of travel and memory in their information seeking behaviour (Srinivasan & Pyati, 2007).
    - *"What role do other sources of information play in learning about the context of your development healthcare projects?"*
    - *"What role does media and/or social media play including any platforms linking you to other members of your diasporic group?"*
    - *"What role does the library play?*
    - *"What role do local information grounds play (community centres, coffee shops, grocery stores, barber, etc.)?*
    - *"What role does travel play?"*
    - *"What role does memory play?"*

Step 9

The participants will then be asked to describe how important each source is with respect to timeliness (e.g., was it recent knowledge or from long term memory); credibility (e.g., how did the diasporan view the credibility of the source providing the information); and immersion (e.g., how involved in the project or healthcare intervention was the information source).

- "For each source of information can you describe how timely the information is? For example, is it recent information or information from long ago?"
- "For each source of information can you describe how credible you think it is?"
- "For each source of information can you describe how involved in the healthcare project was the information source?"

Step 10

Lastly, semi-structured interview questions will query interviewees about their experiences and perceptions of information seeking with respect to their DHDAs.

- These questions are intended to shed some light on the ease or difficulty of the information seeking process itself and to explore potential similarities or differences between participants. Medical device designers may gain a better understanding of the diasporan information seeking process itself through this line of inquiry.
  - *"What information source is the easiest to access and interpret, and why?"*
  - *"What information source provides the most credible information from your perspective and how easy or difficult is it to access this source?*
  - *"What challenges do you experience when you are seeking information for your healthcare development project?*