Investigation of a Generative Design Method that Enhances the Architectural Design of a Healthcare Facility Using a Qualitative Research Method.

by

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Abstract

The main aim of this thesis is to investigate generative design methods to identify user's latent issues in terms of challenges, concerns, and desires to design a user- centric architectural design project.

Particularly this study employed qualitative research method with a user-centered design (UCD) approach in a healthcare facility located in Petawawa, as an example. While UCD has been applied in the field of Industrial Design for years, architects claim to shape people's lives, yet the user is often not involved enough in the architecture design process.

The challenge faced translates to an Investigation of a Generative Design Method that Enhances the Architectural Design of a Healthcare Facility Using a Qualitative Research Method.by proposing the three generative design tools. Employing a UCD approach may decrease the gap between architects and users by identifying the expert users' hidden and unmet needs, resulting in a user-centric design.

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TO MY PARENTS AND BROTHER

Who have supported me in tremendous ways and helped me grow to be who I am today.

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1 Chapter: Introduction

1.1 Background and Scope

The process that industrial designers undergo to design an artifact incorporates a user-centric approach that embraces methodologies that emphasize designing *with* rather than *for* the user (Bate, 2007; Giacomin, 2014; Goodman-Deane, Langdon, & Clarkson, 2010; Lowdermilk, 2013; Säde, 2001). Human-centered design (HCD), coined by Donald A. Norman in the 1980s (Norman, 1988), and is one of the concepts that can be applied to achieve a user-centric design process (Giacomin, 2014; Lowdermilk, 2013), making these two nodes interchangeable. User-centered design (UCD) is herein defined as: "*the active involvement of users for a clear understanding of user and task requirements, iterative design and evaluation, and a multi-disciplinary approach*"(Mao, Vredenburg, Smith, & Carey, 2005). In the early 1970's to 1980's, architects tried to employ this notion, yet a gap still exists half a century later(Van der Ryn, 2013). While the user-centered design is an important concept often used by industrial designers, it seems not as predominant in architecture and related professions (Pedersen, 2017). Hence, architecture claims to be a discipline that aims to influence and shape how people live (Cooper, 2006); however, the user is not considered enough (Schön, 1990).

In this thesis, the author argues that architects directing their aim to enhance the quality of everyday life, through the design of built environments, should take the notion of user-centered design more seriously and systematically into their design process (Sanoff, 1985; Vainio, 2016). As an example of its application, this study used a healthcare facility located in Petawawa, Ontario, Canada, to substantiate the effect of a generative design session, that employs three co-creational tools, in the preliminary design stages. The

healthcare facility used in this study was constructed in 1971 and, since then, it has been enlarged as a short-term solution to continue providing services. Located on a Canadian Forces Base in Petawawa, Canada, this healthcare facility is a field clinic, which seeks to facilitate services for soldiers who are either being deployed, returning from war, or from any other military exercise. Usually, the requirements are set at a managerial level, but, these managers or clients are often not directly involved in the clinic. Thus, some of the information provided to the designer is sometimes inaccurate. Therefore, understanding the distinct and insightful user requirements of this healthcare facility from the expert users is critical.

1.2 Purpose of Study

Since user-centered design is an increasingly relevant approach that aims to enhance the designers' understanding of the expert users, and by extension effectively meet their needs and requirements, the purpose of this study is to demonstrate how a generative design session, using a qualitative research method, can enhance the researchers understanding towards the expert-users' requirements.

To demonstrate how UCD can be applied effectively, this study employed a co-creation[1] method on the end users of the health-care facility. Instead of accepting what the

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[1] Elizabeth Sanders established co-creation tools and methods that often take place during the early front end of the design development process. It is achieved through the use of tools, that help engage the user in the design process for the researcher to capture their unique experiences (Sanders & Stappers, 2012).

participants expressed and desired as an answer, the author considers it as a good question to find the expert user's latent needs and insights. This has been achieved by seeking the "why" factor behind what the expert users communicate during the interviews, thus, allowing the researcher to employ these factors as necessary ingredients to identify their unmet needs.

1.3 Research Question

The study investigates a "*Generative Design Method that Enhances the Architectural Design of a Healthcare Facility Using a Qualitative Research Method*." To respond to this inquiry, the co-creation methods, explained in Chapter 3, were employed followed by seven in-depth interviews. The participants of the interview were the expert users of the healthcare facility who were military and civilian professionals with at least 5 years of experience. The author was able to understand what the hidden requirements were because the users were stimulated and engaged during the interviews.

2 Chapter: Literature Review

The inability to complete everyday tasks is a common frustration shared by end users (Van der Ryn, 2013). This is due to the lack of understanding, on the designers and researchers' behalf, towards end users activities, cultural differences, behavior, and context (Lowdermilk, 2013; Norman, 1988). Design has gone through various movements in well-informed ways, which has assisted in solving the problem. Three paradigms emerged from these movements within design; technology-driven design, environmentally sustainable design and user-centered design (UCD) (Giacomin, 2014). As previously mentioned, this study focuses on user-centered design, which mandates the involvement of all the stakeholders who will utilize the final artifact when the design is complete (Bate, 2007; Norman, 1988; Pascal, Thomas, & Romme, 2013; Taffe, 2015).

In the literature review section, the author examine the notion of user-centered design, regarding its definition, along with its' purpose and origin (ergonomics, cognitive science and other landscapes of UCD) first, and how a UCD approach is implemented. The idea of participatory design and co-creation will be briefly discussed in terms of their tools and methods. It will further assess why UCD faced lengthy implementation process duration in the discipline of architecture. Subsequently, the chapter will discuss the different examples of architects who have incorporated UCD in architecture.

2.1 User-Centered Design

2.1.1 Definition

Donald A. Norman defines the term user-centered design in his book "*The Design of Everyday Things"* (See Figure 1) as a possible way to increase the usability aspect in

design (Norman, 1988). The process that designers use when implementing a UCD approach helps them recognize the influence of users on how the design takes its shape (Endsley & Jones, 2011; Giacomin, 2015; Lowdermilk, 2013; Lucila & Alejandro, 2012; Sanders & Stappers, 2012). The concept concentrates on the need to involve all the stakeholders who will have actual interaction with the final artifact, when the design is complete (Bate, 2007; Norman, 1988; Pascal et al., 2013; Taffe, 2015). This prioritizes human needs, behaviors, and capabilities, followed by considerations of design that will accommodate these aspects. The end users are the personnel that will use the end product/artifact to accomplish their task or goal (Lowdermilk, 2013). Expert users are another type of users who are the people that have extensive experience in a particular field, making them more skillful and knowledgeable than any other user (Neilson, 2000).

There are three types of users: primary, secondary and tertiary, that can be involved in a UCD approach. Primary users are those who are directly involved with the artifact; secondary users are people who occasionally interact with an artifact. Finally, tertiary users are those who are least affected by the artifact directly. However, they sometimes influence a decision-making process (e.g., they could be business owners, clients or the public, etc. (Lowdermilk, 2013). When designers or researchers accept that the end users are more knowledgeable and experienced in a certain field or situations, an adaptation of a UCD approach can be applied for a better understanding of user requirements (Orsel, 2017). However, it is not essential to involve all three types of users directly in the design process; but it is important to consider how they will be affected by the considerations (Lowdermilk,

2013). Expert users are engaged in this study, for the researcher to understand and identify their hidden and latent needs, at the initial stages of the design process.

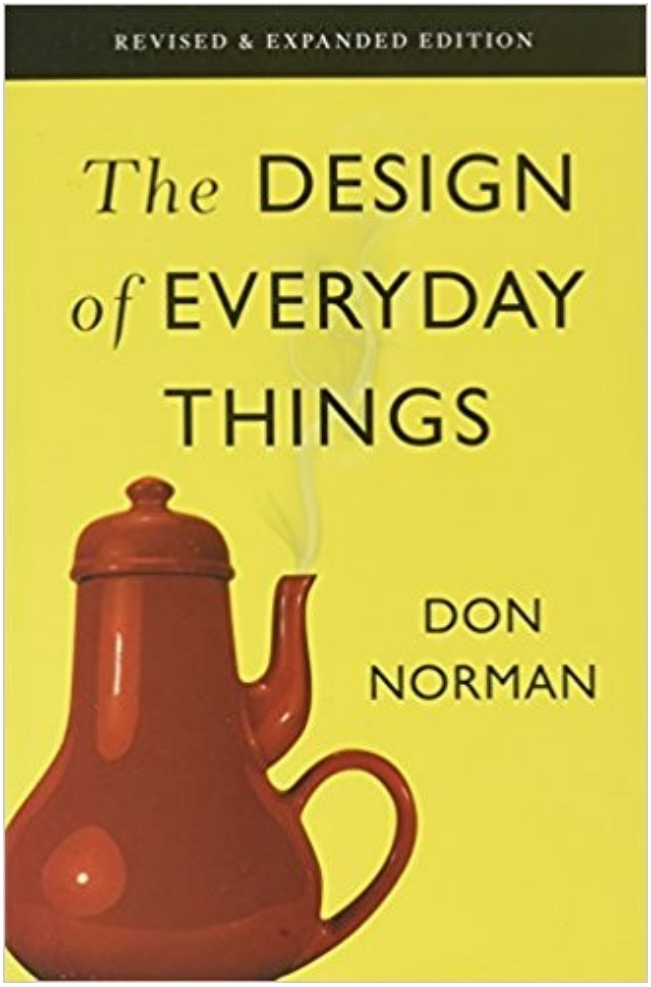

Figure 1. The Design of Everyday Things by Don Norman– Book Cover (Norman, 1988)

2.1.2 Purpose

User-centered design is instigated as a reaction to technology and feature-driven designs, that brought difficulty to their end users (Giacomin, 2014). UCD assumes that the expert users involvement in the design process will reduce ambiguity (Säde, 2001), and result in a successful design solution that meets their latent needs (Pascal et al., 2013).

2.2 Origin

2.2.1 Ergonomics

The concept of user-centered design originated with the development of computer systems and it became valuable to designers as it considered aspects of ergonomics in software systems(Giacomin, 2015; Kelly & Matthews, 2014; Pascal et al., 2013). Being a multidisciplinary approach, user-centered design has been applied in ergonomics through anthropometry, which is the study of the proportions and measurements of the human body. The following Figure 2, represents a time line from 1400 to the 2000's representing the development of Human Factors(Nemeth, 2004).

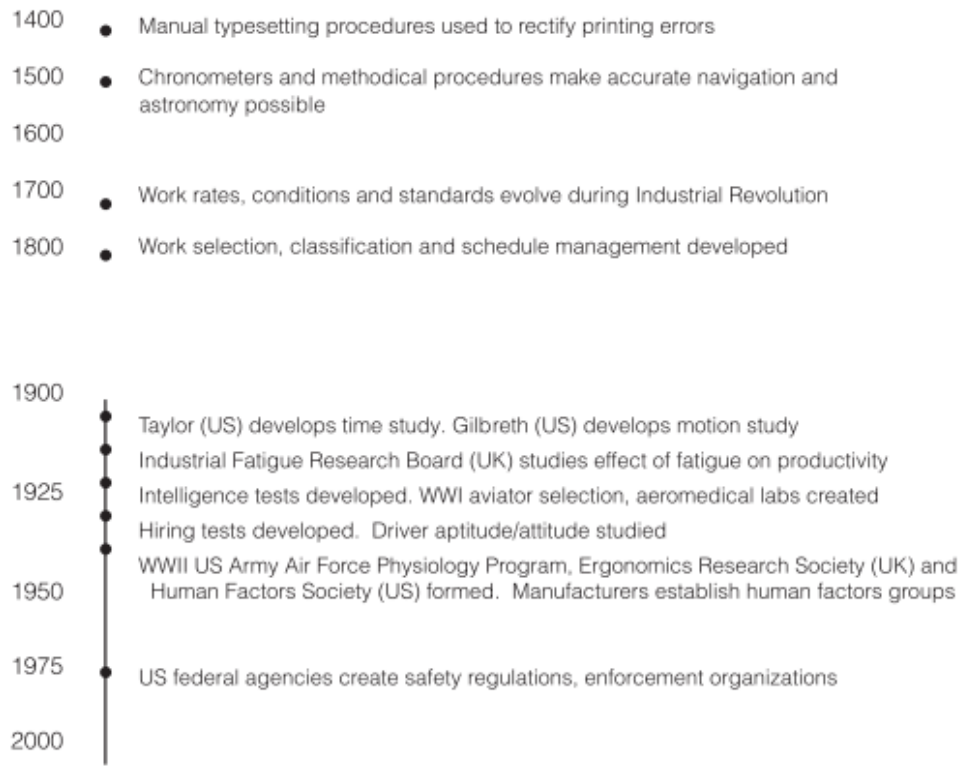

Figure 2. Representation of the Human Factors Development from the 1400's to 2000's (Nemeth, 2004)

The term ergonomics derives from two Greek words: *ergos* which means work, and *nomos* which is defined as natural laws (Nemeth, 2004). The terms human-factors and ergonomics are frequently used interchangeably. Ergonomics describes the physical human factors that aim at recognizing the interactions between humans and artifacts and provides principles and data that creates a better design by optimizing the overall performance and well-being of the user (Attaianese, 2012). This outlines one aspect of human factors, the idea that designers consider the human body in terms of functional features so that user-centereddesign can be achieved.

2.2.2 Cognitive Science

With human factors and ergonomics specializing in the physical boundaries of the human body, cognitive scientists and psychologists opened up an approach that studied the cognitive side of users (Boy, 2014; Hutchins, 1995). Cognitive scientists believed that human needs are not merely based on the physical needs of our body, but also on those of our mind and perception. With the emergence of cognition in ergonomics in the 1990s(Hutchins, 1995), scientists analyzed UCD from the lens of what pleases the end users, focusing on their emotional and cognitive needs, in addition to human factors (Hekkert, 2006).

Hekkert presents a study of the interconnections of people and systems using tangible interactive objects (TIO) (Hekkert, 2006). TIO is an effective way to integrate a user-centered approach, for example, for a pilot, in the design of airplane cockpits. Traditionally, the aircraft was controlled using a yoke, also known as the control column, but the design of the airplane cockpit was enhanced as technology advanced, to integrate a

variety of other functions (navigations, autopilot, control management, etc.). Thus, a new cockpit was designed based on the notion of user-centered design(Boy, 2014; Hutchins, 1995).

The designers were able to understand the fundamental aspects of the users' cognitive abilities enabling them to integrate the users' knowledge of the activities they executed, with the latest technologies. This was accomplished using the user-centered design approach. A possible technique for such an achievement can be done by engaging users in their own work environment, which may stimulate their emotional and physical states (Orsel, 2017). Overall, designers should consider end user's physical and cognitive states to identify the ergonomics and their emotional needs (Van der Ryn, 2013).

2.3 Landscapes of UCD

The landscape of user-centered design continued to expand beyond ergonomics and cognitive science. User-centered design became what could be perceived as an umbrella with various notions existing within (Sanders & Stappers, 2008). Some of these concepts include usability testing, contextual inquiry, design and emotion, critical design, and participatory design research, with the essence of this study related to the latter (Sanders, 2002; Sanders & Stappers, 2012).

2.3.1 Participatory Design

Participatory design emerged in the design field in the early 1970's (Bjögvinsson, Ehn, & Hillgren, 2012). While user-centered design focuses on the user as a subject, participatory design (PD) engages them as partners (Bate, 2007; Pascal et al., 2013;

Taffe, 2015). It originated from Scandinavian countries' movements, to democratize work places (Bjögvinsson et al., 2012; Robertson & Simonsen, 2012; Vainio, 2016), and it required cooperation between end users and professional system developers (Bjögvinsson et al., 2012). The word, "participation" in the notion of Participatory Design (PD) means to: explore, reflect, comprehend, create, develop, and encourage mutual learning amongst the participants (Robertson & Simonsen, 2012; Vainio, 2016), to acquire information that allows for transparency (Robertson & Simonsen, 2012; Vainio, 2016). Designers strive to comprehend what the end users do and the context in which the artifact will be used, while the users have the chance to learn about technological opportunities and challenges (Robertson & Simonsen, 2012).

In addition to mutual learning, the approach of participatory design creates an open dialogue, as well as building trust through communication (Sanoff, 1985). Bjögvinsson, Ehn and Hilgren, explain two values that led to participatory design (Bjögvinsson et al., 2012). The first is the social and rational value that ensures that the right conditions are ensured for user participation to take place. The second value lies in stimulating and engaging the participants to talk about their latent experience and issues. These two values combined to aid the designer to understand the different behaviors of the expert users and identify their requirements for the artifact. Moreover, participation in the design process gives users a sense of influence. It is not entirely the degree to which the users' needs have been met, but rather their feeling of ownership due to their participation, which increases their appreciation of the artifact (Sanders & Stappers, 2012; Spinuzzi, 2005). The author argues that it is sufficient to understand the expert users feedback, as their extensive knowledge is often not known by the researcher or designer. In summary, PD is one of

several ways to meet the challenges of successfully designing a particular product before its actual use (Bjögvinsson et al., 2012). Among others, co-design and co-creation are currently emerging concepts facilitating the participatory design process (Sanders & Stappers, 2008, 2012; Spinuzzi, 2005).

2.3.2 Co-Creation and Co-Design

Co-creation and co-design are approaches where the researcher, the designer, and the end users arrive at workable solutions in conjunction with one another (Spinuzzi, 2005). The "co" in co-design is the instance that advocates a partnership and engages all stakeholders to find an innovative solution for an artifact being designed (Bate, 2007). Specifically, co-design is the creative work that occurs between designers and non-designers in the design process, which is the instance of co-creation (Taffe, 2015). Co-creation happens when an act of collective creativity occurs. It is often practiced in the early stages of idea generation, resulting in a positive impact (Sanders & Stappers, 2008).

According to Taffe, the co-design process consists of three main phases: exploring, designing, and reviewing (Taffe, 2015). In the exploring stage, designers or researchers primarily collect end-user information through surveys or focus groups. Next, the design process takes place when the designer begins to produce a design in seclusion without the involvement of the end user. Finally, the review phase aims to gain user feedback on design refinements by using prototypes and testing them with the future end user. Participatory design emerged in the design field in the early 1970's (Bjögvinsson, Ehn, & Hillgren, 2012). While user-centered design focuses on the user as a subject, participatory design (PD) engages them as partners (Bate, 2007; Pascal et al., 2013; Taffe, 2015). It originated

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2.4 How is UCD applied?

User-centered design has many methods and tools (Lowdermilk, 2013) that can stimulate the users' active participation in a design process, and increase the level of understanding of user requirements (Giacomin, 2014). The following triangle (Figure 3) summarizes the span of questions a UCD approach tries to cover. The basis for this triangle is an understanding of the physical nature of people and their interaction with the product. When the questions higher up in the pyramid are answered, the designs are expected to

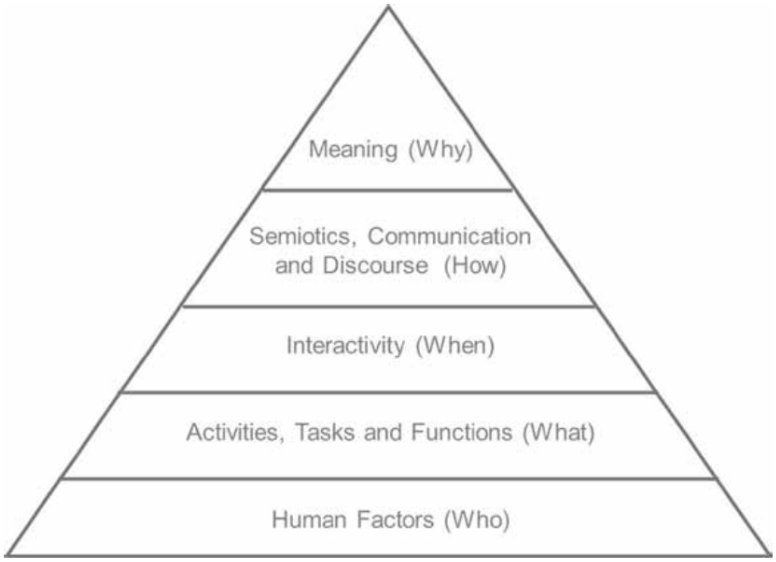


Figure 3. UCD Pyramid (summary of questions it aims to answer) (Giacomin, 2014)

embed themselves deeper in the users' minds, making them more user-efficient (Giacomin, 2014).

2.5 Path of Expression

Elizabeth Sanders explains the theory behind "Path of Expression" which formulates a generative design session, consisting of four steps, represented in Figure 4 (Sanders & Stappers, 2012). She insisted that end users are engaged, and their thoughts are stimulated to express their needs and ideas. It permits the researcher to understand users' experience, which is vital to the design process (Giacomin, 2014; Sanders & Stappers, 2012; Von Hippel, 2007). In a generative session, to evoke memories, the researcher may start with an emotional toolkit, followed by a cognitive toolkit that permits exploration of the underlying motivations behind memories, and then make a tool that allows the end users to create their desired futures.

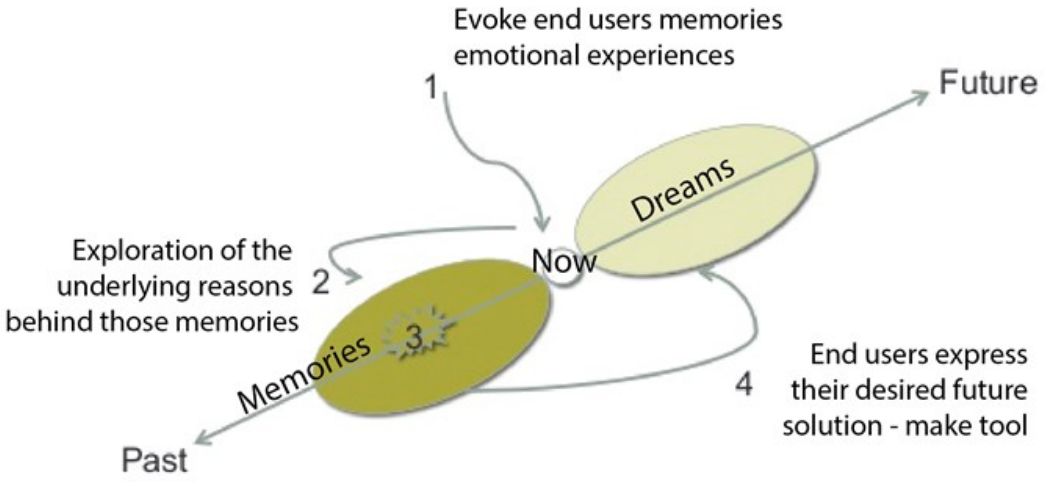


Figure 4. Concept of Path of Expression explained by Elizabeth Sanders Convivial Toolbox

During Step 1, participants are asked to "observe and reflect" on their current experiences; examples of tools that can be used are diaries, user journey maps, and taking photos, etc., that emphasize the present. Steps 2 and 3 reflect on memories, and the tools used in these stages help the participants to recall memories and engage them in sharing experiences. In Steps 2 and 3, prime participants contemplate on their aspirations for future solutions and desires leading them to Step 4, in which their ideal solution is created (Sanders & Stappers, 2012). A common language is established by using methods and tools that bridge the gap between researchers or designers, and users, for their mutual learning to meet the user requirements (Sanders & Stappers, 2012).

2.6 Tools and Methods

Within human-centered design a number of tools and methods exist. The ones applied by the designers will depend on the purpose and goal of their project (Sanders et al., 2010). Unlike quantitative analysis, which is non-technical data analysis that finds the most important category, the qualitative analysis provides the researchers with an opportunity to influence the process (Goodman-Deane et al., 2010). Qualitative research discloses underlying findings in the data by using iterative sorting and categorizing based on the observations and data collected. Additionally, it aims to reflect and elucidate all stakeholder perspectives (Goodman-Deane et al., 2010); it probes and primes the user, and helps the researcher understand the users' needs and desires. This is accomplished because the user (participant) is given a chance to generate their ideal artifact; however, what the

user creates is not necessarily the final design solution. It is a step that triggers designers to create ideas for an innovative solution (Stolterman, 2008).

User Journey Maps are a tool that stimulates users to tell a story from their everyday life (Hanington & Martin, 2012; Szabo, 2017). According to Szabo, people have the *"natural tendency to love an emotionally satisfying tale. Most of our entertainment revolves around stories, and we want to hear good stories. A great story revolves around conflicts in a memorable and exciting way"*(Szabo, 2017). Known to be one of the most common tools used by industrial designers (Hanington & Martin, 2012; Sanders & Stappers, 2012; Szabo, 2017), the user map is often used by researchers and designers to gain an understanding of the users' entire experience by breaking them down into components (e.g., activities) to obtain insights for future innovations (Kumar, 2013).This tool concentrates on the users' emotional experience throughout their entire journey, providing the designer with a wide spectrum of emotional feelings whether positive or negative (Hanington & Martin, 2012; Sanders & Stappers, 2012; Szabo, 2017).

2.6.1 Co-Design Workshop

In her book, *Convivial Toolbox* (Figures 5 and 6) (Sanders & Stappers, 2012), Elizabeth Sanders focussing on an ideal workflow for nurses on a patient floor in a co-design workshop by using three-dimensional dollhouse toolkit with nurses so that they could determine the ideal workflow plan and patient room, Surrounding the "expert users" with the toolkit allows and aids them to think in terms of activities that happened in the patient room rather than the room they occupied currently. Another session employed a

"dollhouse" technique (a 3-dimensional toolkit), using a scaled patient room model, in a co-design session to design an ideal future patient room (Sanders & Stappers, 2012).

Figure 6. 3D Dollhouse Toolkit (Sanders & Stappers, 2012)

Figure 5. Co-design Work flow (Sanders & Stappers, 2012)

To conclude, UCD is an approach that has been explored and implemented primarily in industrial design (Nemeth, 2004). IDEO, a well-known design firm in the US has created toolkits which act as systematic guides for designers and researchers and facilitate user involvement. These toolkits unleash creativity while placing the end users at the center of the process (IDEO, 2018). UCD has expanded its boundaries into different design fields, such as architecture, because of such progression in the last two decades.

2.7 Architecture

2.7.1 Definition

Architects are professionals concerned with physical space and assume that the space they create will have an impact on and shape human behaviors (Sanoff, 1985). However, architects tend to proceed with their designs without having a better understanding on what the expert users' desires, needs, and requirements area. Steven J. Orfields, a famous building researcher, said, *"It's a great irony that most of the big*

companies who design products have user-experience departments. But architecture, perhaps the most complicated science-art of all, doesn't have a user-experience department" (Pedersen, 2017). Architects are known to be inclined to use their knowledge when designing new spaces (Könings, Bovill, & Woolner, 2017). Rem Koolhaus, a Pritzker Prize-winning Dutch architect, told the dean of the Harvard Graduate School of Design in his keynote at the 2016 AIA convention, "*Architects used to be connected to good intentions, notionally at lease. With the market economy, we've slowly found ourselves supporting, at best, individual ambitions, and, at worst, pure profit motives"* (Budds, 2016). Architecture, as a profession, has shifted its orientation to focus on the corporate world, causing it to lose its roots based on the fulfillment of social responsibilities to its users (Budds, 2016). Some professionals believe that the focus of architecture and some related professions, continue to be on art and technology (Sipus, 2014), which was evident in the Bauhaus movement.

2.7.2 Bauhaus Movement

The Bauhaus movement took place in Germany between 1919 to 1933, with a focus on style and form (Bayer & Gropius, 1938). Figure 7 represents the "Curriculum Wheel" developed by Walter Gropius in 1922, illustrating the study of form and materials, and in-depth studies of composition and construction. End users' and how they use the edifice were never specified in the Curriculum Wheel (Bayer & Gropius, 1938). The traditional design process of architecture is found to be a general source of dissatisfaction amongst

several architects, and it is considered to be one of the last disciplines to explore UCD (Bushey, 2012).

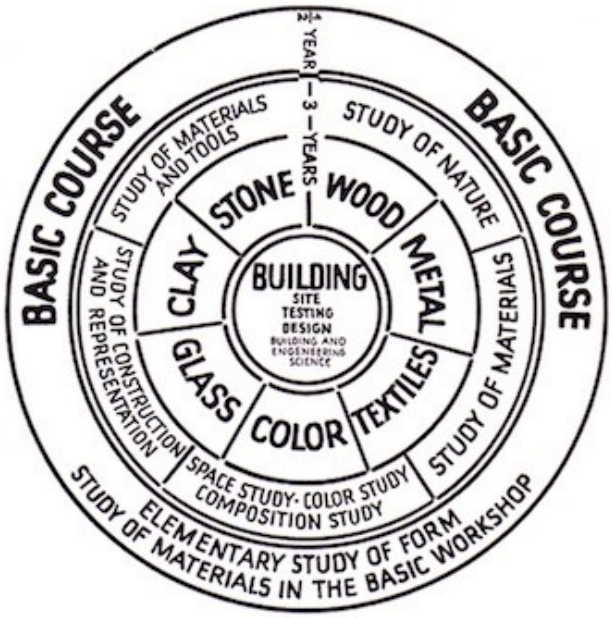


Figure 7. Bauhaus Curriculum Wheel (Bayer & Gropius, 1938)

2.7.3 Architecture Design Process

The life cycle of a building consists of five phases: planning, construction, occupation, demolition, and recycling. The planning stage is where the architect and client meet and the architect creates the design. Once the design is complete, the construction of the building then starts, and upon completion, it is occupied by the users, where unexpected changes often occur. Initially the building use is often dependent on the original planned function; however, with the on-going use of the building, users may alter the original function until a conversion state is reached. As the years progress the building reaches the end of its life cycle, and is set for demolition, then recycling (Bauer, 2010).

Planning and construction are the main building processes (Bauer, 2010). In the early planning stages, a common issue faced by the users is the functional program or the building program, which defines the spaces that will exist within the infrastructure and their layout (Sanoff, 1985).The requirements of the building program are often set by committees or clients that have not been actively involved in the built environment for years. Adopting a user-centric approach to formulate and gather user requirements for the building could be a possible solution to identify building requirements (Bauer, 2010). Currently, the planning process in architecture consists of four design phases: pre-design, concept design, developed design, and detailed design. The Ontario Association of Architects explains the four stages without involving the expert users in the process(OAA, 2012). The pre-design phase initiates after a meeting between the architect and the client, where the architect gathers information regarding the site (site surveys, site zoning planning information, etc.,) and other basic requirements. Concept design then starts, where the project parameters are recognized, and the architect begins developing initial designs, which are usually influenced by the budget and project requirements from the initial meeting. Once the architect and client agree on concept design, the developed design phase begins; and the design is refined and shaped into a final design. This is a crucial phase because it is the architect's last opportunity to improve the overall nature of the building. The budget, time, and quality come into play at this design stage as final decisions are taken. Detailed design is where the construction documents are created and assessed for project scope (overall cost), to start the construction (OAA, 2012).

Figure 8. Architecture Design Process

On the contrary, there are examples of architectural researches that value and incorporate a user-centric approach in their design process, through multidisciplinary teams(Bharati, 2015; Franco, 2016; Pedersen, 2017; Syed, 2017). Norman Foster stated, "Architecture is About People," his architecture firm Fosters + Partners emphasize the importance of connecting people and public spaces in addition to, the relationship of how people live and work to the technological innovations (Foster, 2001).

2.8 UCD in Architecture

Architects are required to be more versatile and work in through an interdisciplinary approach, where they can employ a user-centric approach helping them understand the user's requirements(Sanoff, 1985). The collaboration between social scientists and architecture initiated in the 1970's, creating an interdisciplinary approach to design. Design for Dialogue is a book that discusses the importance of having a conversation between the architect and the client to achieve a better design, highlighting collaborative processes.

Four overlapping activities: relating, talking, exploring and transforming in designing a project are essential in the design process(Franck, 2010).

2.8.1 Ergonomics in Architecture

Similar to industrial designers, architects consider the ergonomics of a building, which studies the overall effect of the environment on the users (Attaianese, 2012; Cooper, 2006; Orsel, 2017). Neufert is a manual for architects, and an essential tool used in the initial design and planning stages of an architectural project. It covers basic dimensions, functions, siting, and planning criteria (Neufert, Neufert, Sturge, & Kister, 2012). Accordingly, IA Collaborative, a Chicago based consultancy firm launched a set of ergonomic design templates, originally produced by Henry Dreyfuss Associates between 1970–1980, named Humanscale's Origins. This collaboration between IA Collaborative and Humanscale's Origins has revived the templates, and now 60,000 measurements for humans of all sizes, ages, and situations exist (Syed, 2017). The Founder and Chief Design Officer at IA Collaborative, Dan Kraemer says: *"Design today has more influence than ever before, and its shapes our most important experiences. Humanscale has the power to ensure those experiences are human-centered. Every designer and architect should own a Humanscale manual, and I'm proud to be part of making that possible"* (Syed, 2017). The

following Figure 9, represent aspects of the templates included in Humanscale's 2.0 manual.

Figure 9. Human's 2.0 Manual Representation 1 (Syed, 2017)

2.8.2 Physical and Soft Mock-ups in Healthcare

Design in the context of healthcare facilities is multifaceted, and constraints in time, budget and identifying distinct functional programming requirements is evident (Kasali, Nersessian, & Zimring, 2013). Changes to an architecture project once actual construction initiates causes delays to occur, which result in the client to loose time and money (Johansson, 2012). Care delivery services that contribute to overall better health as an outcome can be improved through high impact design concepts. Traditionally, building design processes range from 2D drawings, also known as blueprints, 3D models to full-scale physical mock-ups for clients and user evaluation (Dunston, Arns, Mcglothlin,

Lasker, & Kushner, 2011). One of the reasons why full-scale mock-ups were employed, was because of past experiences, where the expert users misunderstood the 2D drawings of various spaces (Johansson, 2012). The standard practice of building 3D mock-ups of healthcare facility spaces, such as: operating rooms, nursing stations, patient rooms allows for an interdisciplinary approach between architects and healthcare workers to design (Dunston et al., 2011; Kasali et al., 2013). It provides the expert users with an opportunity to describe their requirements and give feedback to the design professions (Dunston et al., 2011).

2.8.3 Physical Full-Scale Mock-ups

Figure 10. 3D Full Scale Mock-up Example (Kasali et al., 2013)

Kasali, Nersessian and Zimring researched to solve the challenge healthcare design faces in identifying and satisfying critical requirements for the patient care culture which

goes through constant transformation (Kasali et al., 2013). The design team employed a series of tests with the interdisciplinary team, using full-scale mock-up spaces of the patient rooms, to identify the requirements. The proposed research method for this study initiates a process of engagement with the expert users early on, and before the stages of a full-scale mock-up as it focuses on identifying the building program requirements in the initial design stages (Johansson, 2012; Kasali et al., 2013). The full-scale models engaged the participants in a collective exercise, by using moveable walls that evolved to a finalized design (Kasali et al., 2013). This allowed for the expert users and users to do a physical walkthrough and testing could be done on site (Johansson, 2012).

While this approach incorporates expert users and users, full-scale mock-ups have been realized to be successful yet costly and time-consuming, due to the materials required and construction time (Johansson, 2012; Kasali et al., 2013). Furthermore, physical mock-up and full-scale models require a large space to obtain them, which may require permits adding up in costs for time and money. Additionally, they can be difficult to adjust due to their scale and require a few weeks to adjust, causing a delay for the participants to visit which can be seen as inefficient (Johansson, 2012).

2.9 Virtual Reality Mock-ups

Virtual Reality (VR) is used as a tool to create 3D mock-ups of different spaces. Using design programs such as Google SketchUp and Revit to design and model the 3D mock-up of the space, Johansson, 2012, evaluated three walkthroughs of patient rooms (Johansson, 2012). The volunteers for this study were from the physician and nursing staff of the existing hospital. Through the study of comparing VR soft mock-ups

to physical 3D full-scale models, costs towards construction in time and money were eliminated. Due to everything being virtual, the necessity to gain building permits was no longer required. Additionally, virtual reality allows for users to explore exterior spaces and walkthrough large interior spaces which were not feasible with physical mock-ups. Nevertheless, physical mock-ups of the healthcare patient rooms allowed for mobility of equipment in real time, in addition to identifying the limitations of the spaces that the soft mock-up version did not. VR soft mock-ups today, do not measure and show when there is more than one participant in the room, and limitations in the design are harder to identify (Johansson, 2012).

Figure 11. Virtual Reality Mock-up (Johansson, 2012)

2.9.1 Architecture and Science

A UCD approach does not just consider the human factors aspect, but also the cognitive factors aspect of the users. Scientific methods in research do not consider the emotional aspect of design, whereas a user-centered design approach; a generative design session looks at both the physical and emotional aspects of the user. Esther Sternberg, the author of the book "Healing Spaces: The science of place and well-being" positions scientific understanding in the context of place, identifying how the physical environment contributes to the overall well-being and health of the user (Sternberg, 2009). Sternberg, a medical doctor and immunologist, simply look at answering the question "Can the spaces around us help us heal?" She expresses the importance of the physical space affects and forms the healing process of patients and how it produces changes. This is done through how the visual pathways of the mind are affected by the architectural spaces, and the aesthetics of the space can reduce ones perception of pain. "Healing Spaces" explained by Sternberg, emphasizes on the psychology and our senses, defining the effect of architecture design on the human psyche(Sternberg, 2009).

Also, Alberto Perez-Gomez looks at how architecture can enhance human values while being in a crisis to socially maintain its presence in innovation and technical sustainability (Perez-Gomez, 2016). Architecture is created connecting to its location (siting) as well as its' inhabitants (users), emphasizing how the designed physical space affects the overall well-being of people. Perez-Gomez, 2016, focuses on creating architecture space through the lens of the emotion and atmosphere, connecting it to the

concept of "attunement." The attunement to place is solved through the design of space, where multisensory experience is present(Perez-Gomez, 2016). Similarly, Harry Francis Mallgrave claims that neuroscientific research offers learnings to architecture environments to enhance the relationship between space and multisensory nature(Mallgrave, 2009). He emphasizes that even though there is a lot to learn from neuroscience, it should not be applied in a prescriptive way, but rather, it aids architects in understanding and enhances the design process(Mallgrave, 2009).

2.9.2 Danish Architects and their Connection to Users

A group of Danish architects collaborated with local authorities, researchers and teaching institutions, creating an interdisciplinary group called the "*The Architecture Project.*" They value creating spaces that connect to their users and aimed to revive the city of in Aarhus, Denmark, naming it "Healing Architecture" (Franco, 2016). To achieve this, *The Architecture Project* generated multidisciplinary occasions, where stakeholders combined their tools, skills, and abilities to design future opportunities. It enabled the academics, researchers, and companies to acquire mutually beneficial skills and created solutions (Architecture Project, 2015).

In Franco's article (2016), the interdisciplinary team employed different methods to establish a relationship with the end users who will inhabit the constructed spaces. The architects tried to acquire data regarding the end users' needs, traditions, and experiences to initiate their design process. The first tool employed was the "search for feedback"; architects observed diverse end users gain criticism on how to improve the spaces. The second tool mentioned is "Adaptable spaces – Setting up User Experience" that resulted in

building aimed at stimulating the senses of people with disabilities, and at living with cognitive development. The architects accomplished this by understanding and connecting with the users, and making provisions for accommodating their experiences with the use of the senses. The patient experience was accommodated through technology, where patient rooms were transformed using lighting, sound, and projection of images, transporting patients to various locations. Additionally, the architects created a "sense garden" with recreational elements and stimulating plants for patients to hear, smell, see and touch, creating an overall sensory experience. Interviews and prototypes were also some tools used by the Danish architects. Instead of having a standard interview, architects created mock-up cards to increase the level of response, and small-scale models were used to enable the end user to visualize and reconfigure the edifice to find an ideal solution. Citizen participation and post-occupancy evaluations were the last two tools mentioned (Franco, 2016).

CEBRA, one of the multidisciplinary consultant firms states part of *The Architecture Project* states that, *"The aim of an involving process is to create a mutual understanding of the project and to build up ownership and roots in the local community. At the same time, this approach shall supply the consultants with the necessary basis so*

that they are able to transform the client's intentions into the best project possible." (Franco, 2016).

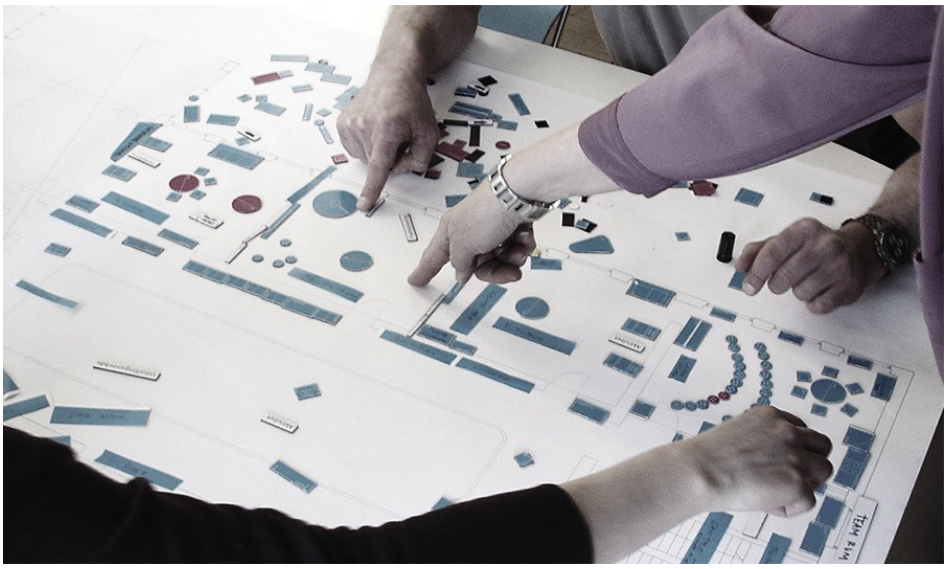


Figure 12. Collaborative Design Activity (Franco, 2016)

2.9.3 Community Engagement

Similar to citizen participation, another attempt to apply a UCD approach in architecture was seen in literature, in participatory planning for community art projects, such as community housing (Robertson & Simonsen, 2012). Community engagement is commonly known as: neighborhood planning, participatory architecture, and citizen participation (Cooper, 2006). It started in the 21st century. Community engagement ideally allows all stakeholders to collaboratively work together. An example is seen in the Orsel of community engagement project where architects attempted to create meaningful connections between architecture and media through emotion and technology (Orsel, 2017). Another example is through community engagement where architects and the public collaboratively worked together to create a space for the users in a park (Arnberger & Eder, 2012). On the contrary, the way a UCD approach was applied here would not meet the user

requirements to identify and design functional programs for distinct buildings, like a field healthcare facility, which is the focus of this study.

2.10 Why did Architecture take a long time to accept UCD?

Even though there are some studies that discuss the ways to include expert users in the design process to gain a better understanding of their latent needs (Bharati, 2015; Dunston et al., 2011; Franck, 2010; Franco, 2016; Johansson, 2012; Neufert et al., 2012; Novella, Bernard, & Christian, 2010; Perez-Gomez, 2016; Sternberg, 2009; Syed, 2017), there are only a few architects who still haven't incorporated this notions. Some reasons are found through the literature review explaining why architecture is one of the later disciplines that integrate UCD approach. First of all, lack of resources, time, and money would be one of the reasons that constrained the employment of UCD methods in architecture. Some architects cite insufficient time to analyze the findings due to budgetary constraints (Goodman-Deane et al., 2010).Additionally, the accessibility of end users to participate during a UCD process, and methods enabling architects to analyze the various concepts derived from the stakeholders pose frequent challenges and limitations (Könings et al., 2017). Goodman mentions other barriers to user involvement from the clients' perception towards the designer. First, some clients may perceive that activities that involve the user will not add value to the final product, revisiting time and budget constraints. Second, designers' fear that inviting client participation will entail loss of their trust and confidence because the client thinks that architects have a complete understanding of the consumer and this belief will be impacted (Goodman-Deane et al., 2010). Similarly, the author of *Convivial Toolbox* also mentions that the notion of co-designing, when used

by design professions, often makes them feel threatened as their "control can be relinquished," and given to the users (Sanders & Stappers, 2012).

The literature review demonstrates that while industrial designers have progressed and diversified in incorporating a UCD approach, there are few examples of researchers and architects who have implemented this approach and accepted its' value. There are several reasons to explain why architecture is one of the later disciplines in implementing a UCD approach; however, this thesis excludes those notions as this thesis proposes and provides co-creation tools that an architect may employ to get a better understanding of the expert users requirements. The generative design approach and tools proposed in this study are used in the initial stages of the design process and are easy to use, handle and make, unlike full-scale physical mock-ups and virtual-reality mock-ups that are usually occurred later in the design process.

3 Chapter: Methods

3.1 Approach to Methods

Architecture and Industrial Design are two disciplines that undergo two distinctive design processes. This study takes a co-creation generative design approach, explained in Chapter 2: Literature review, by using three established tools such as: User Journey Map, Cube Tool, And Velcro Model (Hanington & Martin, 2012; Sanders & Stappers, 2012). The current healthcare facility 2D drawing of floor plans was not available and accessible for this research, further research can be done to correlate the suggested solutions to the existing layout of the facility.

3.2 Overview Research Procedure

First, participants were carefully recruited from end-users or managers in the healthcare facility in Petawawa, Ontario, Canada. Among the 15 units located in the building, people from each unit were invited to participate in this research, and a total of seven participants attended the sessions. The seven participants included military personnel, in addition to civilians who all worked in the existing field healthcare facility, for example: pharmacist specialist, X-ray specialist, healthcare facility managers, general admin managers, etc. Ideally, 15 participants would be preferred, as each participant would have represented a different unit, however, due to availability this was not possible. Each of the seven participants represented a different unit, obtained at least five years of experience in a health-care environment. The Project Director of the healthcare facility, made initial contact with the users via email to get their approval (See Annex A). The researcher then followed the ethical protocols, and once approval was gained, a second

email was sent out to determine a day and time that would best suit the participants, and to circulate “Invitation Participation” (See Annex B).

The study required both the participants and the primary researcher to be in the same location; hence, face-to-face interviews were conducted at the convenience of the participants, in their work setting. Prior to conducting the interview, participants were given the “Signed Consent Form” (See Annex C) and were reminded that the interview would be audio recorded, and were given the option of it not being audio recorded if they wished it. The researcher assured the participants that they had no obligation to answer any of the questions and then started the interview. At the start of the interview, the researcher provided the end users with a detailed description of the study and concluded the interview by asking the participants to fill out the short survey for feedback (See Annex E).

The researcher gave a minute introduction to the participant summarizing the goal of the research, and ensured that the participants were aware that the research would not influence their current rebuild of the health-care facility, but is solely a masters thesis research.

3.3 Data Collection

Once the consent form was signed, the participants agreed to the interview being audio recorded and a brief introduction was provided by the researcher to each

participant; and the interview began. As previously mentioned, the interview was structured into three sections:

1. The first part of the interview required the participants to fill out a user journey map.
2. The second part of the interview required the participants to identify the current issues they faced, using the cube tool.
3. The final part of the interview is where the participants used the Velcro Model to create their ideal plan arrangement of the facility.

3.4 Tool 1: User Journey Map

The User Journey Map was provided to the participants with a set of artifacts to help and guide them to create these maps, as represented in f

Figure 13. This tool helps the participant to recall any memories, whether positive or negative using the visual aids, and allows them to express how they feel throughout a typical workday with the X-axis representing time, and the Y-axis representing their emotions. Self-adhesive stickers were provided for the participants to fill in the journey map, made up of keywords (to stimulate the users' thoughts) and a set of icons representing the 15 units of the building so that the user can identify the space they went to and mark it. Blank stickers were also provided to add any keywords or spaces that were not provided, giving them choice to express how they felt freely. In addition, a Key Legend *(See Annex*

F) was presented to the participants so that they were aware of all the possible choices they had when the researcher asked them to fill out the journey map based on a typical day.

Throughout the activity, the researcher guided the participants if they had an inquiry, and asked the participants a few questions to direct them when roadblocks to thought were perceived. The researcher ensured that the User Journey Map was completed before moving to another tool, the Cube Tool.

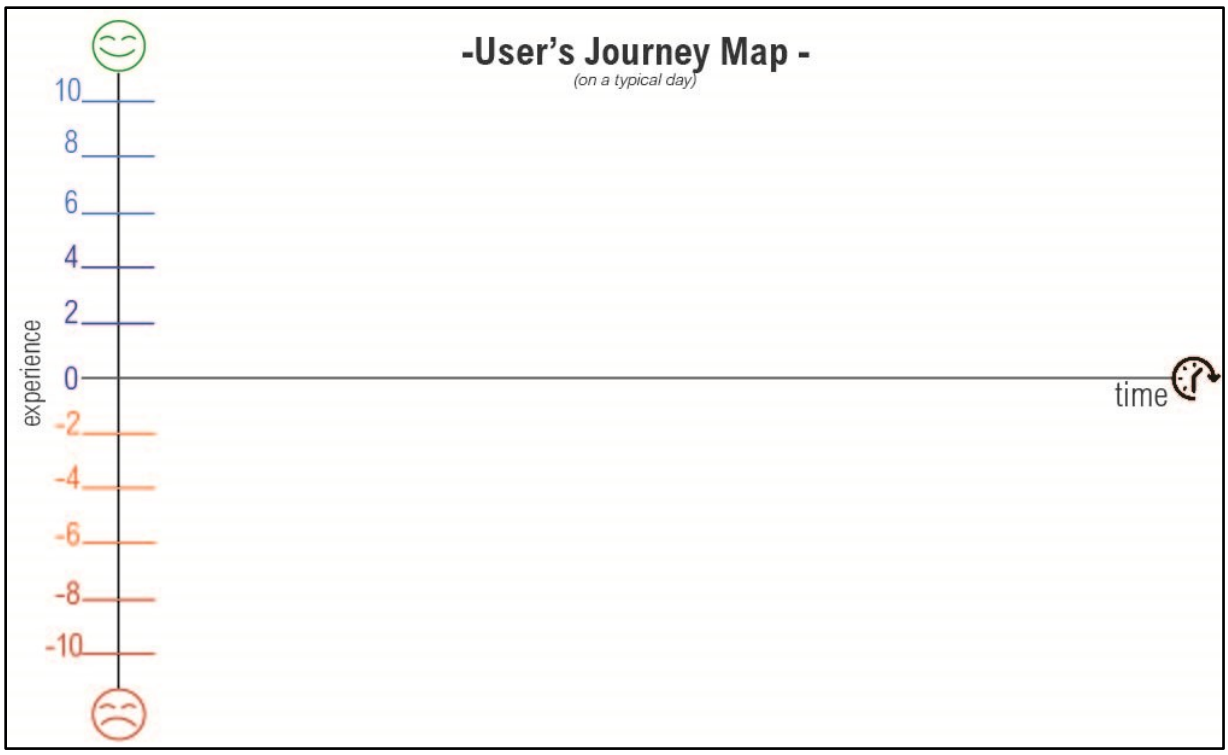


Figure 13. User Journey Map created by the Researcher for this study

3.5 Tool 2: Cube Tool

The cube tool was used to identify all the existing issues that each unit currently faced, and the necessary improvements identified by the end users for the new healthcare facility. In this process, the participants reflect on future requirements, giving the researcher, a better understanding of the current issues and the positive attributes possessed

by each unit. This tool is based on the research conducted by Kirsikka Vaajakllio, a researcher and doctoral student from Finland. She used three generative co-design tools to build an innovative environment and a tool similar to the cube tool was used to identify the activities within the workplace and the culture (Sanders et al., 2010). The participants were handed 15 3D cubes (Figure 14), each one representing a space within the building. Post-it notes and pens were also given to the participants to write down all the issues that they had. The researcher asked the participant to think about each unit separately, talk about it, and note all the issues and enhancements they wished to see in the future design plan.

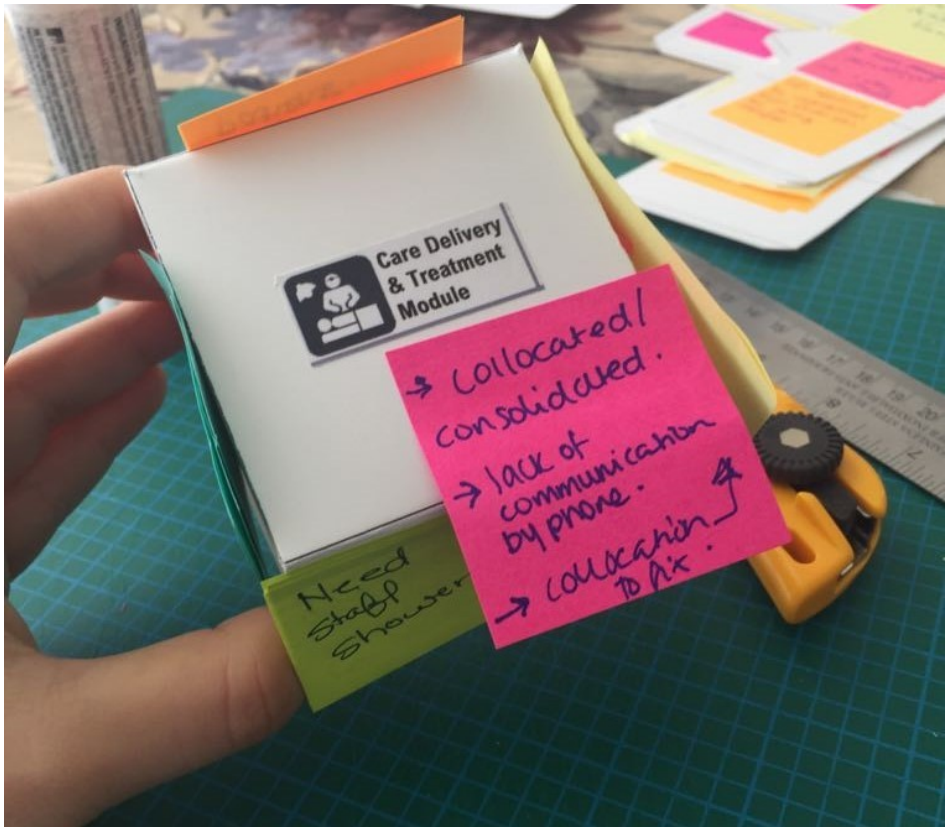


Figure 14. Cube Tool

3.6 Tool 3: Velcro Model

The last generative tool used was a making tool such as Velcro-modelling to create designs that the users wished to have in the future (Sanders & Stappers, 2012). For this thesis research, a Velcro Model (see Figure 15) was adapted for participants to express their ideal future solutions focusing on the "why" factor. This is based on the example of a co-design workshop done in a healthcare facility to determine the ideal workflow on a patient floor, described in Chapter 2: Literature Review (Sanders & Stappers, 2012). The Velcro Model tool used in this study had a similar approach where the participants were given an empty board with Velcro on it and 15 colored circles with Velcro stuck to the back, where each one represented a unit (See Figure 15). The researcher gave the participants the freedom to add different units, and any details that they wanted to present (e.g., doors) on their plan using post-it notes and pens. The researcher explained the activity to the participant by asking them to express and show their ideal arrangement of the healthcare facility. The researcher did not influence their design in any way, and only spoke when questions were directed to them.

The researcher gave the participants the freedom to add different units, and details they wanted to present (e.g., doors) on their plan using post-it and pens. The researcher explained the activity to the participant by asking them to express and show their ideal arrangement of the health-care facility. The researcher did not influence their design in any way, and only spoke when questions were directed to them. The researcher only asked the

participants to explain their reasoning to how they placed the units in those adjacencies, to look at the "why" factor and then a photo was taken of the completed plan.

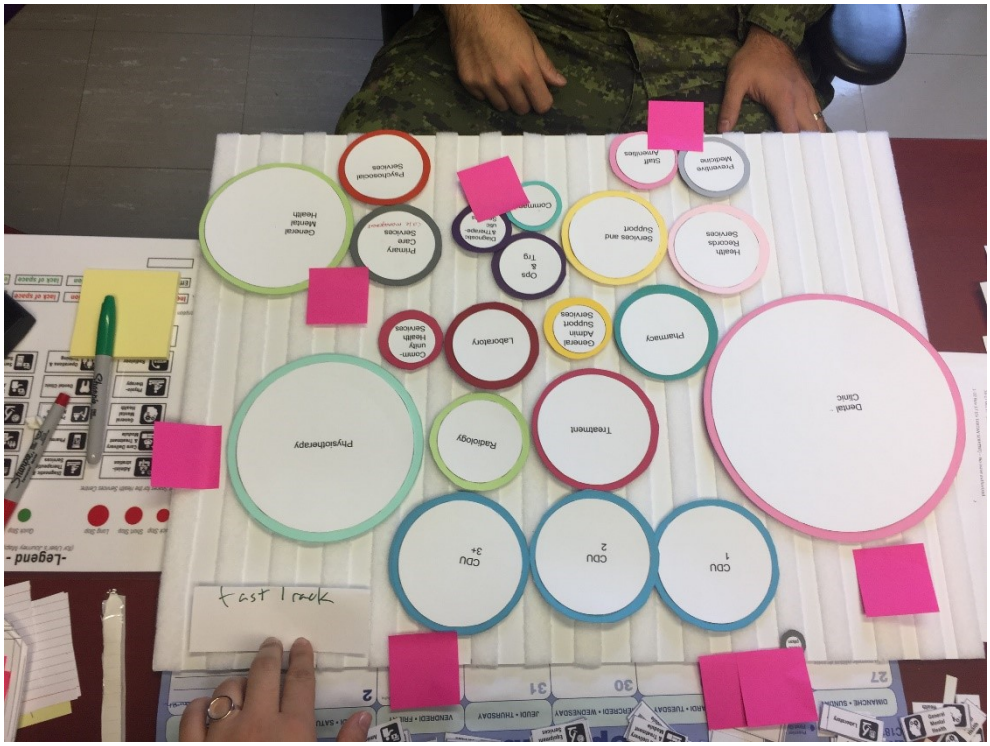


Figure 15. Velcro Model (Participant 6) during an Interview with an end user

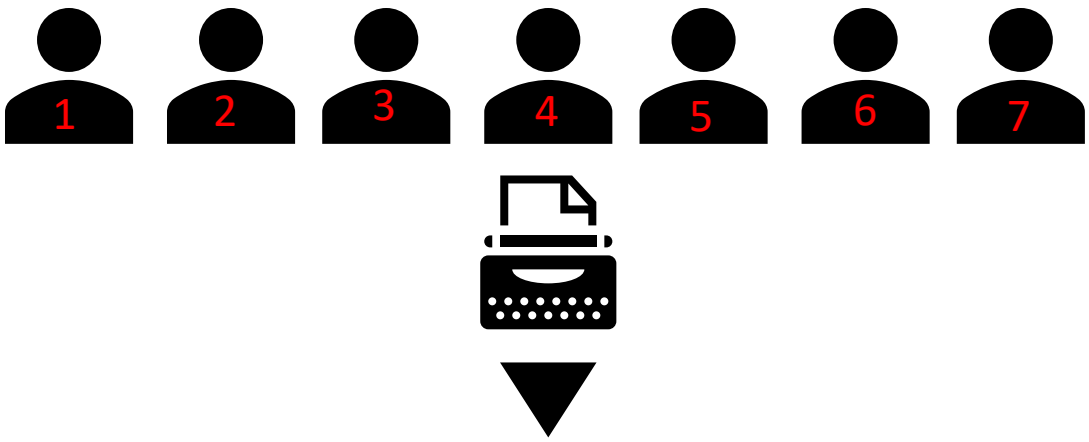
3.7 Survey

After the three tools mentioned above were completed, the researcher asked the participant to fill out a survey. The researcher ensured the participant that the survey would be anonymous *(See Annex e: Survey).*

3.8 Data Analysis

The data gathered from the seven interviews were compiled by the researcher and the audio recordings were transcribed in an excel sheet *"Coding for Audio-Recorded Interviews."* The data compiled was analyzed by two people, the researcher and project

director to decrease and eliminate any biased assumptions, for example if one of the participants based one of their stops on the user journey map on an emotional experience not related to the facility. Using the excel sheet, keywords were identified and grouped by relevance, resulting in five themes explained in Chapter 4. Viable solutions were then provided based on the analysis.



Coding For Audio-Recorded Interviews											
Information				**Researcher Comments**				**Project Director Comments**			
Date	Interviewee	Activity Number	Transcription	Interpretation	Primary Keyword	Second Keyword	Third Keyword	Interpretation	Primary Keyword	Second Keyword	Third Keyword
September 7th 2017	**Participant 1**										
		Part 2: Cube Tool	*bathrooms always back up and the building is falling apart. The heat and air conditioning isn't working anymore. Handicap doors their handle falls up. The elevators has stopped working more than 8 times this year. handy-cap doors break sometimes.*	*The building is old and the utilities, mechanical and electrical equipment is too old and requires an update.*	*Building End of Life*	Updating equipment		Excessive breakdown due to lack of maintenance	Building and systems at end of life	Lacking maintenance	

Figure 16. Diagram of Data Analysis

4 Chapter: Data Collection and Analysis

4.1 Healthcare Facility Background

To gather data, this study conducted in-depth interviews with the current users in the Healthcare Facility, Petawawa, Ontario, Canada. Before the interview, the author gathered information about the current facilities and any emerging issues in the facility using project documents provided by the Project Director. The author gained in-depth information regarding the different units that currently exist in the facility, the history of the facility, and its current capabilities.

4.2 Background Information

The healthcare facility was constructed in 1971 and has been enlarged, and minor repairs were carried out as a short-term solution. Currently, the facility meets neither the operational needs of its end users including patients, caregivers, and other workers, nor the National Building Code of Canada requirements. As shown in Table 1, there are 15 main, different-sized units in the facility (Table 1). They are dispersed into different infrastructure buildings instead of being consolidated into one single infrastructure, making it inefficient. In order to identify the end users' latent needs, hidden problems, and their desires, this study employed the qualitative research approach such as in-depth interviews with tools facilitating the conversation between researcher and participants. A total of seven

participants from the 15 units were recruited and they all have at least five years of work experience in the facility.

Figure 17 - GoogleMap of Site

Table 1. 15 Units and their Net Area's

	Unit	Area (Total Net Area in m^2)
1.	Administration	
1.1	Command	52.2
1.2	General Admin Support Services	58.2
1.3	Reception	6.0
1.4	Health Records & Services	161.4
2.	Care Delivery & Treatment Medicine	
2.1	Primary Care Services	132.3
2.2	CDU (3 Units in this facility)	-
	CDU 1	227.6
	CDU 2	227.6
	CDU 3+	261.9
2.3	Treatment	248.6
2.4	Psychosocial Services	145.8
3	Diagnostic & Therapeutic Services	49.2
4	Pharmacy	136.1
5	Laboratory	126.3
6	Community Health Services	44.7
7	Mental Health	425.1
8	Physiotherapy	561.1
9	Radiology	134.8
10	Preventive Medicine	89.1
11	Biomedical Engineering Services	0
12	Dental Clinic	1151.8
13	Operations and Training	84.9
14	Staff Ammenities	329.4
15	Services and Support	193.0

4.3 Data Collection

The audio recordings of all seven interviews were transcribed and organized in an excel sheet to analyze the data. The tools used during the interview helped the participants to think aloud and stimulated their thought processes to express their desires, needs, and

requirements. Furthermore, the *Coding for Audio Recorded Interviews Excel Table* was useful to transcribe the interviews and to interpret them, and identify up to three key words from each transcription.

Once the seven interviews were analyzed by finding up to three key words in the excel table, the author found different and unique notions as well as common notions amongst all the participants. This helped the author to identify some hidden insights and the users' unmet needs. In addition, The *Excel table* was also forwarded to the Project Director and he was asked to add his analysis including key words and comments.

4.3.1 Tool 1: User Journey Map

This introductory tool used in the interview, stimulated the user to ponder what a typical day was like, allowing the end user to think about their emotional experience. This tool was chosen because the researcher wanted to understand what a typical day is like for the expert users. Through the review of participants' daily activities and the different stops they underwent on a typical dayaid the researcher to understand the expert users overall emotional experience. This tool provided the researcher with tangible results of the expert users breakdown on a typical day in addition to their emotional experience. During the interviews and through analysis, it has been discovered that not all participants had several stops on their user journey. The user journey map allowed the participants to start thinking about their everyday experience in different locations and how they feel towards them. Even though some participants such as pharmacists and the healthcare facility manager mainly worked in their departments instead of traveling to other units, all the participants were asked to develop the User Journey Map. The following figures show a comparison

between two participants, one that had several stops during the day (Figure 18), and one that only had a few (Figure 19).

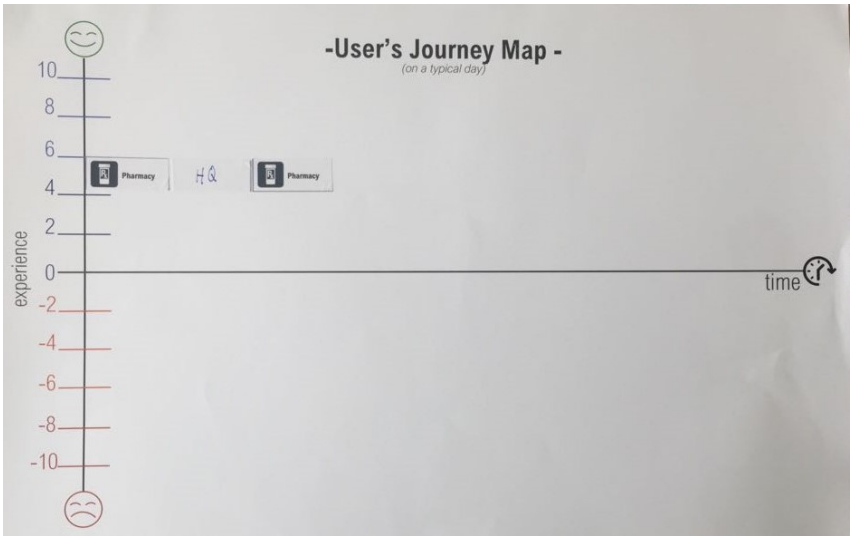


Figure 19. Experience Map 2

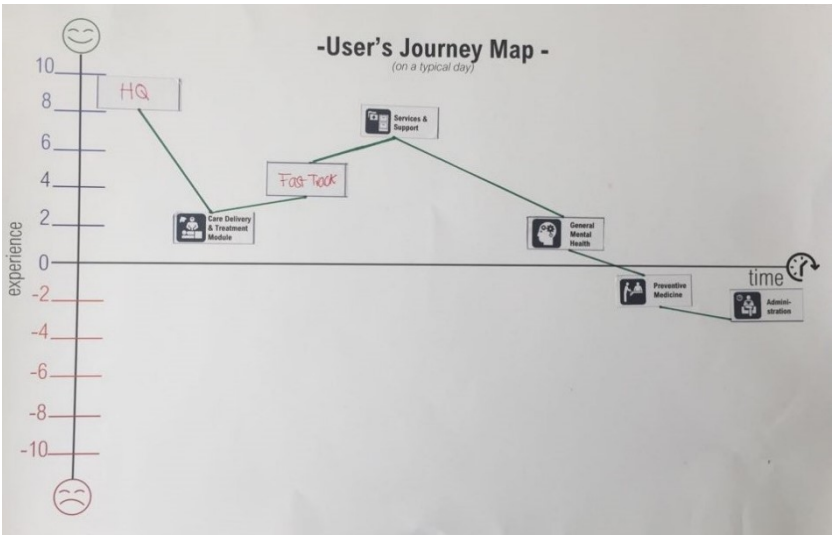


Figure 18. Experience Map 1

The researcher realized that some of the participants were confused about whether they developed the map based on their emotional states, positive or negative, or whether they based it on personal emotions not related to the design project. One of the participants explained that misunderstandings did not affect their mood because, overall, they are just

a happy and positive person. However, another participant mentioned that their mood could be affected by events at home. The researcher had to re-direct the participant to contemplate their journeys around the healthcare facility, how the spaces affected them, and why they did so. Industrial designers often use User Journey Maps to know the end users' experience while using objects in various places (Szabo, 2017), but in architecture, it was more about the activities and spaces.

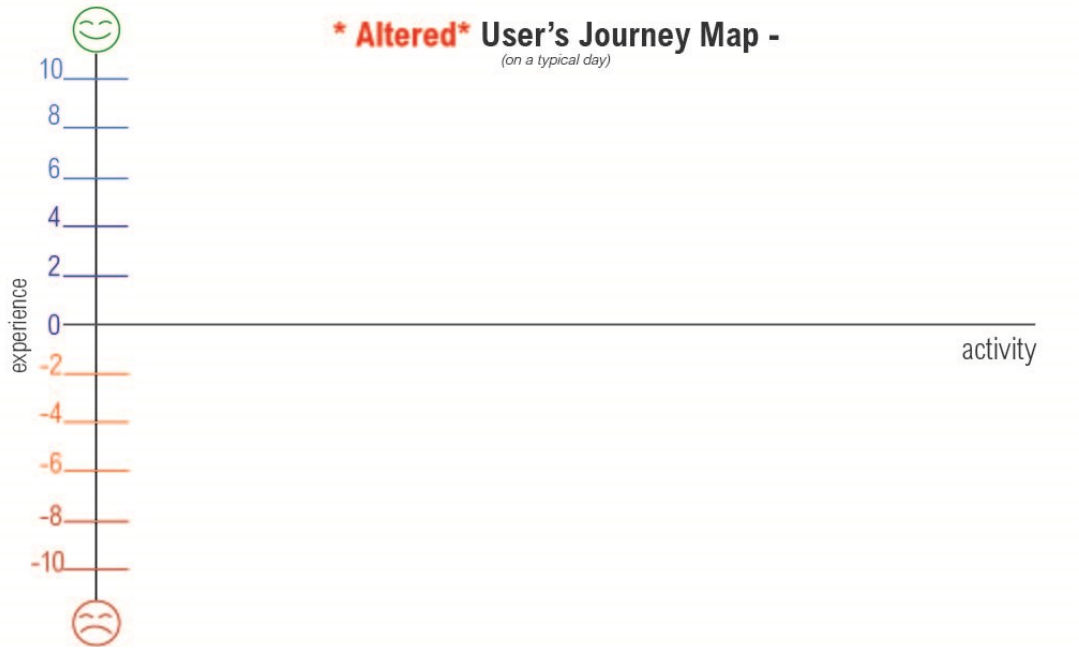


Figure 20. Altered User Journey Map for Architecture Projects

Based on the data from this study, the researcher proposes that the User Journey Map that often used by industrial designers requires some refinements to suit architectural projects. The author suggests that by replacing "time" with "activity" on the x-axis (represented in Figure 20) architects will get an understanding of the spaces and the interaction of the user and the activities. Architects solely view the interaction of the space and the activities within the space, which is their preferred way as they deal with space and

objects. An important and added value future research would be to compare the places with different spatial configurations to identify variances.

4.3.2 Tool 2: Cube Tool

This tool allowed the participants to articulate some of the issues that they currently face in the 15 units within the healthcare facility. It allows the participants to explain their thoughts and reasoning as to why some places did not meet their requirements, and what they wish to see as potential future solutions. Accordingly, this tool helped the researcher to analyze and find key insights on users' unmet needs.

Some of the participants had little knowledge about all 15 units of the healthcare facility and could not comment on the capabilities and deficiencies of those spaces. This was because their work task was mainly limited to one space, and they had no interaction with some of the other units. Here are some of their comments, "*I don't deal or interact with them much,"* and *"I don't know too much about them, and they are down the hall."* Their job was focused in one particular space, and they did not interact with others, which was evident as they expressed a lot of issues in their specialty, for example, pharmacy or radiology, but had little knowledge about the other spaces. On the other hand, some users who were managers of certain units had a clearer outlook and were cognisant of most, if not all, of the 15 units and their capabilities and deficiencies. During the cube tool part of the interview, some participants were curious about others' conceptions of the same space.

This was a positive aspect most of the time, as it prodded them to reflect on these attributes and it often triggered their thoughts and led them to think about other issues.

Specifically, this tool allowed the participants to articulate their concerns and issues in the 15 units through three dimensionalities. First of all, each participant was handed a different color of post-it notes, to write their concerns or issues on, giving them their own identity. The researcher observed that the participants would rotate the cube and pause on each side to think about a different issue for the unit presented. Overall, this tool was perceived positively by the participants, and they were able to express their thoughts freely. Generative design sessions, unlike standard interviews, where the user is asked questions, users may not feel comfortable saying anything negative, but in this case, the end users were free to express their opinions, either positive or negative. One of the participants even said, *"I feel like I've just been saying negative things, but at least you're getting an understanding of what's happening."* The following Figure 21 is an example of one of the

units (Care Delivery Units) with the expert user comments; this was done for all 15 units (See Annex G).

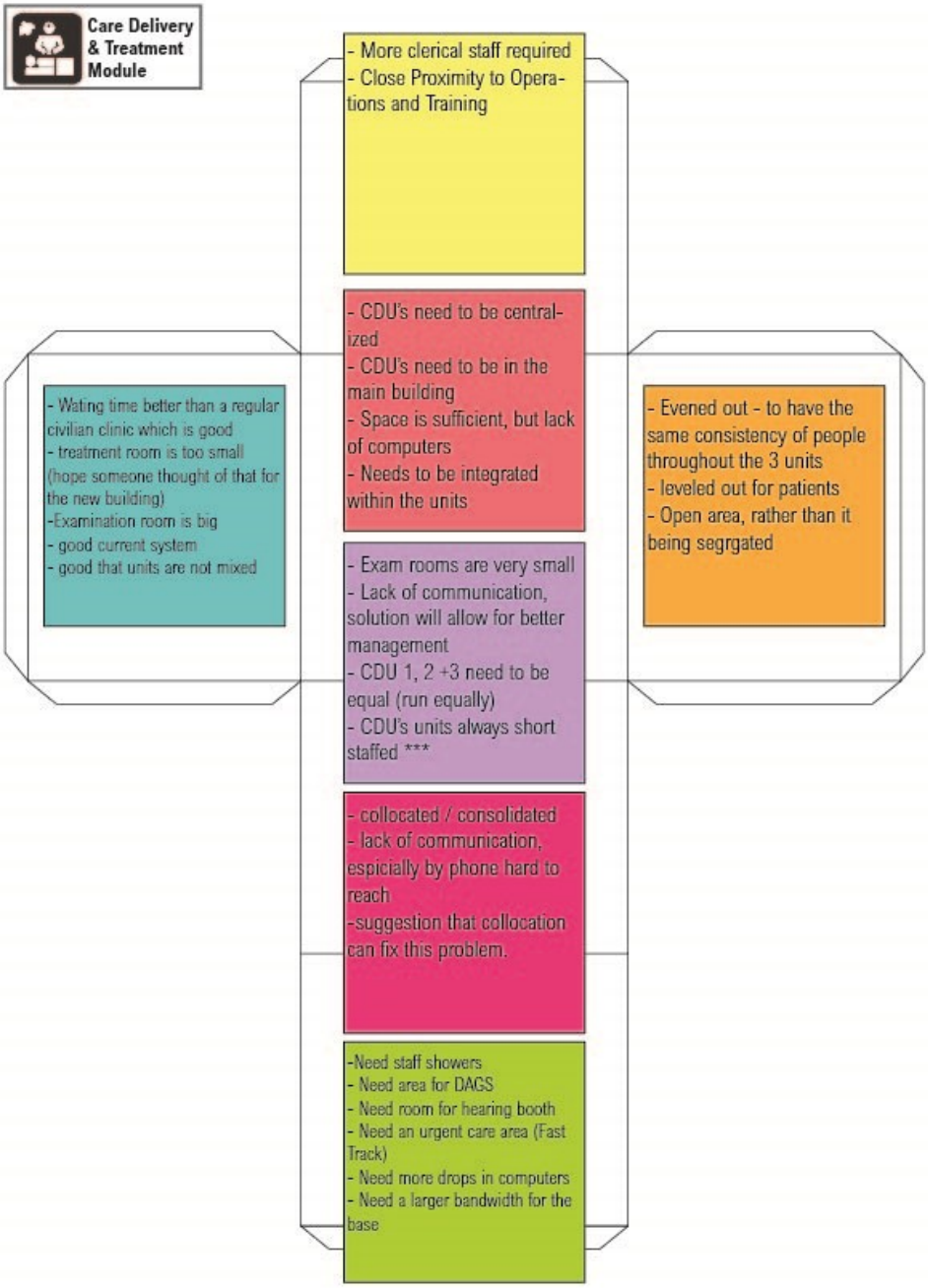


Figure 21. 2D representation of Cube tool with User Comments

4.3.3 Tool 3: Velcro Model

The Velcro Model was the last of the three tools used in the interview. After the expert users' memories have been evoked through the user journey map and have discussed the issues that currently exist in the healthcare facility, participants were asked to express their desired future solution. This was done through a make tool, using the Velcro Model provided. Analyzing the model developed by the participants, the researcher attempted to understand their reasons for creating a specific layout. During the exercise, some of the participants doubted that all the units could fit on the Velcro Model given to them.

One of the participants asked, *"Are you sure this will all fit on here?"* The researcher reassured them that all the units fit into one plan and once they realized that it was true, they started to place the units on the given model. Other participants asked questions like, "*Can I have two levels for my ideal plan*?" And the researcher told them that they were free to create whatever they desired as this was their time to portray and explain their wishes. Additionally, each of the 15 units on the Velcro Model had diverse colours and sizes scaled *(scaled to their actual size referring to Table 1)* to their actual net areas. This created a more colourful and playful tool that made it exciting to the participants when they engaged with them to create their ideal solutions. Furthermore, the researcher found that the Velcro Model allowed the participants to freely express their design and create different layouts without worrying about making a mistake as they could rearrange the plan however they wanted. One of the participants at the beginning of this session commented, *"Oh, all the fun stuff starts."* Additionally, one of the participants used the post-it notes to further describe their plan by adding exit doors where they thought it would be necessary. The researcher found that the Velcro Model tool was an easy-to-make and

use tool that allowed the users to freely express their design. End users could create different layouts, without having to worry about making mistakes, as rearranging the spaces was easy because of the Velcro.

Appendix H, shows all the seven different layouts created by the end users. The following Figure 22 is a photo taken by the researcher on the day of the interview, representing Participant One's desired plan. Post-it notes were used by the participants to add comments and doors for entrances.

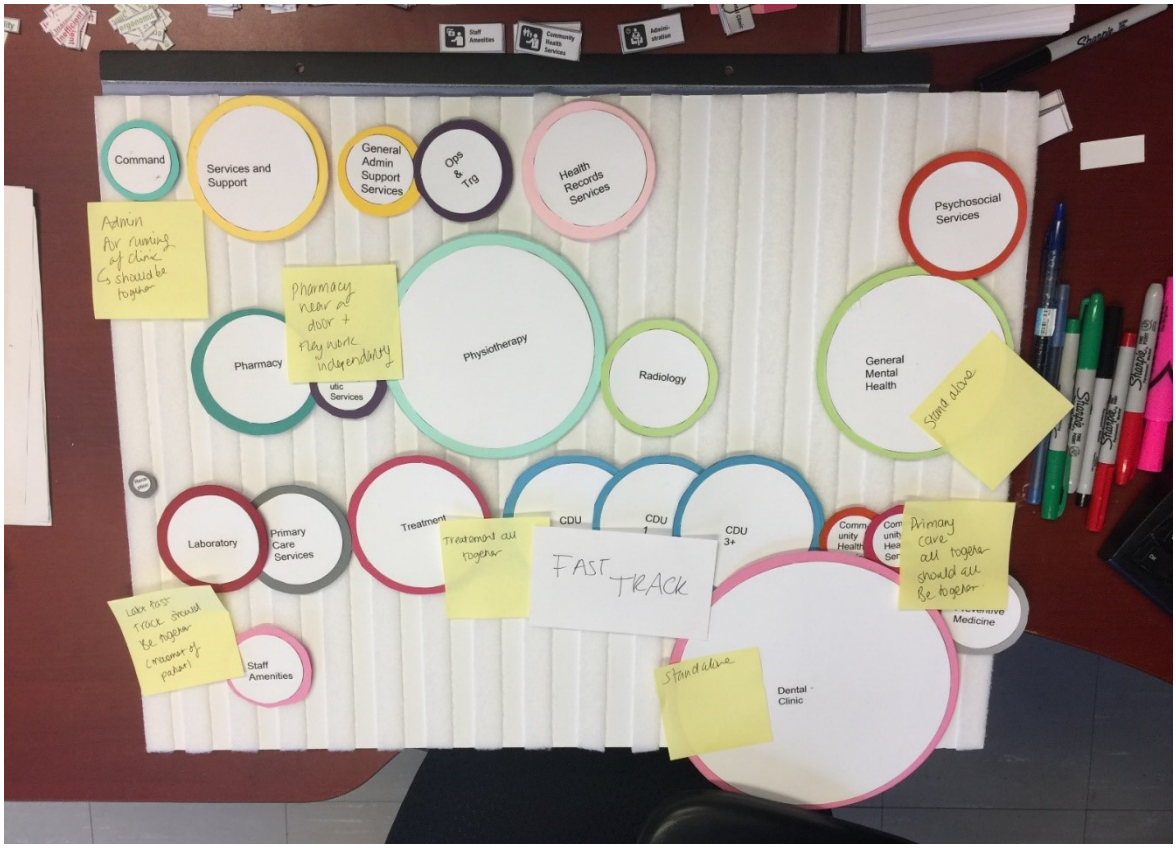


Figure 22. An example of one of the participants Velcro Model

Overall, the three proposed tools seemed to trigger and focus the users' attention to what their everyday life is like, and allowed them to freely explain in detail their needs and desires from various perspectives. One of the participants said at the end of their interview,

"It would've been nice if we could have had time to think about how we wanted to create the Velcro Model. Maybe have the third tool be done on the next day to give us some time." From the interview with the three tools, the author concludes that co-creation sessions with appropriate tools could enhance end users' creativity to design their desired future requirements as well as articulate current invisible problems and issues. In addition, it would be beneficial to employ the concept of co-creation as a way to facilitate user-centered aspect in an architectural design project.

4.4 Data Analysis and Findings

The analysis of the data was done by using *Coding for Audio-Recorded Interviews Excel sheet*, which contained the following headers presented in Table 2. As explained earlier, the data were discussed and modified by the researcher and the Project Director.

Table 2. Coding for Audio-Recorded Interviews Excel Sheet Headers

Coding For Audio-Recorded Interviews											
Information				Researcher Comments				Project Director Comments			
Date	Interviewee	Activity Number	Transcription	Interpretation	Primary Keyword	Second Keyword	Third Keyword	Interpretation	Primary Keyword	Second Keyword	Third Keyword
September 7th 2017	Participant 1										
		Part 1: User Journey Map	*The audio recording was transcribed into this section for both the researcher and project director to come up with the associated keywords*	*The researcher here would note down any interpretations they had for the audio recording*	*Keyword 1*	*Keyword 2*	*Keyword 3*	*Using the same transcription and the researcher's interpretation the Project Director added any extra comments where applicable*	*Keyword 1*	*Keyword 2*	*Keyword 3*

Using the transcribed audio recordings, the researcher initially made comments and identified three keywords that were associated with the transcriptions. Once the researcher completed the analysis on *Coding for Audio-Recorded Interviews Excel Sheet,* it was forwarded to the Project Director to eliminate as much biased data as possible. The director identified three more keywords, and added some relevant interpretations where necessary.

4.4.1 Findings

As previously mentioned the five key notions identified from *Coding for Audio-Recorded Interviews Excel Sheet* are as follows: *end-of-life current infrastructure, inadequate space, team collaboration, affinity, and specialist space/requirements*.

The researcher acknowledged the categories by grouping all similar key words proposed by the researcher and the Project Director. The researcher then sent the suggested five notions to the Project Director to assess their suitability. Initially, the researcher had suggested "adjacency" rather than "affinity," but the Project Director proposed that affinity would be more suitable as an umbrella term for adjacency and proximity, which were two common keys words and attributes identified from the analysis.

The key words were categorized by their similarity and relevance, and the researcher analyzed the *Coding for Audio-Recorded Interviews Excel sheet* further to create the table below (Table 3). Table 3 represents the keys words and where they belong amongst the five key notions (see Annex I for an in-depth table, which represents who identified the keyword, and relevant comments for explanations). There are some key words that overlap to become associated with more than one notion. Table 4 represents the notions and their associated keywords.

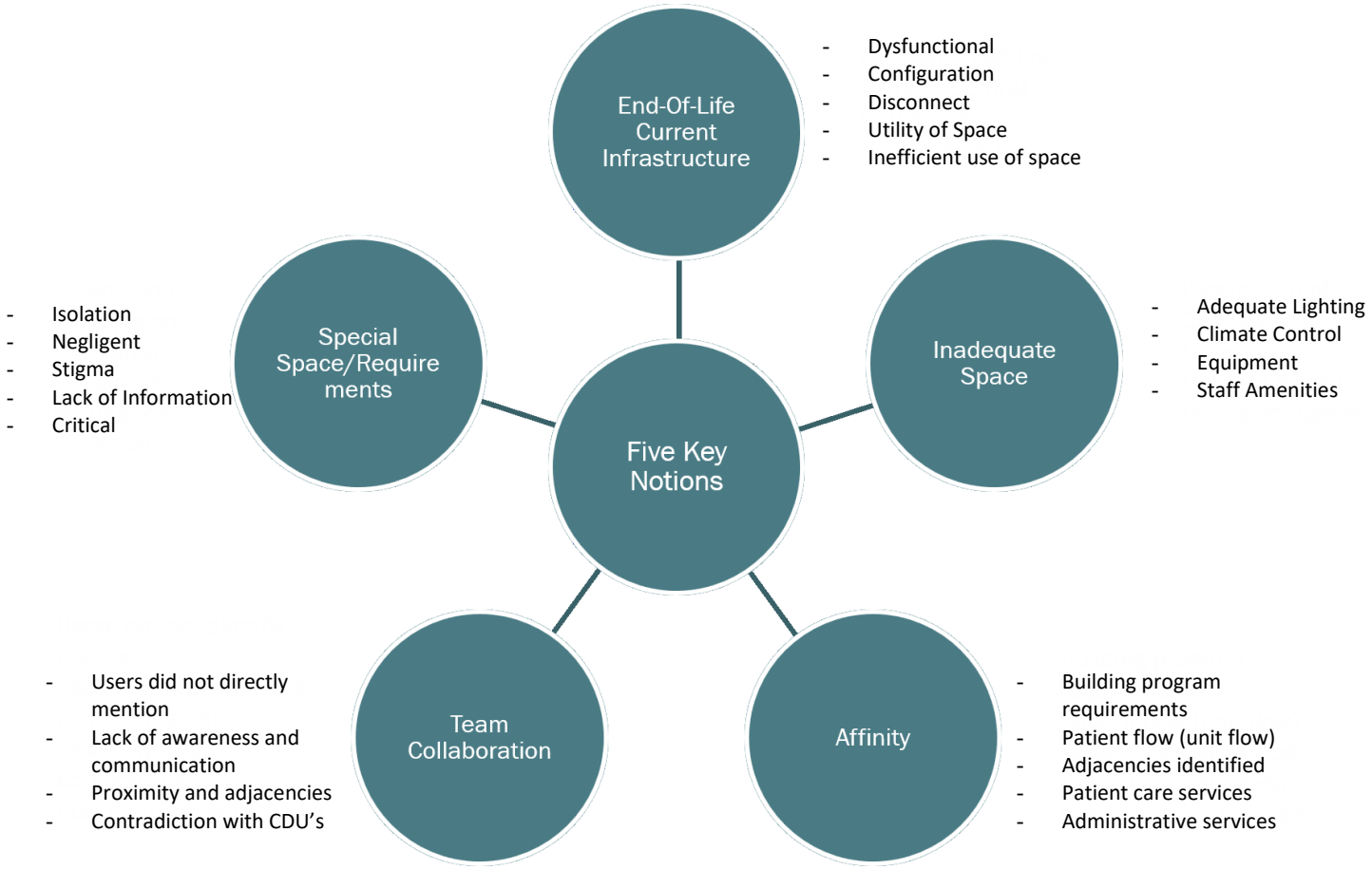


Figure 23. Example of Keywords grouped with their Key Notion

Table 3. Five Key Notions and their Keywords

End of life – current infrastructure	Inadequate space	Team collaboration	Specialist space/ requirement	Affinity
Adequate lighting	Acceptance	Adaptability	Amenities	Adequacy of patient and staff flow needs improvement
Natural light	Flexibility	Constant change	Disconnect	Configuration
Lack of natural lighting	Constant change acceptance	Flexibility	Refresh	Dysfunctional
Inefficient lighting	Adequacy of patient and staff flow needs improvement	Adjacency	Mental Wellness	Listening to User requirements

Building and systems at the end of life	Configuration	Detached/Disconnected	Hygiene	Attempting to reduce stigma
constraints (due to infrastructure)	Dysfunctional	Functional Adjacency	Maintenance	Education
Lack of maintenance	Listening to User requirements	Proximity	Operationally Fit	Visibility
Old building	Adequate lighting	Space allocation	Positive Perspectives	Reducing Judgement
Lack of innovative systems	Natural light	Configuration	Mind and Energy	Stigma
Concern over capacity to deliver services	Lack of natural lighting	Dysfunctional	Kitchenette	Negligent
Interruption of services	Inefficient lighting	Fractured	Entertainment	Relevance
Environment	Adjacency	Proximity	User Emotional Well being	Inclusion
Climate Control	Detached/Disconnected	Centralization	Competing priorities	Isolation
Equipment	Functional Adjacency	Patient Care	Building space	Unawareness
Aged Equipment	Proximity	Indirect patient care	Flexibility	Lack of Knowledge
Lacking function and proper equipment	Space allocation	Unit Adjacencies	Uncertainty	Communication
Unreliable equipment	Configuration	CDU Hub	Determination	Lacking information
Outdated equipment	Dysfunctional	Amenities	Concern	Dissatisfied
Inefficient computers	Fractured	Disconnect	Doubtful	Poor communication
Innovative systems	Proximity	Refresh	Correct configuration and furnishing	Frustration
Lack of space	Centralization	Mental Wellness	Lack of user knowledge (For fit ups)	Misinformed
Office Layout (inefficient and needs enhancement)	Patient Care	Hygiene	Creative resignation towards the users	Poor management
Travel time (between units)	Indirect patient care	Maintenance	Proactive	Lack and ease of communication
No dedicated room for resources (storage)	Unit Adjacencies	Operationally Fit	Innovative systems	Uncertainty
Adequate space	CDU Hub	Positive Perspectives	New system created by user (fast track)	Share of work load

Deficient space	Branches Off	Mind and Energy	Functionality	Communication Flow
Inefficient	Main Entrance	Kitchenette	Poor Functionality	Operation efficiency
Inefficient use of space	Amenities	Entertainment	Functionally constrained	Operation awareness
Utility of space	Disconnect	Cohesion	Inadequate Functionality	Organized
Lacking proper spaces, office space, storage	Refresh	Collaboration	Genuine concern for functionality	Inclusion
Space deficiencies	Mental Wellness	Consolidation	Mistrust	Uncertainty
Space and services inadequate	Hygiene	Need to maintain operational awareness	Inadequate spaces for function	Poor management
Inadequate space	Maintenance	Responsive (to leadership)	Lack of function specific spaces	Lack of knowledge
Legacy thinking (offices)	Operationally Fit	Inclusion	Inconvenience	Open space (for connectivity)
Specialist office requirement	Positive Perspectives	Concern for loss of cohesion	Layout of spaces	Open door concept
Lacking ventilation	Mind and Energy	Consolidation	Open door concept	Communication with other units
Ventilation deficiency	Kitchenette	Isolation	Open layout plan (communication effectiveness)	All staff meeting spaces
Poor / inadequate ventilation	Entertainment	Centralization	Adequacy of Patient and Staff flow needs improvements	Relationship
Operational Functionality	Cohesion	One stop shopping	Ineffective service delivery	User interaction
Fundamental	Collaboration	One entity	Inefficient	Thorough
Lack of IT Support (Virtual and physical)	Consolidation	Communication	Patient Centered	Competing priorities
Safety and security	Need to maintain operational awareness	Lacking information	Patient management (flow)	Building space
Security Standards Upgrade	Responsive (to leadership)	Dissatisfied	Resignation (towards the users)	Flexibility
	Inclusion	Poor communication	Illogical	Creative resignation towards the users
	Concern for loss of cohesion	Frustration	Inconsistency (of practices)	Proactive
	Consolidation	Misinformed	Inconvenience	Innovative systems
	Isolation	Poor management	Randomness	New system created by user (fast track)
	Centralization	Lack and ease of communication	Layout of spaces	Critical

	One stop shopping	Uncertainty	Inadequate services and units	Close Minded
	One entity	Share of work load	Open layout plan (communication effectiveness)	Rigid
	Concern over capacity to deliver services	Communication Flow	User interactions	Inflexible
	Interruption of services	Operation efficiency	User centric flow	Unawareness of user requirements
	Concern over perceptions	Operation awareness	Inefficient office layout	Poor management
	Confidentiality	Organized	Patient flow	Travel time (between units)
	Privacy	Inclusion	Direct patient care	Dynamic
	Space for confidential discussions	Uncertainty	Indirect patient care	Hands on Leadership
	Visibility	Poor management	Inefficient layout of spaces	Engaged
	Conflicted	Lack of knowledge	Lack of space	Ergonomics
	Lack of privacy	Open space (for connectivity)	Office Layout (inefficient and needs enhancement)	Adequacy of Patient and Staff flow needs improvements
	Correct configuration and furnishing	Open door concept	Travel time (between units)	Ineffective service delivery
	Lack of user knowledge (For fit ups)	Communication with other units	Non dedicated room for resources (storage)	Inefficient
	Critical	All staff meeting spaces	Adequate space	Patient Centered
	Close Minded	Relationship	Deficient space	Patient management (flow)
	Rigid	User interaction	Inefficient	Resignation (towards the users)
	Inflexible	Thorough	Inefficient use of space	Illogical
	Unawareness of user requirements	Adequacy of Patient and Staff flow needs improvements	Utility of space	Inconsistency (of practices)
	Ergonomics	Ineffective service delivery	Lacking proper spaces, office space, storage	Inconvenience
	Lack of space	Inefficient	Space deficiencies	Randomness
	Office Layout (inefficient and needs enhancement)	Patient Centered	Space and services inadequate	Layout of spaces

	Travel time (between units)	Patient management (flow)	Inadequate space	Inadequate services and units
	No dedicated room for resources (storage)	Resignation (towards the users)	Legacy thinking (offices)	Open layout plan (communication effectiveness)
	Adequate space	Illogical	Specialist office requirement	User interactions
	Deficient space	Inconsistency (of practices)	Lacking ventilation	User centric flow
	Inefficient	Inconvenience	Ventilation deficiency	Inefficient office layout
	Inefficient use of space	Randomness	Poor / inadequate ventilation	Patient flow
	Utility of space	Layout of spaces	Operational Functionality	Direct patient care
	Lacking proper spaces, office space, storage	Inadequate services and units	Fundamental	Indirect patient care
	Space deficiencies	Open layout plan (communication effectiveness)	Lack of IT Support (Virtual and physical)	Inefficient layout of spaces
	Space and services inadequate	User interactions	Safety and security	
	Inadequate space	User centric flow	Security Standards Upgrade	
	Legacy thinking (offices)	Inefficient office layout	Staffing	
	Specialist office requirement	Patient flow	Efficiency	
	Staffing	Direct patient care	Lack of Staff	
	Efficiency	Indirect patient care		
	Lack of Staff	Inefficient layout of spaces		
		Lack of space		
		Office Layout (inefficient and needs enhancement)		
		Travel time (between units)		
		Non dedicated room for resources (storage)		
		Adequate space		
		Deficient space		
		Inefficient		
		Inefficient use of space		
		Utility of space		

		Lacking proper spaces, office space, storage		
		Space deficiencies		
		Space and services inadequate		
		Inadequate space		
		Legacy thinking (offices)		
		Specialist office requirement		
		Staffing		
		Efficiency		
		Lack of Staff		

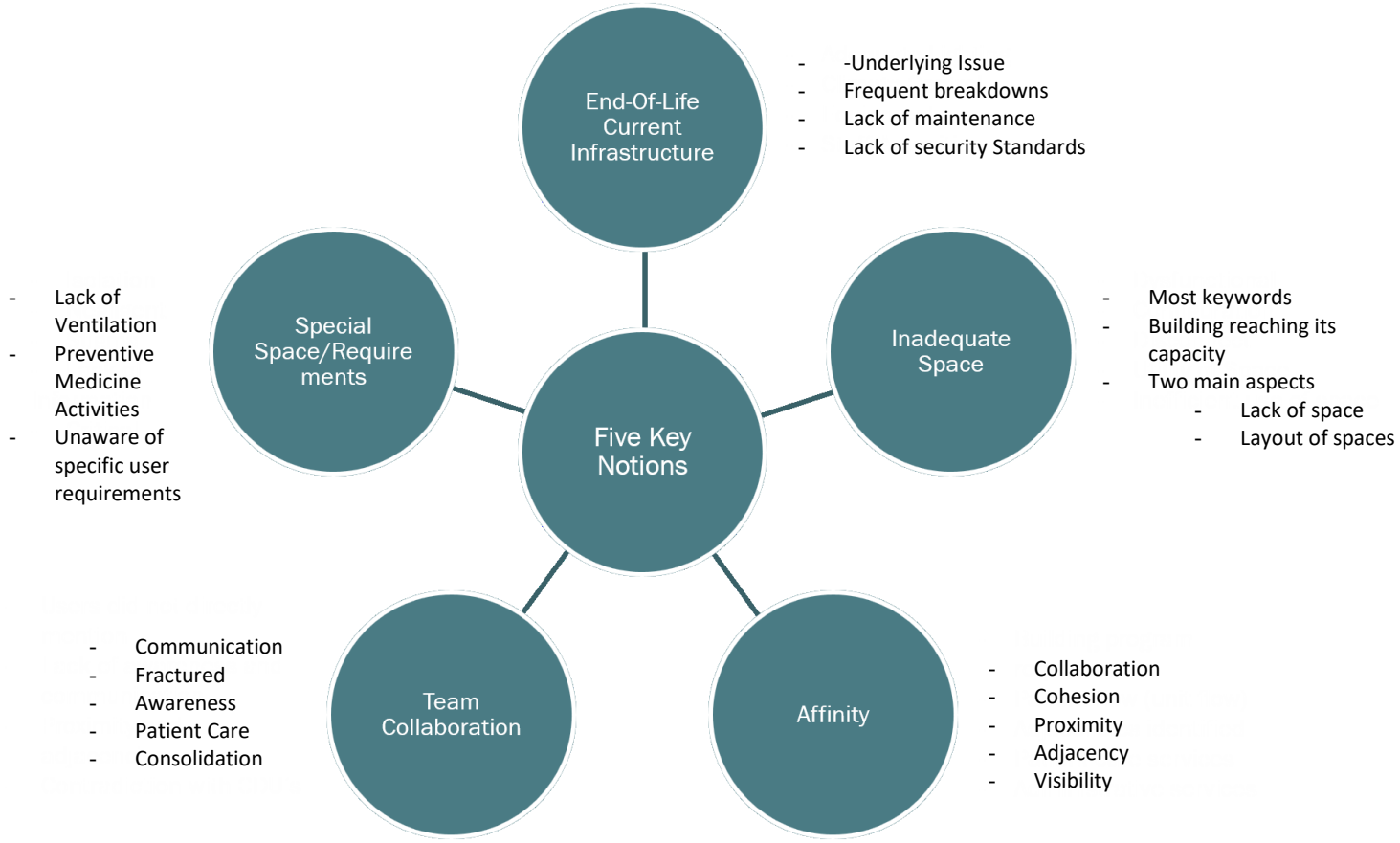


Figure 24. Summary of Key Findings

End-of-Life Current Infrastructure

The notion of the Healthcare Facility reaching the end of its life is apparent, and the end users throughout the interviews repeatedly mentioned that the fundamental issues arise because the building is old, and the units are all located in different buildings because the current facility has reached its capacity. While this is true, the researcher and the Project Director realized from their analysis that the underlying issues went much deeper than just that. As seen in Table 3, it is evident from the interviews that the notion of *End of Life – Current Infrastructure* had the least amount of keywords but is arguably the underlying critical issue for the rest of the notions. One of the issues mentioned under this notion was the lack of equipment and excessive break down of staff amenities and utilities; however, the participants did not realize that the frequency of these break downs could also be from the lack of maintenance. Furthermore, lack of ventilation was another issue that was identified, and it was attributed to the end of life of the infrastructure; but the end users expressed a requirement to have adequate ventilation for a specific unit, that of preventive medicine. Using the Cube Tool, the users expressed that preventive medicine required specific ventilation to suit the activities that took place there. Preventive medicine is a bulk services unit where the soldiers' uniforms are dipped in permethrin (an insecticide). A third issue identified by Participants One, Three, Five, and Seven was the lack of security standards within the building. They all emphasized the importance of security for the offices and community health services unit that had inadequate security at the time of the survey. The following extraction from the *Coding for Audio-Recorded Interviews Excel sheet* represents the aspect of lack of ventilation as an issue. For each issue, the same

process in extracting different aspects of the excel sheet was followed to analyze the notions overall.

Table 4. Extraction from Coding Excel Sheet to represent an Issue

Coding For Audio-Recorded Interviews											
Information				**Researcher Comments**				**Project Director Comments**			
Date	Interviewee	Activity Number	Transcription	Interpretation	Primary Keyword	Second Keyword	Third Keyword	Interpretation	Primary Keyword	Second Keyword	Third Keyword
September 7th 2017	**Participant 1**										
		Part 2: Cube Tool	*bathrooms always back up and the building is falling apart. The heat and air conditioning isn't working anymore. Handicap doors their handle falls up. The elevators has stopped working more than 8 times this year. handy-cap doors break sometimes.*	*The building is old and the utilities, mechanical and electrical equipment is too old and requires an update.*	*Building End of Life*	Updating equipment		Excessive breakdown due to lack of maintenance	Building and systems at end of life	Lacking maintenance	

Inadequate Space

The notion of inadequate space was one of the notions that had the most keywords associated with it. It embodies two main aspects; the first is that the building size has reached its optimal capacity and cannot withstand any future growth, and the second is the layout of the spaces within each unit. Due to the lack of space, the end user group had to add a trailer to the building to be able to continue providing services without interruption. Participant One stated that *"CDUs (care delivery unit) I had to add trailers, in 2009,*

because we outgrew the space. Too much is happening in this space. So I had to add 3 trailers in, because that new building wasn't being built yet, so there always isn't enough space to get the work done that is required. Which was needed to add Fast track the new system that we as end users created in it." This transcription from the audio recording was extracted from Part 1: User Journey map and explains how the building they currently occupy is too small, and that they had to create a new system within the building, a unit named Fast Track to continue providing the service without disruption.

The layout of the spaces within some of the units did not meet the end users needs and requirements. For example, one of the participants who dealt mostly with radiology in the x-ray department was dissatisfied with the current layout, and provided a detailed drawing of their ideal space to the researcher, explaining how the current unit lacks privacy and natural lighting. Participant Five thoroughly explained another issue regarding a specific unit, that of pharmacy, as *"....the proper shelving so they can see what drugs they have. So it isn't flat it is at an angle. Pill counters for sure."* and continued by saying, *"But I will say that when you put in your prescription and where you pick it up should be completely separate areas and should be private. Right now they have these pieces of wood separating it."* Without the input on the current deficiencies directly from the end users, the designer would not have the necessary knowledge to make the required changes in the new rebuild of the facility. This was also evident in the Velcro Model tool because

Participant Five started the Velcro Model by saying *"What is the best layout for those that work here (staff) and the patients that come in is what I am trying to determine…"*

Team Collaboration

Team collaboration is a hidden need the end users did not directly mention, but it was realized by both the researcher and the Project Director. A general dissatisfaction was evident amongst the end users due to the lack of awareness, communication, and knowledge between the end users and the different units within the facility. This created feelings of uncertainty and frustration in the end users, which was revealed by all three tools. The end users assumed that the solution to maintaining operation awareness, enhancing communication amongst the units, and sharing the workload, is the concept of adjacencies of units that frequently work together. However, they did not realize that there is more to it since all three Care Delivery Units (CDUs) are currently adjacent to each other and in the same facility, yet they exhibit a lack of communication. The CDUs are the main patient care areas (the directly involved with patient care) in the Healthcare Facility and are collocated, but Participant Five said, *"They need to be evened out for sure, they try too but I think it fails. Some CDUs have more patients than others. So, you have healthier troops than the other. So, if it is evened out, then they can evenly spread out all the patients."* This contradicts adjacency as a solution to communication and poor management but introduces team collaboration as a hidden problem identified by the three tools.

The feeling of uncertainty, enhancement of communication, and user interaction can be solved by improving team collaboration and work. This can be solved partially by

ensuring that the adjacencies of the units are efficient (notion 4 Affinity), but also by adding collaboration spaces in the facility where applicable. For example, a collaboration space or small meeting rooms can be added between the different units for the end users of the facility to team up and communicate on various issues. This will aid management by providing them with a space to connect with their team and ensure that they are aware of and included in what is happening, thereby reducing assumptions, and fostering an overall sense of inclusion amongst them. Furthermore, the consolidation and cohesion of all the different units that currently exist in separate buildings promote centralization, which will be a benefit to the healthcare facility. Participant Two said that, *"We are isolated from the rest of the units which is the opposite of the open door, as there is a sign that says "authorized personnel only" so maybe it is scary for them."* This will ensure that a "one-stop-shopping" facility exists. This can also be established using open space and an open-door concept within the office spaces; thus ensuring that connectivity can be heightened among the end users. These concepts emphasize the importance of designed spaces in influencing the interactions between the end user groups that affect the delivery of services.

Affinity

A building program defines all the different spaces/units within the building. The affinity matrix is sometimes considered to determine priority proximity between the units. To identify the proximities and adjacencies, input from the end user is required. Currently, not all the units are within the same building with functional adjacency, but rather the configuration of the facility is deemed dysfunctional due to competing priorities. They refer to which units within the healthcare facility require being adjacent or in close proximity.

These adjacencies depend on the description the end user has provided during the interview. Adjacencies and proximity are two key words that were often used by both the researcher and the Project Director throughout the analysis of the audio recordings.

End users identified that patient flow is important to determine adjacencies between the units to establish an efficient building. This implies that the architect should possess an understanding of a patient-centered approach, in order to design and create the appropriate spaces. The cohesion of all the units is highly sought after, but designing the facility to ensure sufficient navigation, and a user-centric flow is what makes it efficient. One key adjacency identified for the 15 units, through the analysis of the Velcro Model from all seven participants and the interviews, was ensuring that all three care delivery units are a central hub, with all the direct patient care units branching off it. The direct patient care units include radiology, laboratories, primary care services, diagnostic, and therapeutic. A general proposal for all the administrative services to be grouped together and in close proximity to the primary care services for the command section was found amongst all the participants. The command section is where the management for the direct patient care units is located. Collocation between management and staff was highly requested for ease of communication; however, a solution consisting of team collaboration stations within the units can help solve the problem without their being directly adjacent. The administrative units are the command unit, operation and training, services and support, general admin. support services, and health records services. Participant Five said, *"It is great that it is going to be in the clinic itself, however it is not part of the clinic, and we have nothing to do with it. Which sometimes is a miss knower for some people where they would call us to book appointments for them, but we have nothing to do with dental. So we get looped in*

with them when we aren't with them. Inconvenient that they are with us, for "one stop shopping" so for people it is easier that it is all in one location." The Dental Clinic is its entity and unit, as it is not managed by the healthcare facility, but all the end users expressed the advantage of having the unit within the same building.

Special Space/Requirements

This notion identifies the unique user requirements the end users have specified. Preventive medicine is one of the 15 units within the healthcare facility. Distinct activities take place in this space like the permethrin dip, which is an insecticide dip meant for the uniforms of soldiers heading out on a mission. Departure Assistance Group (also known as DAGS) is the bulk service for soldiers leaving on missions. This is a special requirement for this healthcare facility. Large open space is required with adequate ventilation to ensure that this service can be delivered efficiently. This requirement ties in with the other notions of the end of life of the facility and inadequate space. The designer must ensure that a thorough understanding is acquired to design this space that meets the special user requirements. These findings were revealed by the interactive tools used by the end users. Being unaware of user requirements will create an inflexible space resulting in an incompetent facility.

5 Chapter: Conclusion

Expert user involvement has been proven to augment the researchers understanding of users' needs, desires, and requirements, which inevitably results in a more user-efficient built environment (Könings et al., 2017). The integration of a generative design approach using three co-creation tools was attempted through the passive and active involvement of the expert users (Attaianese, 2012). While building performances are mostly quantitative data, usually measured by numerous factors such as temperature, natural lighting, and noise, Danish architects tried to involve users in their building design process. Technically they imitated what industrial designers do when they incorporate participatory design and co-design in their product design process (Franco, 2016).

This study aimed to answer the following research question, *"How does a generative design session, using a qualitative research method, enhance the researchers understanding towards the expert-users' requirements in a field health-care facility?"* Because user-centered design is not a common approach used in designing built environments by architects, this thesis proposes three tools to create a generative session for designers to use in specific buildings to gain a better understanding of the building programs, creating a multidisciplinary approach. Among the many tools that exist, this study used the concept created by Elizabeth Sanders, "path of expression" that frames a generative session (Sanders & Stappers, 2012), employing three tools: User Journey Map, Cube Tool, and Velcro Model make tool. The field healthcare facility, located on the base in Petawawa, Ontario, Canada, was used as an example for this thesis to see how the UCD approach can affect the researcher's understanding of the building program for the adjacencies between the 15 units and to identify the hidden needs of the users. Through the

analysis of the data by the researcher and the Project Director, the five key notions identified categorized the user requirements discussed in Chapter 4: *End-of-life current infrastructure, inadequate space, team collaboration, affinity, and specialist space/requirements*. One of the main issues identified from the research was Team Collaboration. All the seven military and civilian expert users from the healthcare facility who participated in this study commented on the lack of communication, uncertainty, awareness, disconnection, mental wellness, etc., which they felt within the existing facility. While they recognized aspects such as the building has reached the end of its life cycle, having inadequate space due to the building capacity and layout of spaces, and the functional adjacencies of the units not meeting the user's needs, they did not recognize Team Collaboration. The co-creations tools used in this study stimulated and allowed the expert users to express their needs, desires, and requirements, as they created a common language for all the stakeholders involved, particularly between the researcher and expert user. Overall, the expert users were stimulated by and engaged in the design process because of the common language existing between the researcher and participant

5.1 Future Research

Most participants at the end of the interview expressed that they were pleased to be engaged in and given a chance to express their opinions on the healthcare facility. One of the participants said, "*more time for the planning process and development strategies would be beneficial."* while another said, *"this approach was successful because it brings different views of people into play, the input from end users will greatly enhance the planning stages making it more effective with time and money."*

With the expert users' feelings of satisfaction, and the researcher gaining a better understanding of their requirements and needs, the next step in this research would be to develop the design of this project and to implement the proposed tools in several architecture projects. This study is an initial point to use easy-to-make, handle and use tools for a multidisciplinary team to design an architecture project. By applying the same proposed tools in distinct architecture projects, focusing on the initial design stages; further enhancement to the use of participatory design and co-creation tools for the architecture field would be explored.

Appendices

Appendix A Initial Approval Email

From:
Sent: April-24-17 2:07 PM
To: [
Subject: Seeking Support for Student

LCdr Davis, good afternoon.

I am writing this email to request your and your staff's support by helping a student, currently working on a graduate placement with my group, complete some research for her Master's thesis. The student's name is Lydia Awad and she is in the final stretch of her post graduate studies ir lia has expressed an interest in using one of the health care projects as her model. In general terms, I gather Lydia wants to engage with you and your staff to determine how you/they would create a new clinic in terms of departmental adjacencies, work flows within departments, patient flow and the like. The intent would be to compare the output from you/your staff – a conceptual layout - with a similar layout prepared by her using industrial design techniques and methodologies. The comparison – similarities and differences – then become the subjects to which Lydia would craft her arguments. Lydia's findings will have no impact or influence on the clinic currently under construction in Petawawa.

I am not certain how Lydia would engage with you/your staff. Some may be done by way of written questionnaire, some by personal interview(s). In either case, a small time commitment will be required. Recognizing this is beyond yours and your staff's normal duties, I can only ask that you see fit to help Lydia.

Having said all that, I will observe that Lydia is currently seeking her Professor's approval to pursue this line of research and that it is not yet approved. While we await her approval, if you see this as something you might support, I would be most grateful. Additional information will be provided when details become firmed up.

Thank you for considering this request. Look forward to your reply.

Best regards.

Appendix B Invitation Participation

Subject: Invitation to Participate in "Title of Thesis"

Hello [Person Name],

My name is Lydia Awad, and I am a Master of Design student with the School of Industrial Design at Carleton University, being supervised by Professor Wonjoon Chung, PhD. As part of my thesis research I am conducting a study with the aim to see how integrating human-centered design in the notion for architecture. To enhance user involvement through the initial design process, and see whether or not this will affect how building requirements are identified and understood. As the Project Director, … initially contacted you to participate in this study, this is a formal invitation to participate in this research study. The purpose of this research will be to suggest an approach to integrate human-centered design in the notion for architecture. To enhance user involvement through the initial design process, and see whether or not this will affect how building requirements are identified and understood.

For my study, I will be conducting 20-30 minute in-person interview, which will depend on the availability and location at your convenience. The interview is structured into three main parts. The first part of the interview is for the participants to fill out an journey map, the second part of the interview is for them to identify what the main issues they currently face with the facility they use and finally to use a Velcro plan to create their ideal floor plan arrangement.

This study has been reviewed and cleared by Carleton University Research Ethics Board – B (protocol #00-000).

Would you be interested in participating in this study? If so, could you kindly respond by signing the consent form attached to then be able to schedule a day and time at your convenience.

Thank you for your time.

Research Contact Information
Lydia Awad
School of Industrial design
Carleton University

Supervisor Contact Information
Wonjoon Chung
School of Industrial Design
Carleton University

Carleton UNIVERSITY
Canada's Capital University

Appendix C Signed Consent Form

Carleton UNIVERSITY
Canada's Capital University

Signed Informed Consent Form

Title: Application of Human-centered design in Architecture
Date of Ethics Clearance: August 23rd 2017
Ethics Clearance for the Collection of Data Expires: August 31st 2018

I _____, choose to participate in a study on 'Bridging the Gap between Users and Architects.' This study aims to identify how human-centered design methods/tools, which are currently used in Industrial Design affect the gap between architecture and user. **The researcher for this study is Lydia Awad in the School of Industrial Design.** She is working under the supervision of Professor Wonjoon Chung, in the School of Industrial Design.

_____

For my study, I will be conducting an in-person interview with the professional user experts of the health-care facility, "Petawawa Healthcare Facility Recapitalization". The interviews involve three separate exercises. The first part is for the participants to fill out an journey map. In this exercise the aim is to get the users to identify their daily experience whilst circulating the current facility they use. The second part of the exercise is to identify the main issues the users experience in the 15 units using a Lego tool. During this part of the interview, the participants will identify where the need for the change will be, due to a requirement the current facility lacks. The third part of the interview is where the participants will use a Velcro plan to create their ideal future floor plan arrangement and help understand which unit is required to be adjacent to the other. Finally a short survey will be handed out, consisting of 5 questions to give the researcher feedback on the interview.

With your consent, this interview will be audio-recorded. As this study will be asking you questions related to your experience and insight of the critical room adjacencies for this facility. There are no risks towards the participants as the interview is solely related to the

health-care facility. While there are no risks towards this study will take precautions to protect your identity.

Information collected will be digitally encrypted, confidential, and anonymously coded for research analysis and publication.

2. In Person Interview. In-person interviews will be recorded using an iOS app called Awesome Voice Recorder. Recorded audio from in-person interviews will be stored on a password-encrypted iPhone before being transferred via password-encrypted Wi-Fi to a password-encrypted MacBook Air.

All recorded audio will be backed-up daily to a password-encrypted USB Flash Drive, and stored in a locked cabinet at Carleton University.

Only my supervisor, Wonjoon Chung and myself will have access to the research data and the coding file linking your personal information to the research data. No personal identifiers will be included in published literature. Upon study completion, the coding file, audio-recorded interviews, and all research data will be kept for one year and may be used for future articles on this topic. After a year, all research data will be securely destroyed. Hard copies of research data (including USB Flash Drives) will be kept in a locked cabinet at Carleton University.

You are under no obligation to answer any questions, and may withdraw from the study at any time, after which your personal information and collected research data will be destroyed. The date to withdraw is before September 15th 2017, as the researcher will start writing the thesis by that date.

If you would like a copy of the published study, you are invited to contact the researcher to request an electronic copy.

This study has been reviewed and cleared by the Carleton University Research Ethics Board–B (Protocol #**10-7054**). Should you have questions or concerns related to your involvement in this research, please contact either my supervisor or myself. The following are our contact details;

CUREB Contact Information

If you have any ethical concerns with the study, please contact:
Carleton University Research Ethics Board

Appendix D Survey

D.1 Survey Questions

Carleton UNIVERSITY

Canada's Capital University

Appendix 3 Workshop Survey

Based on the workshop that you just participated in, this is a survey to gain your feedback on the human-centered design tools/methods. The following survey will be filled out in an anonymous manner so no personal information/opinion will be revealed.

Question 1: Overall, on a scale of 1 to 10 (1 being the least, and 10 the most), how useful was the workshop to getting the user to participate in understanding the issues that you experience?

1 2 3 4 5 6 7 8 9 10

Comments:

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Question 2: Overall, on a scale of 1 to 10 (1 being the least, and 10 the most), how useful was the workshop to getting the user to participate in having an impact in understanding the users requirements?

1 2 3 4 5 6 7 8 9 10

Comments:

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Question 3: Do you foresee this human-centered design workshop to be implemented in future building designs for different projects?

Yes No

If not, why?

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If so, what in particular?

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Question 4: Overall, on a scale of 1 to 10 (1 being the least, and 10 the most), by implementing this type of method/tools to identify the requirements, do you think it can effectively be used to save time and efficiency towards an overall design process for future infrastructure projects?

Yes No

If not, why?

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If so, what in particular?

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Question 5: Do you have any further comments or suggestions to enhance the interview in terms of the methods/tools that were used?

Yes No

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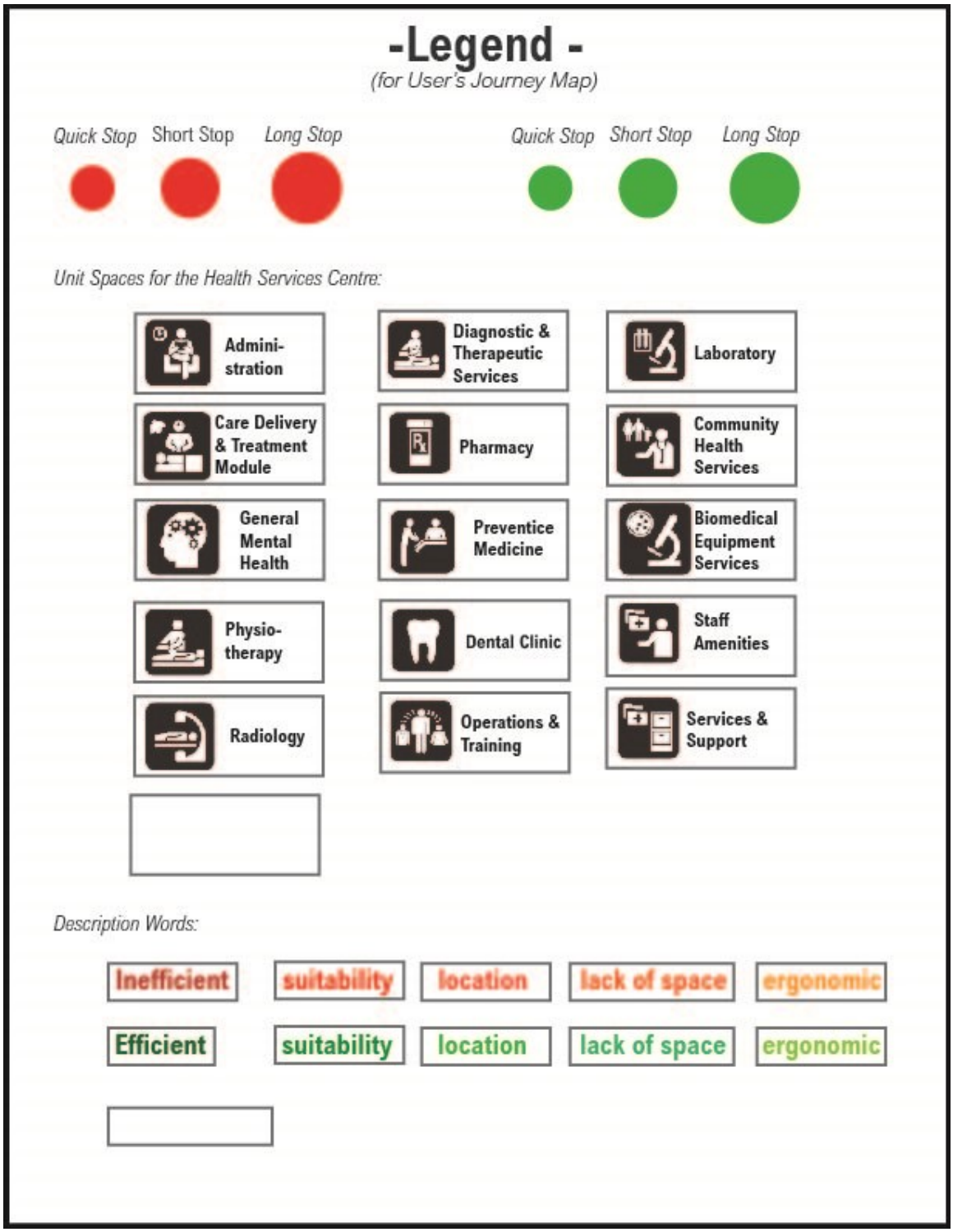
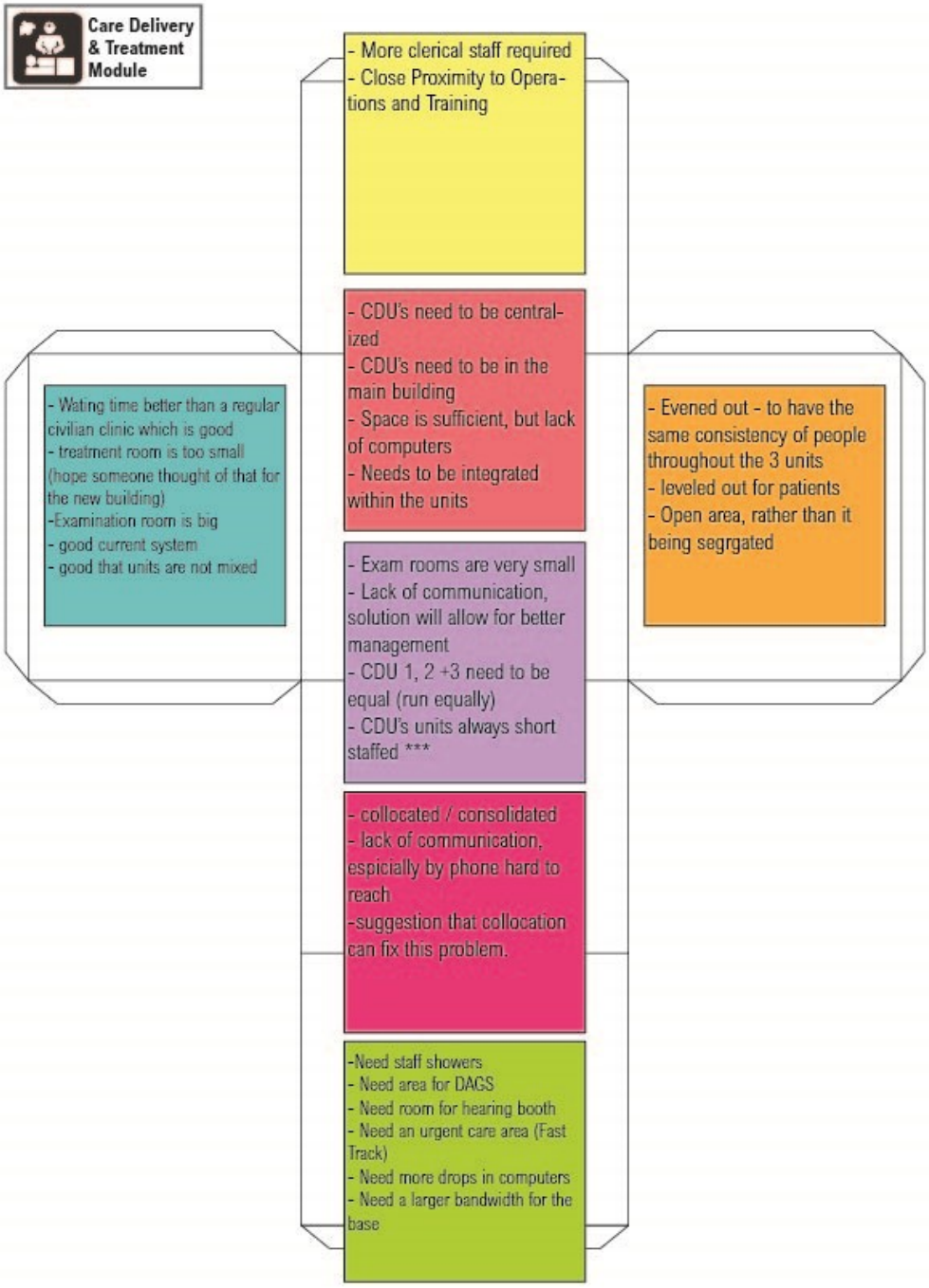
_____

Thank you very much for your time.

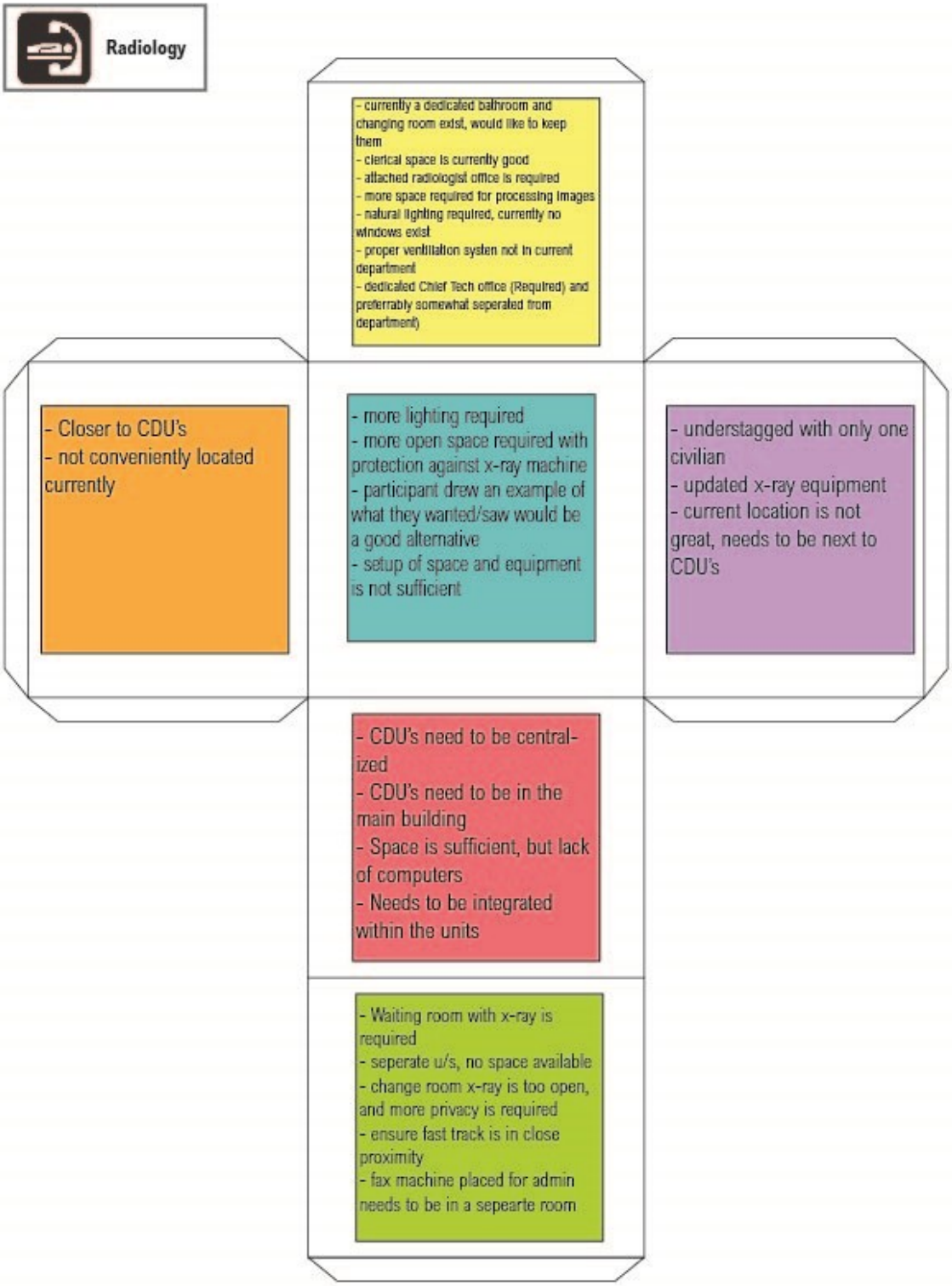
Appendix E Cube Tool Results



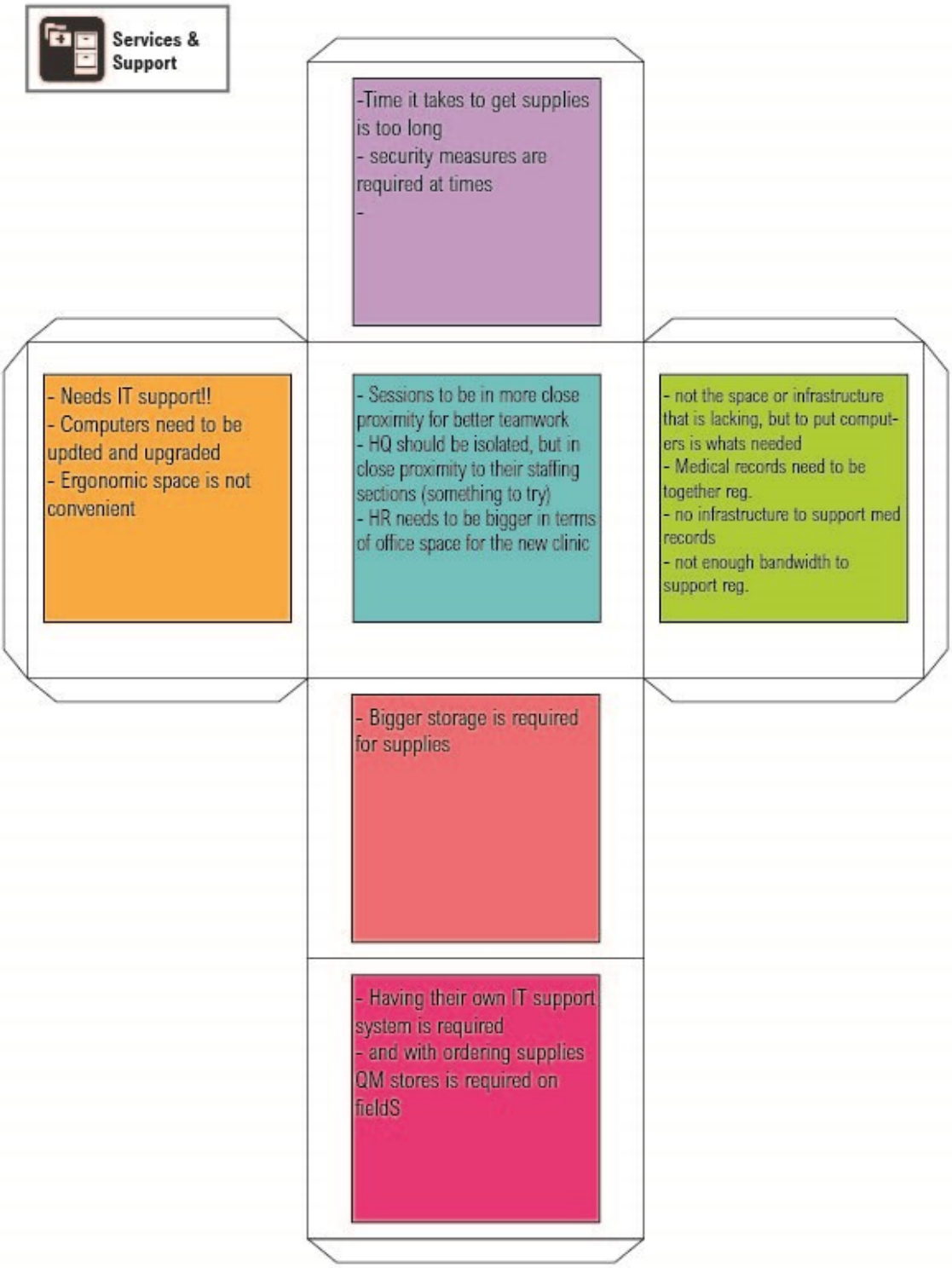
E.1 Care Delivery Unit



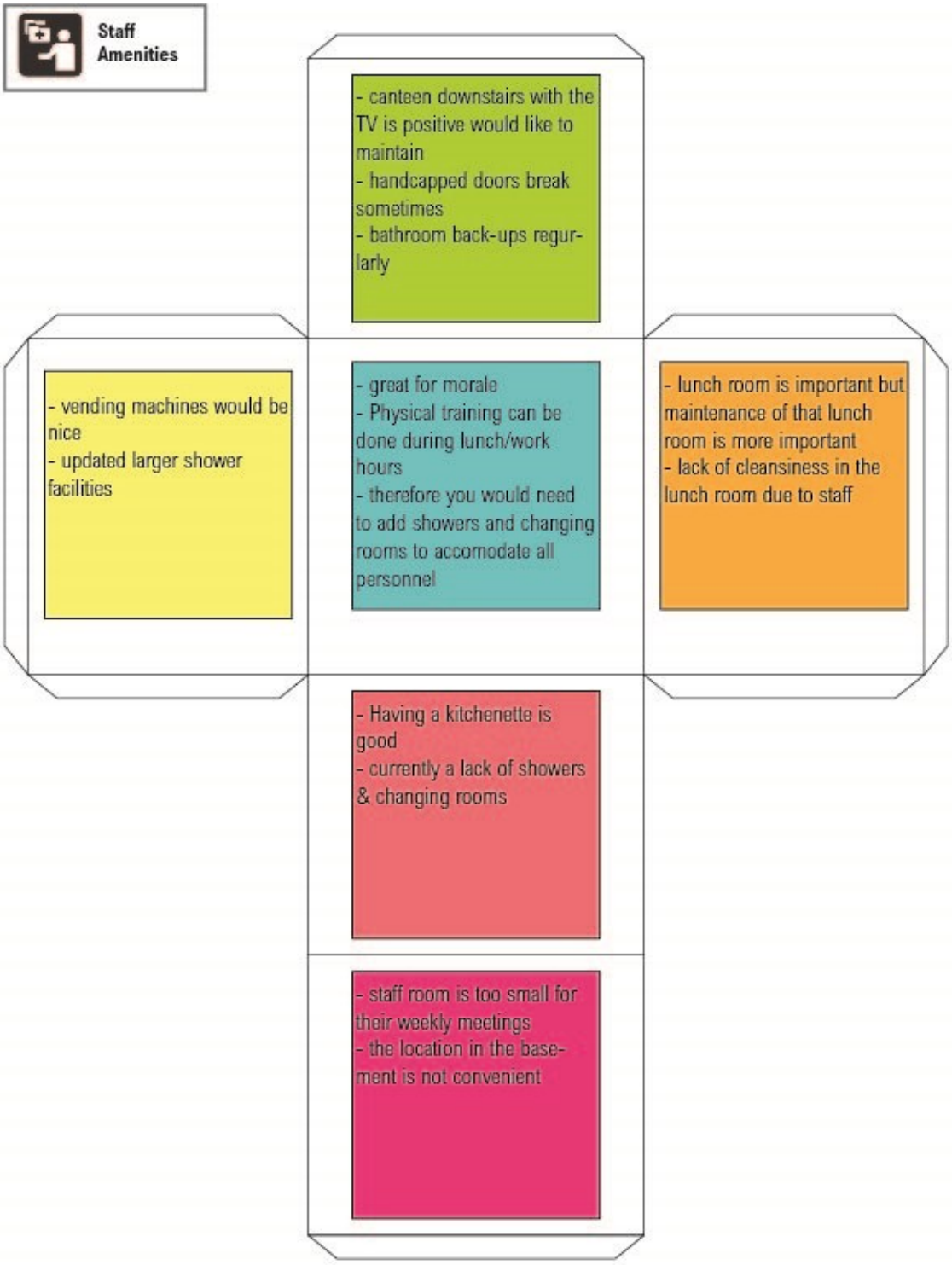
E.2 Radiology



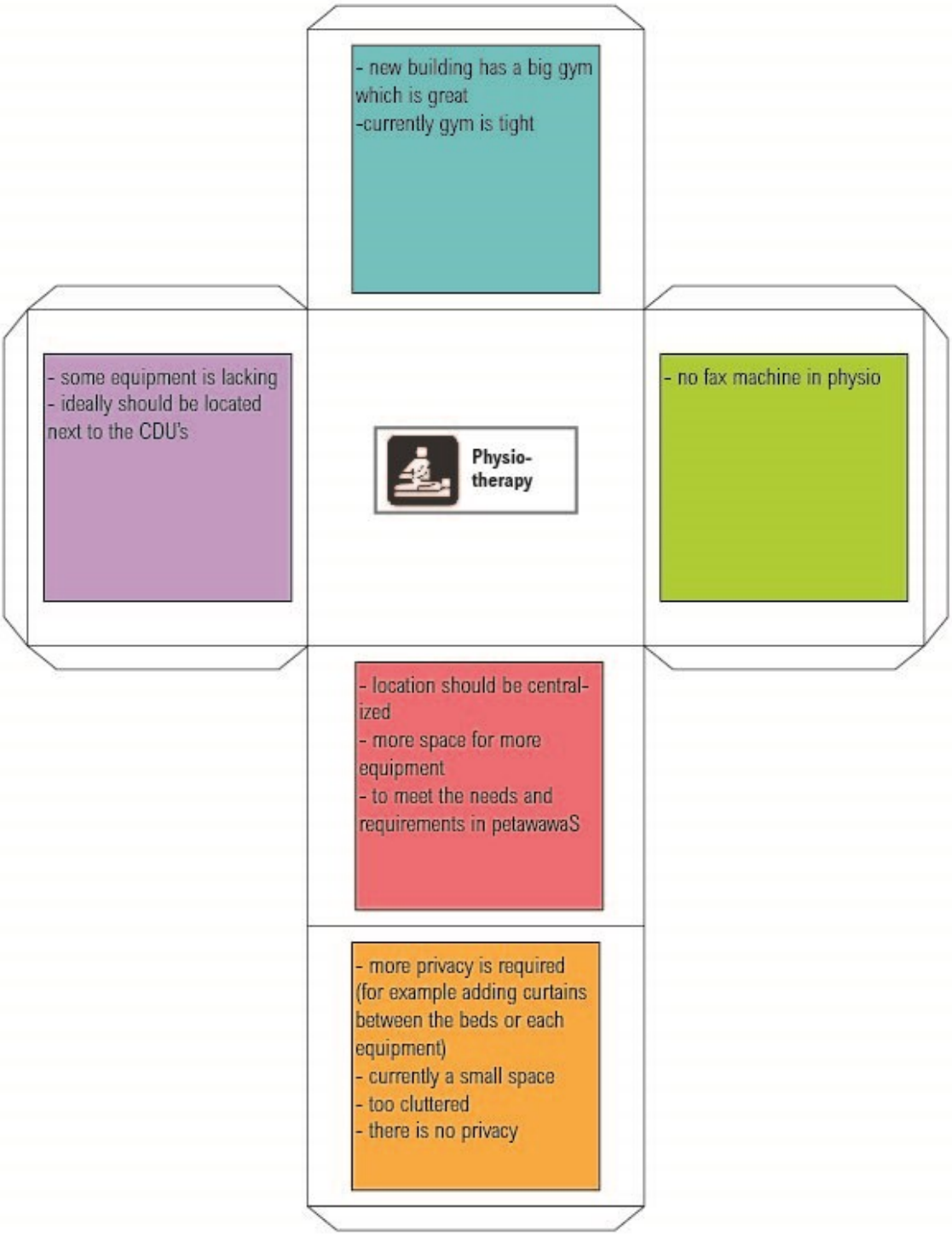
E.3 Services and Support



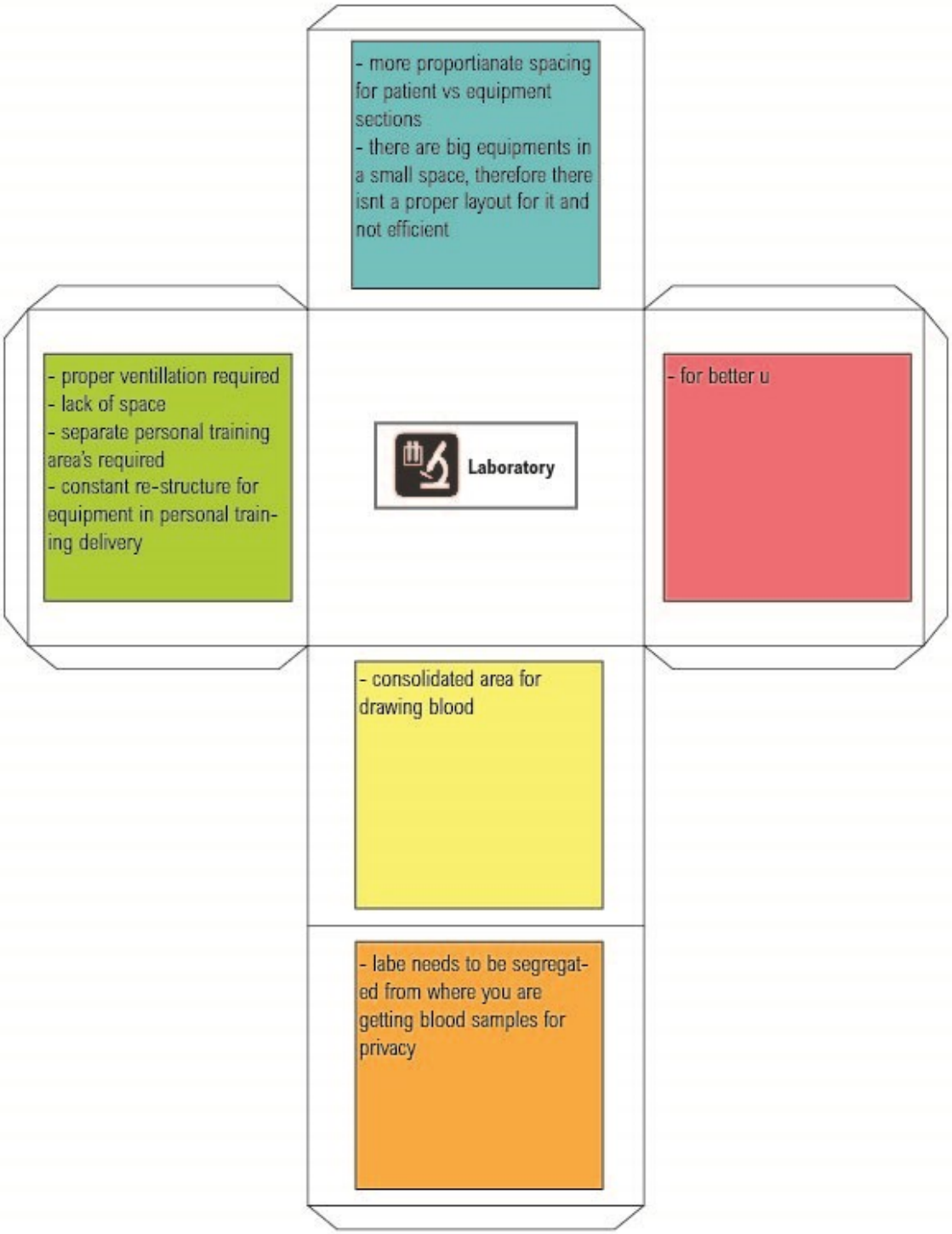
E.4 Staff Amenities



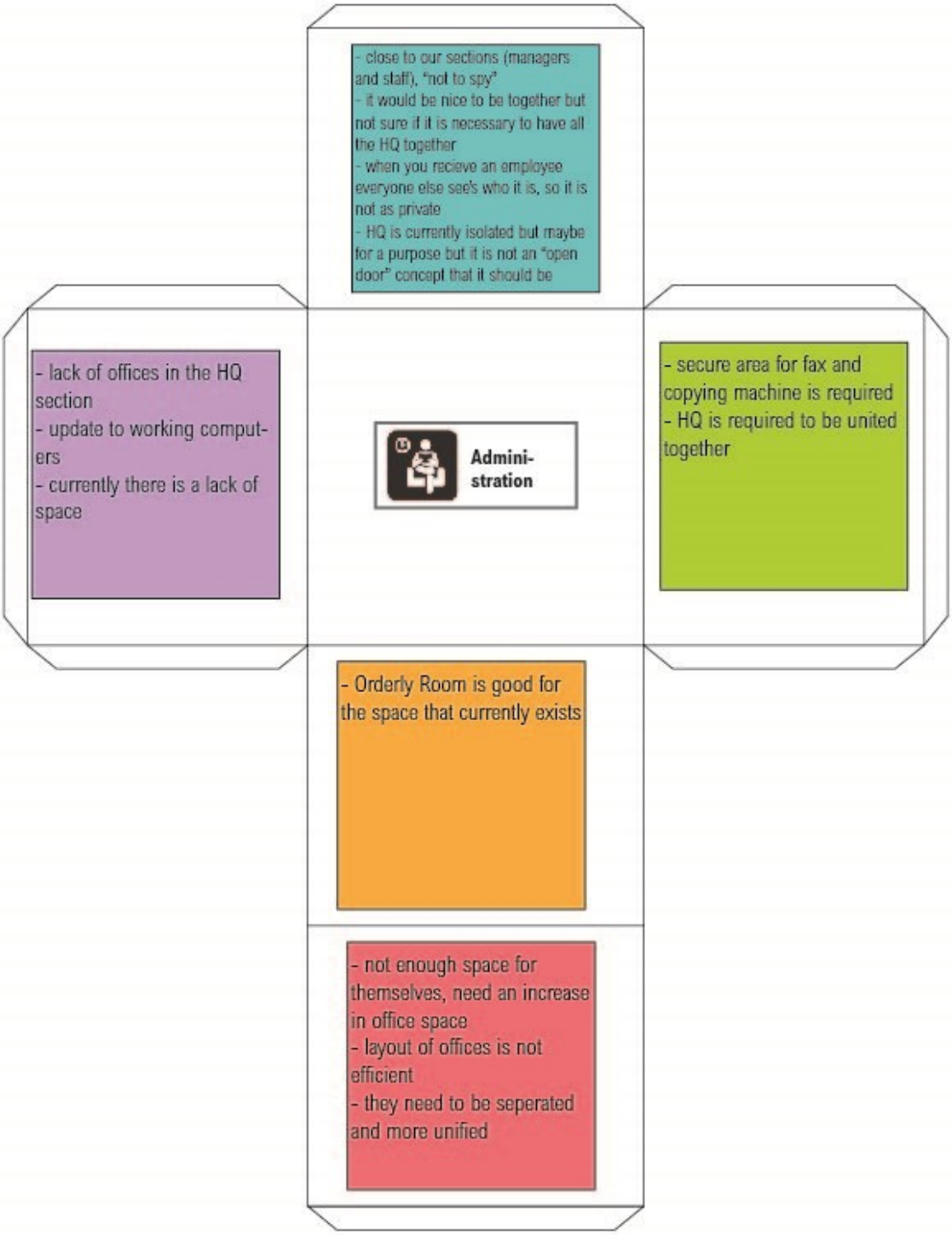
E.5 Physiotherapy



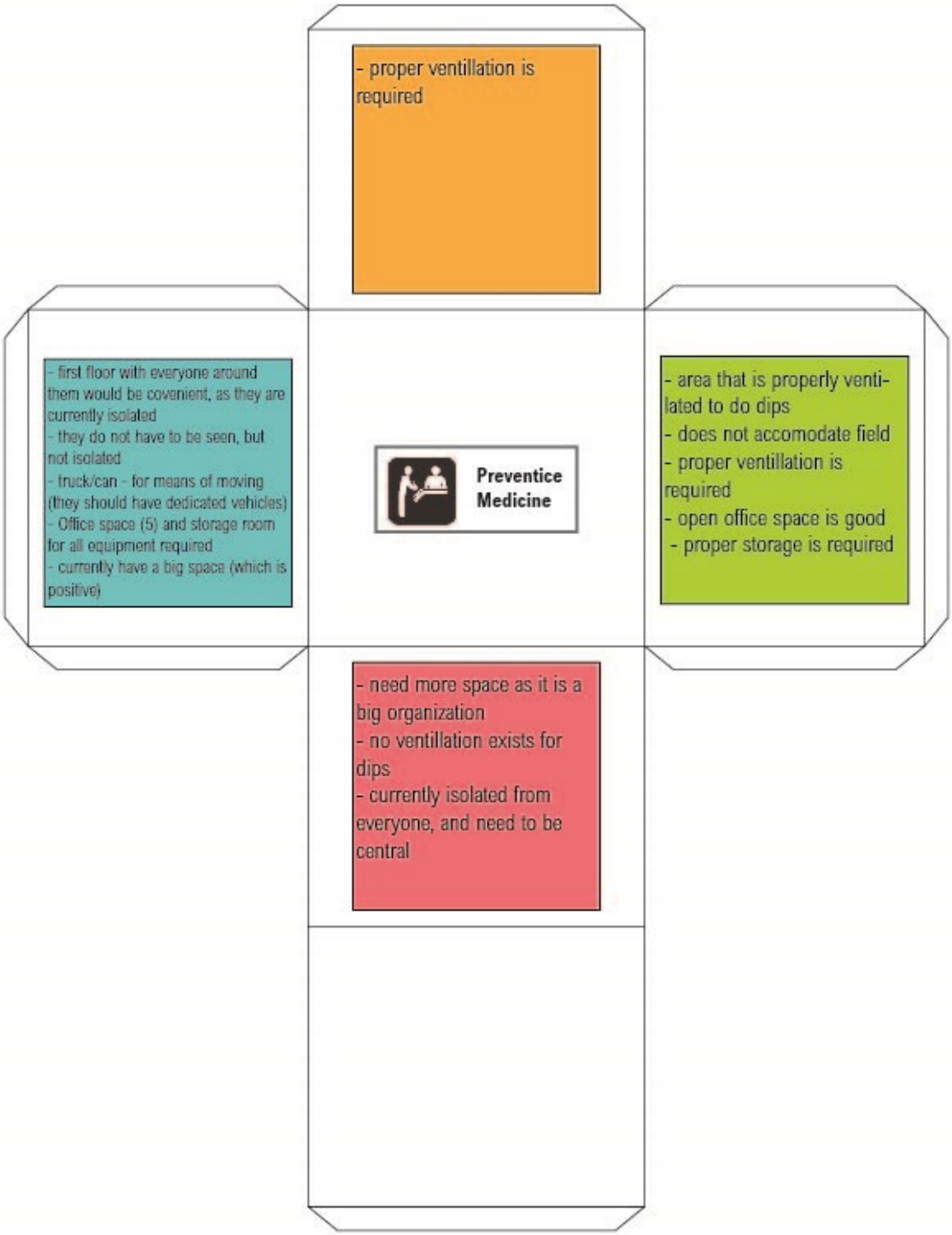
E.6 Laboratory



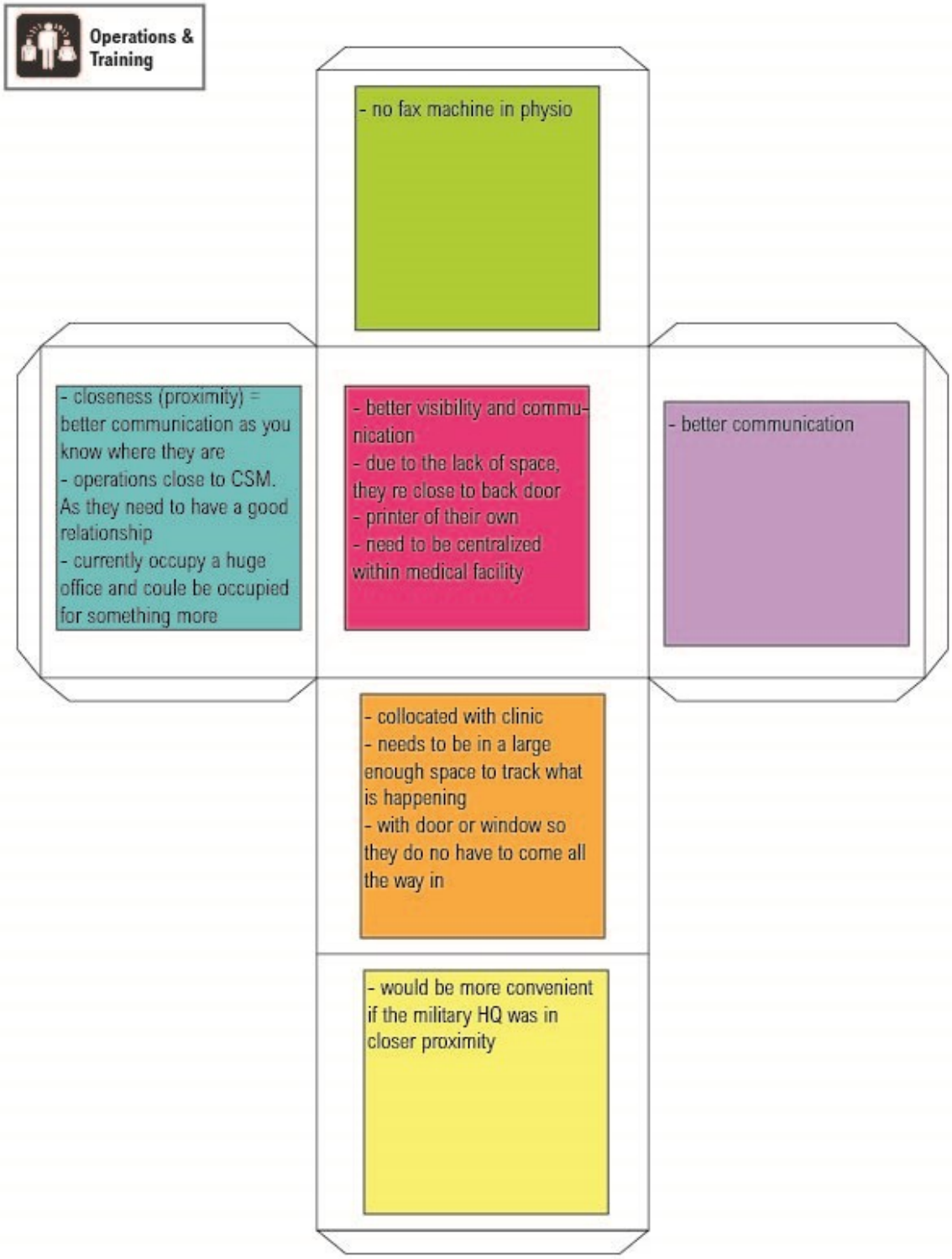
E.7 Administration



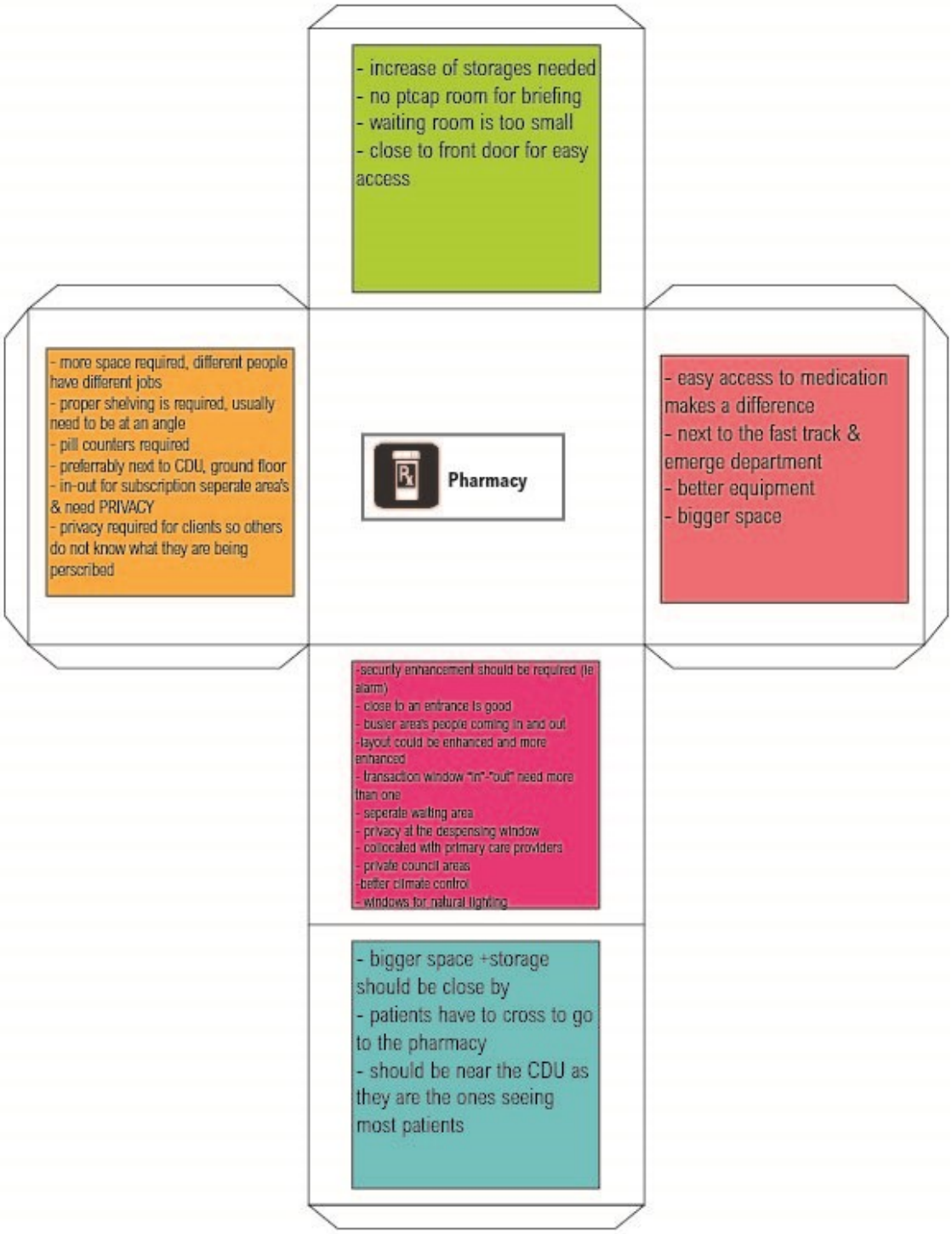
E.8 Preventive Medicine



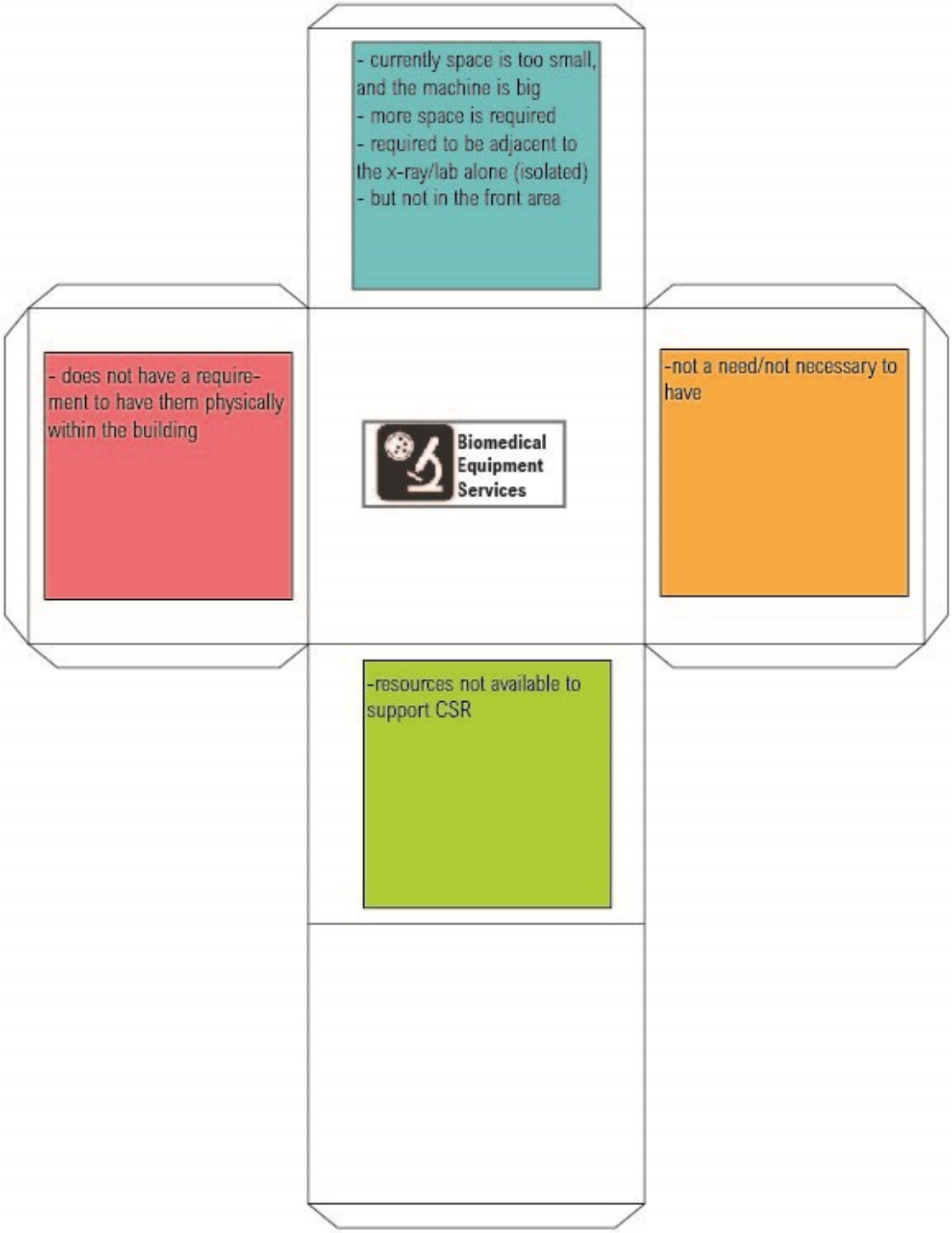
E.9 Operations and Training



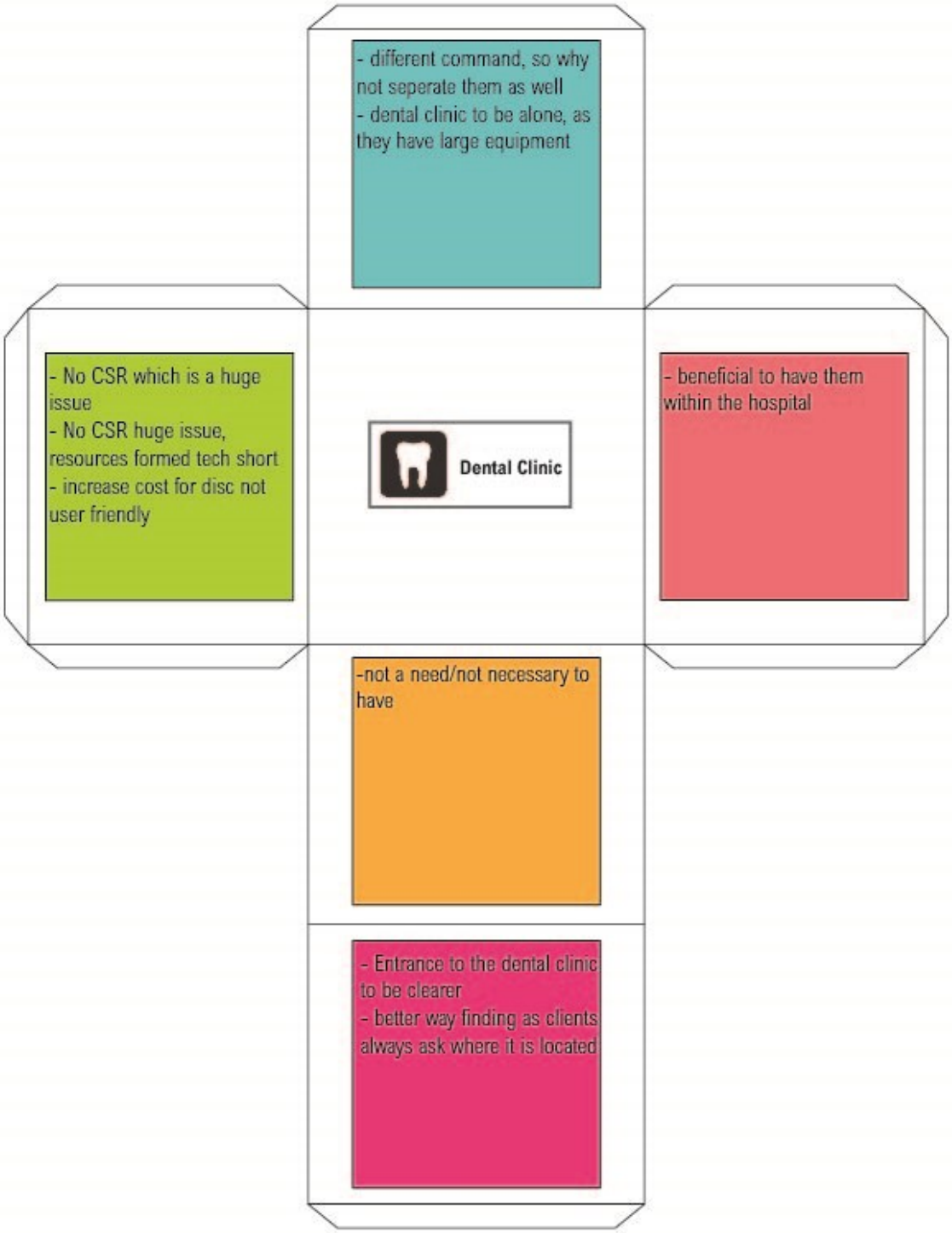
E.10 Physiotherapy



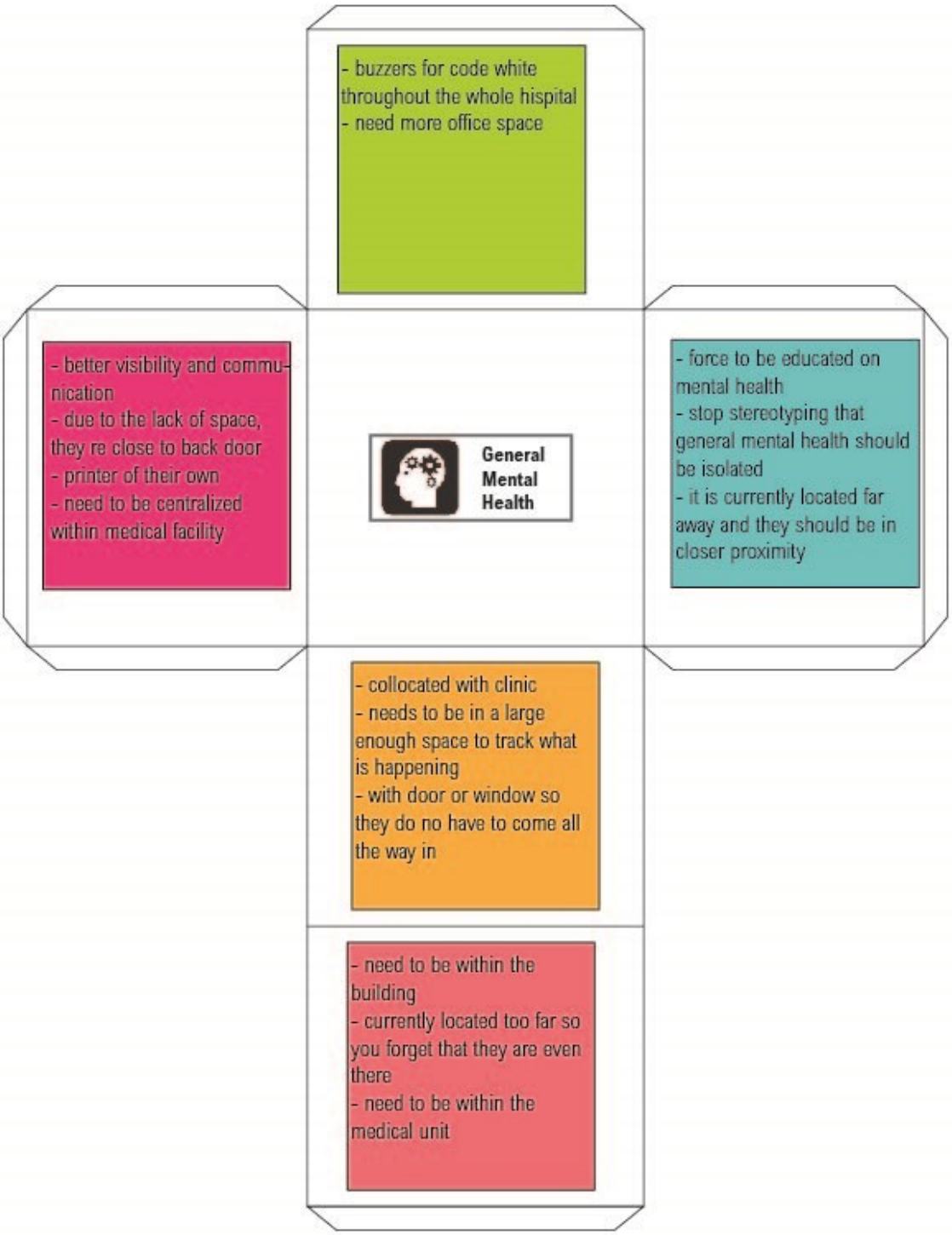
E.11 Biomedical Equipment Services



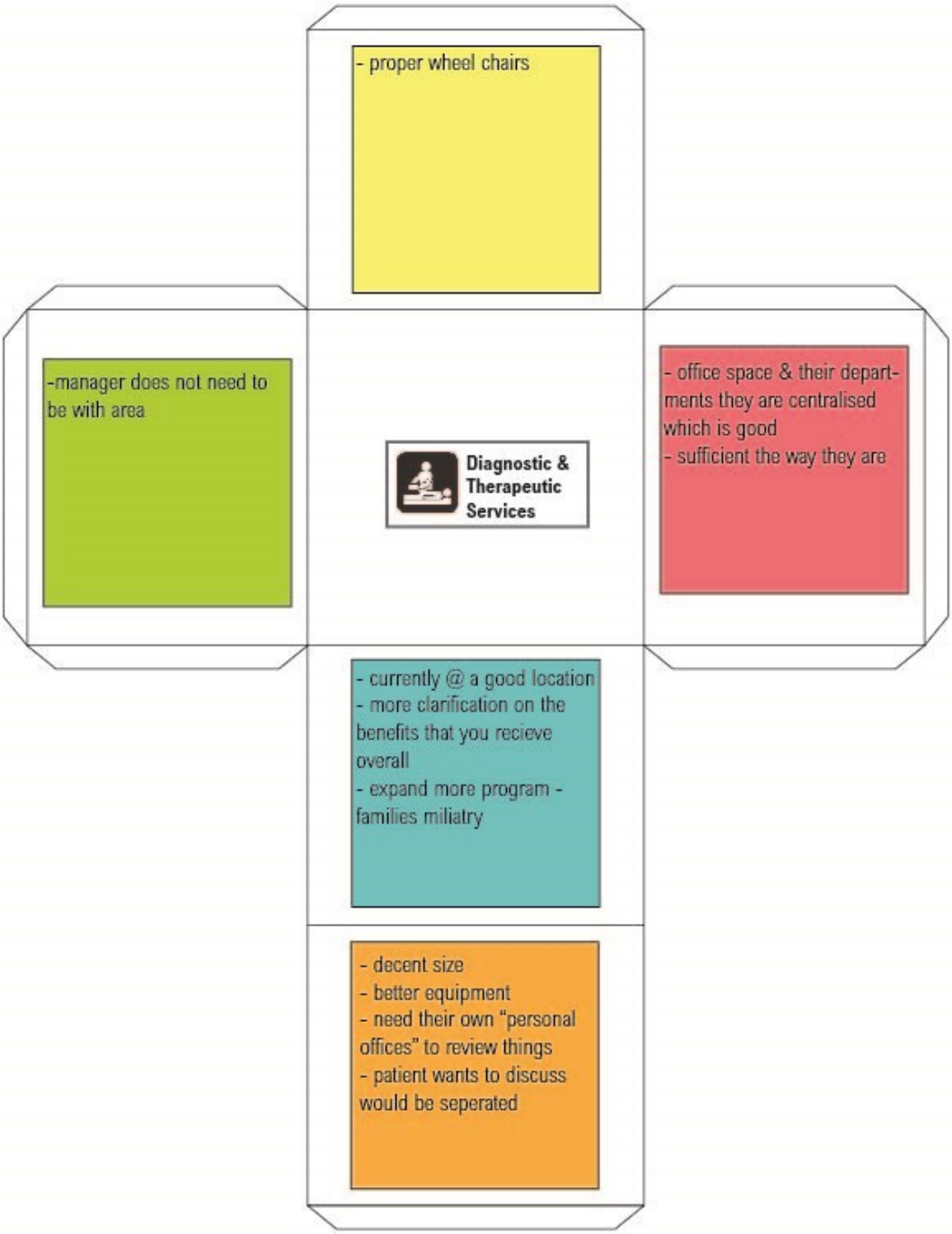
E.12 Dental Clinic



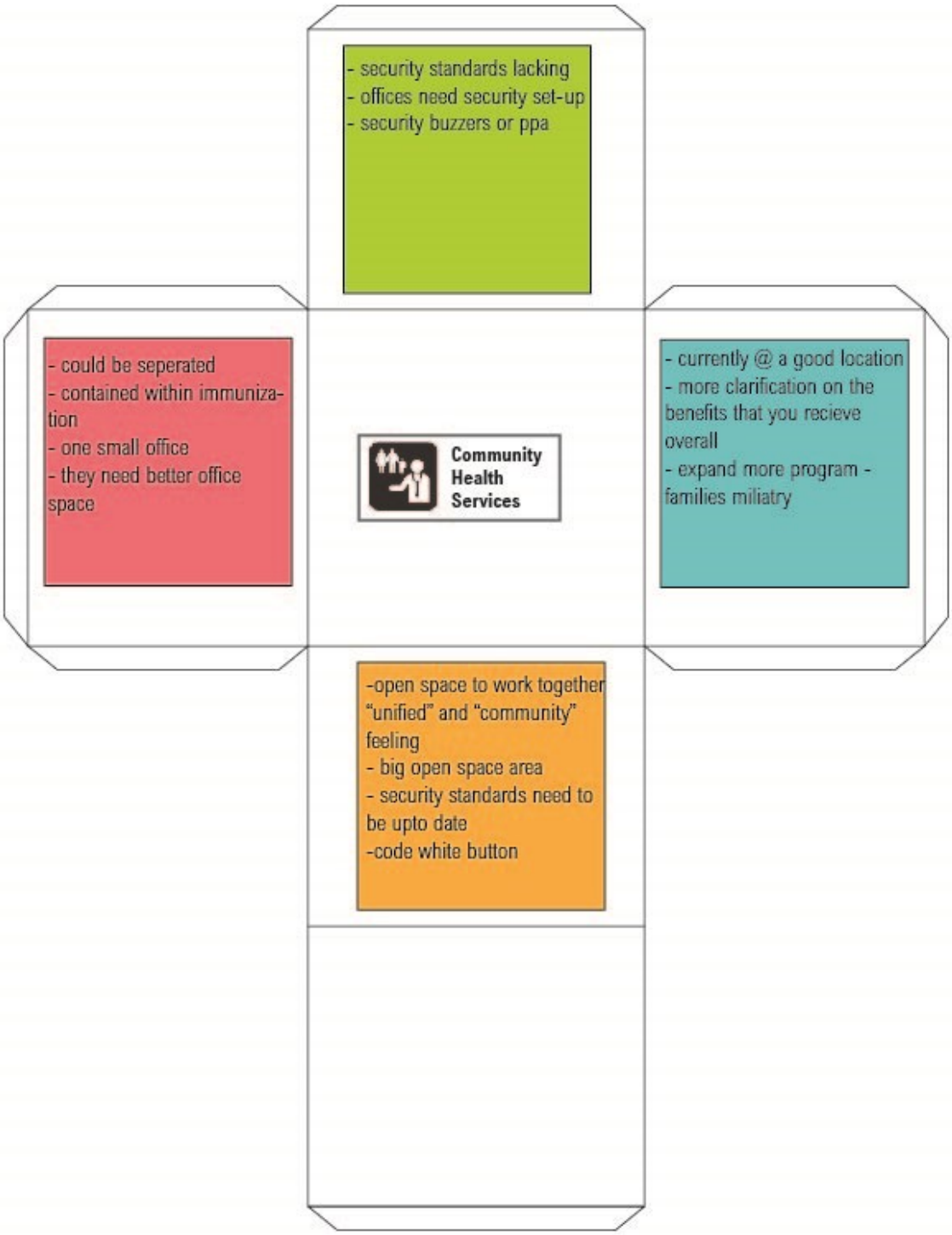
E.13 General Mental Health



E.14 Diagnostic and Therapeutic Services

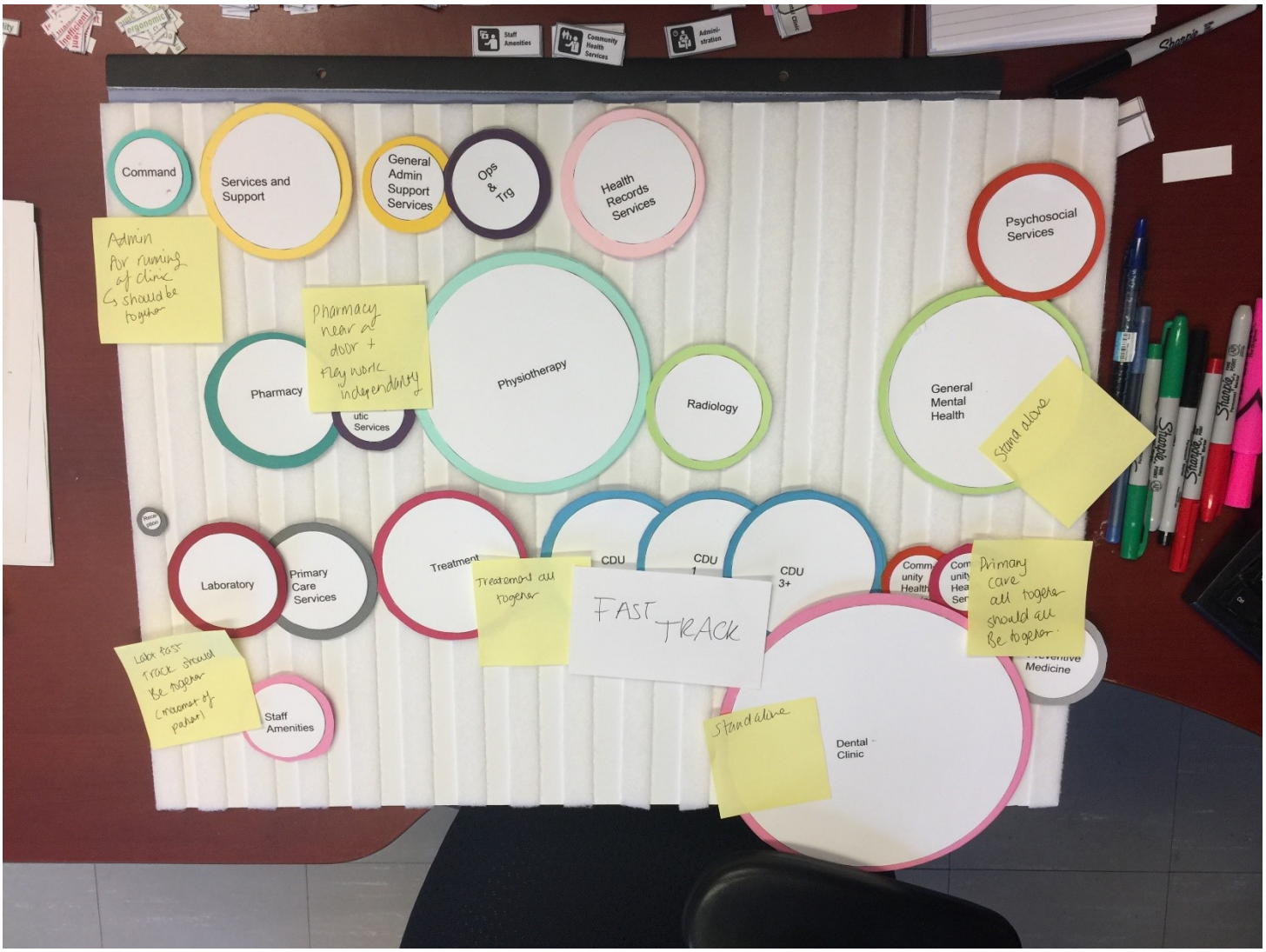


E.15 Community Health Services

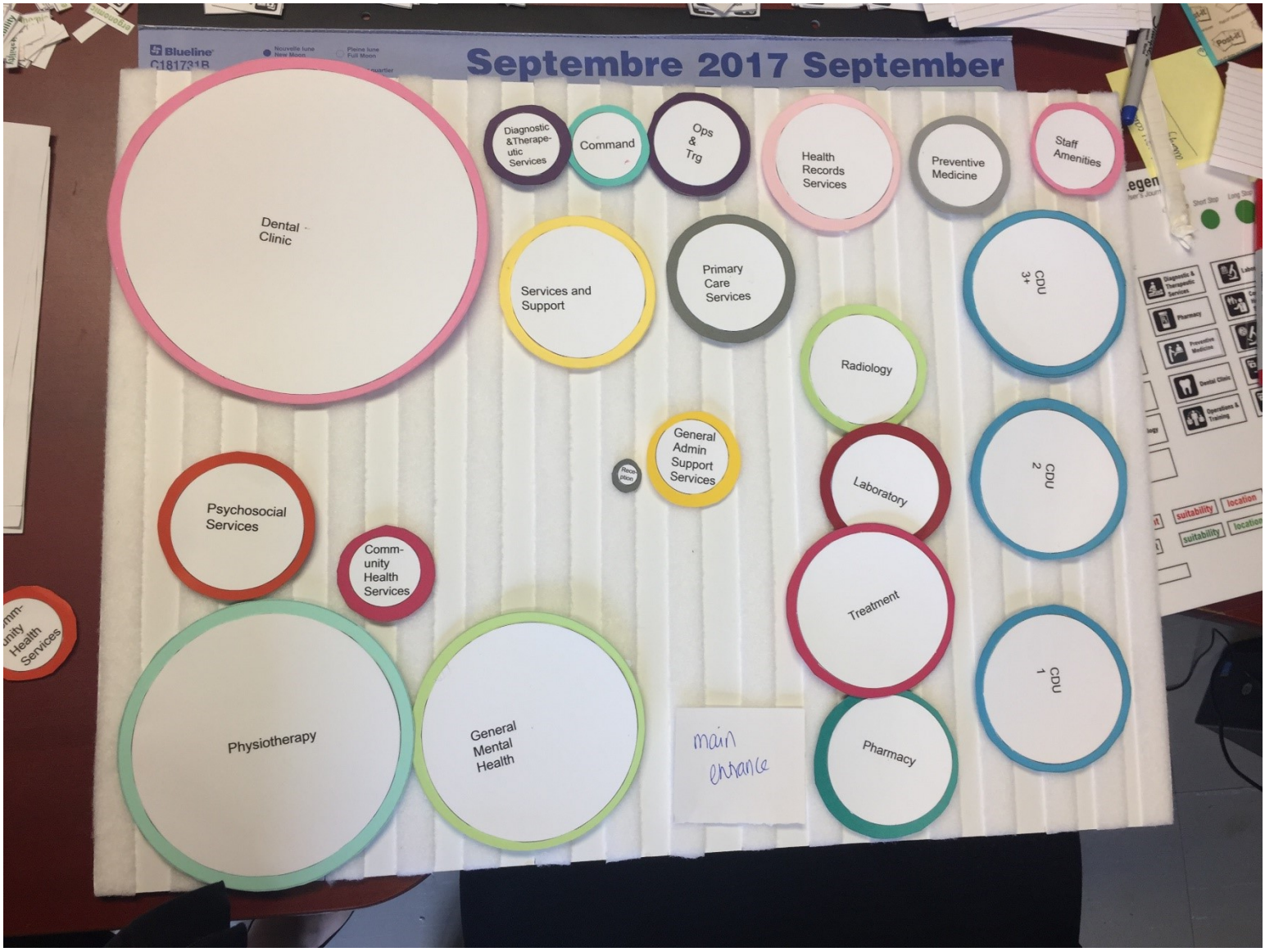


Appendix F Velcro Model Results

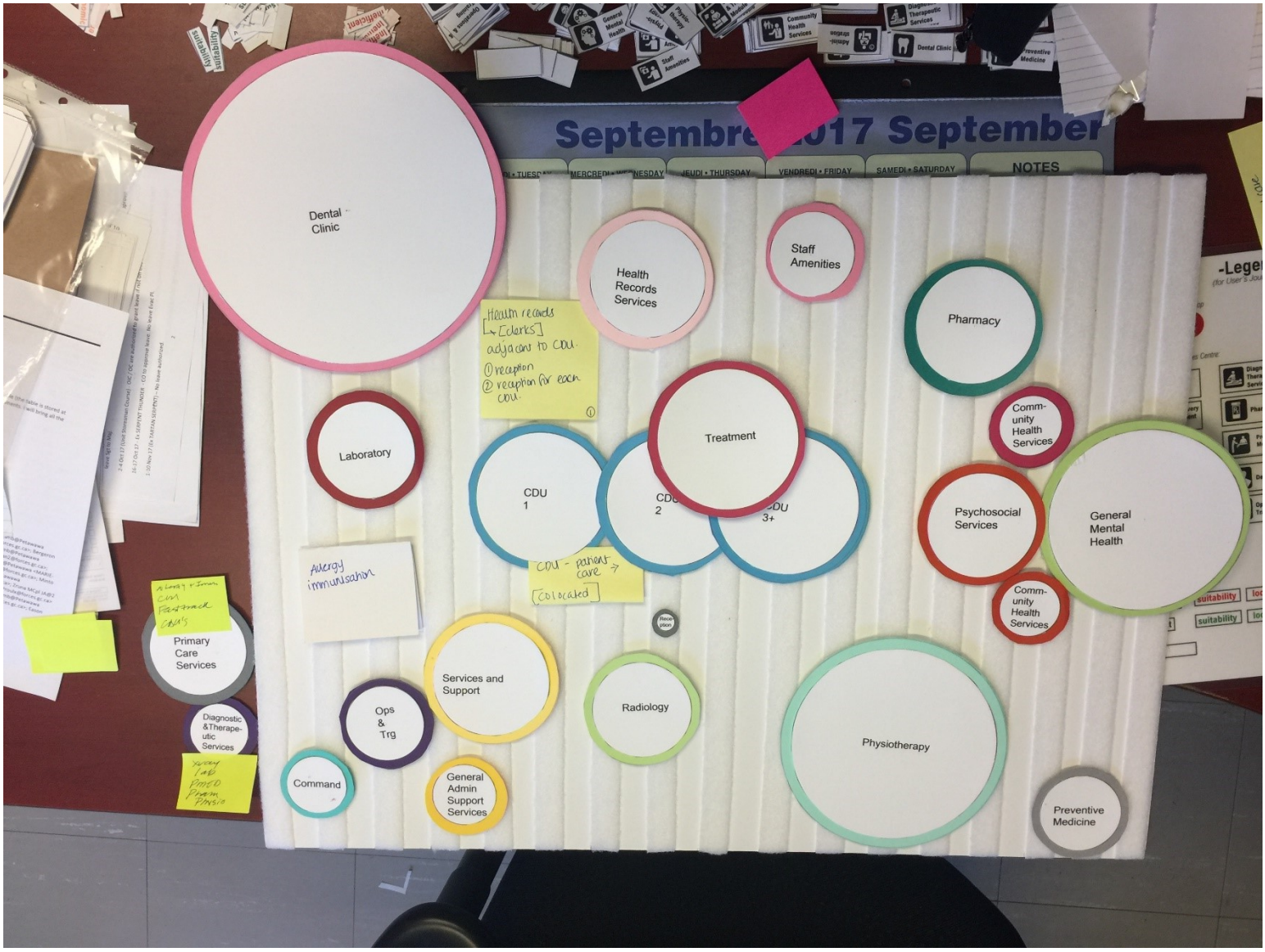
F.1 Participant 1: Velcro Model



F.2 Participant 2: Velcro Model



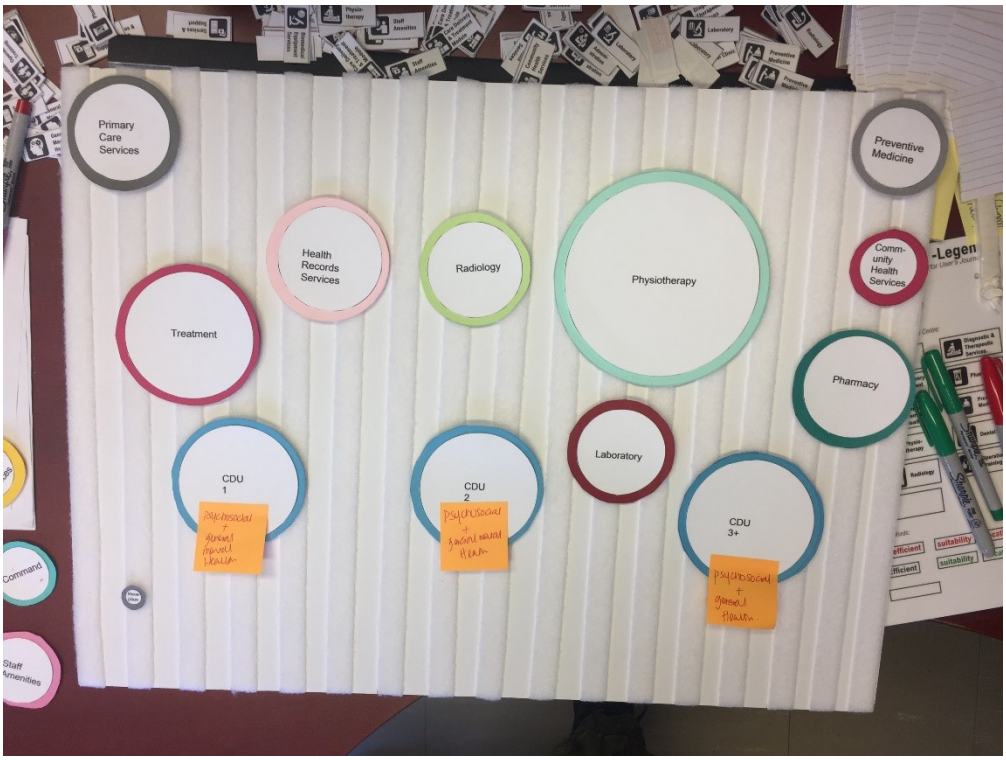
F.3 Participant 3: Velcro Model



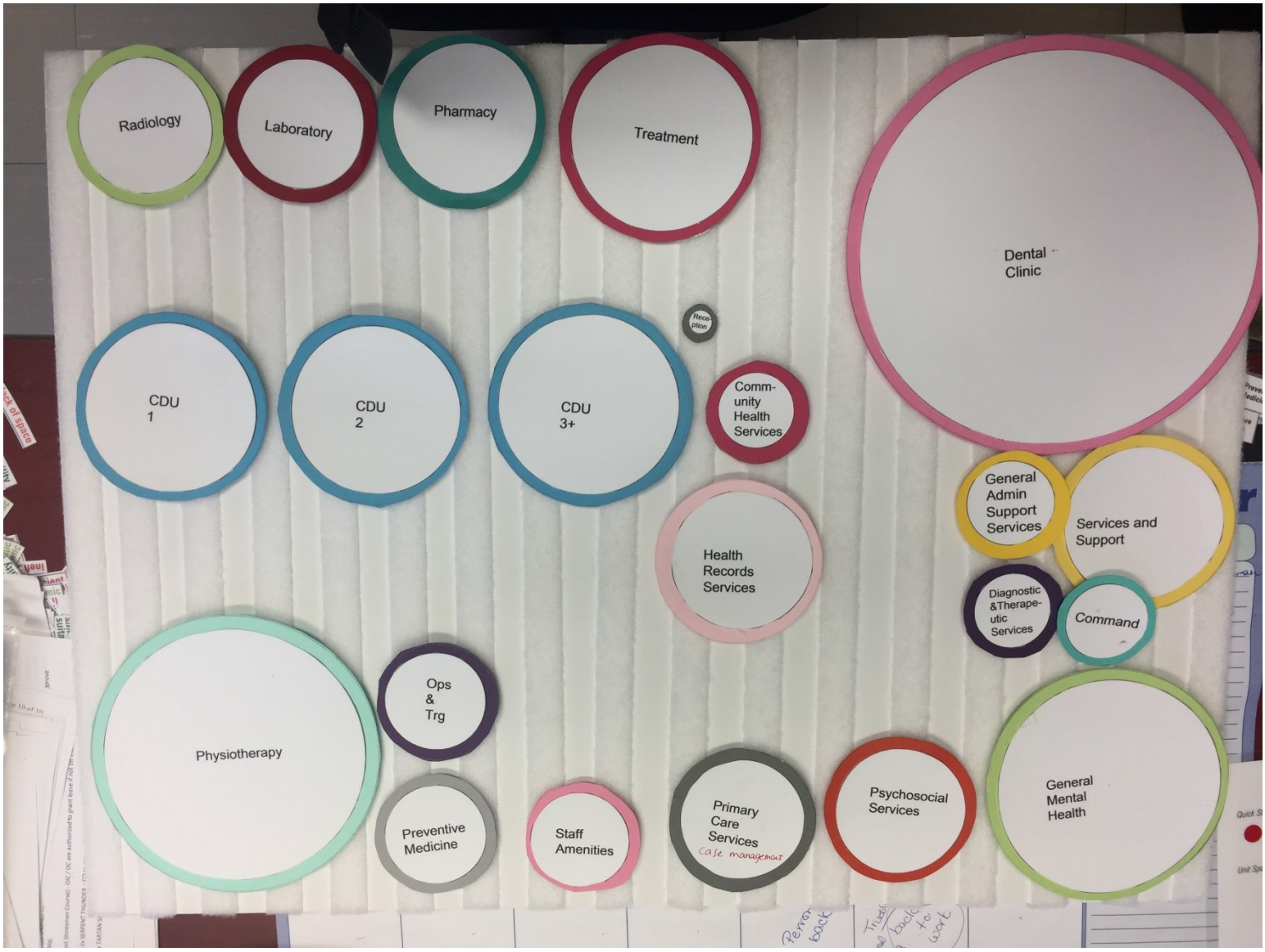
F.4 Participant 4: Velcro Model

F.5 Participant 5: Velcro Model

Levels 1 and 2



F.6 Participant 7: Velcro Model



Appendix G In-depth Table of Analysis

(Notions, keywords and comments by Researcher and Project Director)

Researcher Key Words	Project Director Key Words	Comments	Associated Notions:
			• *End of life -Current Infrastructure* • *Inadequate space* • *Team Collaboration* • *Specialist Space/ Requirements* • *Affinity*
• Positive Perspectives	• Accepting • Adequate • Content • Satisfied • Positive	Accepting the situation as is – for the staff amenities (view of 1 participant) for diagnostic and therapeutic unit (view of 1 participant)	*Not an issue – content with current situation*
• Constant change acceptance • Flexibility	• Acceptance	Acceptance towards the fact that there isn't enough space currently to accommodate for all the operational functional requirements, so trailers were added to create space	• *Inadequate space*
• Constant change • Flexibility	• Adaptability	End users adapt to unforeseen changes that constantly occur. Working as a team will help reduce unforeseen changes and through teamwork they can accomplish any hurdles on the way	• *Team Collaboration*
• Listening to User requirements	• Adequacy of patient and staff flow needs improvement • Configuration • Dysfunctional	Lack of space and inaccurate unit adjacency and layout of space is required.	• *Inadequate Space (Within each unit)* • *Affinity*

		Inadequate layout of space	
• Inefficient lighting • Lack of natural lighting	• Adequate lighting • Natural light	Lighting has aged and there is inadequate natural lighting	• *Inadequate Space* • *End of life -Current Infrastructure*
• Proximity • Centralization • Patient Care Hub • Indirect patient care • Unit Adjacencies • CDU Hub • Branches Off • Main entrance	• Adjacency • Detached/Disconnected • Functional Adjacency • Functional Proximity • Proximity • Space allocation • Configuration • Dysfunctional • Fractured	Functional adjacencies for the different units to suit the operational needs is required for the facility. End users are segmented due to the layout of the spaces (e.g.) offices. End users blame inadequate adjacencies	• *Inadequate space* • *Affinity* • *Team Collaboration*
• Mind and energy • Positive perspectives • Kitchenette • Entertainment	• Amenities • Disconnect • Refresh • Mental Wellness • Hygiene • Maintenance • Operationally Fit	End users would desire staff amenities (kitchenette) in the new facility as it provides space and time for them to get some refresh/disconnect throughout a work day	• *Inadequate Space* • *Special User Requirements (End User Emotional Satisfaction)* • *Team collaboration*
• Isolation • Unawareness • Lack of knowledge	• Attempting to reduce stigma • Education • Visibility • Reducing Judgement • Stigma • Negligent • Relevance • Inclusion	Architecture and cohesion to aid with removing the stigma associated with general mental health unit	• *Affinity*
• Old building • Lack of Innovative systems	• Building and system at the end of life • Constrained (by current infra) • Lacking maintenance	Due to the infrastructure being built in the year 1971 it has come to the end of its life cycle. Lack of maintenance causes the building to reach the end of life cycle quicker and causes more deficiencies for the infra and the	• *End of life -Current Infrastructure*

		operational requirements	
• Consolidation • Isolation • Centralization • 'one stop shopping' • One entity	• Cohesion • Collaboration • Consolidation • Need to maintain operation awareness • Responsive (to the need of leadership) • Inclusion • Concern for loss of cohesion	Ensuring that some units (e.g. management) remains together is essential for most participants (unified). End user is concerned that the adjacency and unity between the management units will be lost	• *Team Collaboration* • *Affinity* • *Inadequate Space*
• Lack and ease of communication • Uncertainty • Share of work load • Communication Flow • Poor management • Lack of knowledge • Open space (connectivity) • Open door concept • Communication with other departments • All staff meeting space • Relationship • User Interaction	• Communication • Lacking information • Dissatisfied • Exclusion • Poor communication • Frustration • Misinformed • Poor management • Lacking communication • Operational efficiency • Operation awareness • Organized • Inclusion • Need to maintain operation awareness • Uncertainty	All the participants mentioned that communication needs to be enhanced. Lack of communication between the different units causes end-users to be unaware and excluded	• *Team Collaboration* • *Affinity*
• Building space • Flexibility	• Competing Priorities	Poor space programming, caused inadequate layout of spaces and unit adjacencies	• *Affinity* • *Special space/requirements*
• Uncertainty • Determination	• Concern- • Doubtful	End user is concerned that the solution provided by the upper management (i.e. clients) will not be doable.	• *Special space/requirements*

• Interruption of services	• Concern over capacity to deliver services	The current infrastructure can not support any more units due to the lack of space.	• *Inadequate Space* • *End of life -Current Infrastructure*
• Lack of privacy	• Concern over perceptions • Confidentiality • Privacy • Space for confidential discussions • Visibility • Conflicted	Due to the lack of privacy within some spaces. False perceptions occur between the end-users. Lack of privacy exists within management. End users attempted a solution but wasn't successful (paper on door)	• *Inadequate Space (Inefficient Layout of spaces)*
• Lack of user knowledge (furnishing)	• Correct configuration and furnishing	The pharmacy, has., inadequate space layout and furnishing (e.g. shelving type)	• *Special space/requirement* • *Inadequate space*
• Innovative systems • New System (Fast track)	• Creative • Resignation towards the users • Proactive	End users were creative to create space that did not exist to continue to provide service by adding and creating a new system called "fast track"	• *Affinity* • *Special Space/requirement*
• Unawareness of user requirements	• Critical • Close Minded • Rigid • Inflexible	Current model of the PCRI made by the clients (upper management) is rigid and does not meet the end user requirement for this specific clinic (those returning from war/combat operations)	• *Inadequate space (layout of space)* • *Affinity (space programming)*
• Poor management • Travel time (between units)	• Dynamic • Hands on Leadership • Engaged	End users (management side) are leaders that are engaged with their staff and must be in constant communication and visit them often in a day/week	• *Affinity*

• Climate Control	• Environment	Inadequate and aged infrastructure affects the climate control of the building	• *End of life -Current Infrastructure*
• Outdated Equipment • Inefficient computers • Innovative Systems	• Equipment • Aged Equipment • Lacking functional and proper equipment • Unreliable equipment	Inadequate and aged infrastructure reflects on the equipment (aged as well) and requires an update	• *End of life -Current Infrastructure*
• Ergonomics	• Ergonomics	Current office spaces do not meet ergonomic requirements	• *Inadequate space (layout)* • *Special User Requirements*
• Layout of spaces • Open door concept • Open layout plan (communication effectiveness)	• Functionality • Poor Functionality • Functionally Constrained • Inadequate Functionality • Genuine concern for functionality • Mistrust • Inadequate spaces for function • Lack of function specific spaces • Inconvenience	Lack of user knowledge results in poor space requirement and space programming to meet end user requirements.	• *Specialist Space/Requirement*
• Layout of Spaces • Inadequate services and units • Open layout plan (communication effectiveness) • User interactions • User centric flow • Inefficient office layout • Patient flow • Direct patient care • Indirect patient care • Inefficient Layout of spaces	• Adequacy of Patient and Staff flow needs improvements • Ineffective service delivery • Inefficient • Patient centered • Patient management (Flow) • Resignation (towards the users) • Illogical • Inconsistency (of practices) • Inconvenience • Randomness • Lack of way finding • Workflow (deficiencies) • Seeking to improve • Effective	Functional proximity is required to enhance service delivery. To do so; patient flow management and patient centered planning is required (ensuring that the units that work together will be adjacent). Resulting in a more effective and efficient flow. Some of the end users were keen on improving the service delivery by explaining specific requirements.	• *Team collaboration* • *Inadequate space* • *Specialist Space/Requirement* • *Affinity*

	• Office Worker		
• Lack of space • Office Layout (inefficient and needs enhancement) • Travel Time (between units) • No dedicated room for resources (storage)	• Adequate space • Deficient space • Inefficient • Inefficient use of space • Utility of space • Lacking proper spaces • Lacking spaces (offices) • Lacking supporting spaces (Storages) • Space deficiencies • Spaces and services inadequate • Inadequate space • Legacy thinking (offices) • Specialist space (Office required)	There is inadequate space available for different units.	• *Team collaboration* • *Special space/requirement* • *Inadequate space* • *End of life -Current Infrastructure*
• Poor / Inadequate ventilation	• Lacking ventilation • Ventilation Deficiency		• *End of life -Current Infrastructure* • *Special Space/Requirement*
• Lack of IT support (Virtual and physical)	• Operational Functionality • Fundamental	IT support both as a physical infrastructure and IT training area missing – that is considered fundamental by the users	• *Inadequate space* • *Special Space/Requirement*
• Security Standards Upgrade	• Safety • Security	Due to the building reaching its end of life the security standards need to be upgraded. Additionally, special security requirements are required spaces within the unit as specified by the end user.	• *End of life -Current Infrastructure* • *Special space/requirements* *s*
• Lack of Staff	• Staffing • Efficiency	Lack of staff (HR issue) causes issues (IT support)	• *Inadequate space* • *Special space/requirements* • *Team Collaboration*

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