The Armadillo Project: Designing a modular birth shelter through biophilic and salutogenic design principles

by Spoorti Sridhar

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Abstract

In regions afflicted by disasters and high maternal mortality rates, the occurrence of calamities amplifies the circumstances surrounding childbirth. In crisis settings, nature and culture often face total devastation, and the existing infrastructure for maternity care is compromised. This project strived to develop a prototype for a transportable and secure birthing module that could be used in crisis settings. Salutogenic and biophilic design approaches were utilized to create a secure shelter for birthing women, serving as a temporary refuge from challenging environments. Using research through design methodology, the project further led to the design of a larger maternity care complex composed of multiple modules. The proposed birthing pod, along with the developed maternity care complex, represents an initial prototype for a portable design solution that can provide improvements to maternal healthcare in crisis globally.

Acknowledgements

I extend heartfelt gratitude to my primary advisor, Doreen Balabanoff, whose constant support and inspiration led me on this transformative journey, thank you. To my secondary advisor, Kathy Moscou, thank you for your guidance and encouragement. To my mother, whose boundless love and belief made this journey possible, and to my father, a pillar of strength, thank you for your constant support. To my partner, a rock through the highs and lows of this journey, your patience, support, and unwavering encouragement have been my compass. Each of you has played an instrumental role in my academic pursuit, and for that, I am grateful.

Copyright

This is for you, mumma, without you none of this would have been possible.

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Chapter 1 : Introduction

“ ಕಪ್ಪು, ಫಲವತ್ತಾದ ಭೂಮಿ,

ಹಸಿರು ಎಲೆಗಳ ವಿಸ್ತರಣೆ, ಮತ್ತು

ಜಾತ್ರೆಯ ಹೂವುಗಳ ಹಬ್ಬ, ನನ್ನ ತಾಯಿ;

ಪ್ರತಿ ಸುಡುವಿಕೆಯೊಂದಿಗೆ ಬಲಶಾಲಿ

ಹೆಚ್ಚು ಸಂಕಟದಿಂದ,

ಹೆಚ್ಚು ಹಣ್ಣುಗಳು ಮತ್ತು ಹೂವುಗಳು.

ಅವಳ ಮಕ್ಕಳ ಕಿಕ್, ಸ್ವರ್ಗೀಯ ಆನಂದ;

ಬುಟ್ಟಿಯನ್ನು ನೆಲದ ಮೇಲೆ ಇಟ್ಟು, ಅವಳು

ನರಳಿದಳು, ಕಣ್ಣು ಮುಚ್ಚಿದಳು, ಮತ್ತೆ ತೆರೆಯಲಿಲ್ಲ “

“ Black, fertile land,

a stretch of green leaves, and

a fest of fair flowers, my mother;

stronger with every burn,

with more suffering,

more fruits and flowers.

kick of her kids, heavenly bliss;

resting the basket on the ground, she

groaned, closed her eyes, didn't open again.”

(P. Lankesh, 1994)

This thesis began as a personal exploration of design ideas for birth spaces and transformed through the research project into a design proposal to aid in addressing motherhood in situations of great crisis. The section below will discuss my motivation, research questions, goals and objectives, and scope of work for the Armadillo Project.

1.1 Personal Motivation

Maternity care environments that offer low-intervention approaches to labour and birth in most regions around the world are inaccessible to the average woman, let alone women in regions with high maternal mortality rates. As an architecture student growing up in India, I have had the honour of experiencing different settings all over the country. In many of the rural villages that I have visited, women endure mistreatment and lack of access to necessities during childbirth. In contrast to urban city-life, where healthcare is accessible and dependent on technology, rural regions barely have the resources to survive, much less provide additional maternal care. I remember one incident that happened when I was on a study-tour in the summer of 2019 in Bandipur, Karnataka. The summer heat was creating wildfires in every corner, and the camp that I was staying at was the centre of one such crisis. A pregnant woman, barely the age of sixteen, was forced to give birth in an elephant shelter while she looked out into the community she called home, burn to ashes. That was the moment I decided to explore different approaches to making the lives of underprivileged women easier, whether it was through the stages of adolescence or motherhood, I was inspired to make a difference. I commenced my inquiry with a contemplation of maternity spaces in a

general context. However, as I delved deeper into the prevailing issues of maternal and infant mortality across the globe, coinciding with the prevalence of global crises making headlines in numerous regions, my focus gradually narrowed towards exploring maternal care within crisis settings.

The issue of maternal and infant health in crisis settings remains largely unaddressed. While designers cannot resolve all infrastructural challenges, this thesis project suggests that design interventions can offer a meaningful contribution by providing temporary yet secure shelters for women delivering infants in disastrous circumstances. My preliminary research and personal experience led me to three main categories that required consideration in the design solution. This research allowed me to dive into the obstacles that were faced by women world-wide and uncover design approaches that could help solve these issues.

1.2 Research Summary

1.2.1 Problem Statement

In designing a birth shelter for crisis settings, there are four key areas that need to be addressed:

- Birthing Shelter: A physical structure that acts as a safe space for women giving birth in regions of crisis.

- Psychological and Emotional Support: Importance of designing a calming setting for a woman in crisis furthermore reducing the negative psychological impact during childbirth.

- Respect and Privacy: Birth process that is enhanced by privacy and respectful care.

- Cultural Sensitivity: Acknowledgement of a woman's sensitivity towards their culture to help them feel dignified, secured, empowered, and supported throughout their childbirth journey.

1.2.2 Research questions

Main Research Question:

Is it possible to design a shelter for birthing women in crisis settings that improves their well-being and overall birth experience?

Sub Research Questions:

- Can biophilic design principles be incorporated into birthing unit environments to enhance the connection with nature and create a soothing environment for expectant mothers?

- Can salutogenic design principles contribute to better birth shelters for crisis settings?

1.2.3 Goal Statement

The goal of this research project is to address maternity care in crisis settings through design of a birth shelter that contributes to maternal and infant health and wellbeing. The intent is to develop an understanding of what might be needed, how biophilic and salutogenic principles can help address the problem, and to produce a first prototype that addresses the identified design problems/issues.

1.2.4 List of objectives

- To understand salutogenic design principles and biophilic design theories through literature review to identify if these principles have a soothing impact on birthing women in crisis situations.

- To explore use of materials that could be viable in disaster settings for providing security and flexibility.

- To contribute to design work that promotes values of sustainability, vernacularity, social cohesion, respects and serves the emotional and cultural needs of its users.

1.2.5 Potential Contributions

This project aims to contribute to design work that promotes future developments in the fields of modular architecture, biophilic design, sustainable architecture, and the design of salutogenic birth environments. The focus on design of a birth shelter for crisis settings will contribute to consideration and design solutions for much-needed shelter systems for birthing women in crisis settings. This work can also contribute to the larger field of global maternity setting design, an area of design that requires much more dedicated attention in order to support respectful and sensitive care during birth.

1.2.6 Scope of work

This research through design project aimed to produce a conceptual prototype, taking inspiration from the fields of biophilic design, salutogenic design, modular design, and midwifery approaches to maternity care. The scope of the design project does not include consideration and development of maternity hospital settings and clinical maternity wards.

1.3 Chapter Overview

This thesis paper is divided into six main chapters:

- Chapter 1 introduces the topic and provides an overview of the project.

- Chapter 2 covers the literature review of two crisis settings—disasters and regions with high maternal mortality rates—and the theoretical frameworks of salutogenic design, and biophilic design.

- Chapter 3 presents the methodologies and frameworks that form the basis of the research and the design process.

- Chapter 4 describes the design work related to the birth module and its features, both as an individual entity and as part of a community.

- Chapter 5 covers the exhibition of work in progress that occurred from March 10th - March 12th, 2024.

- Chapter 6 focuses on the discussion and evaluation of the project.

- Chapter 7 concludes the project and describes the outcomes, contributions to knowledge, limitations and possible future research needed.

Chapter 2: Background

When you change the way you view birth, the way you birth will change.

(M. Mongan, 2018)

To gain a deeper understanding of the subjects , a broad-ranging and interdisciplinary literature review was conducted on disasters and maternal mortality. In addition to disasters and maternal mortality, the subject matter includes biophilic and salutogenic design concepts, as well as findings from important literature reviews on birth centre design. Issues, obstacles, and potentialities are examined and summarised to support the design innovations. The section below introduces the ideology of birth centre design as developed through a midwifery care framework.

2.1 Disaster and Crisis Settings

As this project seeks to design a birthing unit in crisis settings, the literature review included seeking an understanding of how birth and maternal and infant health are impacted by natural and human-made disasters.

2.1.1 What are disasters?

Within the disciplines of emergency management and resilience studies, disasters are defined as occurrences that cause substantial disruption, extensive damage, and intense suffering. Disasters are categorized based on where they originate and how they affect a region. All these events pose different problems that

are derived from fundamental forces or geological dynamics. On the other hand, man-made disasters, which include oil spills, transportation accidents, nuclear mishaps, industrial accidents, and structural failures, highlight the weaknesses in human infrastructure and the possible consequences of technology failures. (Ahmad & Sadia, 2020)

Crises are frequently made worse by societal, political, or environmental stressors. These include conflicts, wars, famines, and pandemics. These crises go beyond isolated incidents; they include protracted times of turmoil and generalized suffering. The vulnerabilities in modern systems are further heightened by technological and environmental factors, which include space weather events, cyberattacks, and power outages (Severin & Jacobson, 2020). It is important to be aware of these different typologies for design to identify the specific issues and regions to be addressed. Further, this insight is deemed important in order to diversify preparedness and response techniques.

2.1.2 How do catastrophes affect birthing women and their healthcare needs?

Many individuals are forced to flee their homes after a disaster, which results in both short-term upheavals and long-term difficulties in reconstructing communities. Displacement and homelessness, public safety, healthcare, and education are negatively impacted when infrastructure, including housing, transportation, and utilities, sustain severe damage. Obstacles to recovery include sickness and malnutrition, and such disasters frequently trigger humanitarian crises where populations have little or no basic supplies like food and clean water. The

psychosocial impact is profound as survivors grapple with enduring mental health conditions such as anxiety, sadness, and PTSD (Setiawati et al., 2023). Physical damage to infrastructure and psychological adverse effects are all important issues that need to be addressed in designing for crisis settings. It is important to note that disasters are circumstances of uncertainty or unfamiliarity causing immense amount of fear for a birthing woman often triggering a domino effect on the lives of those affected (Harville et al., 2021). The domino effect on pregnant women giving birth in crises is caused by a series of interrelated obstacles. Disasters can cause infrastructure damage, disrupting healthcare services and limiting access to necessary maternal care. This, in addition to the increased stress and trauma associated with crises, exacerbates existing health inequities, and raises the possibility of complications during childbirth. Furthermore, economic constraint and logistical challenges impede the timely provision of medical aid, increasing the vulnerability of both mothers and infants.

Even in non-crisis settings, birth is widely perceived as risky and dangerous. "Fear is now understood as a trigger that can make the birth experience feel emotionally and physically risky, and thus potentially traumatic, for all involved." (Balabanoff, 2017). The psychological status of expectant mothers who experience trauma is complicated since the pressures and unknowns that accompany catastrophic occurrences have a negative influence on both their physical and mental health. Feelings of vulnerability and heightened stress levels can be exacerbated by the lack of control over external circumstances in cases of crisis. The psychological terrain following a tragedy significantly influences the psyche of expectant mothers as they navigate the fallout and the difficulties of reconstructing in the face of hardship. Birthing women may relive unpleasant events connected to

the disaster, raising concerns about post-traumatic stress disorder (PTSD) (Muglia et al., 2022). The challenges faced by birthing mothers are aggravated by socioeconomic disparities, cultural barriers, and limited access to quality healthcare in regions with high rates of maternal mortality.

2.1.3 Live Crisis Setting: Gaza

During the time of this research project, the crisis in Gaza unfolded, providing a unique opportunity to access live updates concerning the influence of such a disaster on birth in a particular setting.

According to a report filed by the United Nations Population Fund some of the key figures revolving around this crisis situation included 30,637 fatalities (70% of these were children and women). 1,700,000 people were displaced, including 1,340,000 women who were of reproductive age. There were 13,649 expected deliveries in April 2024; and 12 out of 36 hospitals were only partially functional and able to provide limited services (UNFPA, 2023).

Under the crisis, Gaza's birthing clinics were and still are dealing with never-before-seen challenges. It is now more difficult for these facilities to deliver critical maternal healthcare services because of the devastation's substantial impact on their operational capability (Loveluck & Mahfouz, 2024). The hazards associated with pregnancy and childbirth are obviously increased by persistent violence and the lack of basic resources. The vital need for emergency birth shelters in conditions similar to those in Gaza and the West Bank is highlighted by the statistics showing

that over 13,000 women in Gaza are expecting to have babies in one month alone. This crisis serves as a significant insight into the design process. The Gaza war exemplifies a crisis setting characterized by a prevalence of birth in undesirable conditions. Understanding the dynamics and challenges faced in such environments offers valuable insights into the design process for maternity spaces. By examining how maternal care is delivered and accessed amidst conflict and humanitarian crises, information regarding the needs and constraints of these emergency contexts were identified. Insights from the Gaza war scenario aided in the development of innovative and adaptable design solutions tailored to address the unique challenges of crisis settings, ultimately enhancing the resilience and effectiveness of maternity care infrastructure in similar contexts worldwide. Key finding about the issues that were impacting birthing women in Gaza are summarized below (*Gaza 100 Days*, 2024; *Israel-Gaza War in Maps and Charts: Live Tracker | Israel War on Gaza News | Al Jazeera*, 2024.; Loveluck & Mahfouz, 2024; Mohamed, 2024).

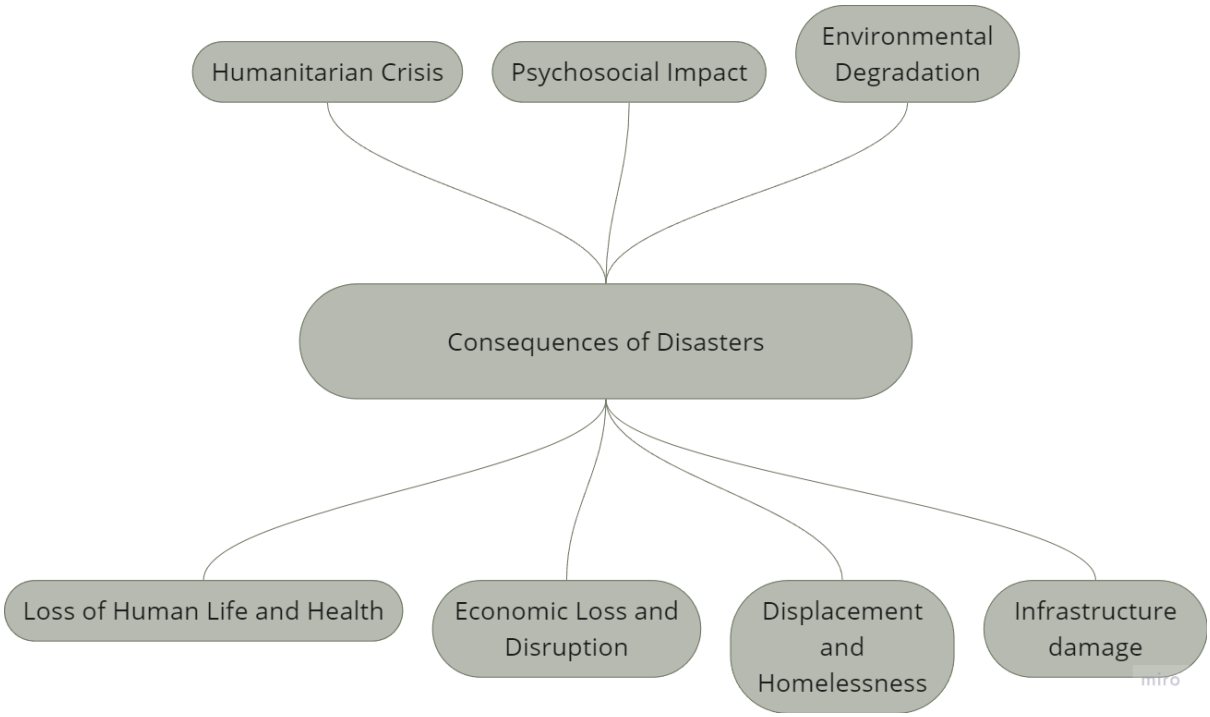


Figure 1. Diagram describing the consequences of disasters; Source: S. Sridhar, 2024

2.2 Maternal Mortality

High rates of maternal mortality persist across the globe. The United Nations Sustainable Development Goal (SDG) 3 pertains to maternal mortality and centres on "Good Health and Well-being." Specifically, Target 3.1 aspires to "lower the global maternal mortality ratio to below 70 per 100,000 live births" by the year 2030 (*World Health Statistics 2023 – Monitoring Health for the SDGs*, 2023). Diverse strategies for attaining this SDG target include enhancing access to high-quality maternal healthcare, addressing social determinants of health, and ensuring health systems that are both equitable and inclusive. The focus on maternal mortality is important in the research since it is directly related to the efficacy and necessity of building birthing pods for crisis settings. Maternal mortality not only reflects expectant mothers' overall health outcomes, but it also acts as an important measure of the accessibility and quality of maternal care, especially in vulnerable environments like crisis settings. High maternal mortality rates highlight the critical need for new solutions to the complicated issues that pregnant women face in these settings. Birthing pods emerge as a viable intervention, providing a compact and movable alternative for safe and sanitary delivery facilities even in resource-constrained and unstable environments. The focus on reducing maternal mortality reflects a broader commitment to advancing the overall health and well-being of women worldwide.

The maternal mortality rate (MMR) represents the number of maternal deaths per 100,000 live births for a given period (*Maternal Mortality - an Overview | ScienceDirect Topics*, 2014). It functions as a vital indicator of the sufficiency and

accessibility of maternal healthcare services, including factors like the availability of emergency obstetric services in a particular healthcare system, the quality of prenatal care, and the presence of trained birth attendants or the provision of midwifery led care. A higher MMR indicates shortcomings in maternal health care. Maternal health is central to the wider range of global health and development priorities because of its role in overall human health and well-being. Ensuring universal access to sexual and reproductive health services is a key element in reducing the global maternal mortality ratio (Bárcena, 2023).

Maternal mortality is a worldwide health issue that calls for an all-encompassing strategy that goes beyond treating symptoms. It is made more complex by overcrowded care facilities, shortages of drugs, supplies, and blood for transfusions, as well as iatrogenic hazards associated with medical procedures like caesarean births. Non-medical factors are crucial; logistical hurdles like poor hospital access, impassable roads, and inadequate transportation infrastructure are major problems, especially in rural areas where maternal death rates are significantly higher (Abou Zahr & Royston, 1991). To address maternal mortality, logistical challenges, socioeconomic factors, and gender disparities need to be considered which depend on socioeconomic, cultural, and regional factors (Abou Zahr & Royston, 1991).

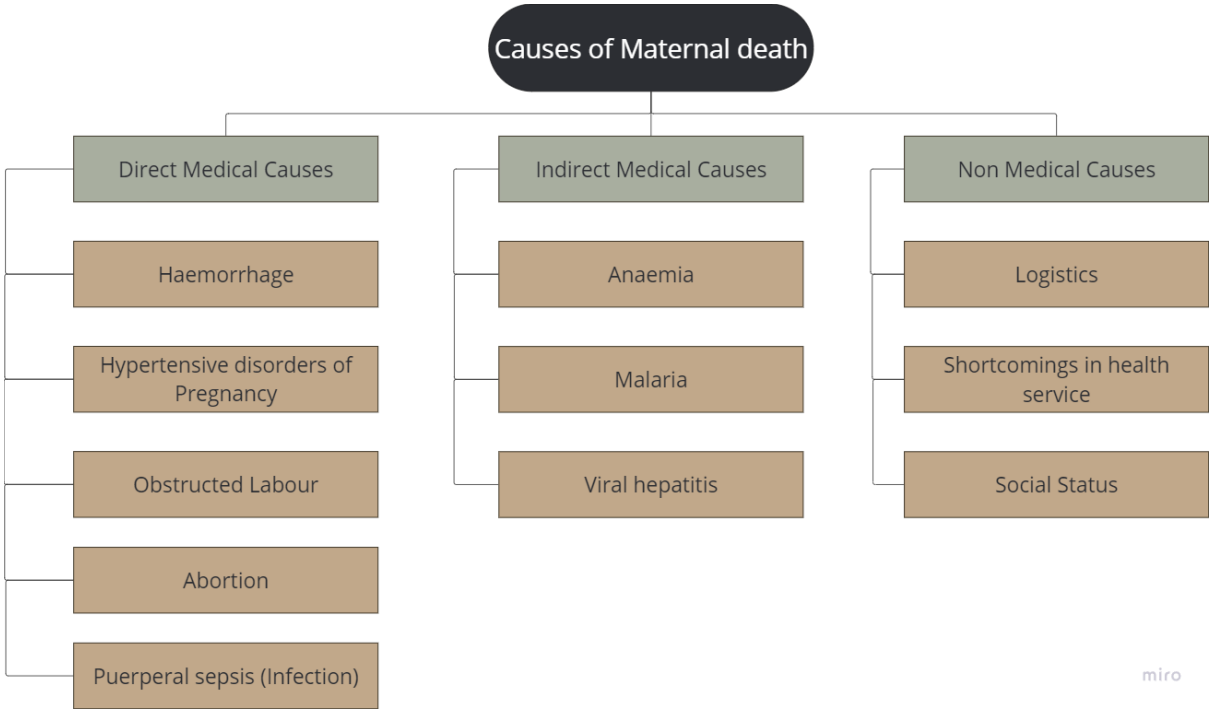


Figure 2. Summarized chart showing causes of Maternal death. Source: S, Sridhar, 2024

2.3 Understanding relationship between Birth Centre Design and the delivery

Studies show that architecture can impact the behaviours, comfort, and well-being of those who occupy spaces. Midwifery-led Birth centres are typically overseen by midwives. These facilities adhere to a care model emphasizing continuous support, natural birthing processes, and prioritization of women's needs, in contrast to a medicalized approach that views childbirth as inherently risky and women as patients requiring intervention (Walsh & Downe, 2004). Variations on birth centres exist, such as hospital-based centres, freestanding establishments apart from hospitals, and specialized birthing rooms inside hospitals. A midwifery-led birth space promotes support and safety for women in labour by emphasizing customized care, continuity, and empowerment throughout the birthing process. Midwives are trained in comprehensive, woman-centred care and develop trusting connections with women, providing emotional support and assuring informed decision-making. Midwifery-led care reduces unnecessary medical interventions while integrating physiological birth processes, resulting in safer and more enjoyable birth experiences. This model seeks to bridge the gap between emergency response and compassionate care by ensuring that women in crisis situations receive critical support and advocacy while maintaining their dignity and autonomy, fostering a culture of respect, compassion, and empowerment within maternity care services.

Research on birth environments is expanding, with an increasing recognition of the impact of the physical and ambient surroundings on maternal well-being and birth outcomes. The physical environment of a midwifery-led birth space is

purposefully designed to resemble a home, where labour and birth can occur in a calm and supportive atmosphere. A home-like setting prioritizes comfort and seclusion. This setting encourages the woman to decide where she would like to give birth and can include family involvement in the birth experience.

Studies have shown there is a link between the neurohormone oxytocin, which triggers and supports the birthing process, and the birth environment (Hammond et al., 2013). Birth Territory theory has suggested that the birthing environment is crucial for normal birth and that clinical settings can have a negative impact on birth processes and outcomes. Fahy, Foureur, and Hastie argued that the design of birthing environments can either support or impede natural physiological birth, which they believe is essential for improving the health and well-being of both mothers and infants (Fahy et al., 2008). The hormone oxytocin production can be stimulated by warm low lighting, sensual and sexual touch, ambient and physical sensations of warmth and softness, natural materials; view of nature, water, sky; calming music/ sounds and aromas (Uvnas-Moberg, 2011; Uvnäs-Moberg et al., 2015)Progression of labour may be delayed by hormones released when labouring in a crisis/stressful environment. This research aimed to design an environment that would reduce stress hormone release and promote labour.

The goals of midwifery-led birth units are to promote continuous care, provide uninterrupted birthing experiences, and prioritize woman-centred care over a medicalized approach. The midwifery-led birth units strive to provide holistic care that respects women's physiological and emotional requirements while also creating a supportive and empowering setting for labour. In essence, these midwifery approaches, based on hormonal research and centred on personalized, woman-

centred care, provide critical insights and key concepts for designing birth environments tailored to crisis settings, ensuring women's safety, support, and dignity in labour under challenging conditions.

For expectant mothers, having a supportive partner has been linked to lower levels of stress, anxiety, and perceived discomfort (McCarthy et al., 2021). For the objective of improving the birthing experience and encouraging favourable maternal outcomes, a partner's support is essential throughout labour. The birth supporters including midwives, partners, and attendee also have both practical and emotional needs that can contribute to a sense of calm and wellbeing (Harte et al., 2016). The woman in labour benefits from emotional support when she receives it in the form of verbal encouragement, physical touch, or active involvement in the birthing process (McCarthy et al., 2021). This assistance can create a more upbeat psychosocial atmosphere, which can benefit the mother's mental health during a delicate and trying time. Additionally, this personalized space can feel more familiar with a partner who is supportive and can serve as an advocate, facilitating collaborative decision-making and ensuring that the delivering mother and healthcare practitioners communicate well. It is consistent with the holistic approach to maternal care to acknowledge and prioritize the involvement of partners in the childbirth process, which ultimately contributes to a happier and more empowered experience.

2.4 Theoretical Frameworks

The key theoretical approaches underpinning this project are salutogenic theory and biophilic design theory. In seeking to ameliorate trauma for expectant

mothers in crisis settings, these models of understanding health and wellbeing are foundational, as they go beyond the physical and medical to include emotional and psychological wellbeing.

2.4.1 Salutogenic Design

Sociologist Aaron Antonovsky developed the theory of salutogenesis, which concentrates on the elements that enable people to feel more in control, meaningful, and coherent in their lives, in contrast to pathogenesis, which focuses on illness and medical intervention (Downe et al., 2020). Salutogenic design aims to create spaces that holistically contribute to people's health, resilience, and general quality of life, going beyond a focus on merely aesthetics and utility (Golembiewski, 2010). Key features of a salutogenic built environment include:

- Comprehensibility - referring to the clarity of information and communication, sense of control and user participation (Abdelaal & Soebarto, 2019).

- Manageability, involving social connection and support, facilitates the ease of interaction and navigation within the environment. Here, biophilic design incorporating organic features and natural elements fosters a connection with nature and is also promoted (Abdelaal & Soebarto, 2019).

Furthermore, Debra Singh and Mary Newburn conducted a survey among new mothers regarding the birthing environments they had experienced recently, revealing that women firmly believed that the setting

could influence the ease or difficulty of childbirth (Mary Newburn & Debbie Singh, 2005). Elements of the design, for example, whether there was space to walk, impacted outcomes of the birth process. Salutogenic design principle promoting physical activity almost seems like an ideal solution for the issues of birth environment design raised by many women.

- Meaningfulness, encompassing both personalization and vernacular inclusivity, creates a purposeful environment (Abdelaall & Soebarto, 2019).

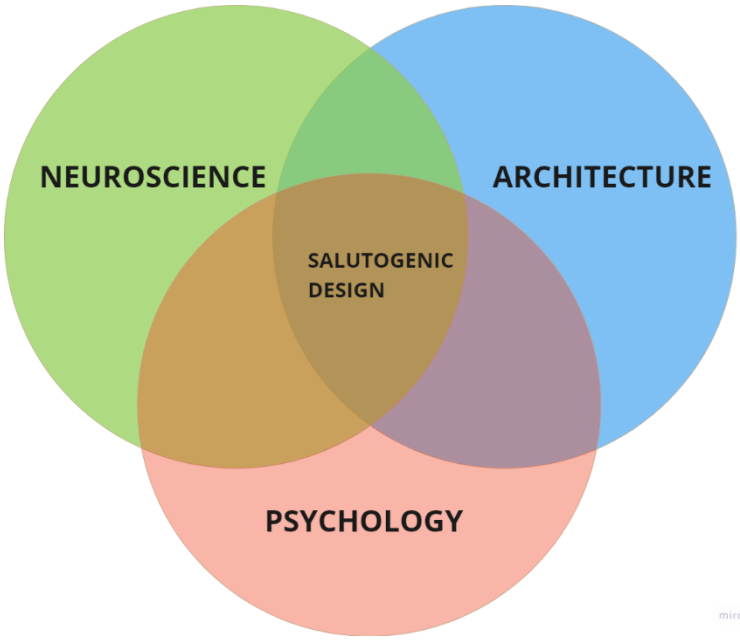


Figure 3. Triple Venn diagram of three theories - neuroscience, architecture, and psychology leading to an intersection of salutogenic design; Source: (S. Sridhar, 2024) based on (Brick, 2022)

A study conducted by Harte et al. highlighted that the aesthetics of the setting strongly correlated with occupants' perception of a "lack of control" over the

space, with supporters unable to modify the environment to foster a sense of belonging. The authors emphasized the importance of a space's ability to be personalized or made familiar in the development of design guidelines (Harte et al., 2016).

Exploring the salutogenic principles outlined above revealed the importance attributed to support systems throughout the perinatal phase.

2.4.2 Biophilic Design

biophilia, which I will be so bold as to define as the innate tendency to focus on life and lifelike processes

(E. O. Wilson, 1984)

The idea of biophilic design springs from the powerful conceptual coining of the term Biophilia. Architect Stephen Kellert collaborated with Wilson on the first substantial theoretical and practical discussion of biophilic architecture/design (Kellert, 2019). Based on the hypothesis that humanity has a fundamental connection with nature, biophilic design is understood as comprehensive and creative way to improve people's quality of life in built environments (Ryan & Browning, 2020). As Maurice Merleau-Ponty stated, factors like light, air, ambiance, sound, and scent profoundly influence how humans perceive a place. Our perception is deeply rooted in the connection between our mind and body with the

surrounding environment, including the presence of other inhabitants or factors (Merleau-Ponty & Landes, 2014). Using natural materials, adding living plants, maximizing natural light, and incorporating patterns and forms seen in the natural world are all examples of biophilic design strategies.

In biophilic design theory emphasis is on designing spaces that actively support enhanced cognitive function, less stress, better physical health, and mental wellness. (Huntsman & Bulaj, 2022). Additionally, biophilic design acknowledges the significance of natural processes and flowing patterns in nature, so it integrates spiral forms, biomimetic design approaches, and botanical themes and eschews sharp edges and lines (William Browning & Joseph Clancy, 2014). This design principle theory also highlights the use of vegetation, water features, and landscape views to enhance the multisensory experience, fostering calmness and lowering tension (William Browning & Joseph Clancy, 2014). Location-based approaches to design are also emphasized, as they pay homage to the essence of a physical geographic location while considering historical and cultural contexts that are tied to a range of emotions, from curiosity and enticement to security and protection. Integrating biophilic design principles into birthing environments is essential for fostering a connection with nature, promoting relaxation, and creating a supportive and healing atmosphere for expectant mothers.

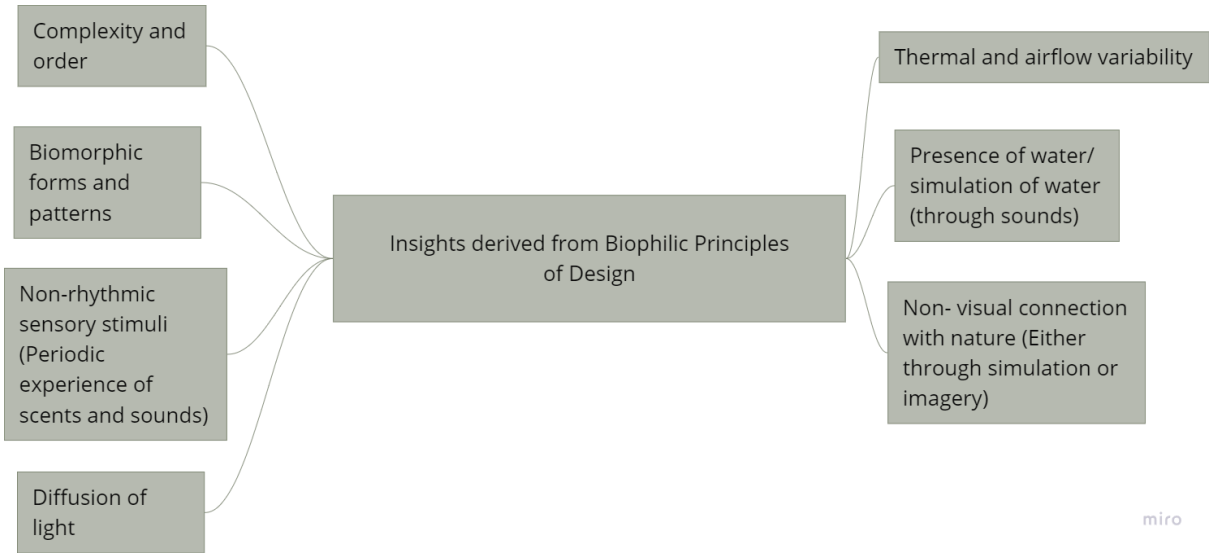


Figure 4. Insights derived from Biophilic Principles of Design; Source: (S. Sridhar, 2024)

Chapter 3: Methodologies and Methods

Research through DESIGN through research

(J. Wolfgang, 2006)

Chapter 3 presents the methodologies and the theoretical design processes employed in developing the thesis research. It encompasses the conceptual and development phases as well as the key features of the prototypes. Further, the research uses a multidisciplinary approach to investigate theories of biophilic and salutogenic design. Some of the multidisciplinary methods of research included consulting experts from other disciplines. For example, through workshop with other artists, I developed insight into the use of diverse materials, including hands-on experimentation at the studio of artist Ron Wild. Under his supervision, I was able to learn how to bend, join, cut, and make models using Aluminium Composite Panels. This interaction fostered the exchange of ideas, methodologies, and different perspectives on eco-friendly materials such as ACP Panels and how to re-purpose them. The following section describes the methodology and methods used in this project.

3.1 Methodology

The study utilized a design thinking model as a methodological framework to support the creation and refining of birthing centres adapted to crisis situations. This approach entailed empathizing with the needs and experiences of women in labour in these contexts, defining the challenges and requirements of maternal care in crisis settings, developing innovative solutions, prototyping birthing centre designs, and testing their efficacy in real-world scenarios. Using design thinking concepts, the study aimed to construct responsive and adaptive birthing environments that promotes safety, support, and dignity for women giving birth in crisis situations.

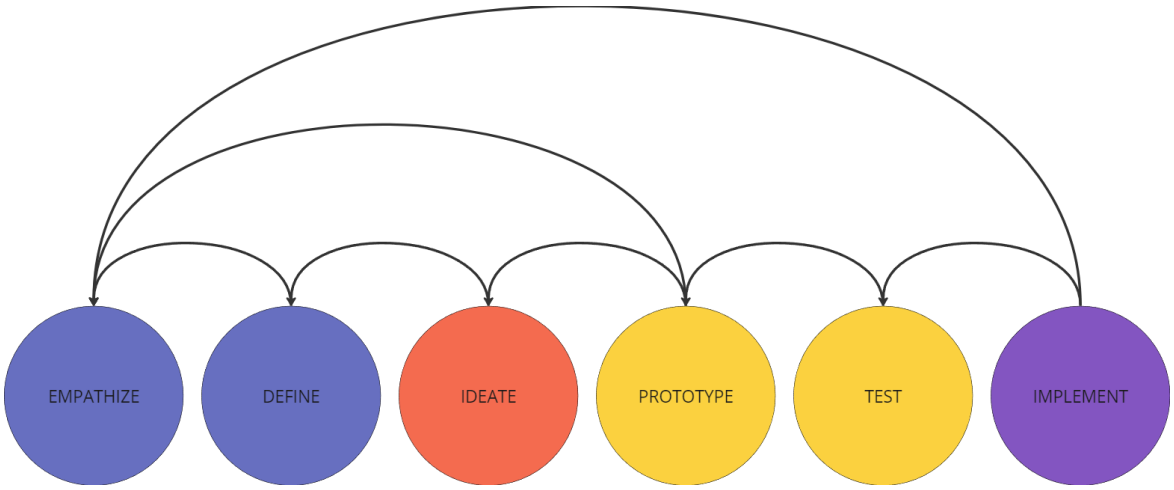


Figure 5. Design thinking model; Source: (S. Sridhar, 2024) based on Standford University model (*The Design Thinking Process*, 2019)

3.2 Methods

Methods used included: Creating a data board, sketching, material study, prototyping, visualization and conceptualization, 3-D modelling, rendering and SWOT analysis used for foundational research, creation, and analysis.

3.2.1 Creating a data board

Use of a Miro Board aided in identifying and analysing collected data. Figure 5 and Figure 6 are screen captures of the process of data collection and analysis conducted on the Miro software online.

This stage of the process was defined by a systematic approach aimed at achieving clear objectives and milestones. It involved planning, implementation, and evaluation to ensure the project's effectiveness.

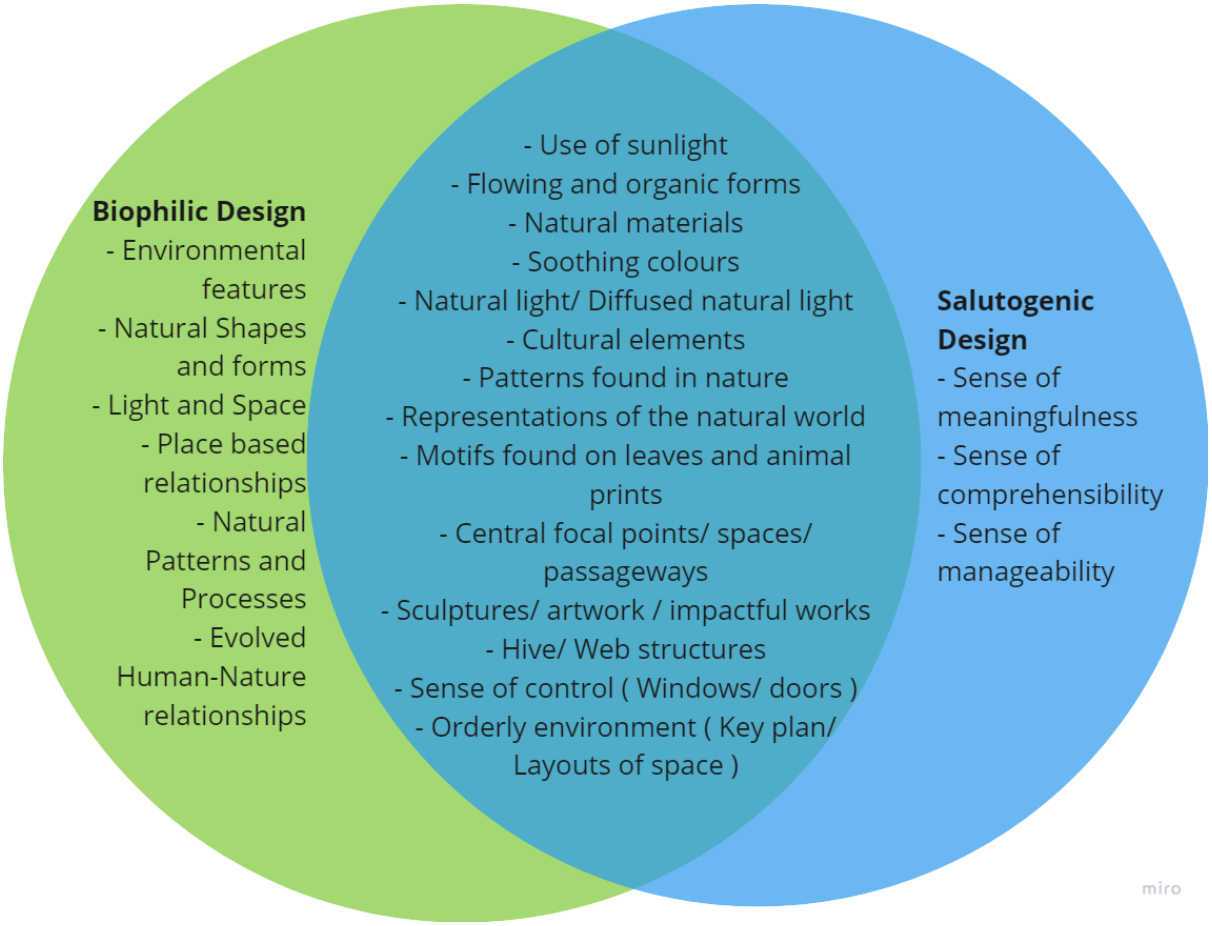


Figure 5. Common features of biophilic design and salutogenic design; Source: S. (Sridhar, 2024)

Through the process of identifying common elements between biophilic design principles and salutogenic design, the following insights were identified:

- Emphasis on holistic health: considering physical, mental, and social well-being is crucial to the design process.

- Recognizing the value of suitable surroundings is an important feature in supporting over-all good health.

- The utilization of natural features such as natural light, views of nature, and access to green spaces can enhance the overall ambiance and psychological nature of the user.

- Biophilic features, such as the use of natural materials and textures, assist in decreasing tension and relaxation.

- It is important to create settings that provide a sense of protection and security, especially in designing for birth-environments, as it encourages emotional well-being.

- Integration of variables that promote physical activity and movement in the surroundings should be taken into consideration.

- Consider cultural and individual preferences to create inclusivity, and a sense of belonging must be a priority in designing for women.

- Use of sustainable design principles should be promoted to reduce environmental impacts while promoting long-term health and well-being.

The "Overlapping key features" of biogenic and salutogenic design facilitates an understanding of the project's design elements. By categorizing the salutogenic principles and biophilic design characteristics, it became apparent how each facet contributed to the broader goal of creating a supportive and nurturing atmosphere

for women in labour. This organization led to effective design decisions and ensured that all relevant variables were considered when developing birthing pods. Below is the list that was generated defining the user needs.

In the context of crisis settings, understanding the diverse array of challenges becomes imperative as it allows for a focused approach to design solutions. In this research, design was focused on regions of high maternal mortality rate prevalent in Sub-Saharan Africa (Abou Zahr & Royston, 1991), western Rajasthan in India (Nour, 2011), and Gaza. These locations were specifically identified due to the ongoing crisis and similarity in climate. The climate in each region was characterised by hot summers and mild wet winters. This insight served as the cornerstone of the design. Climate informed considerations such as adequate ventilation to mitigate the effects of heat, rather than emphasizing heat insulation. Additionally, the need for waterproof features was acknowledged, albeit not prioritised over other issues such as addressing visual barriers, access to essential resources, flexibility, and modularity of the design. Through the design research, desired elements as well as those that would not be addressed in this research project were identified. Thus features such as, ability to float above water during floods (*Siem Reap's Floating Villages - How to Visit Tonle Sap Responsibly*, 2022) and intensive anchorage to the ground in the case of earthquakes, etc. were not addressed, although they laid the groundwork for further exploration and refinement. Ultimately, an analysis of the challenges faced by new mothers during crises emphasized the necessity of coming up with solutions that prioritize the needs of the mother. Insights derived from biophilic principles of design included the use of biomorphic forms and patterns, non-rhythmic sensory stimuli, i.e., the experience of scents and sounds, the diffusion of light, thermal and airflow variability, the simulation of water, and a non-visual connection with nature.

Salutogenic principles of comprehensibility, through means of creating a legible environment, social cohesion, encouragement of physical activity, and enhancing the sense of significance of the spaces designed,

Research on salutogenic and biophilic design is important for addressing the complex needs of women in labour in crisis zones by providing insights into creating environments that promote psychological well-being, reduce stress, and enhance the sense of connection to nature, thus contributing to safer and more supportive childbirth experiences.

Drawing insights from literature review helped generated the user needs as follows:

- Emergency preparedness: Rapid response; Facilities for emergency deliveries
- Safe and Sterile Environments: Clean and sterile surroundings; Sanitation facilities
- Infrastructure Resilience: Design for disaster resilience; Safe and stable structures
- Communication and Transportation: Reliable communication systems; Accessible shelters
- Postpartum care
- Community Education: Education program for expectant mothers and raising awareness for mental health needs post disasters.
- Psychosocial support: Emotional support during and after childbirth
- Cultural Inclusivity: Understanding and respecting cultural practises and accommodating cultural preferences.

Here, defining user needs helped determine the requirements of this project. This method is intended for identifying the design goals.

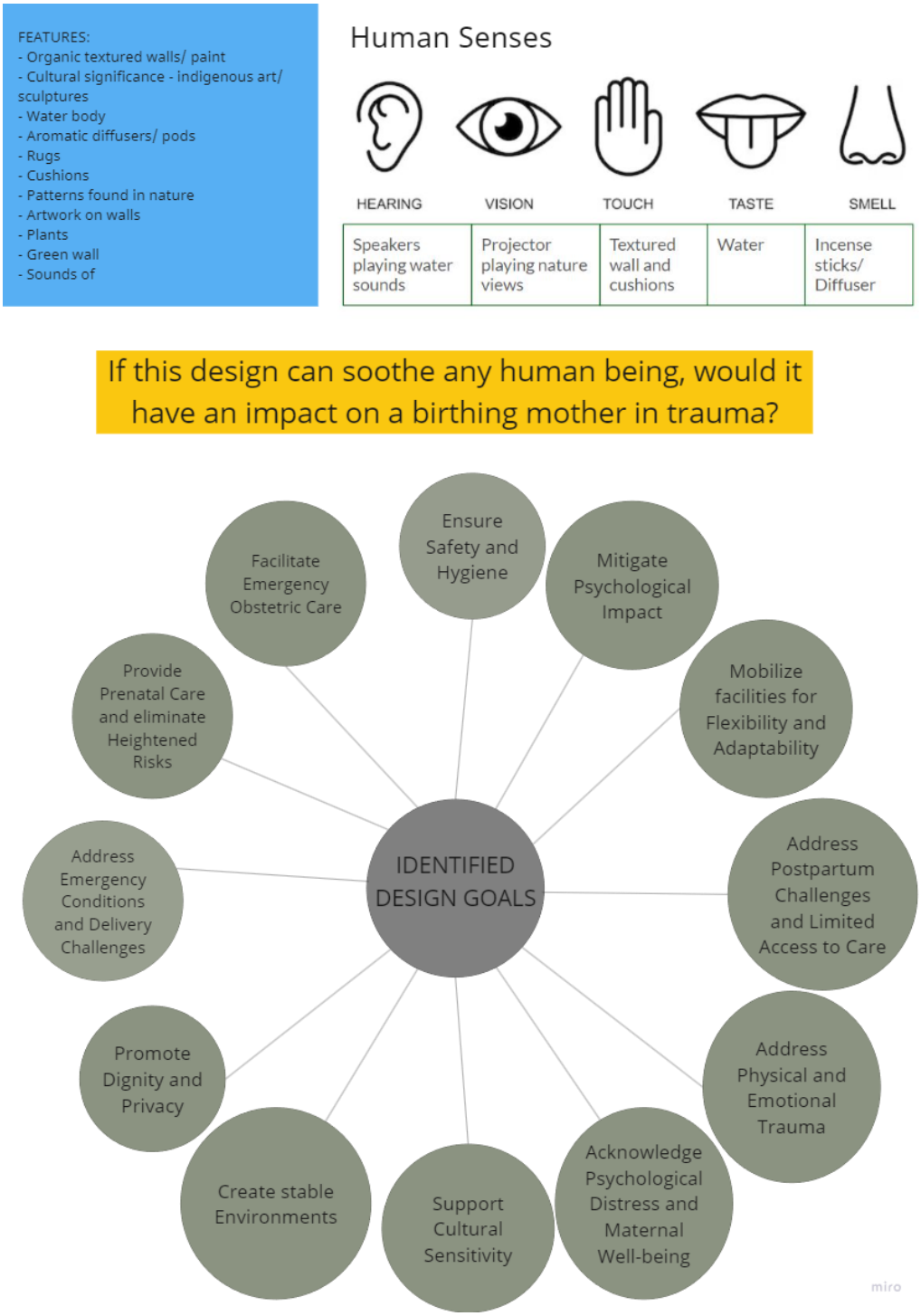


Figure 6. Defining the user needs and identifying design goals; Source: (S. Sridhar, 2024)

3.2.2 Sketching

While analysing the data collected, sketches and conceptualization were also incorporated into the design process. Figure 7 shows images of initial sketches and concepts.

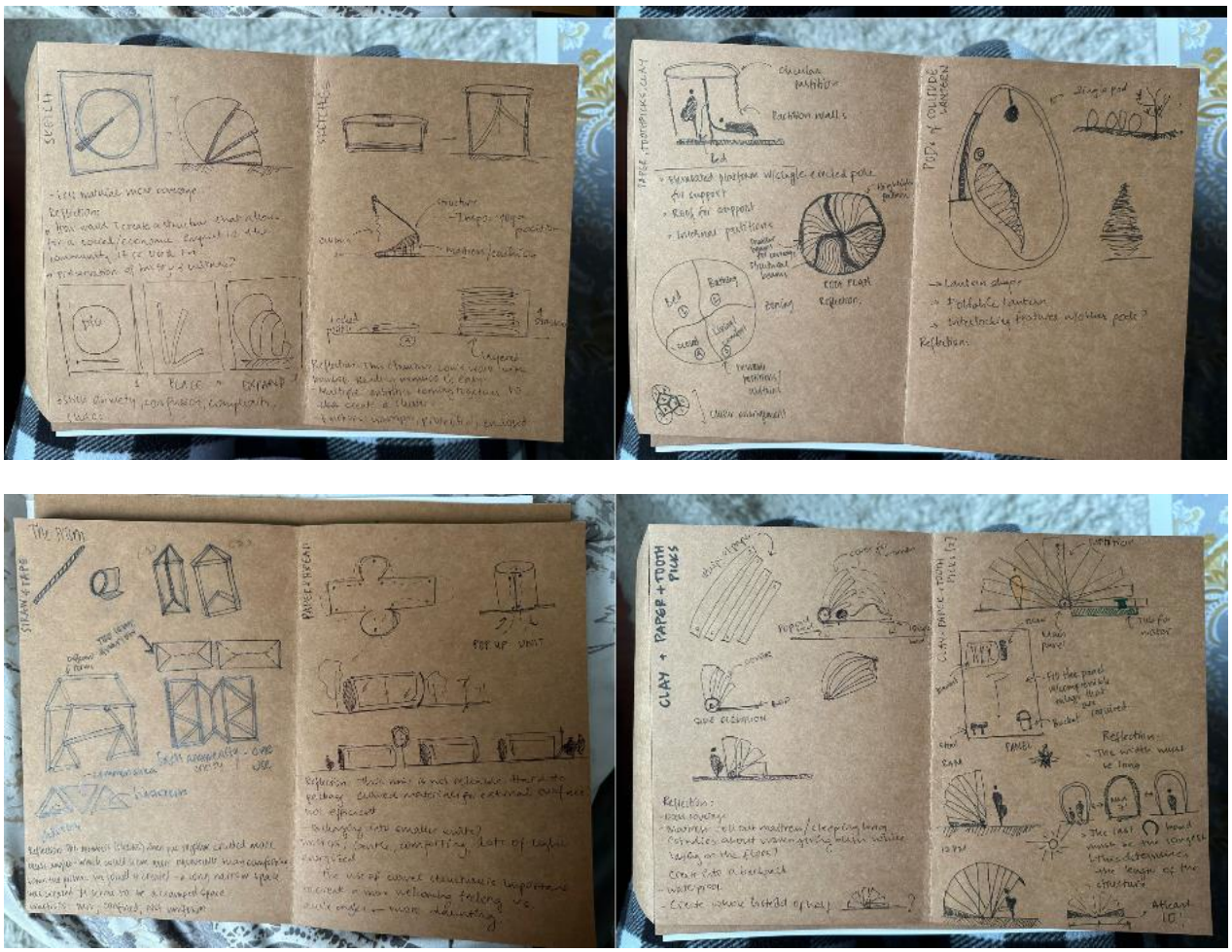


Figure 7. Collection of sketches; Source: S. Sridhar, 2024

3.2.3 Material Study

An exploration into eco-friendly and sustainable materials was undertaken. After rejecting materials such as bamboo, cork, recycled polyester, hemp, and

canvas due to limitations of the project such as limited availability and expensive costs of purchase, I stumbled upon aluminium composite panels. Aluminium Composite Panels (ACP) are 3mm sheets of plastic layered between aluminium sheets.

Advantages and Disadvantages of ACP

The birth centre's intended design was effectively realized through the use of aluminium composite panels, resulting in a small yet sturdy prototype that highlighted the material's structural stability and adaptability. A model was created of an organic shape and form and measured sixteen inches in width and twenty-four inches in height.

Aluminium composite panel sheets, which were initially four feet in width and eight feet in length, were recycled from an advertisement billboard and used to create prototypes for the birthing centre. The ACP was selected to demonstrate the project's dedication to sustainability and reuse of a material that was primarily objectified as a single use plastic derivative. Choosing this lightweight material helped achieve the goal of reducing the amount of waste that ends up in landfills. Furthermore, the panels' fire resistance is useful in areas that are prone to disasters or are currently experiencing ongoing crises. In order to minimize environmental effects, Aluminium Composite Panels (ACPs) must be disposed of responsibly. This involves separating the aluminium sheets from the polyethylene core to enable recycling. Recycling the polyethylene core presents difficulties, including a requirement of about a thousand years to decompose when put in a landfill (*Where Does Plastic Waste Go?*, 2023). In addition, the rise in plastic manufacturing over the past 60 years, even with controlled recycling procedures, emphasizes the critical need for

more widespread changes toward sustainable behaviours and a decrease in the usage of single-use plastics (*A Whopping 91 Percent of Plastic Isn't Recycled,*). Attached below are images of alterations to an ACP panel, and prototypes made from it.

Figure 8. Typology prototypes; Source: (S. Sridhar, 2024)

3.2.4 Prototyping

Simultaneously, while exploring the material of aluminium composite panel sheets, other forms were developed as massing models to help conceptualize the birthing unit. Prototypes were developed with different materials, including straws, clay, cardboard, paper, and metal. Attached below are different prototypes and forms.

Figure 9. Primary prototype made with straws and tape; Source: (S. Sridhar, 2024)

Figure 10. Prototype made with paper, clay and a toothpick; Source: (S. Sridhar, 2024)

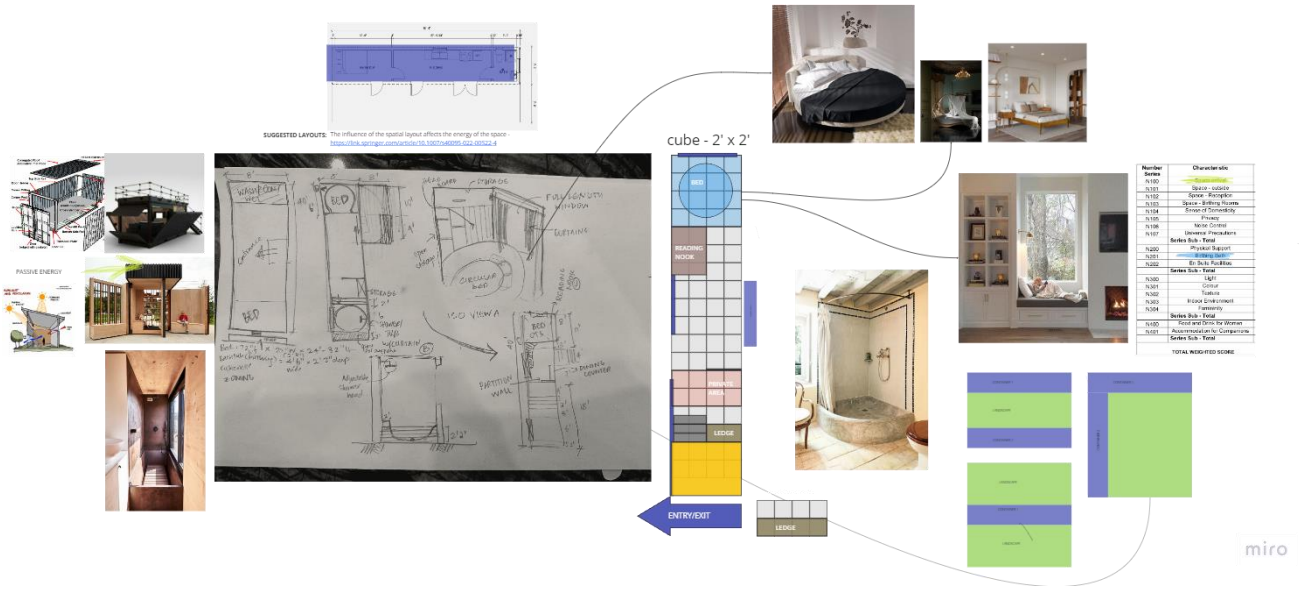


Figure 11. Exploration into shipment containers; Source: (S. Sridhar, 2024)

A study was also undertaken on using shipment containers as prospective birthing units, but difficulties were soon discovered. The containers' hard structure caused issues accommodating the intended fluidic design. Furthermore, practical concerns about transportability and adaptability in crisis situations contributed to the rejection of this idea. These concerns include transportation and adaption barriers for shipping containers, generally caused by construction limitations, logistical obstacles, and regulatory restraints. Shipping containers are structurally designed for freight transit rather than human habitation, therefore adaptations such as insulation, ventilation, and plumbing may be required. Furthermore, the size and weight of containers can make transportation difficult, necessitating the use of specialized equipment and infrastructure for loading, unloading, and transport via land, sea, or air. Furthermore, regulatory constraints, such as building standards and zoning restrictions, can change throughout regions, complicating the approval and deployment of container-based structures in multiple locations. These constraints highlight the necessity for careful planning, engineering skill, and regulatory

compliance to ensure the successful adaption and transportability of shipping containers for various uses, such as healthcare facilities (Islam et al., 2016).

Through this process of trying to veer away from linear forms and use of ACP panel sheets, an organic and free-flowing form developed that resembled one of an armadillo shell.

3.2.5 Visualization and Conceptualization

The genesis of the design is a fusion of salutogenic and biophilic design principles, inspired by the structure and movement of an armadillo. This process of fusion aims to create connections between humans and the natural world through their built surroundings. The armadillo's remarkable capacity to change from a closed, protective form to an open, expansive one is a clear example of biophilic design in action. This form was identified through the making process, and attached below are images of the structure created using the ACP panels.

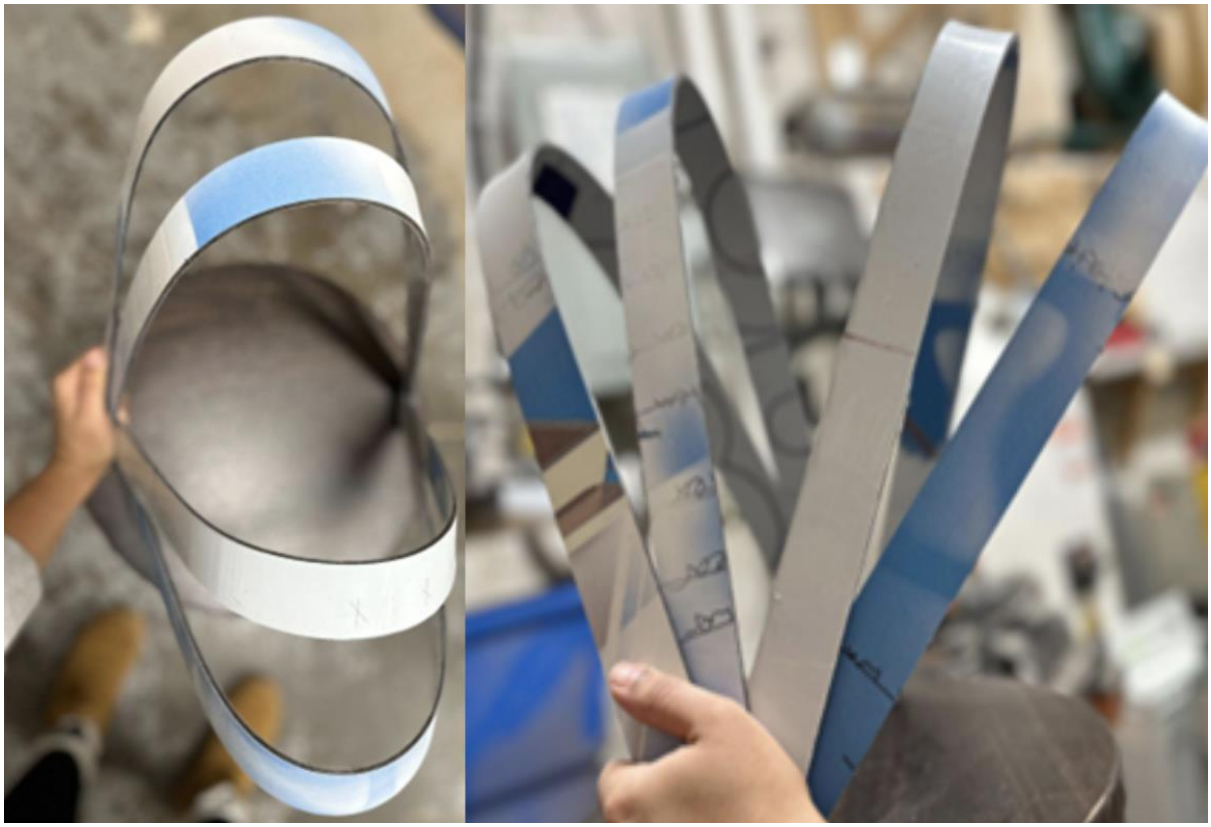


Figure 12. ACP prototype; Source: (S. Sridhar, 2024)

The design mimics the armadillo's segmented shell, which offers protection and flexibility. This allows the structure to change from a small static environment to a large, living one. The concept of a robust armour-like structure with the flexibility to curl up and fold intrigued me. This fascination became the catalyst for delving into the exploration of potential folding and retracting structures.

Figure 13. Transformation of the Armadillo; Source: (*Armadillo Tecture Images – Browse 0 Stock Photos, Vectors, and Video*, 2024)

These preliminary forms were then categorized into three fundamental parts: the head, body, and tail. Each segment played a pivotal role in the functional articulation of the birthing pod.

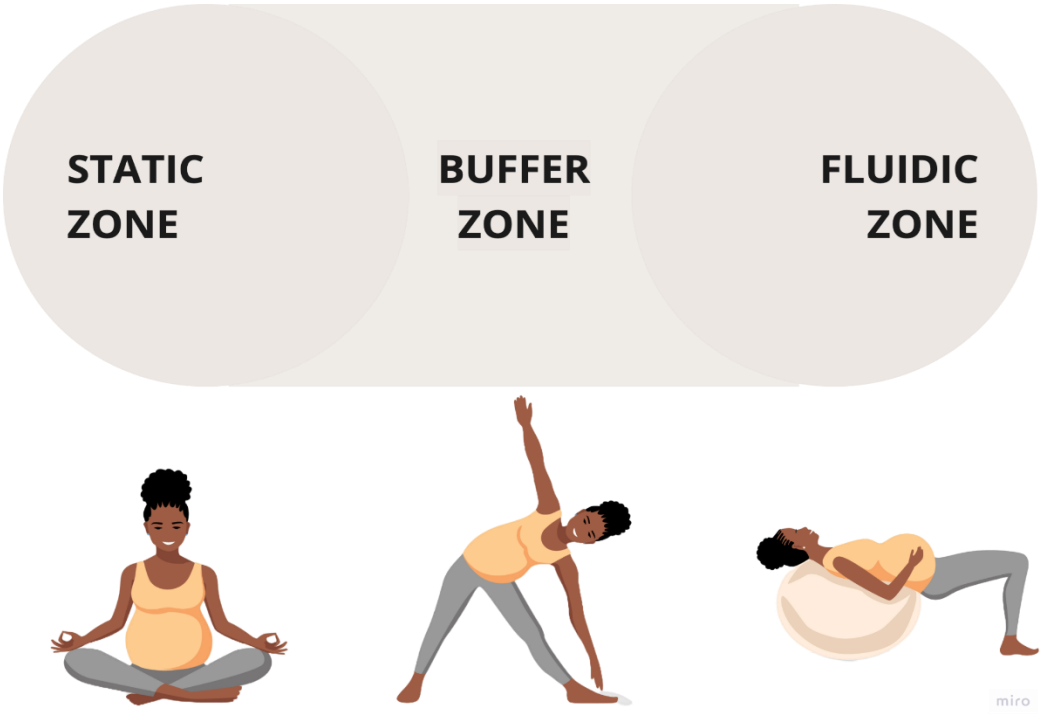


Figure 14. Zoning of the pod; Source: S. Sridhar, 2024 created using Adobe Stock Vectors (Adobe Vector *Texture Images – Browse 1 Stock Photos, Vectors, and Video*, 2023)

The Head

The head, envisioned as a sanctuary for the birthing mother, not only serves as a sleeping area but can also incorporate a curtain or partition to provide a cocoon of privacy. The armadillo head reflects the concept of sanctuary because of its distinct design elements that convey emotions of safety, security, and protection. The armadillo's inherent defence mechanism, its armoured shell, represents strength and tenacity, creating a sense of safety and sanctuary within the birthing unit. Furthermore, the rounded and enclosed shape of the armadillo head creates a comfortable and personal chamber, similar to a nurturing womb or cave-

like environment, in which birthing mothers might feel sheltered and supported during the delicate and transformative experience of childbirth. The head of the pod is designed as an enclosed space void of direct sunlight promotes intimacy and hence a more warm and comforting enclosure for the birthing mother. This is consistent with concepts articulated in Birth Territory theory (Fahy, K., Foureur, M., & Hastie, C., 2008) and Balabanoff's thesis about embodied experience and use of light and colour in birth spaces (Balabanoff, 2017).

The Body

Moving to the body, this central region of the pod could function as a dynamic buffer zone. Its versatility allowed for the creation of an open pathway between two pods, facilitating both circulation and ventilation. Recognizing the importance of mobility during labour, this zone was intentionally designed to accommodate the birthing mother's movement, ensuring a conducive environment for physical activity, stretching, exercising, and an over-all healthy childbirth experience.

The Tail

The tail region was designed as a multifunctional space. Beyond providing room for stretching and reading, it was crafted to offer seating for both family and the midwife. In contrast to the head, the birthing unit's tail envisions a versatile setting. This contrast stems from the lack of a raised sleeping area, which is distinctive of the head region. Furthermore, the tail area lacks heavy furniture, giving mothers plenty of space to move around easily. Unlike the head, which is primarily intended for rest and sleep, the tail emphasizes activity, similar to an armadillo's tail, which

allows the animal to be more mobile in nature. Thus, the tail came to represent the concept of fluidity and adaptability, providing a diverse environment that could accommodate a variety of activities while also allowing birthing women to move freely.

3.2.6 3-D Modelling and Rendering

In the next stage, preliminary massing models of the mobile birthing unit were created on SketchUp and there were further refined using the same software. The model was then rendered with Lumion, Enscape, and Photoshop to make it appear lifelike. By depicting the birthing pod in a range of contexts, the pods' potential utility and functionality were showcases.

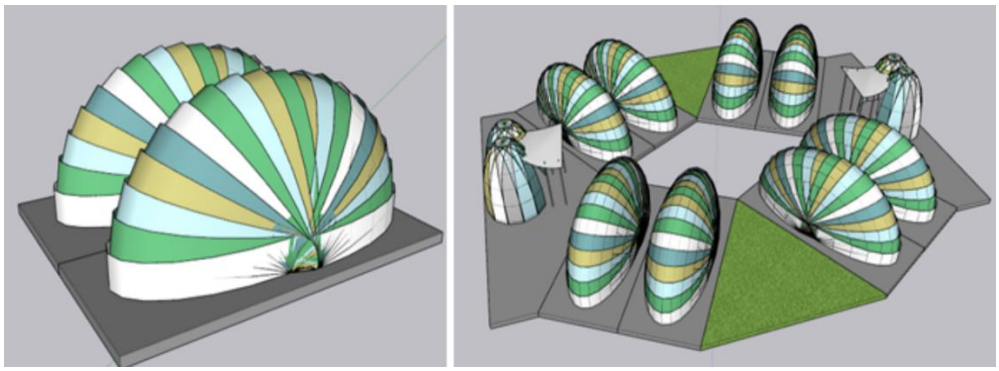


Figure 15. Sketchup model of armadillo conceptual pod; Source: S. Sridhar, 2024

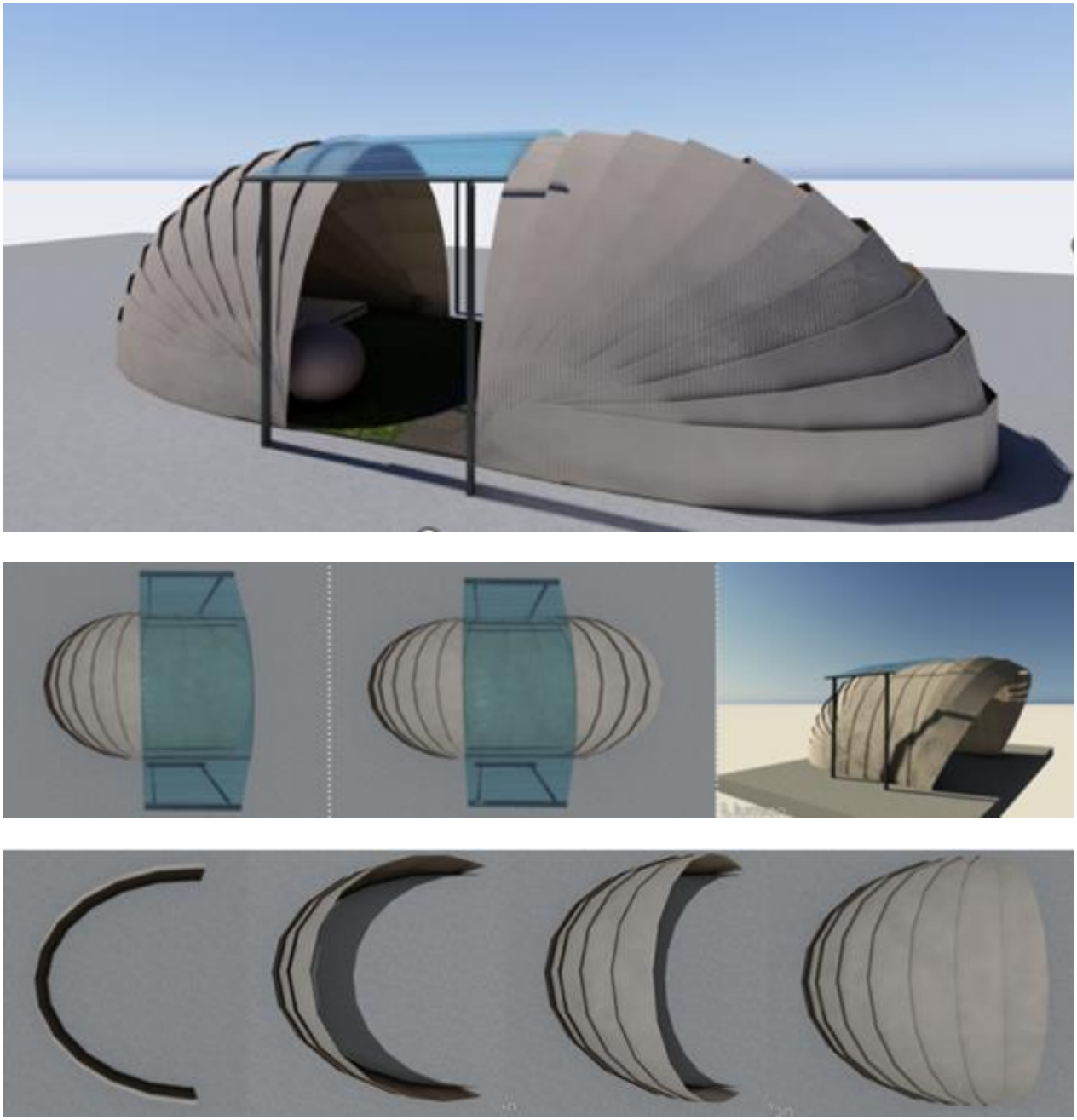
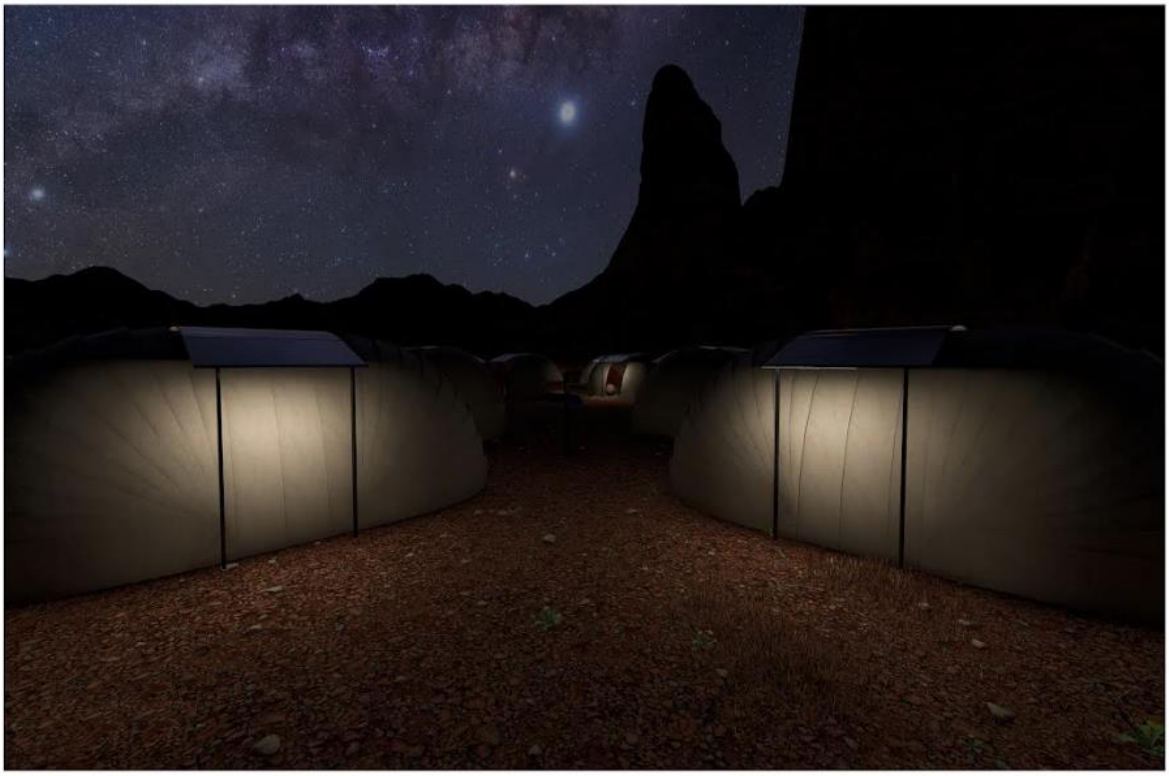


Figure 16. Development of armadillo pod; Source: (S. Sridhar, 2024)

Group of Armadillo Pods
Desert Community



Armadillo Pods at night
Desert Community

Figure 17. Renders of armadillo pods; Source: (S. Sridhar, 2024)

Closed Birthing Pod
Desert Community

Open Birthing Pod
Desert Community

Figure 18. Renders of armadillo pods; Source: (S. Sridhar, 2024)

Chapter 4: The Pod Design

Design creates culture. Culture shapes values. Values determine the future.

(R. L Peters, 1993)

Chapter 4 covers the features of the design module, also known as The Armadillo Pod.

4.1 Design Goals

Through the process of identifying the design goals, the specific objectives and key challenges were identified. These goals that were attained are categorized into three types of solutions:

1. Physical manifestation of the birth shelter
2. Psychological and emotional impact
3. Providing respect, privacy, and cultural sensitivity.

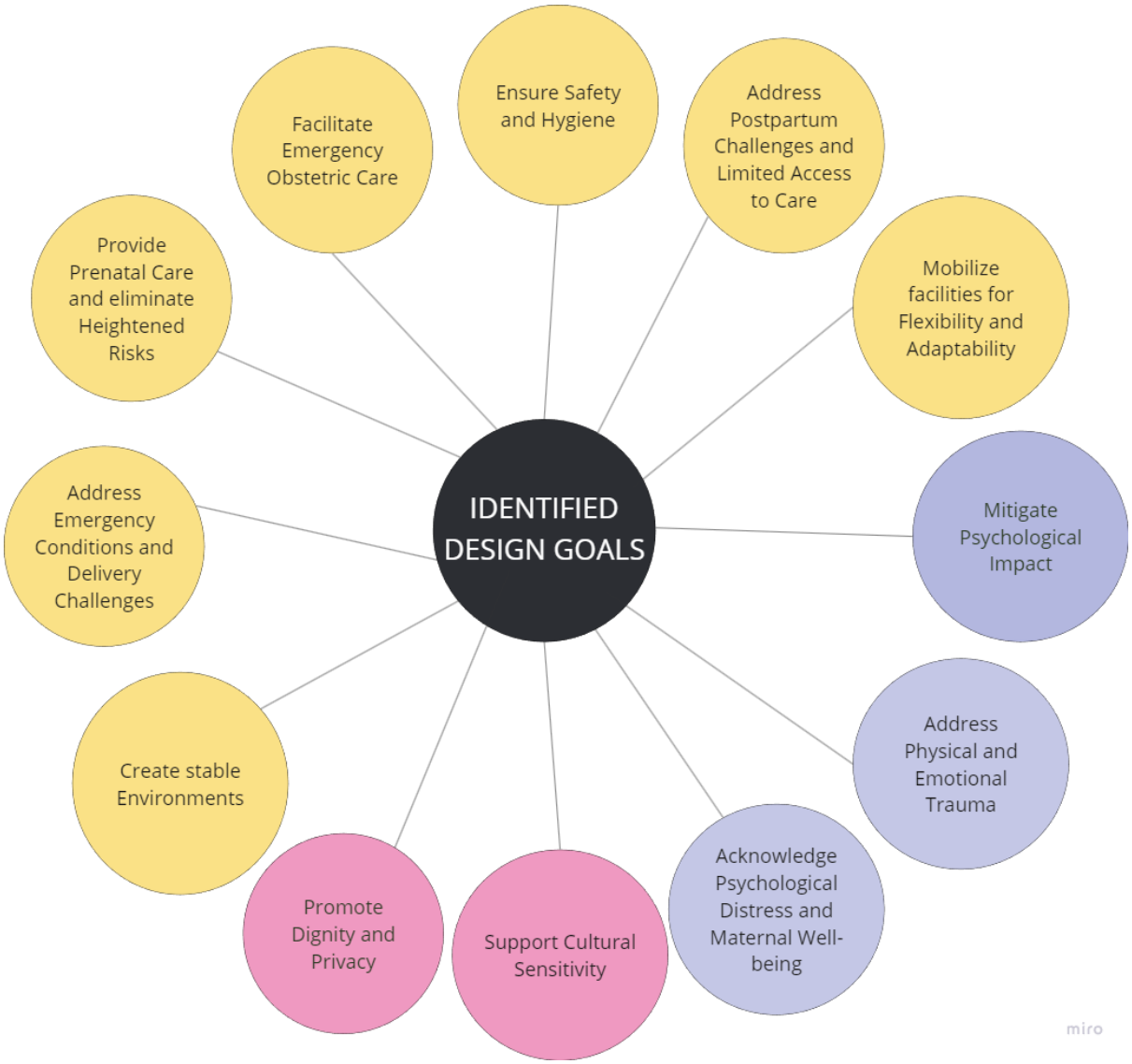


Figure 19. Identified Design goals; Source: (S. Sridhar, 2024)

The following section describes the goals achieved.

4.2 Birthing Shelter

Women giving birth, especially those with high-risk pregnancies, are more susceptible to complications that could have been avoided in stable circumstances if they received normal treatment before and during labour. Hence, importance must be given to providing a physical space that can serve prenatal care as well as perinatal needs, and the introduction of the perinatal pods allowed for the same. The prenatal pods allow the birthing mother to occupy the space as early as four months into labour. These pods also have hooks to hang a pregnancy sling; this product allows the mother to stretch in various comfortable positions. The prenatal pods also come with a blow-up pregnancy ball, also known as a birthing ball, that can be used for various exercises and movements to alleviate discomfort, improve posture, and promote relaxation. Additionally, during labour, bouncing or rocking on a pregnancy ball helps ease labour pains. These pods also come with a foldable sink, which is extremely helpful if the mother is nauseous, and an adjustable desk that can change height levels based on a mother/ midwife's comfort or requirements. Under the supervision of midwives well before the onset of labour, potential risks are minimized as expectant mothers receive attentive care and monitoring, diminishing the likelihood of complications.

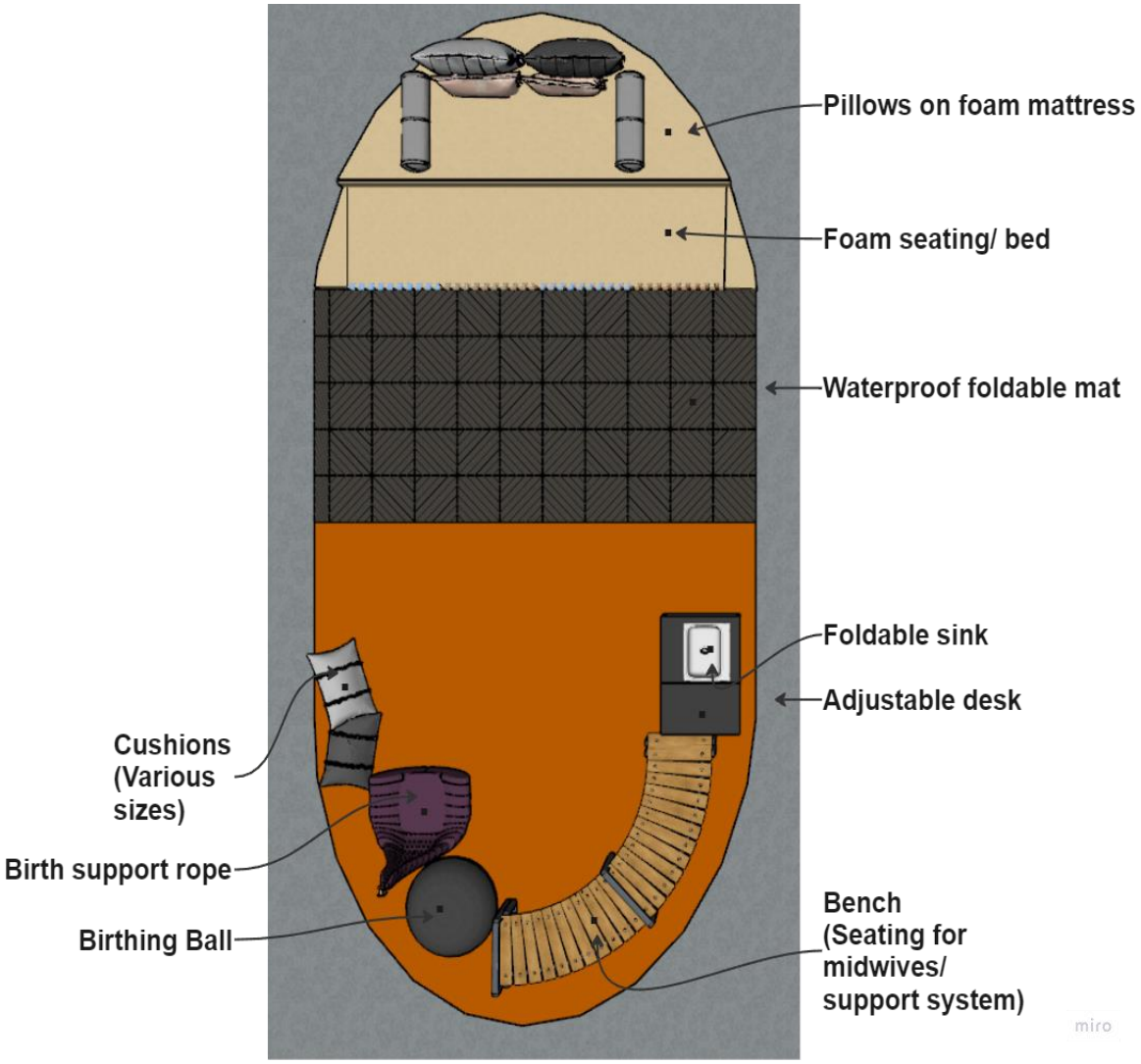


Figure 20. Plan of Birthing Pod; Source: (S. Sridhar, 2024)

In crisis settings, the physical safety and well-being of the mother and the baby are compromised, which also raises stress and anxiety levels. Emergency conditions and birthing challenges are another key consideration in design and can be solved by the ease of transport, packaging, and assembly. The transportation and packaging of the birth pods are designed for maximum efficiency and ease of assembly on-site. All components can be disassembled and packed into a single

entity, making transportation straightforward. The flat panels, each one foot in width and sixteen feet in length, are a key component. These long panels, designed to be manually bent on-site, are joined together using a joining piece included in the packed entity. The unit also contains panelled foam cut to precise dimensions, which can be easily assembled with a lock and key mechanism. Each packaged unit includes an emergency essentials kit and, specifically for birth pods, a birth sling and an inflatable birth ball. Similar to *Ikea* products, the foldout sink, storage, and bench are part of the package and come with simple pictographic instructions for assembly. This compact entity is suitable for transport in a shipment truck, and further research will determine the optimal number of units that can fit into a truck of specific dimensions. The lightweight and portable nature of these units also allows for dispersal to various parts of the world via air and water. These pods, assembled swiftly within a timeframe of no more than six hours, serve as a rapid response solution to emergency situations and birthing obstacles, ensuring prompt care for birthing mothers.

4.2.1 Community Support for Postpartum Needs

The postpartum period, which is already a dangerous time for women and infants, becomes more difficult in these settings (Harville et al., 2021). Postpartum challenges are approached with the creation of a community and the placement of recreational pods that encourage social cohesion. Postpartum difficulties often involve the emergence of depression in many women. By introducing recreational pods, new mothers gain a reprieve from the demands of infant care. These pods

serve as communal spaces where women can convene, engage in conversations, pursue artistic activities, and unwind. While the pods prioritize privacy, they are clustered together to foster community building. Through the research conducted, it was found that communities foster a deep sense of belonging, cultivate supportive social circles, empower individuals, and lay the groundwork for collaborative problem-solving (Kornelsen et al., 2011). Hence, laying the pods as a community instead of isolated units and the integration of recreational pods serves as an active solution for postpartum challenges.

4.2.2 Displacement

Creating a design activating a community addressed the objective of having an unstable environment. By providing a vital support system during times of crisis, immense relief through the inherent idea of mutual assistance is offered. It provides emotional support and solidarity, allowing individuals to share their burdens and experiences with those who understand and empathise. Communities also form a pool of resources and knowledge, enabling more effective problem-solving and resilience-building efforts. Overall, being in a community during crises promotes collective strength in navigating adversity (Weisman, 2005).

4.2.3 Ensuring Safety and Hygiene

Disasters frequently jeopardize the cleanliness and safety of birthing environments. The provision of having separate restrooms and surgical pods for emergencies, both situated away from the living pods, plays a crucial role in

ensuring safety and hygiene within the communal living setup. By placing the restrooms separately, potential sources of contamination and the spread of infections are minimized, thereby reducing the risk of illness among residents. Further research is to be conducted to identify the correct layout of plumbing lines, which can vary based on the pattern of pod spatial layouts. Maintaining hygiene in disaster zones is difficult since restrooms are frequently unavailable. While toilets are essential for maintaining cleanliness, the usefulness of separate toilets in increasing overall hygiene varies. Separate toilets may improve cleanliness by providing designated waste disposal areas, lowering the chance of contamination and disease transmission. However, its impact is determined by elements such as accessibility, maintenance, and user behaviour. Inadequate accessibility or upkeep, as well as cultural norms surrounding toilet use, can reduce its effectiveness. While separate toilets can help to enhance hygiene, complete measures that address accessibility, maintenance, education on correct sanitation practices, and cultural concerns are critical for boosting hygiene and sanitation in disaster areas.

Having dedicated restrooms enhances privacy and promotes personal hygiene practices among individuals, fostering an overall healthier environment.

4.2.4 Flexibility for Adaptability

The unpredictable nature of crisis scenarios emphasizes the importance of developing birthing pods that are mobile, adaptable, and easy to deploy. These pods, as described above, are mobile and enable swift transfer in response to emerging emergency circumstances or changing needs on the ground. Flexibility in design guarantees that the pods can adapt to changing environmental conditions

and space limits, making them appropriate for deployment in a variety of crisis scenarios. The figure below shows the flexibility of the pods, which can be utilised for various activities.

Furthermore, the pods have a simple set-up system of just bending and attaching to a joinery piece, to be further researched and detailed, allowing rapid assembly and deployment by minimally skilled workers under demanding conditions. By reflecting these characteristics, birthing pods can effectively satisfy the urgent demand for secure and functional birthing facilities in disaster-affected areas, offering critical support to pregnant mothers and healthcare providers in the face of unpredictable and constantly changing conditions.

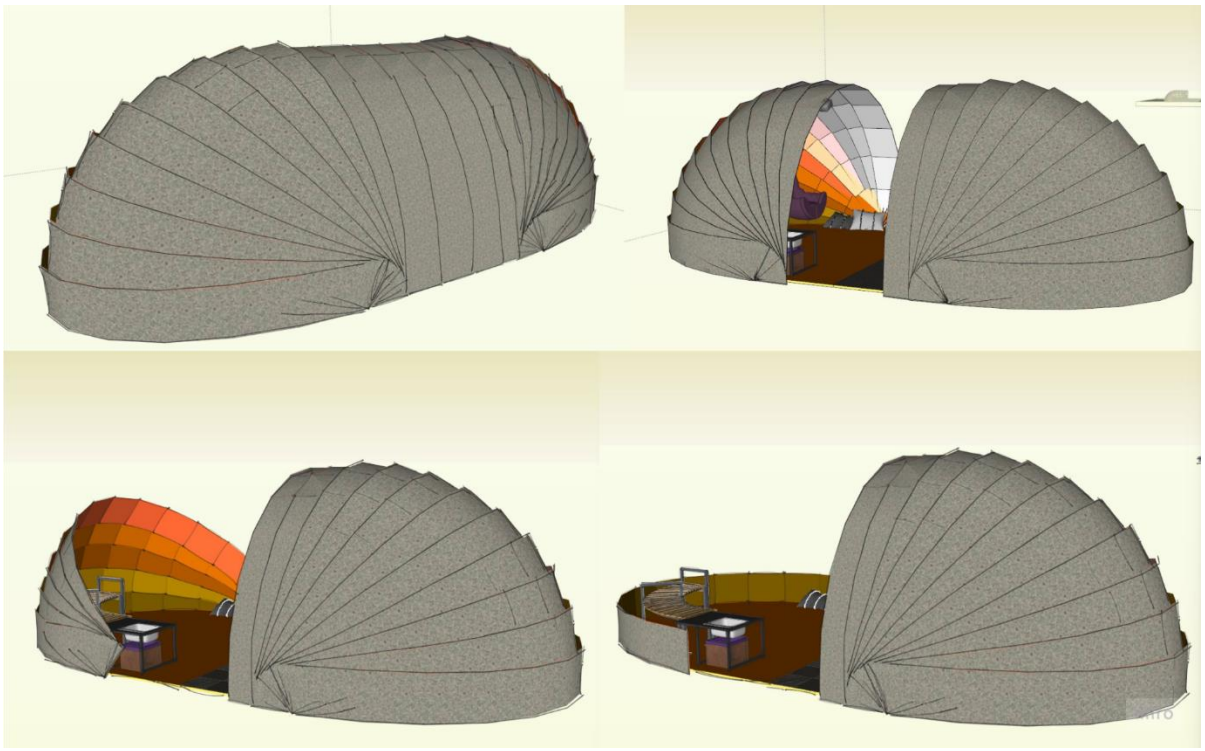


Figure 21. Flexibility of pods; Source: (S. Sridhar, 2024)

4.3 Psychological and Emotional Significance

Designers have started looking at how spaces make us feel, considering how our surroundings affect both our minds and bodies (Böhme & Thibaud, 2016). When designing birthing surroundings, women's psychological health is important. Birth units can be designed to reduce tension and anxiety and improve feelings of well-being and a sense of control. Components that offer privacy, comfort, and familiarity can have a beneficial psychological impact on women giving birth and contribute to more positive feelings and memories about this life experience.

Severe psychological distress arises from exposure to conflict, violence, and the loss of homes or family members (Guha-Sapir et al., 1986.). Factors that contribute to a peaceful and supportive environment should be given priority. Key factors could include the use of calming colours and materials, nature-oriented aesthetics, and the creation of privacy areas (William Browning & Joseph Clancy, 2014).

4.4 Respect and Cultural Sensitivity

Respectful care in birthing contexts includes cultural sensitivities in addition to personal considerations. Respectful care is characterized by a healthcare approach that promotes patients' dignity, autonomy, and rights while also addressing their physical and emotional well-being. This includes treating patients with empathy, compassion, and cultural sensitivity, involving them in

decision-making processes, and respecting their healthcare preferences and choices. Respectful care is not unique to labour and delivery, but it is especially important in this setting because birthing is intimate and delicate. Respectful care in birth settings comprises providing a supportive and empowering environment for women, respecting their autonomy, addressing their emotional needs, and upholding their preferences throughout the childbirth process.

Spirituality and culture are closely interwoven, with spiritual beliefs and practices frequently reflecting the values and traditions of a specific community. The cultural setting provides a framework for spiritual expression, impacting individual and societal perceptions of the divine, meaning, and connectivity (Crowther & Hall, 2015). Creating an atmosphere that is attentive to local culture was an important design goal. This was enforced by promoting the use of vernacular materials for the construction of seating outside the pods and for the signboards. Importance was also given to the local artwork, can be displayed wherever possible to promote feelings of hope and strength. The recreational pods were also designed as centres where the community can come together and create art; this artwork can then be displayed within the community. The use of local blankets and rugs was another important feature of promoting cultural sensitivity. The pods were designed to be dispatched to regions with a kit consisting of different items such as first aid kits, diapers, clothes, etc. These kits would also include cultural elements local to the region, whether they are blankets, idols, or toys. An active effort would be made to include at least one local product in the kit. The ideology behind this step is to respect the ways of the community and allow them to hold on to their sense of belonging. With the option of opening and closing the pods, the birthing mother has

a sense of control over her personal space. This is an important aspect in promoting dignity and privacy, as discussed below.

4.4.1 Promoting Dignity and Privacy

Even in difficult circumstances, it is vital to protect the privacy and dignity of mothers giving birth. The presence of a closed pod structure and the addition of a privacy screen give privacy to the birthing mother when she requires it. The addition of the privacy screen ensures that expectant mothers feel dignified during childbirth. It alleviates anxiety and stress by creating an intimate and secure space, it blocks out distractions, allowing mothers to concentrate; and it protects the modesty of the mother by shielding them from the view of others (Rados et al., 2015). Overall, privacy screens play a vital role in promoting a supportive and respectful birth environment.

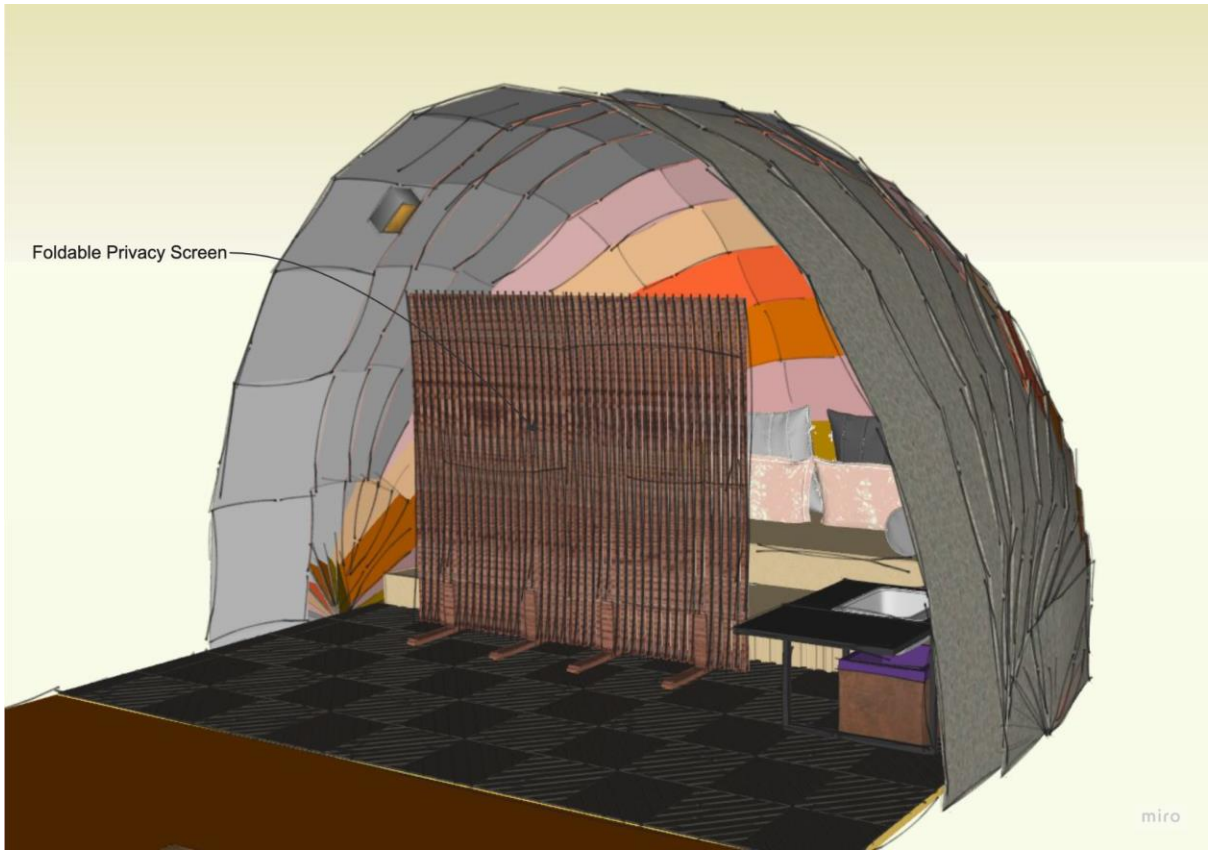


Figure 22. Privacy screen within the pod; Source: (S. Sridhar, 2024)

4.4.2 Dimensions

The birthing unit is a curved structure crafted from aluminium composite panels, bent and joined to create an organic, seamless design. Comprising two sections, the pod can be assembled at any location and securely

anchored to the ground using L angles. The pods can be used as two separate sections or joined together by attaching an additional set of four panels. Each panel measures one foot in width and sixteen feet in length. The aluminium composite sheets are manufactured as sheets of width four feet and length sixteen feet, which can then be cut and joined to make panels of width one foot and length sixteen feet. When bent, a height of eight feet is attained. The interior dimensions of the pod are designed for optimal functionality and comfort, as the interior wall to wall width is up to eight feet and the length is nine feet. These are the dimensions for one half of the entire pod. With the addition of the adjoining panels of length four feet, the overall pod, consisting of two halves and the additional central part, attains a length of twenty-two feet and a width of nine feet.

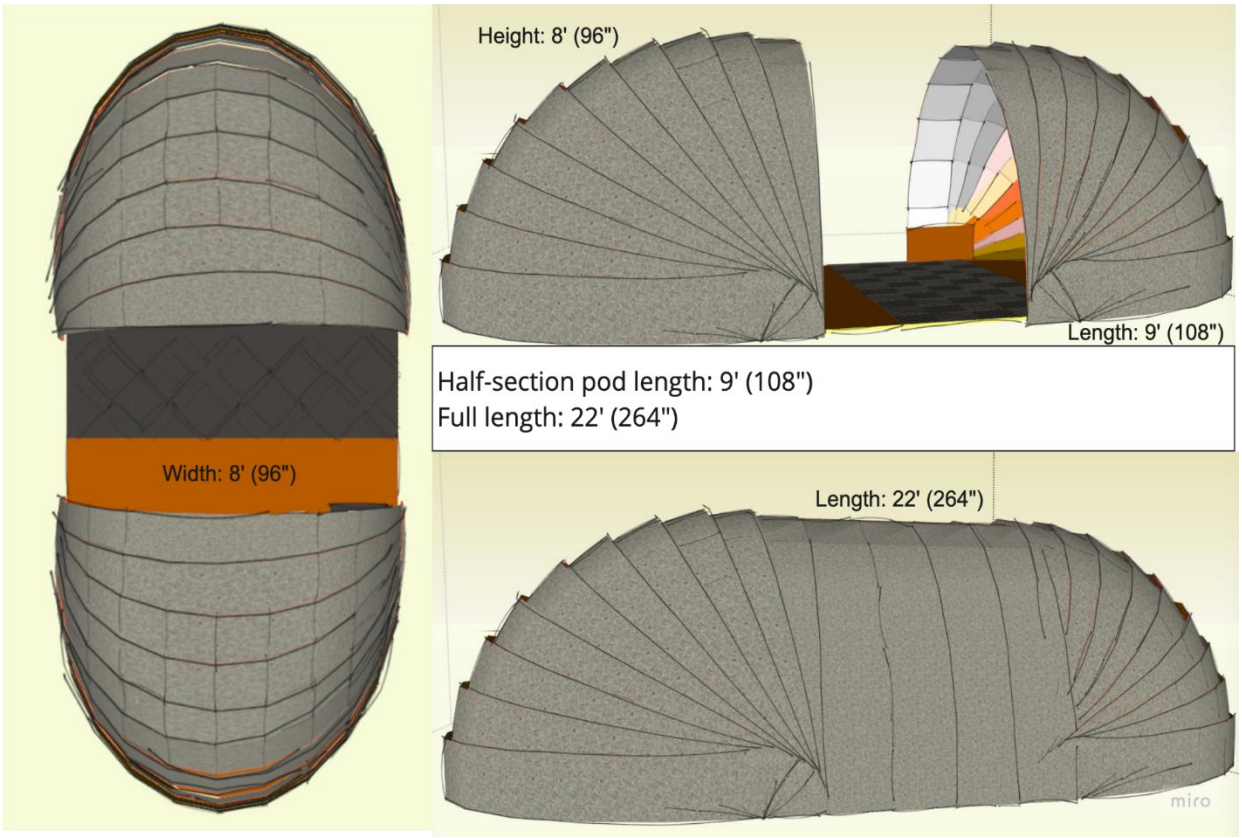


Figure 23. Dimensions of the armadillo pod; Source: (S. Sridhar, 2024)

4.4.3 Flooring

The flooring is made of foam panels that are precisely linked using lock-and-key joinery and layered to create a raised platform suitable for seating and sleeping arrangements. The sleeping platform, which is elevated sixteen inches off the ground, has a comfortable width of four feet, facilitating sufficient space for a single occupant and multiple cushions for utmost comfort.

4.4.4 Interiors

With increasing awareness of the interdependence of environmental elements, it is clear that the design of birthing rooms requires careful thought. The

birthing environment has a significant impact on women in labour, infants, their attending caregivers, and partners, all of whom are influenced by their surroundings. Furthermore, the intentional use of colour and light in such settings can help to promote beauty, comfort, lower stress levels, closeness, and the formation of long-lasting personal, emotional, and spiritual experiences. As a result, it is critical to approach the integration of colour and light in space design with caution, drawing on specialized expertise and empirical evidence. Architect Bianca Lepori, an early advocate for birth environment reform, highlighted the importance of light and colour in the design of birth spaces (Lepori, Bianca, 2008 in Balabanoff, 2017).

Attending to the theories of salutogenic design and biophilic design these theories, the pod additionally encompasses two solar lamps for interior illumination with warm light settings, a foldable privacy screen, and a multipurpose workstation with adjustable height for enhanced convenience. A bench also provides seating and support for midwives or support systems, and a foldout sink with a built-in garbage bin ensures that cleanliness standards are met. A noise-cancelling speaker delivering relaxing sounds of nature is also provided, along with cushions of varying sizes to provide individualized comfort. In a recent trial of an alternative birthing room in Sweden it was found that there were three highly valued elements: the bathtub, projected images of nature on the walls, and dimmable lighting. One woman said: I think it [the room] made me a lot stronger during birth. It maybe sounds strange, but you are dependent on the surrounding environment. It influences you and the feeling of strength and safety (Participant 6) (Lisa Björnson Skogström et al., 2022). Aburas et al. (2017) explored the impact of displaying nature photographs on a small television screen in the delivery room, but found minimal changes in outcomes, which could be due to challenges with scale and

presentation(Aburas et al., 2017). Hence, a solar-powered projector was added as part of the pod to project visuals with soothing sounds, adding to the sense of relaxation.

More research needs to be conducted in order to determine the ideal colour palette for these pods. Identified below are the proposed colours for this project. The interiors of the pods have been designed with a rich palette of earthy tones, evoking a sense of calm and closeness to nature. Warm browns, light greens, and mild white shades engulf the space, producing a relaxing and welcoming atmosphere. The employment of such tones creates a harmonic and calming environment, creating a sense of serenity and comfort for the labouring mother. Furthermore, the earthy colour scheme contributes to a visually unified and aesthetically beautiful interior design, which improves the overall experience within the pod. In her thesis on light and embodied experience in birth spaces, Balabanoff has noted that " stress situations can be caused not only by colours but also sounds and smells, which may contribute to creating an uncomfortable ambiance."(Balabanoff, 2017). These insights further led to the idea of placing aromatic sprays throughout the pods that contained calming natural scents such as lavender, jasmine, cinnamon, etc. The scents are selected based on the availability in the locality of where the pod is to be placed, and also based on the cultural beliefs of the community.

The pod is designed to offer a comprehensive solution to blend functionality, comfort, and a nurturing environment for expectant mothers in crisis settings.

4.4.5 Emergency Kit

In imagining the further interior development of each pod, necessities to guarantee the safety of mothers and their newborns were considered. Regarding apparel and personal supplies, emphasis was placed on offering a change of clothes, comfortable footwear, outerwear suitable for the weather, personal hygiene products, and feminine hygiene items. A first aid kit, water purification tablets, reusable water bottles, and non-perishable food items can all be available in the food and water section. The first aid pack can include standard supplies, prescription drugs, and over-the-counter pharmaceuticals. Each pod can be equipped with elements such as a lightweight sleeping bag or thermal blanket to provide warmth and shelter, a signalling whistle, a radio that runs on batteries or can be turned by hand, and a flashlight used for communication and illumination. A multi-tool or knife, duct tape, rope or paracord, and sewing kit are examples of tools and multifunctional items. All these items included in the pods are subject to availability in the region in which the pods are deployed.

4.6 Armadillo pods as a community

As the design evolved, the idea of incorporating multiple types of pods emerged. Below, I present some examples of potential pod typologies to illustrate this conceptual exploration.

The birthing pods were initially conceived as individual, isolated units, but, through research, it was determined that their utilization and placement within a community setting would be more advantageous. However, it is important to note that each pod retains all the functional capabilities necessary to operate independently. Subsequently, the following section elaborate on the configuration and features of the birthing pods within a communal context, where various typologies and functionalities are assigned to different pods.

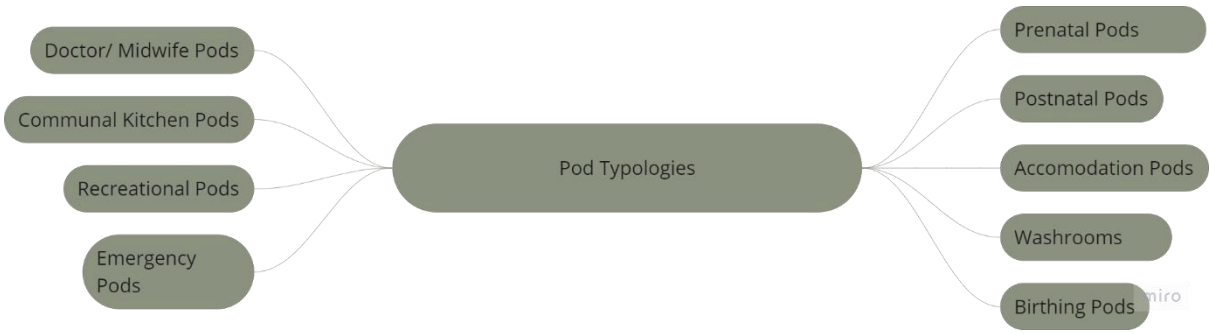


Figure 24. Pod typologies; Source: (S. Sridhar, 2024)

4.6.1 Birthing pods

The women in immediate labour are served by this typology. These pods' colour palette is primarily soft brown with subtle tonal variations that complement the common tan furniture. A woman going into immediate labour goes through a flurry of feelings and bodily sensations. Feelings of nervousness, excitement, and anticipation may coexist with sharp focus, resolve, and a sharpened awareness. The woman must focus entirely on the contractions since they can be physically intense and all-consuming (Abdullahi et al., 1990).

The surroundings in this kind of situation might greatly influence the woman's experience. The colour soft brown, when applied inside the pods, can be especially helpful. Brown is a soothing, neutral colour that is frequently linked to dependability, ease, and simplicity. It is discrete and modest, offering a calming background that does not draw attention to itself or exacerbate sensory overload (Jayashankar and Lakshmi, 2023). The soothing brown interiors can help create a calm and pleasant setting. In the middle of the intensity of labour, it can offer steadiness and serenity, calming anxiety and encouraging relaxation. This is in line with salutogenic design principles, which emphasize the development of spaces that promote health and wellbeing.

4.6.2 Prenatal Pods

This typology is intended for expectant mothers. A pregnant mother will be allowed to stay in this birthing pod two months before the period of labour and

will be moved to the postnatal pod one month after to allow ease of transition during these crucial periods. These pods, which have walls painted in various tones of blue, offer a soothing and refreshing atmosphere. Tan furniture compliments the gradient of soothing blue tones on the inside shell-like panels that make up the framework.

The colour blue is frequently linked to stability, tranquilly, and calmness (Jayashankar and Lakshmi, 2023) and its usage here suggests tranquil natural features like a calm body of water or a clear sky. Blue can be utilized to create a peaceful and tranquil ambience in a birthing mother's surroundings.

4.6.3 Postnatal Pods

This type focuses on postnatal care, which is a stage that demands peace and comfort above all else. A new mother is frequently going through a significant emotional and physical shift. Along with the pressing needs of taking care of a newborn, she could feel relieved, happy, and tired. Hormone surges that might heighten feelings and hasten the development of postpartum mood swings are another feature of this time (Martell, 2003).

In this case, the mother's postnatal experience can be greatly influenced by her surroundings. Applying pink hues to the pod walls could be especially advantageous. Pink is frequently linked to emotions of coziness, comfort, and love. It is a comforting colour that can give one a feeling of security and serenity (Jayashankar and Lakshmi, 2023). Here, the pods are equipped with a table that can also be used as a platform to change the baby. The table can be adjusted to the required heights, depending on the comfort of the mother. The new mother may

find a calming and cosy atmosphere enhanced by the pink interiors, which can evoke feelings of warmth and affection, which can be especially consoling at this delicate time. This, in line with salutogenic design principles, emphasizes the development of spaces that promote health and well-being.

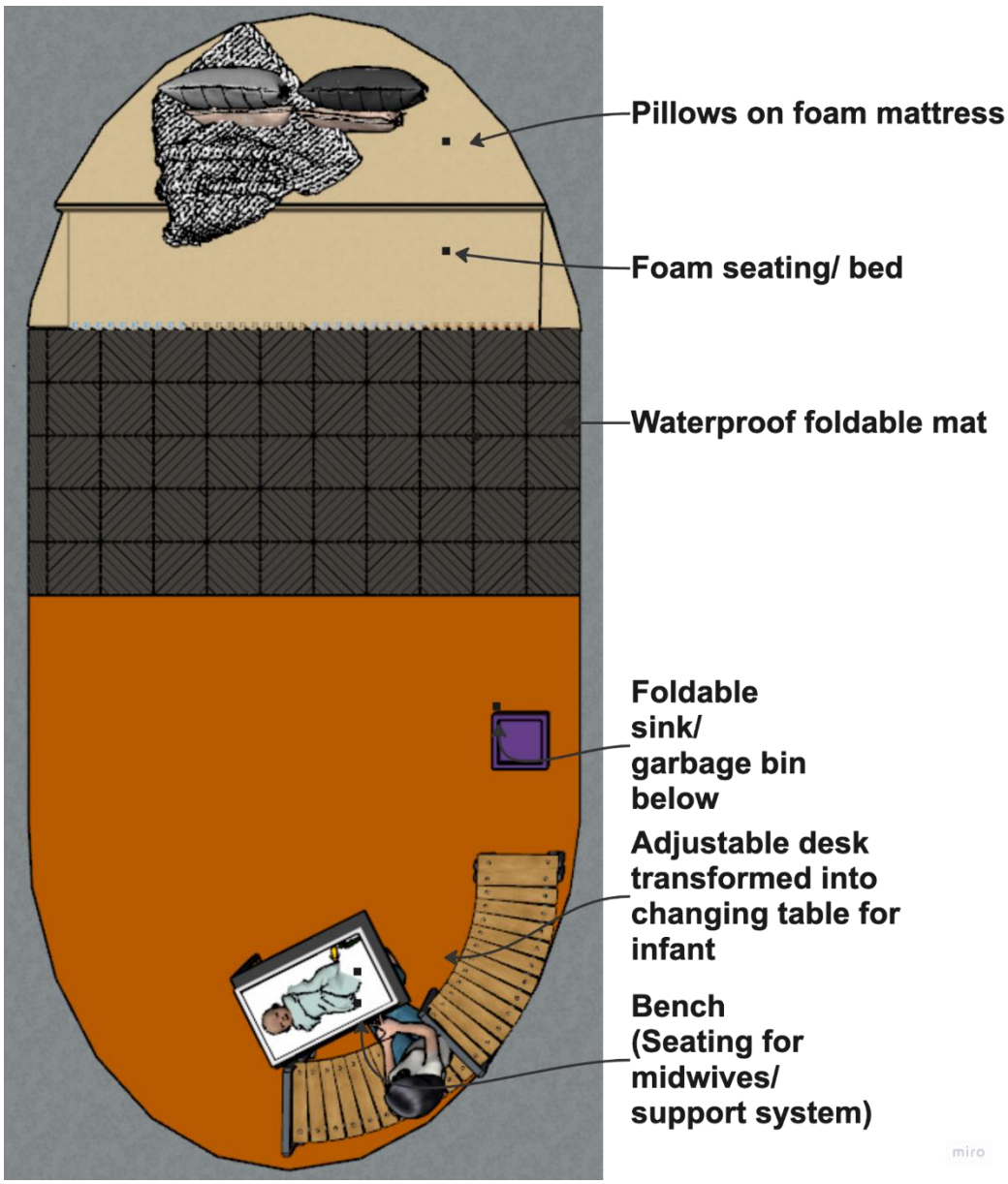


Figure 25. Plan of postnatal pod; Source: (S. Sridhar, 2024)

4.6.4 Accommodations Pods

These pods have the same soft brown interiors as the birthing pods. The purpose of these pods is to provide additional sleeping accommodation for the supporting pillars of the birthing mother. Support persons may include friends, same sex partners, doulas, mothers, wives, husbands, children, siblings, or fathers, this accommodation pod is designed to be minimal and only contains the bedding foam on either side of the pod. It also contains the essential pod pack and two storage bins. This accommodation pod has the primary usage of being attached to the primary birth pods or being placed in a close vicinity to these birth pods.

4.6.5 Restrooms

The restrooms located inside the pods are the subject of the next typology. These areas are planned to meet the needs of expectant women. They include a shower area for bathing, a sink area for personal hygiene, and, in some pods, a blow-up birthing bathtub.

As stated earlier in the paper, In a recent trial of an alternative birthing room in Sweden it was found that there were three highly valued elements: the bathtub, projected images of nature on the walls, and dimmable lighting. (Björnson Skogström et al., 2022). This led to the inclusion of a blow-up bathtub, that could be inflated and utilised when necessary.

The bathrooms have interiors in tones of brown and olive green. These hues were picked because they have a calming and grounding quality that helps create a relaxing atmosphere that reduces tension and encourages relaxation. The image

below is a conceptual image, and the material imagery is a depiction, not the actual flooring to be used. By utilizing these organic, earthy hues, the built world is further connected to nature in accordance with the ideas of biophilic design. The restrooms are to be further developed upon further research.

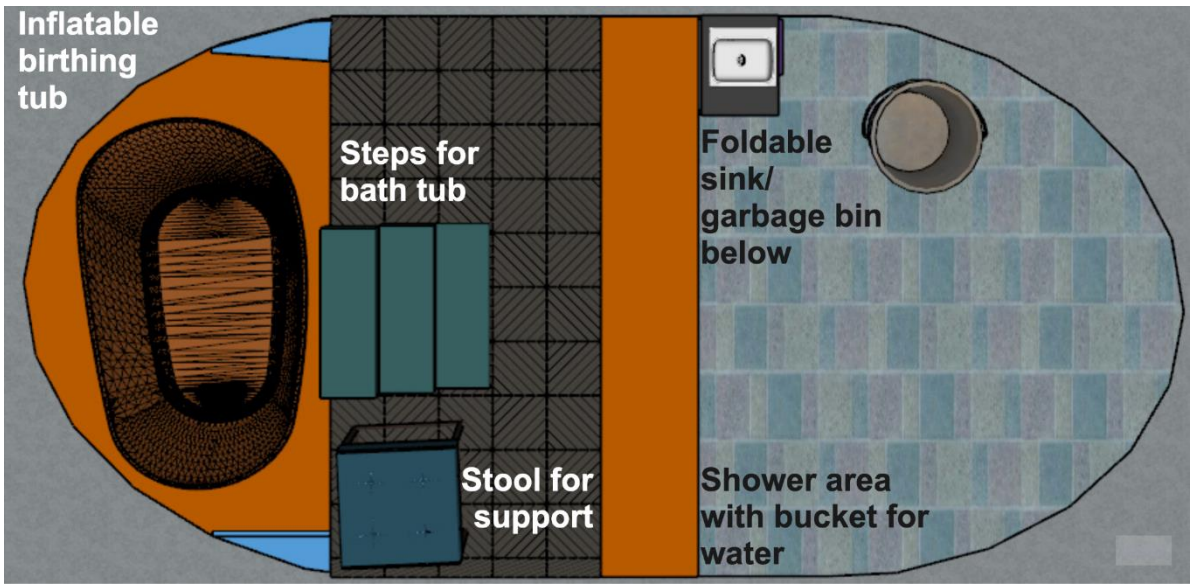


Figure 26. Plan of restroom; Source: S. Sridhar, 2024

4.6.6 Doctor/ Midwife Pods

The accommodation of physicians and midwives is the focus of this pod typology. These pods are intended to give the medical staff—who are vital to the birthing process—a cozy place to rest and rejuvenate. These pods' interiors are distinguished by their vibrant walls as well. Vibrant colour schemes can help create a bright, exciting environment that improves mood and energy levels. Those who work long hours in challenging environments, like midwives and doctors, may find this very helpful. In addition to adding to the cheerful and inviting ambience, the pods' colourful interiors make them comfortable places to relax and refuel. This thoughtful design reflects the principles of salutogenic design, which emphasizes the creation

of environments that support health and well-being. It showcases the use of multiple colours and can enhance the positivity of the space.

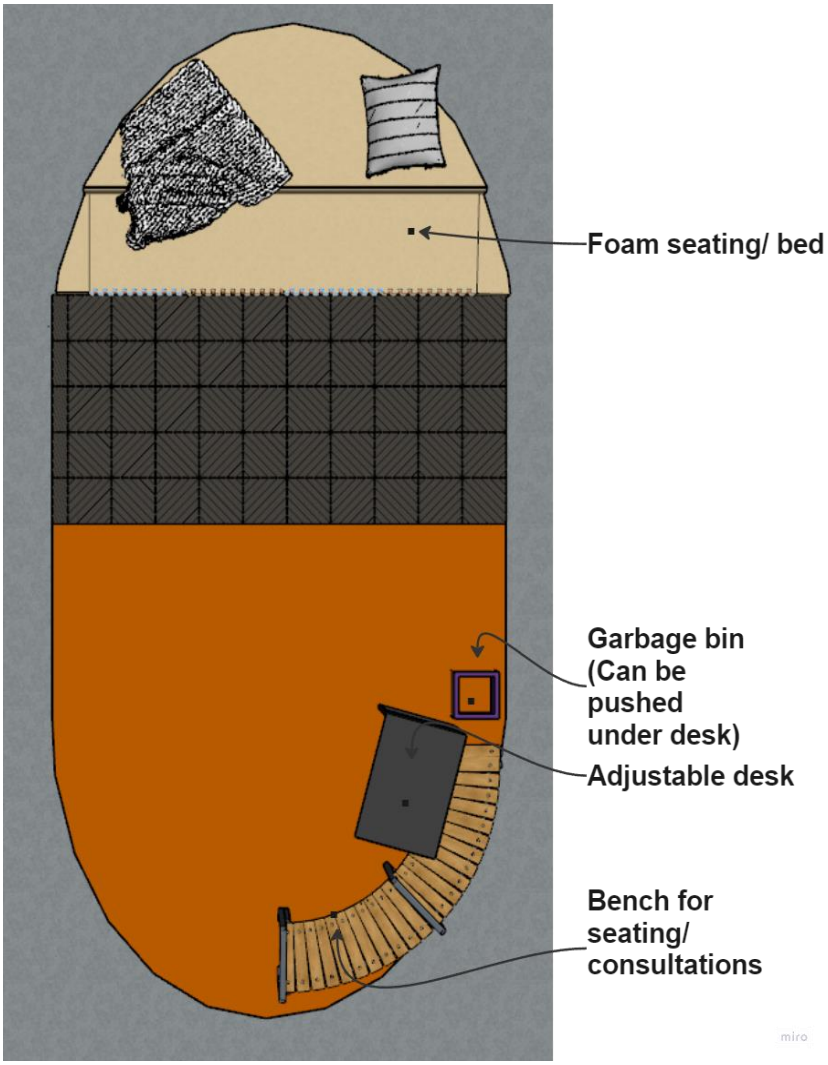


Figure 27. Plan of Doctor/ Midwife Pods; Source: (S. Sridhar, 2024)

4.6.7 Communal Kitchen

The common kitchen pod, which is the next pod typology, is positioned in between a collection of ten pods. By providing a common area for meal preparation and conversation, this communal kitchen helps the residents feel more connected to one another. The walls in these pods have been painted darker

colours because of the nature of kitchen activity. Darker hues not only make an environment feel cozier and more welcoming, but they are also more practical because they hide stains and grime better. This deliberate design decision is in line with the ideas of biophilic design, which aims to create connections between people and nature in built spaces, and salutogenic design, which emphasizes the construction of habitats that enhance social cohesion. The idea for this project was to have a communal kitchen as a common gathering space for families in the community, and the details of the same are to be further researched and detailed.

4.6.8 Recreational Pods

The birthing centre's rec pods, or recreational pods, are designed to combine parts of salutogenic principles with the promotion of a lively social dynamic among community members. This serves a dual function. The minimalist design of these rec pods is deliberate; typical furniture has been replaced with a few cushions and bars for support. Grounded in salutogenic design principles, this intentional design promotes movement and creates settings that foster social interaction among pregnant women.

The recreation pods have a significant impact on strengthening the community's social fabric. These vibrant areas serve as hubs for pregnant mothers, offering a safe location for them to interact, exchange stories, and form a network of support. This focus on social ties is consistent with the salutogenic design principle which acknowledges the beneficial effects of strong social networks on general well-being.

Furthermore, the pods' versatility broadens their use beyond interpersonal communication. These areas were purposefully created to serve as resource centres, providing knowledge through educational sessions hosted by doctors and midwives on childbirth, safety measures, and associated subjects. Essentially, the recreational pods represent a comprehensive method of providing care for expectant mothers by incorporating salutogenic concepts into the social and physical elements of their surroundings, ultimately enhancing the general health of these women in the community.

4.6.9 Emergency Pods

The emergency pods aim to reach the goal of importance provided to facilitate emergency situations within the community. With a wide range of instruments required for emergency operations and surgeries, emergency pods are designed to deliver critical treatment in a timely manner for childbirth-related crises, They are the only type of pod equipped with clinical instruments required for surgeries. These pods' interior design places a strong emphasis on a mother's psychological health by using colourful and vibrant walls. These colourful and eye-catching components are purposefully arranged to arouse feelings of serenity, assurance, and hope, resulting in an upbeat and pleasant experience. The deliberate use of colour tries to lessen these negative emotions in emergency situations where tension and anxiety levels might be heightened, providing a supportive and comforting environment for the mother and the attending medical staff. This holistic approach to design acknowledges the emotional and functional aspects of emergency care, creating a space that is not only aesthetically pleasing

but also optimized for critical medical interventions (to be further developed in future work).

4.6.10 Functional Capacity

The community's layout and the armadillo-inspired pods are designed to aid expectant mothers and their families. Each pod offers a private and cozy environment for childbirth, with room for the birthing mother and one support person. The design makes sure that the woman's family is close by during the birth, so they may offer support and share in the event. A midwife pod is also situated close by to guarantee that expert support is easily accessible. Restroom pods are also placed within proximity of the birth pods. There is an allotment of two restroom pods for every three birth pods and a separate one for doctors and midwives. This arrangement ensures the safety and well-being of the women giving birth as well as the newborns by enabling prompt response to any crises or unforeseen circumstances that may develop.

During the process of developing the birthing pod, I mounted an exhibition that displayed the on-going works of the thesis. The following chapter discusses the details of the event in further detail.

Chapter 5: Exhibition

Design is in everything we make, but it's also between those things. It's a mix of craft, science, storytelling, propaganda, and philosophy.

(E. Adigard, 1983)

As part of the requirement for the IAMD degree, the mandate is to create an exhibition. Through the exhibition, one should explore and represent the principles studied.

As noted above, I was guided by the theoretical principles of salutogenic design and biophilic design. These are all theories that are dear to my heart since I overcame multiple challenges in my life relying on the features of the same. Whenever I am feeling low, I take a walk outside. In moments of extreme anxiety, the colour green is what calms me down. Unknowingly, I was connecting with the essence of nature, which, after research and continuous study, I found out was termed 'Biophilic Design'. The feeling of comfort I get when I celebrate at a gathering with my friends is social interaction, an important theme of salutogenic design. Lastly, the multiple crises we read about in the newspaper are the same crisis situations that inflict trauma on millions every day. The acknowledgment and design for those in these horrific situations, in simple terms, is design for trauma or trauma-informed design. Therein began my exploration of what it was that I was to bring to the exhibition.

My first thought was to recreate a prototype of the birthing pod in the 12' x 20' space I was allotted for my exhibition. As I started creating smaller-scaled versions of this model to visualize the final product to be displayed, I ran into multiple problems, including the ceiling height restrictions and accessibility to the exhibition room for set up. These obstacles seem like a negligible concern in theory but are a problem in reality. The curves I sculpted so seamlessly using one click of a button took a lot more power to be created in real life since I could not just copy/paste the function and had to make each curved wall separately. It also got me thinking

about how I should be open to other materials and that this is a project that requires further research. I soon realized that the essence of the theories I studied was to make one feel at ease. To be isolated from chaos into a moment of peace, even if it is just momentary. Thus began the idea of creating a zen space within the allotted exhibition room. The interior design within the four walls is to create an escape from the bustling movement of the school outside. If a human being can escape into a moment of solitude in the space created, imagine the power of these theoretical themes on the psyche of a birthing mother enduring trauma. The ideology of this exhibition was to create tangible features out of the intangible theories of biophilic design and salutogenic design studied.

The exhibition room was divided into two realms. On the left side was the immersive space, where projections of nature were played on all three sides. The visuals were accompanied by relaxing sounds of water. The entire atmosphere created was relaxing and soothing. The other side of the room had a physical manifestation of the biophilic and salutogenic principles. Here, an area for seating was created where one could go through my design journal and feel like they were part of the immersive experience. This seating area had a loveseat that was described as a pale, creamy off-white colour, layered with cushions that were of varying shades of olive green. This seating area also had a lamp emitting warm yellow lights and an artificial vertical garden. The ideology behind creating this space was to enhance the overall feeling of the occupants by connecting the users with nature. This space was also created to reduce stress and relaxation. Through this process of fostering a sense of calm and tranquillity, it was established that the principles of salutogenic design and biophilic design can create a feeling of relaxation through artificial means.

Most of the users that came inside felt calmer. The terminology that was frequently used was “zen” and “tranquil”. Through these conversations, it was established that the room, void of natural sunlight and living plants, did create a sense of calmness. This got me thinking, if an ordinary person could come into this space and feel calm, imagine the power of these principles for birthing women in regions of crisis.

Here is a description of the elements:

1. Vertical Garden: The wall featured a vertical garden built from existing materials, including bed slats. Indoor gardening has numerous benefits, including reducing stress levels, improving cognitive function, boosting productivity, and enhancing air quality. This aligns with both biophilic and salutogenic design principles, which emphasized the importance of nature and stress reduction in promoting health and well-being. (Kellert, 2019)

Figure 28. Vertical garden (Exhibition)

2. Projector Display: The wall featured projectors displaying a presentation of a virtually modelled birthing pod along with imageries of a forest. This use of technology provided an engaging and informative element to the exhibition.

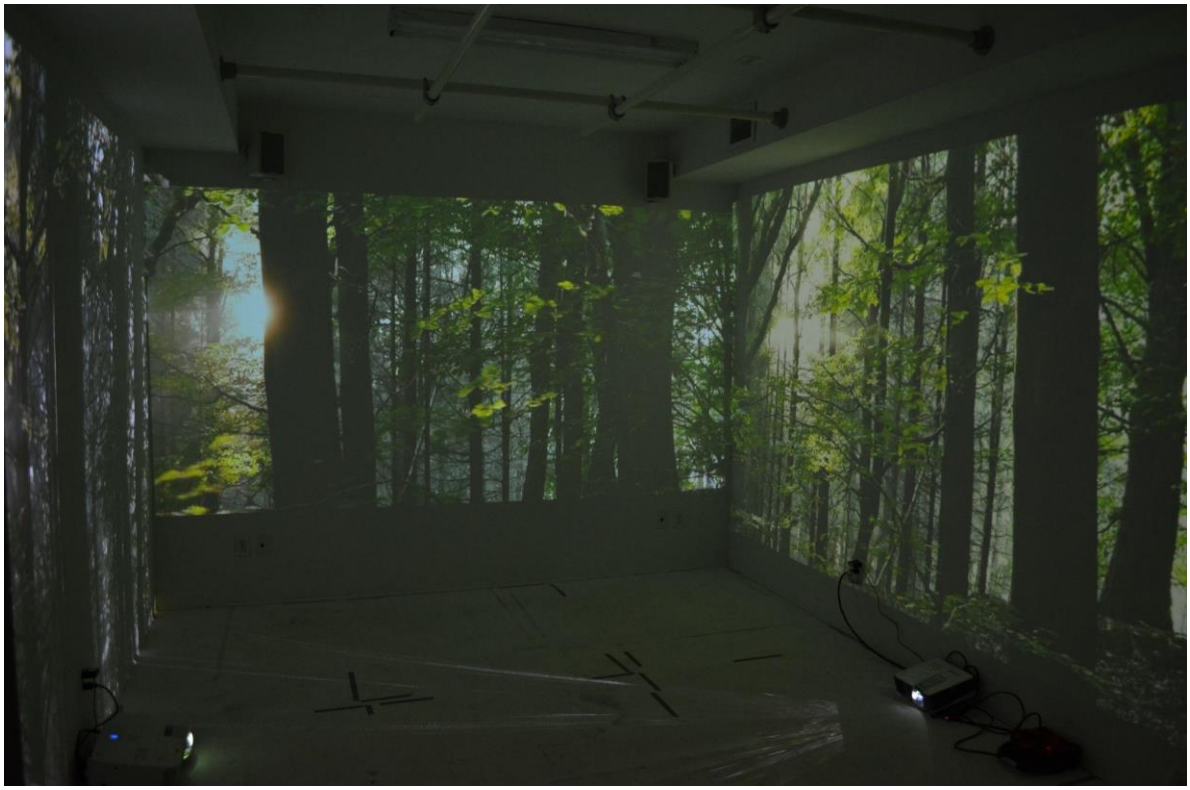


Figure 29. Projector display (Exhibition)

3. Aromatic Diffusers and Nature Sounds: The room was enhanced with aromatic diffusers spraying scents of nature and speakers playing soothing sounds of nature. These elements help reduce stress, increase clarity of mind, and improve mood. I hoped to create a sense of peace within the birthing pods with amenities by placing incense sticks, which provided both an aromatic and healing aura. The sounds of nature, drowned out the sounds of chaos going on beyond this safe space. I understood that there will not be any peaceful natural sounds in the pod amidst a crisis, but being able to integrate speakers into the pod is a feature I hoped to further develop.

4. Comfortable Seating: The comfortable seating was setup with ample cushions in neutral tones to provide a welcoming and relaxing space for visitors.

Figure 30. Seating (Exhibition)

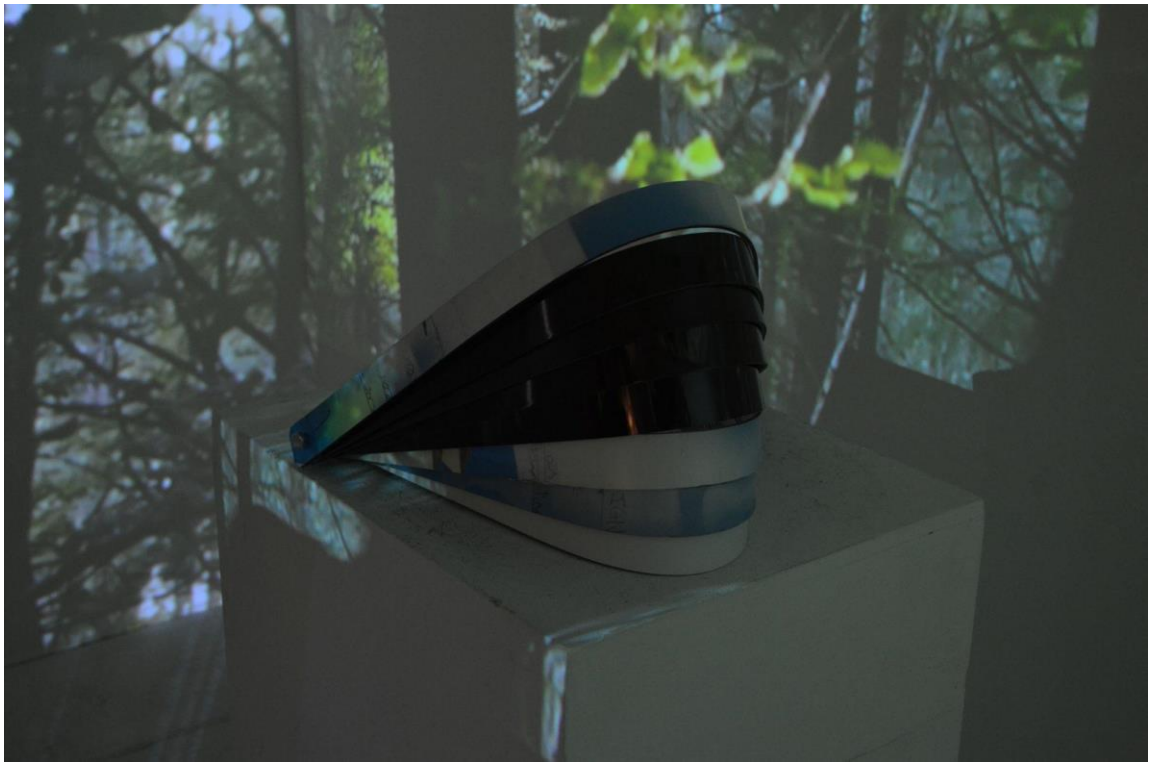


Figure 31. Prototype of armadillo pod (Exhibition)

Figure 32. Prototype of armadillo pod (Exhibition)

Chapter 6: Discussion

The aim of argument, or of discussion, should not be victory, but progress.

(J. Jubert, 1838)

Chapter 6 covers the evaluation of the prototypes in Chapter 4.

The Armadillo project embarked on a journey to enhance the birthing experience for expectant women in disaster zones and regions marked by high maternal mortality rates. Through the exploration of numerous prototypes, the project sought to integrate principles of salutogenic design and biophilic design, aiming to conceive a sanctuary-like pod conducive to comfort and solace. The discussion of this endeavour illuminates several key insights and considerations.

In its initial stages, the project emphasized the significance of design solutions that are targeted to the specific challenges and circumstances found in disaster-prone locations and countries with high maternal death rates. By emphasizing expectant mothers' needs and experiences in various circumstances, The Armadillo Project advocates for a human-centred approach that recognizes the interplay of environmental, social, and psychological elements influencing maternal health outcomes.

In the following section, the integrations of salutogenic design principles and biophilic design principles in the project are discussed.

The armadillo pod incorporates biophilic and salutogenic design concepts to create birthing spaces that focus women's well-being and comfort during childbirth. Biophilic principles are visible in many design features, beginning with the use of natural light. The armadillo-inspired pod's physical design allows natural light to penetrate, encouraging a connection to the outdoors while also improving mood and well-being. Furthermore, the ability to modulate light within the pods using adjustable panels guarantees that the appropriate amount of light is permitted, adapting to individual preferences and needs.

Natural analogies have an important role in design, especially in the usage of colour palettes. Soft brown tones replicate earthy hues, producing a relaxing and grounding ambiance that promotes relaxation and comfort. Various tones of blue in prenatal pods convey soothing natural characteristics like as water or sky, instilling a sense of peace and serenity. Conceptual imagery representing organic, earthy materials strengthens the link to nature, creating a relaxing and pleasant setting for women during birthing.

The use of natural components throughout the design emphasizes the connection to nature. Projected images of nature, as well as armadillo-inspired pod shapes that resemble organic structures seen in nature, convey a sense of harmony with the surroundings, fostering serenity and tranquillity. Biomorphic forms, such as shell-like panels in perinatal pods, provide a sensation of comfort and protection similar to being in a womb, thereby improving the whole birth experience.

The armadillo pod demonstrates salutogenic principles through various design features aimed at promoting holistic well-being during childbirth. Beyond its soothing colour palettes and incorporation of natural elements, the pod enhances psychological comfort through layout and amenities. Cozy atmospheres are created through furniture arrangements, soft lighting, and comfortable amenities, fostering a sense of security and relaxation. The inclusion of functional features such as blow-up birthing bathtubs and adjustable tables in restrooms caters to the physical needs of mothers, promoting comfort and relaxation during childbirth and postnatal care. Additionally, recreational pods serve as multifunctional spaces for physical activity and educational sessions, encouraging holistic health promotion through exercise, social interaction, and knowledge sharing. By prioritizing the physical, emotional, and social aspects of well-being, the armadillo pod provides a supportive environment that enhances the overall birthing experience and promotes positive health outcomes.

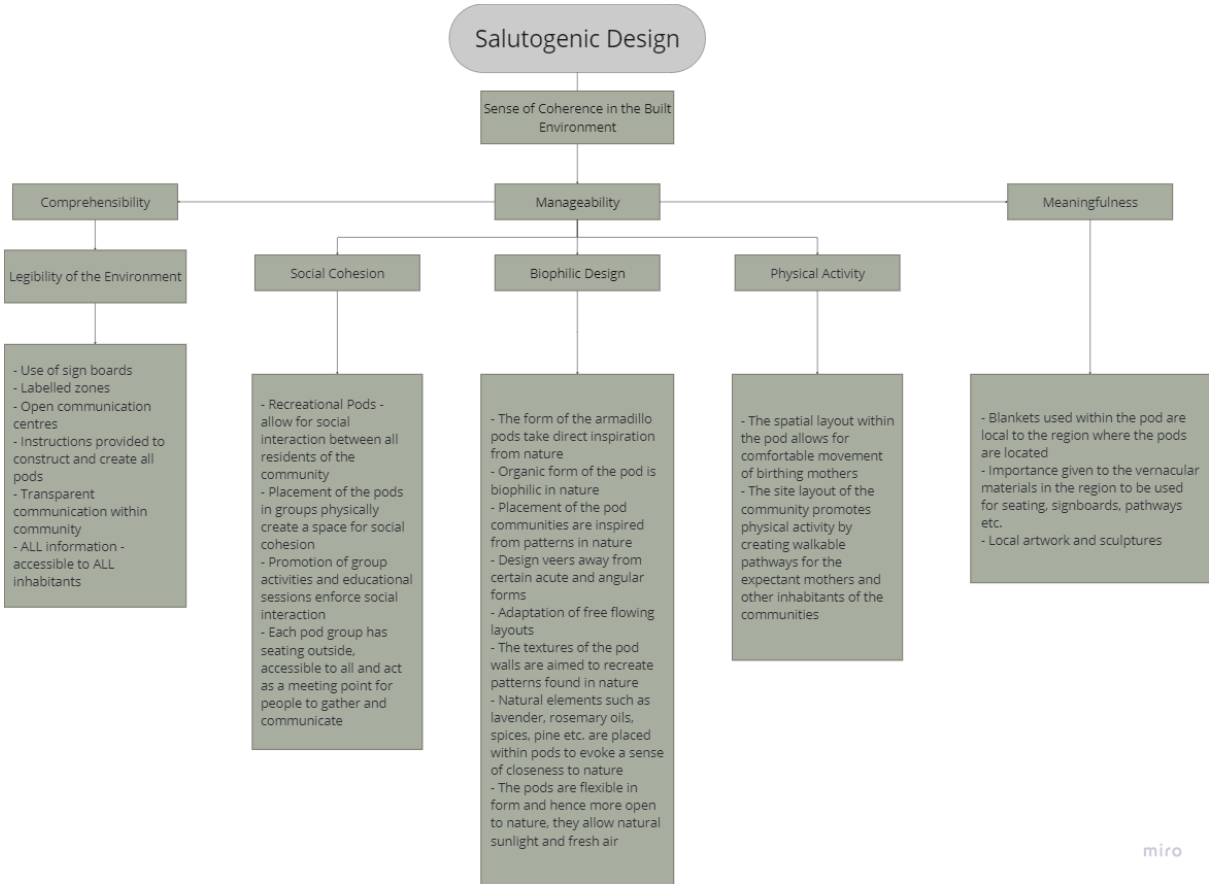


Figure 33. Features of Salutogenic Design; Source: (S. Sridhar, 2024)

This project was subjected to a SWOT analysis to help evaluate the over-all design. "SWOT is a convenient tool at the evaluation stage in order to gain an initial idea of possible future consequences." (Elwalda & Benzaghta, 2021).

Through the process of SWOT analysis, four key domains including strengths, weaknesses, opportunities, and threats were evaluated.

Figure 34. SWOT Analysis; Source: (S. Sridhar, 2024)

Strengths: the advantages that contribute positively to the well-being of an individual, society, and the environment are discussed.

- Integration of salutogenic and biophilic design principles.

- Human-centred approach modified to meet the needs of expectant mothers.

- Iterative design process allows for continual refinement.
- Emphasis on context-sensitive interventions for disaster-prone areas.
- Recognition of the psychological and emotional dimensions of childbirth.
- Potential to adapt to diverse environments.
- Contribution to improving maternal health outcomes.

Weakness: the limitations of the project module are highlighted.

- Limited budget and resources for extensive prototype development.
- Lack of opportunities to test in real-life scenarios due to logistical constraints.
- Reliance on theoretical frameworks without empirical validation.
- Potential challenges in scalability.
- Adaptability to diverse cultural contexts.
- Adaptability to cold climates.

Opportunities: favourable circumstances or possibilities that can be leveraged to achieve project objectives and enhance its overall workability are discussed.

- Expansion to other disaster-prone regions with similar birthing challenges.

- Collaboration with humanitarian organizations for implementation in emergency settings Integration of feedback from experts and professionals to refine and improve the design.

- The long-term consequences of the birthing pod remain uncertain, presenting an area for future investigation and research.

- Research partnerships to explore additional features and innovations.

- Future iterations considering the impact of having to walk distances to use the toilet, and instead have in-suite restroom options.

- Addressing emergency surgical situations require intensive set-up processes, further iterations should include ways to address this design goal.

Threats: Threats in this project refer to external factors or challenges that may hinder its completion and full capacity for efficiency.

- Limited access to materials required for the construction of the birthing pods.

- Uncertainty regarding the acceptance and adoption of the proposed pods by healthcare institutions or clinically affiliated communities.

- Challenges related to transportation and logistics in delivering the birthing pods in inaccessible regions affected by disasters.

- Potential competition from existing solutions or alternative approaches to improving maternal healthcare in crisis situations.

- Regulatory hurdles or bureaucratic delays in obtaining necessary approvals, and local permits in the crisis regions during the deployment of the birthing pods in various locations.

The birthing pod design, although showing promise in improving maternal healthcare in crisis settings, needs further development to address its weaknesses, capitalize on opportunities, and mitigate potential threats to refine and successfully implement the design in a real-life scenario.

Chapter 7: Conclusion

The finding of arguments for a conclusion given in advance is not philosophy but special pleading

(B. Russell, 1935)

The Armadillo project explored possible solutions to improve the over-all birthing experience of an expectant woman in disaster zones and regions of high maternal mortality. By experimenting with the development of the prototypes, this project aimed to explore the amalgamation of salutogenic design and biophilic design to create a pod of solace.

The Armadillo Project was primarily focused on modular and temporary forms of architecture, specifically targeting midwifery-led birthing units, while not extending to the realm of clinical healthcare. The prototypes emphasize proof of concept rather than fully functional applications, with key takeaways from the development process highlighting the need to prioritize objectives and consider geographical limitations, such as suitability for arid climate zones.

The envisioned birth capsule, which blends the concepts of salutogenic and biophilic design, offers a constructive answer to these issues. The birthing pod offers a nurturing and encouraging atmosphere to address the unique psychological factors and encourage positive mother experiences even in the face of challenging circumstances. The interplay of emotional and mental aspects is acknowledged by this holistic approach, which also highlights the value of individualized support networks and compassionate care.

This project contributes to expectant mothers, healthcare providers, community organizations, and policymakers. Further research and implementation can also lead to findings that can be used for future developments in the field of birth environment design.

7. 1 Limitations and Lessons Learned

Trauma-informed design is an approach that integrates an understanding of trauma and its effects into the design process, with the goal of creating environments that promote healing, safety, and well-being (Dietkus, 2022). Principles of trauma-informed design include creating spaces that foster a sense of safety and control, minimizing sensory overload, promoting autonomy and choice, and facilitating positive social interactions (Hopper et al., 2010.). Salutogenic design and trauma-informed design share several compatible principles and goals. Both approaches prioritize creating environments that support individuals' psychological and emotional needs, promote a sense of safety and empowerment, and facilitate positive experiences (Abdelaal & Soebarto, 2019). While a comprehensive analysis of trauma-informed design went beyond the scope of this thesis, the need for a detailed examination of this essential domain is recognized for future endeavours in this field or subsequent iterations of this project. The study encountered various limitations during the design phase, including the challenge of addressing relevant contemporary issues and sourcing appropriate materials like reused shipment containers and bio tarps. Despite these challenges, the project contributes valuable

insights to design practice, expanding knowledge on healthcare facility design in high-maternity-rate and disaster-prone areas, albeit while grappling with the ongoing balance between practicality and aesthetics and navigating technical constraints and financial limitations.

Further limitations include global dispatching of the pods. Shipping pre-packaged pods made from ACP (Aluminium Composite Panel) panels from Canada to various destinations across the world involves substantial obstacles. The size and weight of the packaged pods may result in expensive shipping expenses, particularly for international transportation. Furthermore, because ACP panels are not locally sourced, they may require handling and transportation procedures to assure their safe birth. Overcoming customs laws and import/export restrictions in several countries could also complicate and delay the shipping procedure. Finally, adverse weather, port congestion, and logistical problems can all impair the pods' timely and efficient shipment to their intended destinations. It is critical to emphasize the importance of the challenges inherent in material sourcing and shipping. As a result, rigorous exploration of local sourcing options becomes essential for efficiently addressing these logistical challenges and the locality in which the pod will be assembled must be studied.

For example, in the state of Rajasthan straw bales and bamboo are accessible materials. Both are flexible and lightweight building materials. Straw bales are abundant in agricultural areas and can be easily obtained locally. They have good insulating capabilities, which can help keep temperatures comfortable inside the pods. Furthermore, straw bales are lightweight and simple to work with, allowing for speedy and cost-effective building. For the structural support, bamboo can be

bent and joined providing a solid framework. Bamboo is widely available in Rajasthan and has various advantages, including flexibility, strength, and sustainability. It can be sourced locally, which saves money on transportation and reduces environmental effect. Additionally, bamboo is lightweight, making it easier to handle and carry. Furthermore, bamboo is naturally resistant to weather conditions, making it suited for usage in a variety of climates. Using a combination of straw bales and bamboo for pod structures in Rajasthan would also benefit local farmers, promote sustainability, and lower transportation costs involved with importing materials from far away.

In conclusion, the Armadillo Project offers a creative and considered approach to maternal healthcare in disaster areas, as well as a demonstration of the use of biophilic and salutogenic design concepts. An environment of support and nurturing is created by the design of the armadillo-inspired pods, aimed at responding to the physical and psychological needs and desires of women giving birth. Even though this design is a step forward, more investigation is required to guarantee its best performance in a variety of crisis scenarios. These investigations should focus on materials, shipping strategies, logistics, transport, prototypes, testing, and budgeting. In conclusion, this project represents a significant step forward in the evolution of birthing pod design, offering an innovative solution to address the unique needs of expectant mothers in crises.

Chapter 8: Glossary

The following terms are used in this thesis document specifically to discuss the research project.

- Birthing Centre: "a facility usually staffed by nurse-midwives that provides a less institutionalized setting than a hospital for women who wish to deliver by natural childbirth " (*Medical Definition of BIRTHING CENTRE*, 2022.)

- Disaster: "a disaster is a chain of events that terminates human life or results in destructive and devastating effects that will cause disabilities. "(Eryilmaz, 2007)

- Biophilic Design: "The process of basing decisions about the built environment on intuition or credible research – derived from either an appetency for nature or measurable biological responses, respectively – to achieve the best possible health outcomes. "(Ryan & Browning, 2020)

- Salutogenic Design: Salutogenic design is defined as a description for a positive socioenvironmental influence on health. "The central idea is that there are three resources that combine to provide a Sense of Coherence—a forward thrust that resists the entropic forces of illness and infirmity. The sense of coherence is made up of resources that improve manageability—the capacity to maintain homeostasis and physical

function; resources that improve comprehensibility—an ability to negotiate circumstances in order to maximise their benefit; and resources that enrich a sense of meaningfulness—the desires, causes and concerns that give us the need to resist illness in the first place."(Golembiewski, 2017)

- Maternal Mortality Rate: "The maternal mortality rate is the number of maternal deaths per year per 100 000 females in the reproductive age group (15–49 years). This considers not only the obstetric risk but also the frequency with which women are exposed to that risk. " (*Maternal Mortality - an Overview | ScienceDirect Topics*, 2014)

- Sustainable Development Goal: "The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity." (*World Health Statistics 2023 – Monitoring Health for the SDGs*, 2023)

- Practice Based Research: Practice-based research in architecture refers to a research approach that integrates theoretical exploration with practical application within the field of architecture. It involves actively engaging in design activities, such as sketching, conceptualization, anthropometric and dimension data collection, planning, designing, prototyping, 3D modelling, and rendering. This methodology emphasizes hands-on experience and iterative processes, allowing researchers to gain insights, test hypotheses, and generate knowledge through the application of design principles and techniques.

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