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Beyond Design Thinking: Holistic Thinking Approach For Product Innovation

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Amidst complex design problems and increasing scrutiny of Design Thinking approach, this paper illustrates a Holistic Thinking approach for stable and sustainable product innovation through two student projects. The first project addresses 'Biomedical Waste Management System,' targeting issues of non-compliance through improvements in information accessibility, training, enforcement, and monitoring. The second project, 'Protecting Artist Work and Building Resilience in an AI-Driven Landscape,' aims to safeguard artists' rights and creations in context of Generative AI, fostering trust, safety, and productivity.

This paper proposes a framework for Holistic Thinking and illustrates its application through these case studies. By combining Systems Thinking and Design Thinking methodologies, it demonstrates effective way to tackle complex design problems.

***Keywords**: Design Thinking, Systems Thinking, Holistic Thinking, Product Innovation, Complex Problems*

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1. Background

In 2023, Design Thinking (DT), a popular human-centred innovation process, faced intense scrutiny following critical analysis published by Fast Company and MIT Review. Fast Company in 2023 featured an article that suggested that the era of Design Thinking has ended following IDEO.org laying off its staff by 32%. It claimed that the company that elevated DT, a methodology using design to solve business problems, was changing its own business model as it fell out of favour in the boardroom. (Mittersinker, 2024). Similarly, the MIT Review published an article 'Design thinking was supposed to fix the world. Where did it go wrong?' (Ackerman, 2023) which meticulously documented various case studies highlighting the shortcomings of DT implementations. While the article cites number of failings of DT, the reasoning resonating with this paper is, DT approach does not consider the complexities of the problem, the solutions are short term focused and lacks the ability for seamless systemic integration in broader context.

History of Design Thinking (DT): Founded in the 1990s, IDEO was instrumental in popularizing the Design Thinking process throughout the 2000s and 2010s, alongside Stanford's Hasso Plattner Institute of Design or "d.school". IDEO's way of working: a six-step methodology for innovation called Design Thinking, which had emerged in the 1990s had started reaching the height of its popularity in the tech, business, and social-impact sectors in 2011 (Ackerman, 2023). At the time, economies in the developed world were shifting from industrial manufacturing to knowledge work and service delivery, innovation's terrain was expanding. Its objectives were no longer just physical products; they are new sorts of processes, services, IT-powered interactions, entertainments, and ways of communicating and collaborating - exactly the kinds of human-centred activities in which Design Thinking made a decisive difference. (Brown, 2008). Its influence stretched across health-care giants in the American heartland, government agencies in DC, big tech companies in Silicon Valley, and beyond (Ackerman, 2023). The large part of its success was due to its wide range of application across different industries and functions within a company. Thomas Lockwood (2009), former President of the Design Management Institute (DMI), extensively documented Design Thinking's application in enhancing Customer Experience, Brand Value, Business Transformation, and Service Design.

Significance of DT: Design Thinking (DT) brought significant transformation within design practice in corporate world. When DT emerged in the '90s and '00s, workplaces were made up of cubicles and closed doors, and the term "user experience" had only just been coined at Apple. Despite convincing research on collaboration tracing back to the 1960s, work was still mainly a solo endeavour in many industries, including design (Ackerman, 2023). Historically, design had been treated as a downstream step in the development process - the point where designers, who have played no earlier role in the substantive work of innovation, come along and put a beautiful wrapper around the idea (Brown, 2008). Design Thinking injected new and collaborative energy into both design and the corporate world more broadly (Ackerman, 2023). Rather than asking designers to make an already developed idea more attractive to consumers, companies asked them to create ideas that better met consumers' needs and desires which leads to dramatic new forms of value. (Brown, 2023).

Limitations of DT: However, by 2023, the limitations of Design Thinking (DT) became apparent, as previously discussed. For instance, in a 2021 article on the evolution of IDEO's practices, Brown, along with Shauna Carey and Jocelyn Wyatt of IDEO.org, cited the Diva Centres project in Lusaka, Zambia, where they worked to help teens access contraception and learn about reproductive health. Through the DesignThinking methodology, the team came up with the idea of creating nail salons where the teens could get guidance in a low-pressure environment. While the process focused on generating the most exciting user experience within the nail salons, it neglected to consider the world outside their walls—a complex network of public health funding and service channels that made scaling the pilot "prohibitively expensive and complicated," as the IDEO.org leaders later wrote. Though IDEO intended to build 10 centres by 2017, neither IDEO nor the partner organization ever reported reaching that milestone (Ackerman, 2023). This recurrent lack of systemic comprehension across numerous case studies reveals a consistent pattern of failing to fully understand the diverse stakeholders within the ecosystem, including their values, beliefs, and the resources required to effectively implement proposed solutions.

Almost two decades after DT rose to prominence, the world still has no shortage of problems that need addressing. Design leadership and design processes themselves need to evolve beyond Design Thinking (Ackerman, 2023). To address this imperative, a shift towards Holistic Thinking is proposed to foster innovation, integrating a systemic view with the DT framework. This paper argues that the limitations observed in DT can be effectively addressed by adopting a Systems Thinking approach. While DT excels in focusing on user needs through detailed analysis, the complementary Systems Thinking approach advocates zooming out to comprehend the broader systemic context at play.

2. Literature Review

History of Systems Thinking

The concept of systemic relationships and interdependencies as fundamental to universal evolution has been explored since ancient times. Jan Smuts (1930) articulated this theory in "Holism and Evolution," building upon earlier philosophy introduced by Plato around 365 BCE. In the 1920s, an interdisciplinary discourse in Europe involving biologists, psychologists, and ecologists deepened the understanding that “the essential properties of whole (system) are derived from the relationships among the parts (elements), and the processes in which the parts are involved” (Capra, 2023).

Systemic thinking in the design literature dates back to the Gestalt theory of perception applied to design. According to this theory, the role of a product or the solution it provides must be interpreted and framed according to the contextual landscape, while embracing all aspects and relationships surrounding the object and the user-product relations (Cautela et al., 2021b).

Definition of a System

A system is a set of elements that someone (observer) sees as related in some way and that persists, often with a purpose. An observer defines a system’s boundaries within an environment. The system may seek to maintain certain relationships with its environment, for example, maintaining dynamic equilibrium in the face of ongoing disturbances; that is, it may seek “to preserve its manner of living (Dubberly, 2023). Thus, each element within a system possesses the capacity for internal adaptations to suit its environmental conditions.

Systems Thinking in Design

Systems exhibit high volatility and continually evolve through a process of co-evolution, wherein systems and their environments mutually adapt. Co-evolution involves variation and selection (through both competition and cooperation), as well as drift (random fluctuations) and flow (recombination) (Maturana & Varela, 1972). Designers play a pivotal role in facilitating this systemic evolution through the creation of artifacts. According to Hugh Dubberly (2023), designers engage with systems across six levels:

- Acting outside the system.
- Accepting and applying the system.
- Extending the system.
- Managing the system.
- Creating the system. (Or later transforming it.)
- Automating the system

Thomas Edison created the electric light bulb and then wrapped an entire industry around it. The light bulb is most often thought of as his signature invention, but Edison understood that the bulb was little more than a parlour trick without a system of electric power generation and transmission to make it truly useful. So he created that, too. Thus, Edison’s genius lay in is ability to conceive of a fully developed marketplace, not simply a discrete device. He was able to envision how people would want to use what he made, and he engineered toward that insight (Brown, 2008).

Therefore, those who build/design artifacts must not just concern themselves with artifacts but must also consider the way in which the artifacts relate to social, economic, political and scientific factors. All these factors are interrelated, and all are malleable. Thus, innovators are best seen as system builders (Law, 2018). In this context, designers are viewed as innovators who shape and adapt systems to meet evolving needs.

Systems Thinking in present context

Every day, our world seems to grow more complex. Creating better ways of being in the world, that is, designing responsibly, requires understanding systems. Most challenges-that really-matter involve interaction among natural, social and technical systems (Dubberly, 2023). As result, the industry is changing and moving beyond mere digital applications. Rather than stand-alone apps, designers should consider a series of touchpoints across a service journey For instance, a person with diabetes might wear a continuous glucose monitor (CGM) that “talks” to an insulin pump. Both the monitor and pump may talk to a smartphone that runs a related app. In addition, the phone app talks to a database in the cloud, which provides information to designated family members and healthcare providers (Dubberly, 2023). This interconnected network comprises human and non-human elements that continually interact and inform one another.

In such a context, designers might map how insulin and blood glucose interact. They might map people and care networks, disease progression and patient journeys, and technical systems and their interactions. Further steps might look at interactions with ambient displays, systems involved in clinical trials, or systems that collect and fuse data from other sources. (Dubberly, 2023). Thus, each design artifact and user requirement is situated within a larger system. Designers must zoom in to comprehend individual elements and zoom out to grasp their interrelationships, essential for making informed design decisions that resonate across the entire system.

2.1. Advantages of Systems Thinking in Design Practise

In 2023, Hugh Dubberly, former Apple Creative Director overseeing graphic design and corporate identity, and Paul Pangaro, a faculty member at the School of the Visual Arts, Carnegie Mellon University, authored an influential article titled "How might we help designers understand systems." This article delineates the fundamental characteristics of systems, their behavioural dynamics, and their relevance to both design practice and education. The present paper considers this seminal work as a primary source in the field and applies concepts derived from it to analyse two design projects as case studies. These concepts are selected based on their potential to foster product innovation and complement the Design Thinking methodology.

(Unless otherwise specified, subsequent sections draw from the above article.)

A. Frames for understanding the world: Systems theory provides frames for observing the world and making sense of it — frames for understanding. Systems theory also helps designers understand what is designed (framing “the system” to be a result of a design process); potential consequences or effects on other systems and the mitigation of actual consequences; the context of use for what is designed; and the design processes itself.
Systems may be framed in as many ways as there are situations and observers. The best approach to framing a system depends primarily on the observer’s goals. In design situations, the stakeholders’ goals should take precedence along with considerations about the system type and context.

Systems may be viewed in terms of:
- Their parts (form and constituent elements).
- Their materials (natural, social, and technical).
- Their structure (the relationships between their parts).
- Their growth (how they form and evolve).
- Their purpose (goals — the relationships they seek to maintain).
- The people involved (participants, stakeholders, designers, and other “observers”).

B. Systems Integration: Systems designers examine the context of the artifact: the stakeholders, goals, activities, interactions, and environments that the artifact gathers; artifacts need to relate to other artifacts — that is, they need to fit or otherwise work together in a system.

C. Socio-Technical Systems: Natural systems (for example, genes, cells, plants, animals, and ecologies) support and are affected by social systems (for example, groups, organizations, communities, and languages), which support and are affected by technical systems (for example, products, buildings, services, and platforms). Thus, a system is dynamic combination of natural systems, social systems and technical systems that is interrelated and potentially malleable.

Artifacts often necessitate the construction of a supporting system. For instance, Edison's problem was simultaneously economical (how to supply electric lighting at a price that would compete with gas), political (how to persuade politicians to permit the development of a power system), technical (how to minimize the cost of transmitting power by shortening lines, reducing current, and increasing voltage), and scientific (how to find a high resistance incandescent bulb filament) (Law, 1987). Therefore, designing within such systems demands in-depth understanding of socio-technical factors, encompassing their values and intricate interrelationships.

D. Future State of Design Artifact: A sustainable artifact needs a system that anticipates future change (or at least some reasonable types of change). Considering multiple time frames ranging from design implementation to after-life of the artifact can aid in such artifact development. The range of questions to ask are:

- How does the project relate to adjacent systems or layers that might change at faster and slower paces? Where does it change quickly? Where does it change slowly?
- What aspects of the system (and its related social systems) help it to adapt to a rapidly changing world? What aspects help it to conserve its essential properties over time?
- What effects will the project have over weeks, months, years, lives, and generations?
- Systems (particularly complex systems) may be organized into layers that operate at different paces or speeds. Layers that operate quickly may be important in responding to change. Layers that operate slowly may be important in conserving the system's structure and manner of living (including its intentions, strategies, and values).

One challenge to understanding systems is that they are often invisible or inchoate, or they may be difficult to see all at once as they stretch across space and time. Many change continuously. That means working directly on systems is not always possible; sometimes proxies are needed (including models, white-board sketches, maps, prototypes, digital twins or data-driven dynamic models). Sharing and iterating models can help teams agree on purpose, current structures, operations, bugs, goals, plans, etc. Shared models create shared understanding and alignment (Dubberly, 2023). Hence the systemic thinking approach is demonstrated in the case studies through different models.

2.2. Holistic Thinking in Design Practise

That which comes to be always does so as a whole.
so that if a man does not count the whole among
realities he ought not to speak of substance or of
coming-to-be as real. "
- Plato

ST provides a broader understanding of the contextual landscape encompassing social, economic, technological, and political factors that influence problem domains. By situating artifact design within this larger system and considering diverse time frames, ST ensures the stability and sustainability of innovations. Yet, ST primarily categorizes user groups rather than addressing individual user nuances, which poses risks to product desirability.

Therefore, Holistic Thinking advocates for the integration of DT and ST methodologies in the evolution of design practices. This approach not only leverages DT's strengths in user-centric innovation but also incorporates ST's systemic insights to mitigate operational risks and enhance long-term viability.

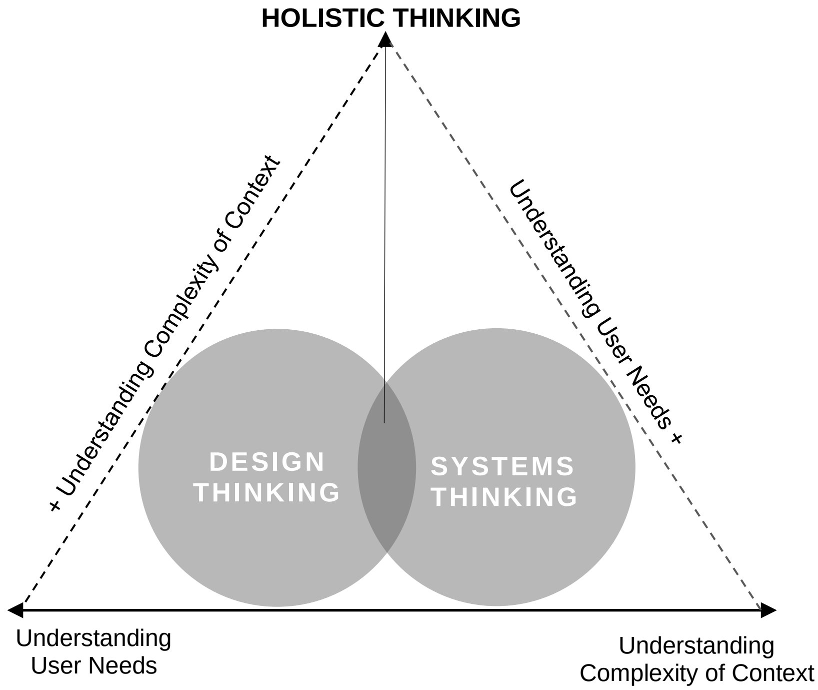


Figure 1: Holistic Thinking Framework

3. Case Studies

This section presents two case studies exemplifying Holistic Thinking methodologies applied to enhance the stability and sustainability of design artifacts. Each study is detailed with an overview of the problem complexity, methodology employed, data collection protocols, project outcomes, and deliverables. The integration of Systems Thinking (ST) and Design Thinking (DT) methods is emphasized throughout.
The first case study deals with the complexity of emerging technology, Generative AI(GenAI). It seeks to help the visual artist community build resilience and protect their artwork in context of GenAI. It leverages Systems Thinking principles such as 'future state of design artifact' and 'understanding socio-technical systems' to achieve a sustainable design solution. Second case study, Medical Waste Management in the Healthcare Sector of India. This case study addresses the challenge of medical waste management within India's healthcare sector. It employs Systems Thinking concepts such as 'frames for understanding the world' and 'systems integration' to develop a stable design artifact.

3.1. Case Study 1: Generative Image AI and Virtual Artist Community

The launch of Generative Artificial Intelligence (GenAI) platforms in 2023 significantly disrupted the creative industries, eliciting a mixture of excitement, curiosity, and fear. Generative artificial intelligence (GenAI) refers to AI capable of generating text, images, videos, or other data using generative models, often in response to prompts. These models are trained on diverse bodies of work, including writings, paintings, and musical compositions by various artists. Recognized as the fastest-growing technology, GenAI is projected to become a $1.3 trillion market by 2032 (Bloomberg, 2023).

The widespread adoption of GenAI has profoundly impacted the arts community, heightening concerns about the future of artistic occupations. Some wonder if their work will become irrelevant, and whether the work they produce will be protected (Pantaloni, 2023). This unease has led to significant movements such as the WGA writers' strike and the SAG-AFTRA actors' strike. While writers and actors benefit from union support to defend their rights, visual artists must navigate these challenges independently.

In an interview, faculty member from the Illustration department expressed this disparity: “They have a union that fights for their rights. It's hard for us (illustrators) to unionize because the word illustration encompasses so many things. You have entertainment, you have editorial, you have people just working for companies like Hallmark that does cards, surfaces and textiles. All that is illustration.” Consequently, individual visual artists such as Karla Ortiz, Sarah Anderson, and Kelly McKernan have taken the lead in the battle, crowdfunding to support lawsuits against image GenAI companies.

Problem Statement

Visual artists face significant challenges due to the rise of Generative AI (GenAI) technology in three primary areas. Firstly, there is the issue of art theft. To develop GenAI platforms, product developers must train AI models using millions of high-resolution artworks. These artworks are often scraped from internet platforms and social media without the consent of the original artists, raising serious moral and ethical concerns.
Secondly, copyright infringement is a major problem. When prompts include an artist's name, the GenAI platform typically generates artwork that closely mimics that artist's style, often making it indistinguishable from their original work. This directly impacts the income of freelance artists, whose unique skills are easily replicated by GenAI, undermining their hourly wage opportunities.
Lastly, job insecurity is a growing concern. Companies can now produce a higher volume of high-quality ideas in less time using GenAI. Research report by CVL Economics (2024) indicates that a significant percentage of creative jobs will be affected by GenAI in the following years, placing considerable pressure on early career artists.

Project Goals

Given the vulnerability of the visual arts community, particularly those in Illustration and Concept Arts, this project aims to conduct further research and develop solutions to support and protect artists amidst rapid technological advancements. Based on insights gathered, the three main goals of the project were:

1. Empower visual artists to protect their artwork from art theft - The project will provide tools and strategies to safeguard artists' creations from unauthorized use ensuring their intellectual property rights are upheld.

2. Build resilience by creating awareness about the technology and its use cases - Through educational initiatives, the project will inform artists about GenAI technologies and potential applications, enabling them to navigate the evolving digital landscape with ease.

3. Facilitate a holistic integration of technology into their workflow - The project will explore ways to seamlessly integrate GenAI tools into the creative processes of visual artists, enhancing their productivity while preserving the integrity.

Methodology

The problem is complex and ongoing. The technology is still evolving within a rapidly changing dynamic system. According to Gartner's Hype Cycle (2023), the technology is at the peak of its hype cycle. This indicates that while it has garnered significant public attention, there is widespread confusion regarding its ethical implications, and inflated expectations fuelled by advertising campaigns. It is anticipated that the technology would stabilize within the next 2-5 years. Until then, the artifacts produced by this project must evolve in tandem with the changing system, by maintaining close observation of elements in the system. Hence the Holistic Thinking method, combination of DT and ST (as explained in literature review), was used to address this complexity.

Systems Thinking for Sustainable Innovation

The method employed aimed to determine the "future state of design artifact" and understand "socio-technical systems" (STS). To achieve this, various models were used. Such as STS framework to locate different human and non-human elements in the system, actor's network map to examine the interdependencies between these elements and stakeholder exchange map to analyse the value exchanges between stakeholders. This analysis culminated in identification of the innovation ecosystem and target audience.

Furthermore, the future state of the design artifact determined by a comprehensive framework. This framework guides the systematic integration of GenAI technology into workflows, incorporating technological changes and promoting sustainable practices.

Design Thinking for User-Centric Innovation

The method facilitated a deep understanding of the target audience and the development of empathy. Contextual interviews, surveys, and cultural probes were utilized to collect data points from users. The collected data points were then grouped into affinity diagram, which revealed an "ideal experience framework" for using GenAI technology. This framework guided the development of initial concepts.

Approach	Aims	Tools and Activities	Outcomes
Systems Thinking	Understanding socio-technical systems	- Socio-Technical System Framework - Actor's Network Map - Stakeholder Exchange Map	- Innovation Ecosystem - Target Audience Identification
	Future state of design artifact	- Ten Step Integration Model	- Sustainable Integration
Design Thinking	Developing user empathy	- Contextual Interviews - Survey - Cultural Probes	- User Needs
	Data Analysis	- Affinity Diagram - Coding - Design Criteria	- Actionable Insights
	Concept Development	- Ideation	- Design Proposal

Fig 2: Holistic Thinking framework for the case study

Data Collection Protocol

At the project outset, desk research aided in developing systemic understanding through review of over twenty-five diverse sources consisting of books, articles, blogs, webinars and interviews. Since the job insecurity issue was mainly faced by the early career artists, a survey was distributed among Illustration majors at Savannah College of Art and Design, yielding 66 responses that were meticulously analysed.

Additionally, twelve interviews were conducted with a varied group including two illustration faculty members, six artists, one gaming industry employer, one Generative AI software engineer, one museum curator, and one copyright expert.

Further insights were gathered through a cultural probe involving five artists at a farmers' market to gauge perceptions and ideal forms of GenAI. Data sets from these activities were synthesized using yellow sticky notes on a Miro Board, coded, and categorized into affinity diagrams to derive actionable insights.

Findings and Outcomes

This section represents outcomes of the project, systematically divided into four distinct parts:
1. In-depth understanding of Socio-technical Systems.
2. Comprehensive understanding of user needs.
3. Product proposal.
4. Determining sustainable integration of design artifact.

Part 1: In-depth understanding of Socio-technical Systems.

Recognising Generative AI system's multiple elements through a socio-technical framework. This approach highlights the elements of social, economic, and political factors that shape and influence the technology.

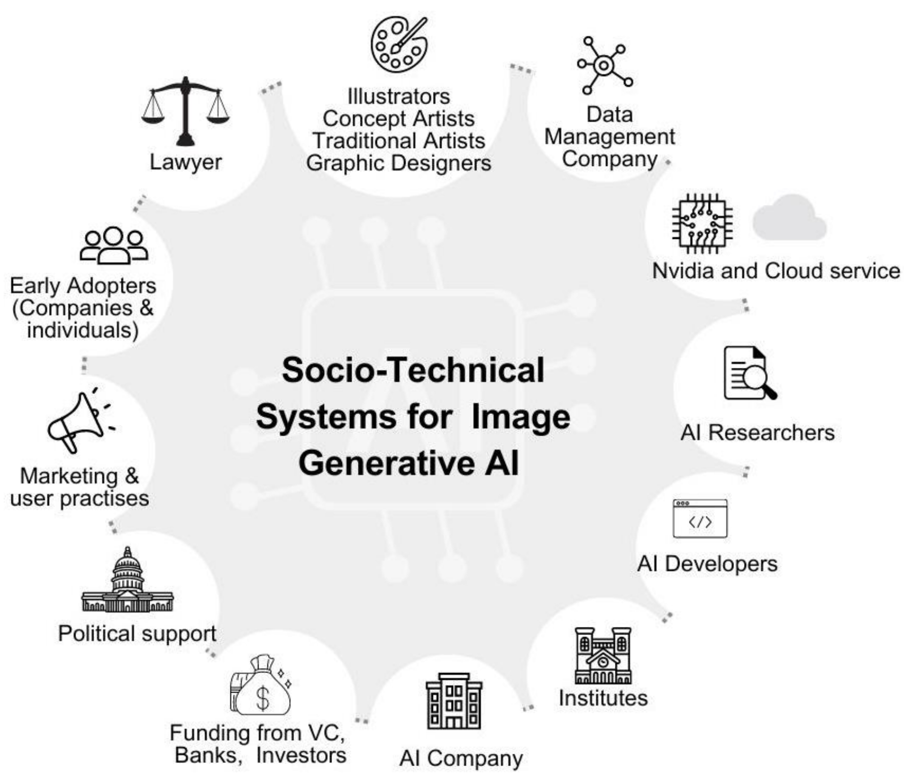


Fig 3: Socio-Technical System of Generative AI Technology

The inter-relationships between elements of the Generative AI system were Analyzed using an Actor-Network Theory (ANT) framework. This analysis yielded two major insights.

Firstly, the adoption of generative AI by companies negatively impacts artist job security. However, the innovation ecosystem, comprising individual artists and employers, can transform this negative impact into a positive one by integrating responsible technology within workflows while acknowledging and valuing human expertise.

Secondly, systemic violations occurring during the generative AI product development stage render artists' work vulnerable to theft and copyright infringement. Government regulations are essential to maintain system integrity and protect intellectual property. In the interim, until such regulations are established, the responsibility for protecting artwork falls on the artists themselves.

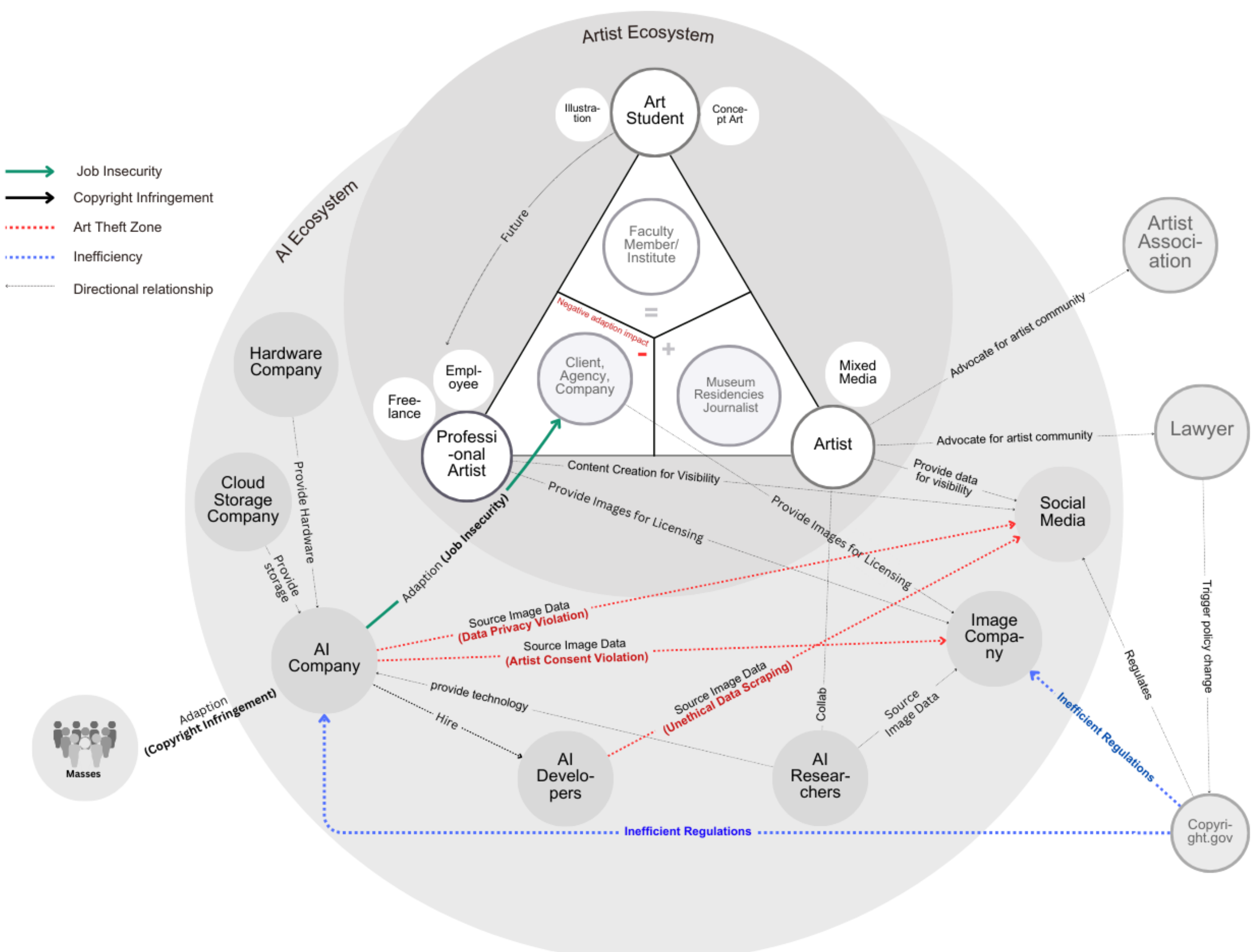


Fig 4: Actor's Network Map

The Stakeholder Value Exchange Map illustrates the interaction between the ecosystems of artists and Generative AI (GenAI). Artists disseminate their work on various internet platforms to enhance visibility and outreach. However, generative AI developers frequently scrape these artworks without the artists' consent for machine learning purposes. This unethical practice adversely affects the artist community.

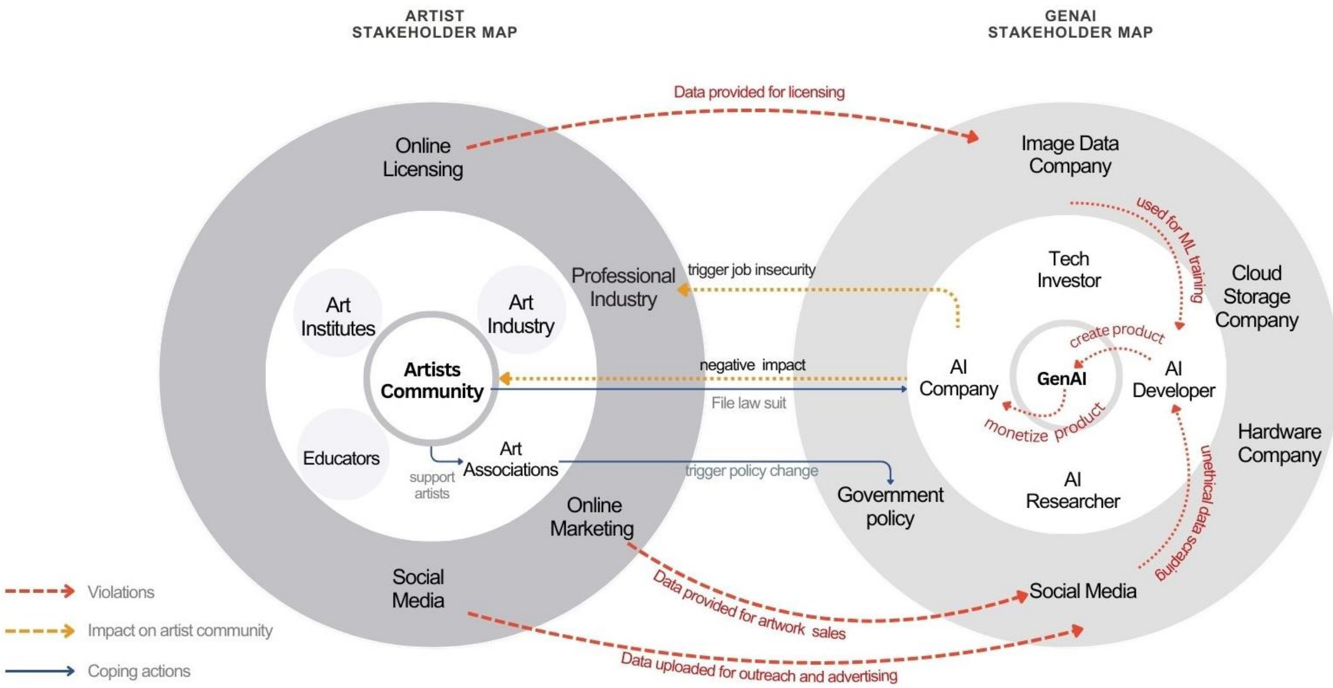


Fig 5: Stakeholder Exchange Map

Part 2: Comprehensive understanding of user needs.

Lextant's Ideal Experience Framework for artists is a product of the Design Thinking methodology. User interviews revealed that, despite ethical concerns associated with generative AI, artists recognized its clear benefits and expressed willingness to learn to use the software to enhance efficiency and save time. However, it is crucial for employers, clients, and agencies to treat generative AI as a co-worker rather than a replacement for artists. Artists are seeking relief amid present chaos.

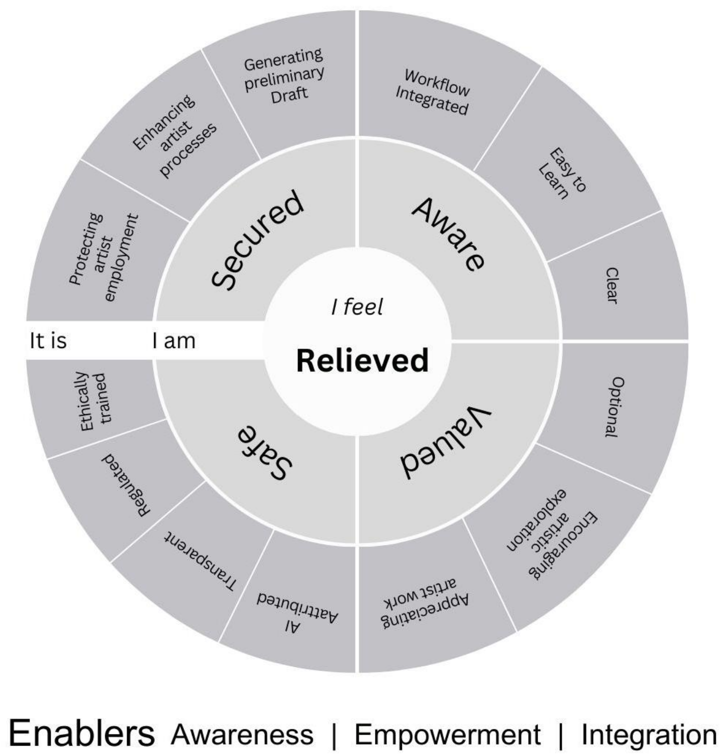


Fig 6: Artist Ideal Experience Framework for using GenAI

Twelve design criteria were derived from the attributes outlined in the outermost circle of the Ideal Experience Framework. Only those criteria that demonstrated feasibility, desirability, and viability were advanced to the concept development stage. These include integrated workflow to streamline artist processes, heightened awareness of technology and measures for safeguarding artwork.

Fig 7: Design Criteria

Concept exploration encompassed three ideas. The first involved a series of workshops, while the second proposed a summit featuring lectures and panel discussions. The third idea centred on an accordion-style poster encapsulating comprehensive information about GenAI.

Due to the rapid evolution of technology, particularly within the GenAI domain, both the poster and summit were challenging to maintain and update, which is critical for the project's success. Hence, the workshop series was selected as the preferred concept, designed to include monthly upgrade workshops to keep pace with technological advancements.

Workshop

Navigating Disruption

Summit

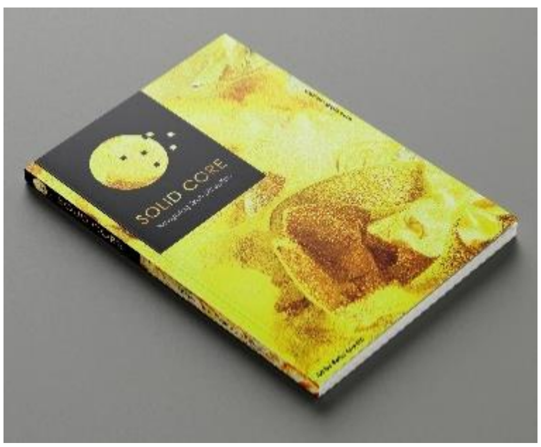
Art in AI Age

Poster

Unveiling GenAI

Fig 8: Concept Development

Part 3: Product Development



Product 1:
Solid Core – Employer Facing Consultancy

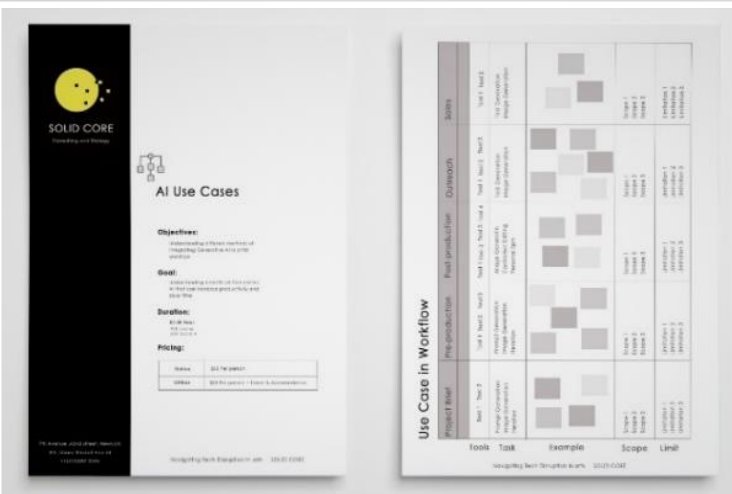
This business plan aims to facilitate the comprehensive integration of GenAI technology into the overall workflow of companies

Fig 9: Business Innovation

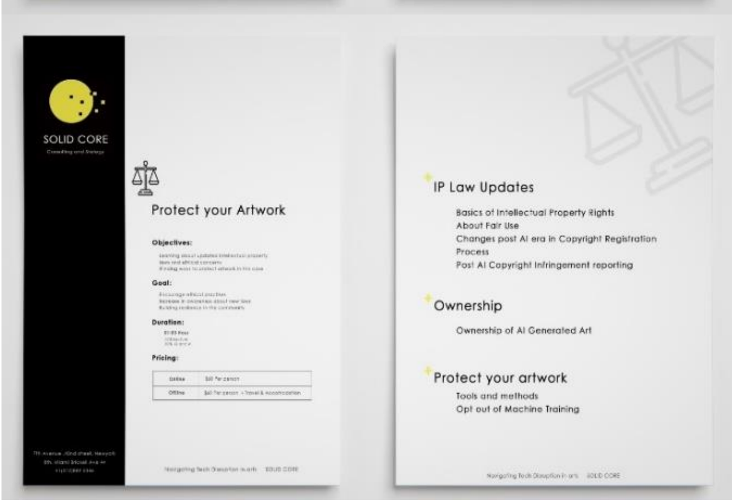
Product 2: Four-Module Workshop Series

This deliverable comprises a structured workshop series designed for artists and professionals to facilitate the seamless integration of GenAI technology into individual workflows.

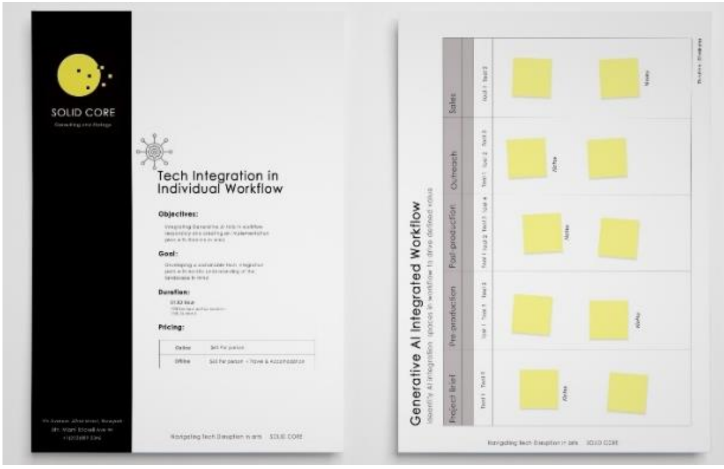
Module 1: Provides a foundational lecture on the basics of GenAI technology, elucidating the processes occurring within the system.



Module 2: Demonstrates various use cases of GenAI within the artistic workflow, illustrating practical applications.



Module 3: Offers a lecture focused on copyright laws and introduces tools and strategies essential for protecting artistic creations in the context of GenAI.



Module 4: Involves the co-creation of personalized workflows integrating GenAI, tailored to individual participant needs and objectives

Part 3: Sustainable Integration Plan

This section outlines a ten-step model for the integration of the artifact over a three-month period. For businesses, GenAI applications can aid in all sorts of ways depending on organizational needs. In a three-month span, following these ten steps ensures sustainable adaption of technology across art and entertainment business.

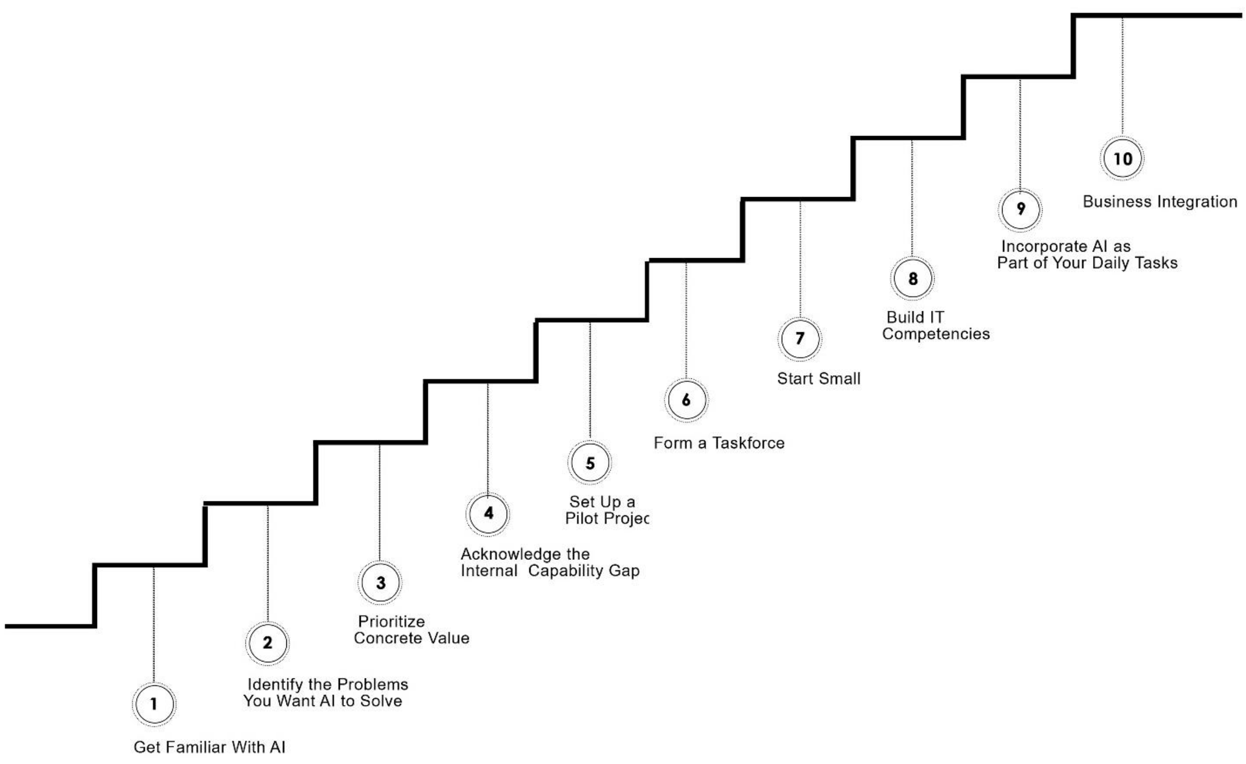


Fig 10: Sustainable Implementation Plan

Learnings:

Achieving Holistic Thinking demands a flexible mindset capable of seamlessly zooming in and out to navigate complex design problems. Systems Thinking approach enables generation of diverse perspectives essential for comprehensive problem-solving. Ultimately, Design Thinking serves as the guiding framework for selecting the most appropriate lens to design the final artifact.

3.2. Case Study 2: Bio-Medical Waste Management System

In 2016, India implemented specific regulations to manage biomedical waste, mandating that all healthcare centers and facilities adopt a color-coded waste separation system and transfer waste to treatment facilities within 48 hours. The COVID-19 pandemic exacerbated the rapid growth of biomedical waste, straining existing waste management facilities, particularly in developing countries like India. Improper waste separation practices often lead to the mixing of hospital waste with general waste, resulting in harmful overall waste flows. These waste generation and management issues pose daily challenges and significantly impact the global environment, contributing to air, water, and soil pollution (Manekar et al., 2022). India continues to struggle with the proper management of biomedical waste and its associated risks (Javeed and Kallihal, 2021).

Addressing such complex problems requires a Systems Thinking approach. Designing without a thorough understanding of systems raises ethical concerns and may border on malpractice (Dubberly & Pangaro, 2023). Systems thinking facilitates an understanding of the interconnected nature of organizational environments (Simona, 2019).

History of Bio-Medical Waste Management in India

Effective management of medical waste has been critical due to its potential health hazards. According to the World Health Organization, failures in healthcare waste management often stem from a lack of awareness about the associated health risks, inadequate training in proper waste management, the absence of waste management and disposal systems, and the low priority given to this issue. Many countries either lack appropriate regulations or do not enforce them effectively. Untreated biomedical waste is a potential source of pathogens, with literature documenting more than 40 species of harmful microorganisms capable of transmitting and causing human illness (Chand et al., 2021).
India’s Bio-Medical Waste Management and Handling Rules, established in 1998, mandate that healthcare institutions ensure the proper implementation of biomedical waste management protocols (Joshi et al., 2015). Despite these regulations, challenges persist in achieving effective waste management practices, underscoring the need for continued focus and improvement in this area.

Problem Statement

The Central Pollution Control Board (CPCB) is the apex body responsible for monitoring biomedical waste (BMW) management activities in India under the Ministry of Environment, Forest, and Climate Change (Manekar et al., 2022). Despite the CPCB's efforts, the COVID-19 pandemic has highlighted significant problems at various levels, including hospitals, small clinics, and households. Notably, 70% of healthcare practitioners do not receive any orientation or training regarding biomedical waste handling (BBRJ, 2023), and 57% of healthcare personnel are unaware of the categorization of biomedical waste and its proper disposal in color-coded bins or bags (Golandaj and Kallihal, 2020).
Research identifies improper waste separation at the point of generation and a lack of awareness among sanitation workers as key factors leading to improper waste disposal. The daily production of biomedical waste and its processing capabilities are inversely proportional, suggesting that India is at risk of being overwhelmed by its own garbage if current practices do not improve (Manekar et al., 2022).

Project Goal

This case study aims to address two key challenges faced by small healthcare facilities and clinics:
1. Raising awareness and emphasizing the importance of safe medical waste disposal among sanitation workers and doctors.
2. Establishing an error-free waste segregation process.

Methodology

According to *Hemingway's Iceberg Principle*, the factual meaning of a part of inscription should not be obvious from the surface fiction for the reason that the main point of the work is under the surface (Darzikola, 2013). Similarly, the innovation process in a complex sector like healthcare necessitates a holistic approach due to the extensive complexity of the system, which involves multiple stakeholders and interconnected subsystems. For sustainable, long-term solutions, it is crucial to begin by understanding the intricate interconnectedness of the system and identifying its root causes. This foundational understanding allows for the development of systemic solutions that address underlying issues comprehensively, rather than merely treating the symptoms.

Systems Thinking for Stable Innovation

Systemic thinking was employed at both the beginning and end stages of the process to achieve a comprehensive understanding of the biomedical waste management ecosystem. Initially, this involved monitoring the system through extensive research, including reports, regulations, academic papers, webinars, and competitive analyses. The goal was to identify key stakeholders, map the ecosystem, understand power dynamics and mental models of stakeholders, and formulate initial problem statements. This approach also helped identify internal and external forces that could impact the long-term viability of proposed solutions. Towards the conclusion, systemic thinking was instrumental in optimizing potential ideas and assessing their implementation feasibility within the existing system to ensure sustainability.

Design Thinking User-Centric Innovation

Design thinking played a pivotal role in crafting a comprehensive project plan. Each step was meticulously planned, with outcomes informing the scope for subsequent steps, ensuring cohesive progression. Surveys, contextual interviews, and in-depth interviews with identified stakeholders provided insights for reframing the problem statement and establishing opportunity areas and design principles.Co-creation and co-design workshops with key stakeholders, which included brainstorming sessions, facilitated ideation and visualization. A prioritization matrix was utilized to analyze and prioritize ideas, leading to the formulation of outcome and impact statements. Low fidelity prototyping enabled usability and feasibility testing, refining the project's vision and implementation map. This iterative process helped refine the outcome and impact statements and define service metrics for subsequent prototyping and experience measurement.

Data Collection Protocol

Desk research played a crucial role in understanding the medical waste management system and government guidelines. Over 20 research materials were sourced, including research papers, blogs, virtual webinars, and waste management reports. Through desk research, stakeholders were mapped, and an ecosystem map was designed to understand the value exchange and interdependencies among them. A service blueprint was created to delineate frontstage and backstage activities and the technology involved in the system, helping identify problems within the current medical waste management system. This comprehensive process facilitated the identification of key stakeholders, specifically doctors and waste handlers. A survey published to gather data received over 50 responses from doctors. Additionally, 12 in-person and virtual interviews, both in-depth and contextual, were conducted with six doctors who run their own clinics in tier-one cities, one waste management manager responsible for educating waste handlers about medical waste, two assistants/waste handlers whose primary responsibilities include waste segregation, one waste inspector who regularly inspects hospitals, and two Ph.D. students researching medical waste management. These interviews provided valuable insights into the prevailing practices of

biomedical waste management within their respective facilities or workspaces, pinpointing existing challenges and identifying specific stages in the system where improvements are necessary.
Finally, co-creation workshops were conducted with six doctors to understand their current needs and desired changes in the system. Analysing the gathered data yielded 550 data points, resulting in 12 insights and three design principles. These findings were instrumental in crafting the ideal experience framework, which visually emphasized the pressing need to improve biomedical waste segregation practices and make information more accessible.

Findings and Outcomes

The outcomes are structured into three parts, beginning with Systems Thinking (understanding the system as a whole, including value exchange among stakeholders and their mental models), transitioning into Design Thinking (understanding user needs), and concluding with Systems Thinking (integrating the design artifact within the current system).

Part 1: Understanding the System as a Whole

The Service Ecosystem Map comprehensively illustrates all actors, interfaces, and their interactions within the healthcare waste management value network. This holistic view facilitates understanding of the system dynamics and the extent of stakeholder involvement. The Stakeholder Map was instrumental in identifying and categorizing stakeholders based on their levels of participation, interest, and influence within the healthcare waste management system.

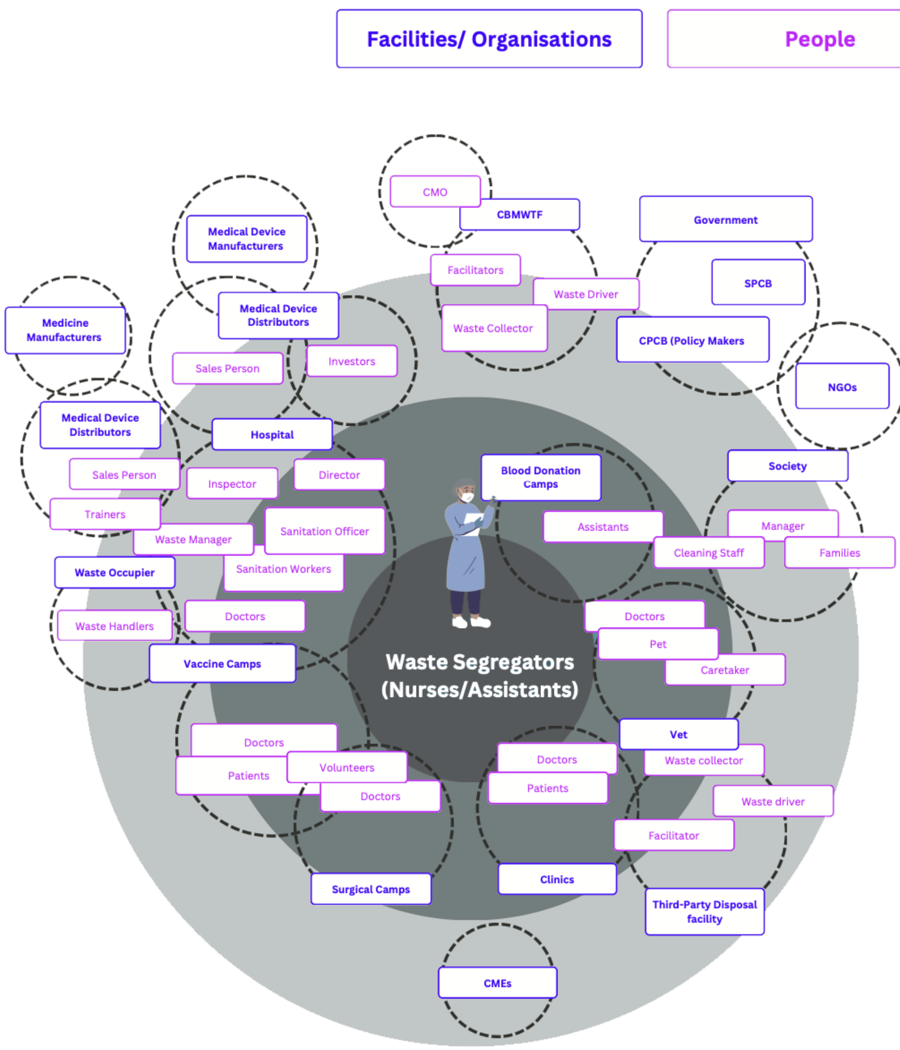


Figure 11: Ecosystem Map

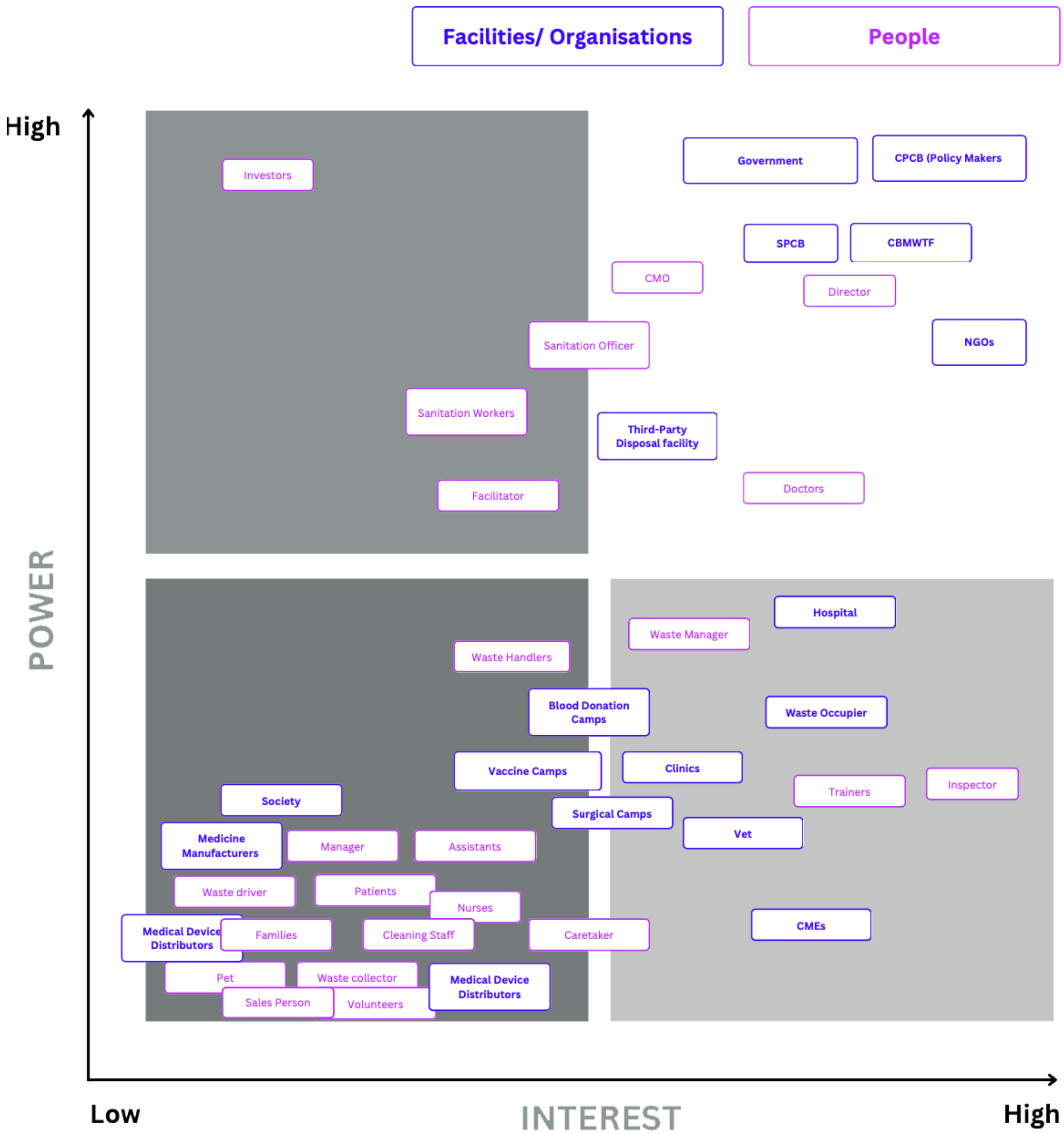


Figure 12: Stakeholder's extent of Involvement

The value exchange map delineates stakeholders involved in the biomedical waste management process, arranged hierarchically from top to bottom based on their system rank. Higher-level stakeholders typically exhibit a perceived process attitude, focusing on regulatory oversight and assuming that lower-level stakeholders perform their tasks correctly without detailed evaluation. This method facilitated navigation of obstacles and challenges in the scenario by illuminating disconnects within the current system.

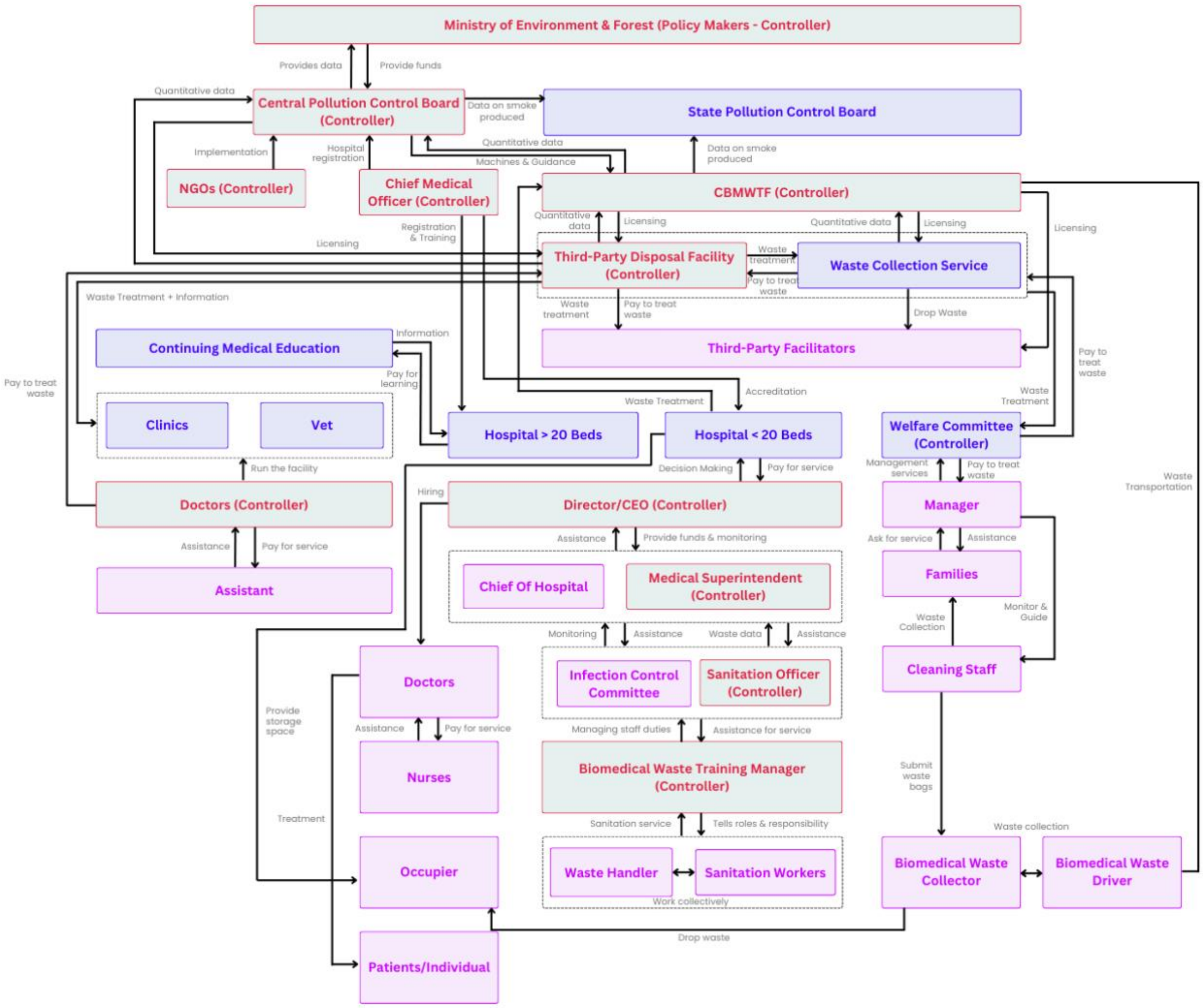


Figure 13: Stakeholder Value Exchange Map

Part 2: Understanding User Needs

The Lextant's Ideal Experience Framework, derived from the Design Thinking methodology, outlines the desired experience of doctors and waste handlers. Insights gleaned from user interviews indicated that these stakeholders require a system where they feel knowledgeable about medical waste management norms and current regulations and are motivated to practice safe handling without feeling burdened. Through Affinization, 12 key insights were identified, culminating in the formulation of three design principles: proactive decision-making, accessibility to relevant information, and effective tracking of waste generated by healthcare facilities. These principles aim to address the identified needs and enhance the overall experience of stakeholders involved in medical waste management.

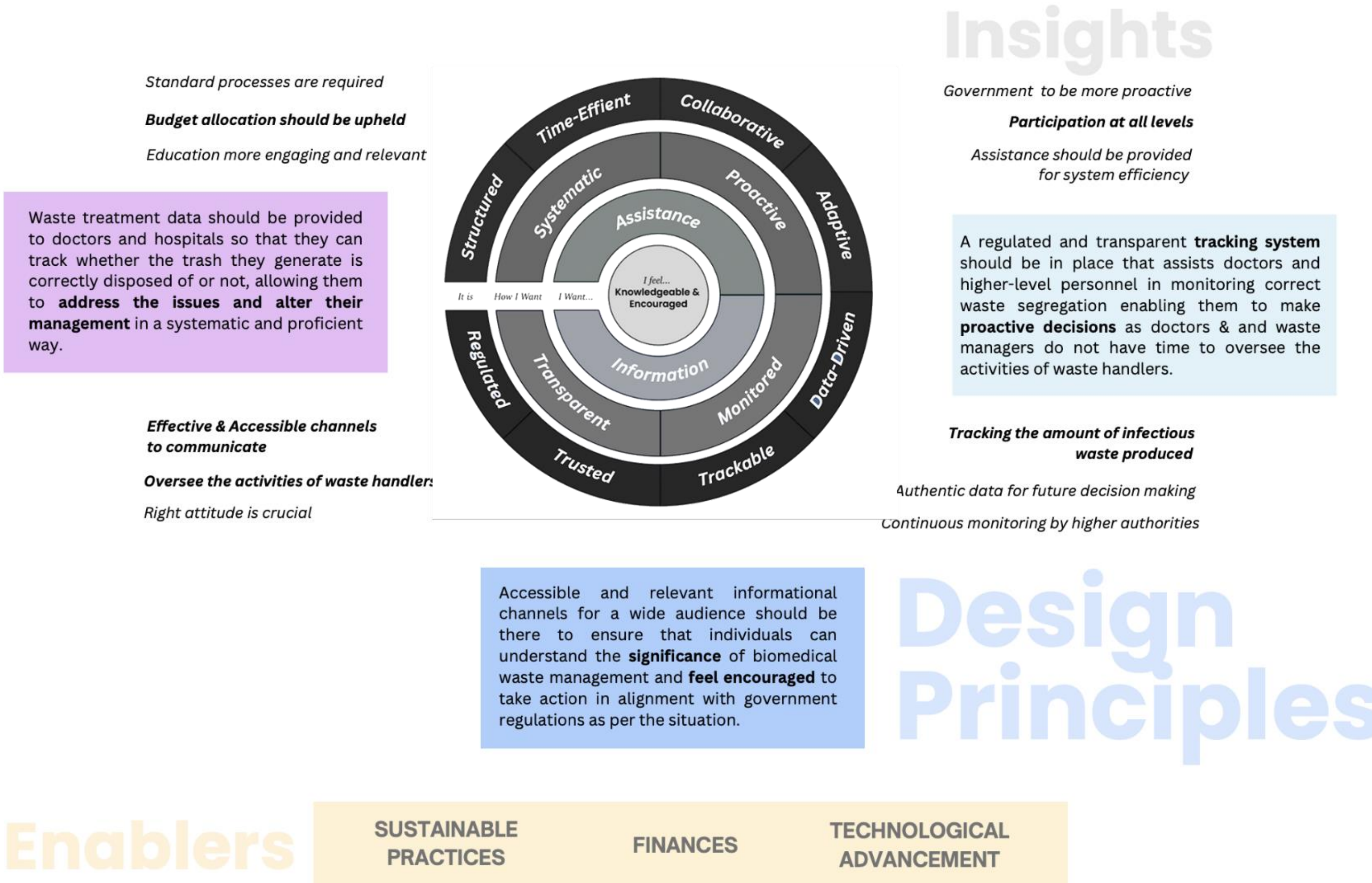


Figure 14: Ideal Experience Framework

Design and Development of Mediguide: A Comprehensive Biomedical Waste Management Platform

Design criteria were derived from the attributes outlined in the outermost circle of the Ideal Experience Framework. However, only those criteria deemed feasible, desirable, and viable progressed to the concept development stage. Utilizing these design criteria, Mediguide was developed as an innovative and comprehensive platform designed to facilitate the safe and efficient disposal of biomedical waste in small healthcare facilities. Mediguide empowers doctors by providing effective and inclusive informational channels and waste segregation tools, thereby enhancing the handling of biomedical waste. The platform includes training modules and assessments that empower assistants and nurses to educate themselves, thereby alleviating the burden on doctors and enhancing overall productivity.

Furthermore, Mediguide enables doctors to monitor the performance of their assistants in tests, identify knowledge gaps, and provide additional learning materials to bridge any divides. This integrated approach aims to streamline biomedical waste management practices and improve compliance with regulations in healthcare settings.

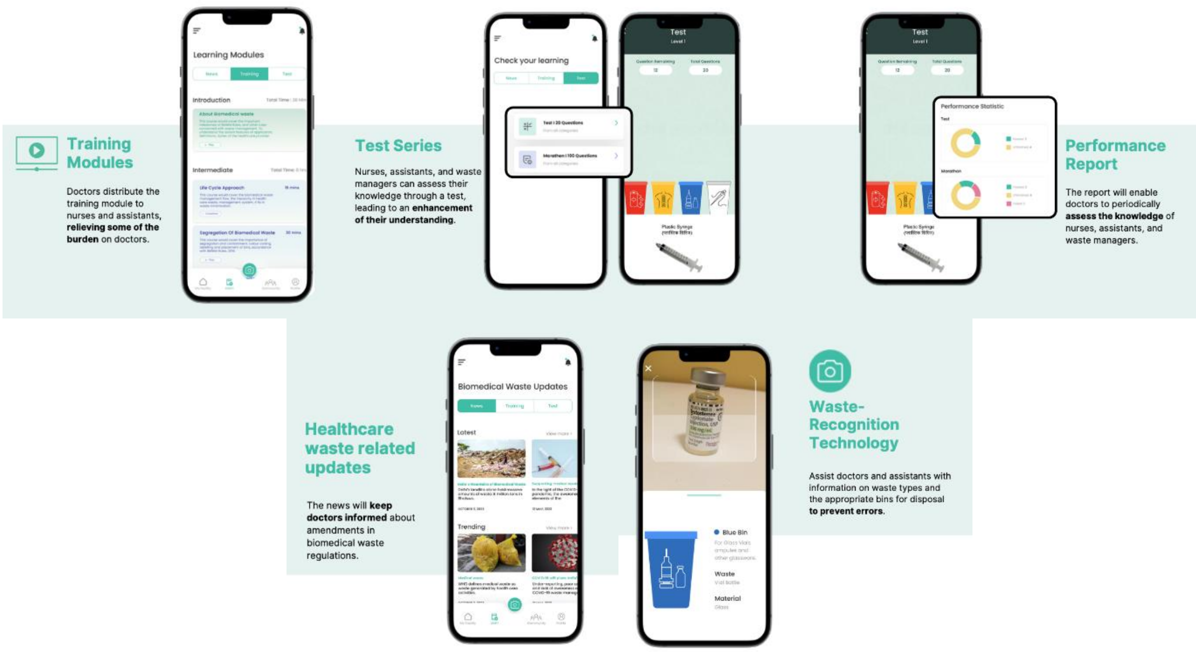


Figure 16: Product Development

The training modules and test series are designed to enhance the knowledge of waste handlers regarding waste segregation norms. Doctors will receive performance reports of their waste handlers, enabling them to evaluate training effectiveness and identify areas for further improvement through additional training modules. Waste recognition technology will facilitate error-free waste segregation processes, while regular updates on healthcare waste management practices will encourage doctors to actively implement biomedical waste management protocols in their healthcare facilities. This integrated approach aims to improve compliance with waste management regulations and enhance overall efficiency in waste handling practices.

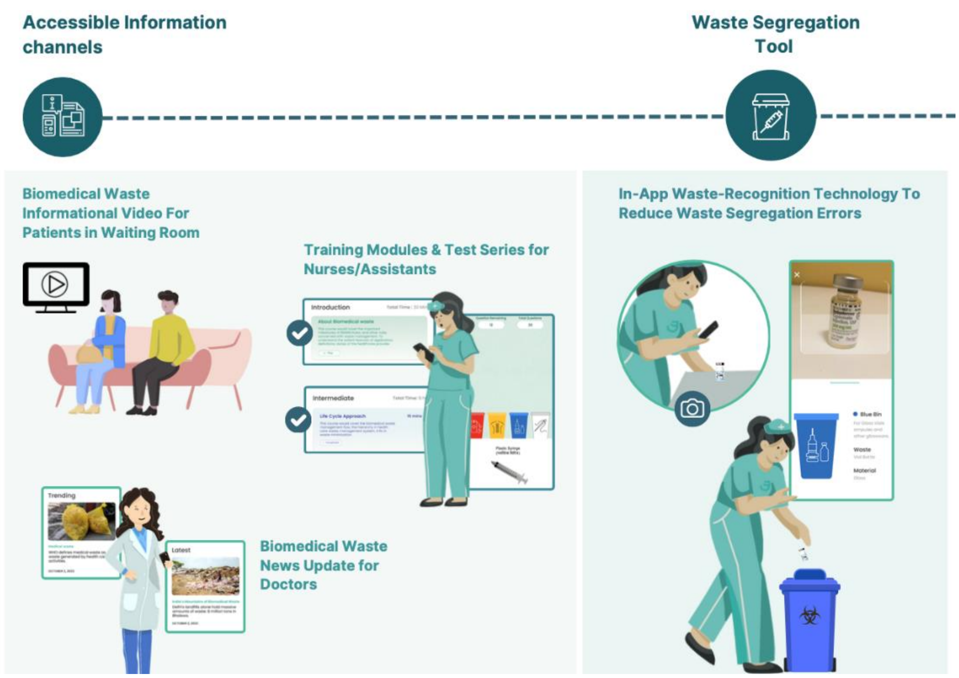


Figure 17: Waste Management Monitoring

Part 3: Systems Thinking to Integrate the Design Artifact within the Current System

An updated ecosystem map was developed to identify the key stakeholders who will utilize the MediGuide platform. Additionally, a service blueprint was designed to illustrate how this design artifact will integrate into the current healthcare facility system. This approach aims to ensure seamless integration of the MediGuide platform into existing healthcare facility operations, enhancing biomedical waste management practices through structured engagement with stakeholders and effective utilization of technology.

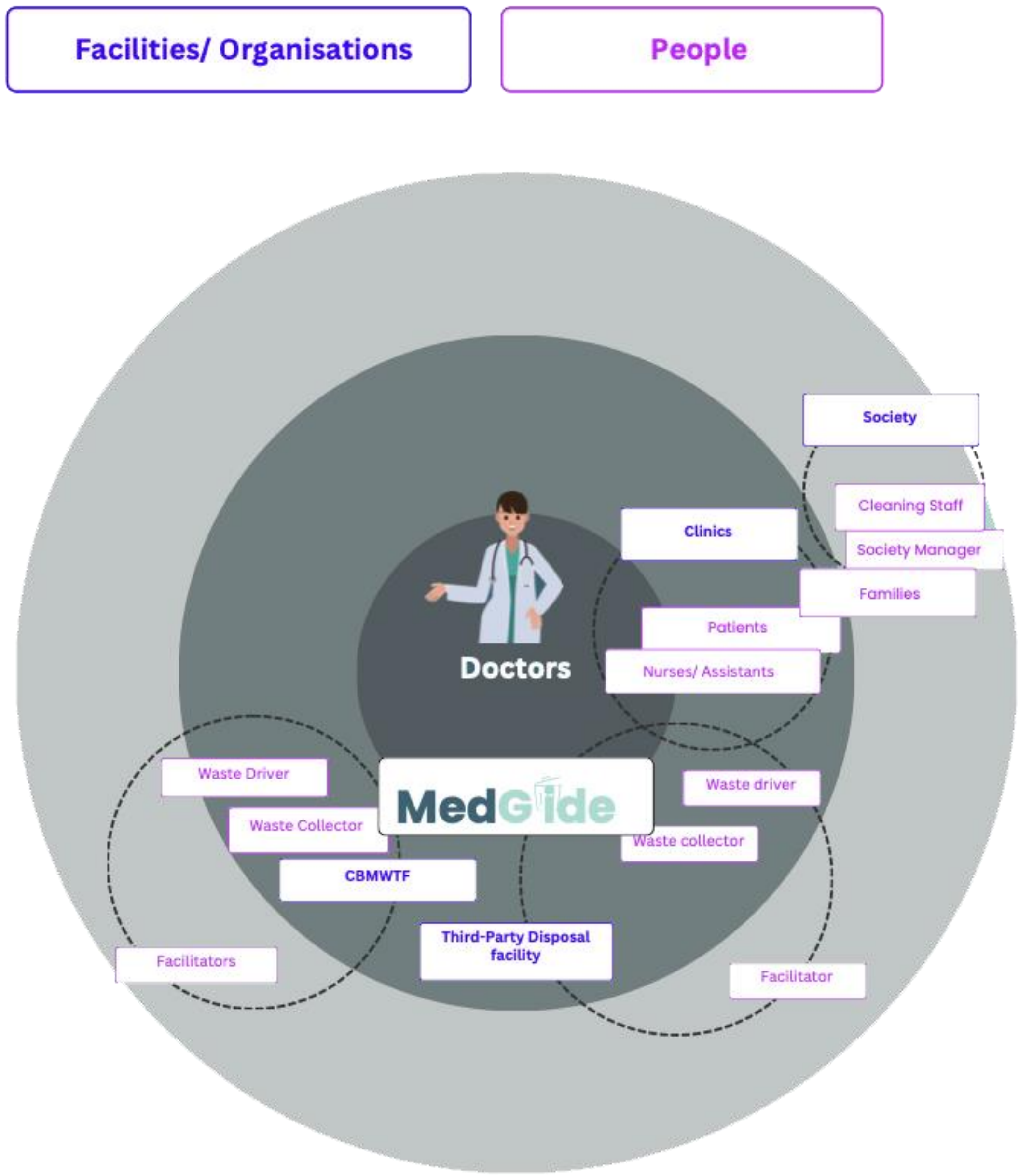


Figure 18: Ecosystem Map Post Product Integration

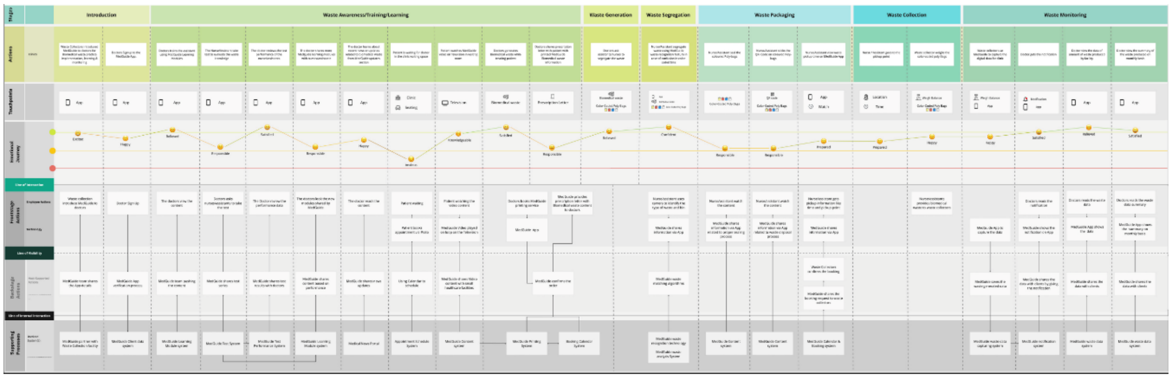


Figure 19: Service Blueprint (http://bit.ly/4c0RRUV)

Learning: By employing a holistic methodology, this project integrated design thinking and systemic thinking, resulting in a comprehensive and structured approach. Design thinking played a pivotal role in developing a robust project plan and understanding user needs and pain points. This iterative process ensured a cohesive progression throughout the project lifecycle.
Systemic thinking was strategically applied both at the outset and conclusion of the process. Initially, it facilitated an in-depth understanding of the ecosystem, stakeholders, their emotional perspectives, and mental models. This approach also helped in identifying internal and external factors that could potentially influence the long-term viability of the proposed solution

4. Conclusion

Systems thinking and Design Thinking complement one another. Systems Thinking aims at being holistic by following a method whereby the understanding of a system starts from the apparent issue and widens the system's boundary by expanding the circle to include those other factors that may not be so apparent but have an influence on and are connected to it, emphasizing the connections and synergy. Design Thinking, on the other hand, is more empathetic and human-centred and requires the modeler to be inside the problem and design the solution after having walked in the shoes of the affected (Mugadza, 2015).

The case studies presented highlight three key insights into the integration of Design Thinking (DT) and Systems Thinking (ST) for stable & sustainable product innovation. Firstly, combining DT and ST capitalizes on their complementary strengths: while ST provides a comprehensive understanding of the larger context and multiple perspectives, DT ensures the creation of user-centric products, resulting in lucrative business opportunities. Secondly, the Holistic Thinking approach emphasizes flexibility, allowing for a non-linear process with iterative back-and-forth movements, zooming in on user needs and zooming out to consider systemic forces. Thirdly, Holistic Thinking fosters multiple perspectives by understanding diverse stakeholders, their values, and behaviors, leading to stable products that align with the ecosystem.

The methodology discussed involves employing ST at the beginning and end of the project, with DT sandwiched in between. This sequence allows for a deep contextual understanding at the outset and systematic, sustainable integration post-product development. Future research should explore how ST can be effectively applied in non-wicked problem situations and identify case studies demonstrating the profitability and business value of Holistic Thinking.

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5. References

Mittersinker, G. (2024). Repairing a Relationship: The Fall of Design Thinking and What We Can Learn from It. *Design Management Review*, *35*(1), 94–95. https://doi.org/10.1111/drev.12391

Ackermann, R. (2023, August 15). Design thinking was supposed to fix the world. Where did it go wrong? *MIT Technology Review*. https://www.technologyreview.com/2023/02/09/1067821/design-thinking-retrospective-what-went-wrong/

Brown, T. (2008). Design thinking. *Harvard Business Review*, 85. https://designthinkingmeite.web.unc.edu/wp-content/uploads/sites/22337/2020/02/Tim-Brown-Design-Thinking.pdf

Lockwood, T. (2009). *Design thinking: integrating innovation, customer experience, and brand value*. https://e-library.ittelkom-jkt.ac.id/index.php?p=show_detail&id=1894&keywords=

Townsend, H. G., & Smuts, J. C. (1928). Holism and evolution. *The Philosophical Review*, *37*(1), 85. https://doi.org/10.2307/2179530

Capra, F., & Luisi, P. L. (2014). *The systems view of life*. https://doi.org/10.1017/cbo9780511895555

Cautela, C., Simoni, M., & Moran, P. (2021a). Microfoundations of dynamic design capabilities: An empirical analysis of "excellent" Italian design firms. ˜ *the œJournal of Product Innovation Management*, *39*(1), 3–23. https://doi.org/10.1111/jpim.12592

Dubberly, H., & Pangaro, P. (2023). How might we help designers understand systems? *She Ji*, *9*(2), 135–156. https://doi.org/10.1016/j.sheji.2023.05.003

Law, J. (2018). Technology and heterogeneous engineering: the case of portuguese expansion. *Logos*, *28*(5), 169–202. https://doi.org/10.22394/0869-5377-2018-5-169-199

Maturana, H., & Varela, F. (1972). Autopoiesis, the Santiago School of Cognition, and Enactive Cognitive Science. *Boston Studies in the Philosophy of Sciences*, *42*. https://doi.org/10.1007/978-94-009-8947-4

Pantaloni, N (2023, July 11). Ask the Expert: What are legal issues surrounding AI, its impact on the arts? News at IU, Indiana University. https://news.iu.edu/live/news/31782-ask-the-expert-what-are-legal- issues-surrounding-ai-it

Bloomberg - Are you a robot? (2023). https://www.bloomberg.com/company/press/generative-ai-to-become-a-1-3-trillion-market-by-2032-research-finds/

Chand, S., Shastry, C., Hiremath, S., Joel, J. J., Krishnabhat, C., & Mateti, U. V. (2021). Updates on biomedical waste management during COVID-19: The Indian scenario. Clinical Epidemiology and Global Health, 11, 100715. https://doi.org/10.1016/j.cegh.2021.100715

Manekar, S. S., Bakal, R. L., Jawarkar, R. D., & Charde, M. S. (2022). Challenges and measures during management of mounting biomedical waste in COVID-19 pandemic: an Indian approach. Bulletin of the National Research Centre/Bulletin of the National Research Center, 46(1). https://doi.org/10.1186/s42269-022-00847-4

Simona. (2019, February 7). A Systems Thinking and Design Thinking Approach to Leadership - Expert Journal of Business and Management. Expert Journal of Business and Management. https://business.expertjournals.com/23446781-701/

Tomita, Y., & Maeno, T. (2018, June 20). Designing Structured Design Thinking Framework for Societal system Design in the Unknown Context. Tomita | Journal of Management and Strategy. https://www.sciedupress.com/journal/index.php/jms/article/view/13998/8642

Saxena, P., Pradhan, I. P., & Kumar, D. (2022). Redefining bio medical waste management during COVID- 19 in india: A way forward. Materials Today: Proceedings, 60, 849–858. https://doi.org/10.1016/j.matpr.2021.09.507Bansod H S, Deshmukh P (February 03, 2023) Biomedical Waste Management and Its Importance: A Systematic Review. Cureus 15(2): e34589. doi:10.7759/cureus.34589

5.1. AI Policy

ChatGPT and Google bot, text to text Generative AI tools aided in paraphrasing, sentence construction and grammar correction.