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1.0 Introduction

Nowadays, businesses function under conditions of a very volatile, uncertain, complex, and ambiguous environment. Classical models of problem-solving can hardly help solve complex issues, as they use analysis of historical data. The Design Thinking approach is a people-centered approach that allows companies to deal with the complexity of the contemporary business environment. It uses human desirability, technological feasibility, and economic viability as means of searching for problems, but not solutions to those problems. The process of innovation has become one of the key drivers of economic development, technological progress, and competitive advantage. Without innovations, companies become incapable of competing in the highly dynamic environment of globalization and digitalization (Brown, 2009).

Problem-solving methodologies that belong to the classical category always require focus on analysis, efficiency, and optimization. Such methodologies are extremely valuable and very effective. However, in relation to complicated human-oriented problems, they do not work effectively at all. Another approach to dealing with complicated problems can be found in design thinking. It came from industrial and product design but has now developed into a multidisciplinary approach to innovation, which applies to many spheres. Including education, health care, policy making, software development, strategic business, and social innovation (Liedtka, 2018). Companies like Google, IBM, Apple, IDEO, Microsoft, and Airbnb use design thinking.

2.0 Understanding Design Thinking

Design thinking is an innovative method of design that involves user comprehension, problem reformulation, ideation, solution prototyping, and testing of the proposed solution. Design

thinking, as explained by Brown (2009), is a method of innovation that embraces the designer's perspective and incorporates the needs of people, technical feasibility, and business considerations into the process. Design thinking is different from conventional problem-solving since it starts with people rather than technologies. The philosophy of design thinking is that people should always be at the heart of innovation. The problems are never well understood in the beginning, and creativity can be taught.

2.1 Conceptual Definition of Design Thinking

Design thinking is a people-centered problem-solving process that uses creative techniques, analytical tools, empathic skills, experimental approach, and collaboration among others to create new ways of dealing with problems. Generally, design thinking is all about making a shift from the traditional way of solving problems, which involves beginning the process with considering what is technologically and organizationally feasible, to an approach that begins with people and their experiences. However, design thinking is not necessarily about designing tangible items but instead involves thinking in an orderly way whereby uncertainties are uncovered, problems are redefined, solutions are found, and these solutions are improved through iteration. As explained by Simon (1996), design thinking involves the process of changing from one situation to another that one prefers. Therefore, design thinking is a field that is all about change and improvement. In contrast to scientific thinking that seeks understanding of what exists, design thinking seeks new possibilities through the imagination of new futures.

2.2 Design Thinking as a Human-Centered Innovation Approach

The human-centered approach associated with design thinking is another characteristic that makes design thinking different from any other form of innovation. Innovation activities in many cases

begin from what the capabilities of the technology available can offer or what the market considerations may be. On the other hand, design thinking begins by gathering insights about users, their environment, behavior, needs, frustrations, problems, and desires. Human-centered design considers that any successful innovation must solve the problems of people. As noted by Norman (2013), the design requires the understanding of the connections between people, technology, and the environment.

The human-centered aspect of design thinking refers to the principle of empathy. Empathy is an important element of design thinking, which entails observing and interacting with users to understand their experiences from their perspectives. The methods of empathy include interviews, observation, survey, ethnography, user journey mapping, and contextual inquiry. Through empathy, innovators go beyond making assumptions and learn the unknown needs. For example, while designing educational technologies, the designer could realize that students' needs involve more than just having gadgets; they also require a culturally relevant experience. Brown (2009) argues that empathy allows designers to uncover opportunities for innovation by identifying problems that users may not explicitly recognize themselves.

2.3 Design Thinking as a Nonlinear and Iterative Process

One of the common misconceptions regarding design thinking is that the design process is a linear sequence of steps. However, design thinking is a nonlinear, iterative, and flexible process where designers will have several iterations from researching the users' needs, defining the problem, idea generation, and creating a prototype. It takes into consideration the element of uncertainty in innovations and enhances the solution through experiments and learning. As argued by Plattner, Meinel, and Leifer (2011), there are cycles of inspiration, ideation, and implementation in design

thinking. Inspiration entails identifying problems or opportunities through user research. Ideation entails idea generation to the identified problem.

2.4 Design Thinking and Creative Problem Solving

Design thinking is associated with creativity since design thinking encourages divergent and convergent thinking. Divergent thinking means coming up with various possible solutions but without immediate judgment of the suggested solutions. Brainstorming, mind-mapping, scenario-building, and creative workshops are some of the ways divergent thinking can be achieved. This process aims at increasing the possibilities of Convergent Thinking, which means evaluating various ideas and selecting the most appropriate based on elements such as user value, feasibility, cost, and sustainability. Both processes are used in design thinking. Designers increase the number of options before narrowing down through evaluation and testing. According to Guilford (1967), divergent thinking is a major aspect of creativity.

2.5 Design Thinking and Problem Reframing

Redefining the problem is another feature of design thinking. There are many cases when innovations fail because firms are working on solving the wrong problems. Designers know that there is no perfect understanding of the problem at the beginning. It may be related to some assumptions. For that reason, they redefine the problem and find a new interpretation. Common problem definition approach. How to improve internet connectivity in rural regions? The problem was reframed using design thinking. What should be done to ensure that digital services are accessible to rural communities despite the limitations on infrastructure? The second definition of the problem expands the field for innovation by considering other solutions such as offline digital platforms, community technology centers, mobile learning, and local digital training. According

to Dorst (2015), reframing allows innovators to create new connections between the problem and the solution, rather than improving the existing methods.

2.6 Design Thinking as a Collaborative Practice

Creativity never happens alone. Design thinking is based on teamwork since it involves people with expertise in other areas. The members of a design thinking team may be Designers, Engineers, Business professionals, Educators, Researchers, End-users, and Policymakers. According to Cross (2011), designers have unique modes of knowing associated with synthesis, experimentation, and solution-oriented reasoning. Collaboration between people from different disciplines creates opportunities for diverse perspectives. For example, collaboration between Computer Scientists, Historians, Culturists, Indigenous people, and Multimedia designers is essential for creating an Artificial Intelligence system to preserve cultural heritage.

2.7 Design Thinking and Prototyping

One of the most critical steps in design thinking is prototyping. In contrast to constructing perfect products from the beginning, designers create basic designs for testing purposes. Some of the types of prototypes include paper sketches, wireframes, digital models, virtual reality models, multimedia presentations, and AI-based designs. The essence of prototyping lies not in the validation of an idea but in the learning process from the idea. According to Kelley & Kelley (2013), prototyping assists in experimenting and in being less afraid of failure, as weak ideas can be quickly checked and refined. Through prototyping in digital innovations, it is possible to estimate User experience, accessibility, performance, emotional aspects, and usability.

2.8 Design Thinking as a Mindset

Design thinking not only refers to the process, but it is also perceived as the mindset that comes with certain attitudes and practices. As indicated by Liedtka (2018), there are certain characteristics of the mindset of design thinking. For example, curiosity is among the characteristics of the mindset. Design thinkers are known to be very curious and full of questions. They pay attention to people's experiences (empathy). They believe in the existence of better solutions, and they are very optimistic.

2.9 Relationship Between Design Thinking and Innovation

Design thinking is a tool that connects creativity and innovation. Creativity entails the creation of novel ideas, while innovation entails the implementation of such ideas to deliver value. Design thinking offers organizations the capacity of bringing together both analytical and intuitive thinking skills. This ensures that organizations are capable of handling uncertainties. The relationship can be summarized as:

Design Thinking → Creativity → Experimentation → Implementation → Innovation

Organizations use design thinking to identify emerging opportunities, understand users, develop new products and services, improve existing systems, and address complex social challenges.

2.10 Design Thinking in the Era of Artificial Intelligence (AI)

The introduction of AI has increased opportunities in design thinking. AI can play a role in different stages of the design process. These are empathy support, which highlights how AI can be used to analyze data related to User behaviors, Online behaviors, user feedback, and social media behaviors. Ideation Support, which is an AI that can generate concepts and ideas. Prototyping Support, where AI is used to develop interface designs, images, simulations, and other forms of

multimedia. Testing Support, where AI analytics can be used to assess User performance, engagement, and accessibility. Nonetheless, AI should work alongside man-centric design, not against it. The human element, including empathy, cultural awareness, moral decision-making, and context-awareness, should not be ignored. In the opinion of Verganti, Vendraminelli, and Lansiti (2020), artificial intelligence is changing innovation through a transition from human-led creativity to human-computer cooperation.

2.11 Criticism and Limitations of Design Thinking

Although design thinking has gained global popularity, scholars have identified several limitations, such as;

a) Lack of Clear Definition. Johansson-Sköldberg, Woodilla, and Çetinkaya (2013) argue that design thinking has multiple interpretations, making it difficult to establish a universally accepted definition.
b) Risk of Superficial Application. Some organizations adopt design thinking as a short-term workshop activity rather than embedding it into organizational culture.
c) Limited Attention to Power Relations. Critical scholars argue that design processes may overlook issues of social inequality and stakeholder power.
d) Difficulty Measuring Outcomes. Because innovation outcomes are uncertain, measuring the effectiveness of design thinking remains challenging.

Nevertheless, when implemented thoughtfully, design thinking remains a powerful framework for innovation.

For design thinking to be understood, it must be viewed beyond its design context. It is a theory of innovation that involves empathy, creativity, collaboration, experimentation, and learning.

Through design thinking, organizations can come up with solutions that are both sustainable and feasible by integrating the experiences of humans in solving problems. The significance of design thinking has been made even more critical through the emergence of technology like artificial intelligence and multimedia, and the growing complexities of global issues. In developing countries such as Ghana, design thinking can be used to solve different kinds of problems, among them education-related.

3.0 Historical Development of Design Thinking

Historically, the evolution of design thinking has depicted the changing perceptions about the nature of design, ranging from the perception of design as art or technology to design thinking as a means of innovation and problem-solving. Even though design thinking was formulated as a concrete concept in the late twentieth century, the philosophical foundations of design thinking have their roots in some of the oldest concepts related to creativity, systems theory, architecture, engineering, and cognitive science. Over the past six decades, the experts have refined the process of design thinking into a multidisciplinary approach that involves human-centered design, collaboration, experimentation, and strategic innovation.

Design thinking in today's world has numerous applications across various fields including business management, education, medicine, software development, public policy, Artificial Intelligence (AI), digitalization, and cultural heritage conservation. Being familiar with the history of design thinking will help in comprehending why design thinking is one of the most influential innovation strategies of the twenty-first century.

3.1 Early Origins of Design Thinking

The theory behind design thinking was formulated in the 1950s and 1960s as researchers endeavored to understand the distinctions in problem solving among designers compared to other professional fields such as science and engineering. This was because of the increased industrialization, technological advancement, and complexities in society that made it necessary to come up with systematic approaches to design beyond aesthetics alone. The approach of engineering was analytical in nature, where the nature of the problem was known, and solutions were arrived at through logical deduction. The problems faced by designers were not clearly defined and had uncertainties and varying interests of stakeholders, among other factors, which needed a more creative approach. According to Lawson (2006), designers tend to begin with a possible solution based on their emerging understanding of the problem.

3.1.1 Herbert Simon and the Science of Design

Herbert A. Simon is an early influence on design thinking as he wrote "The Sciences of the Artificial" in 1969. In this book, Simon introduces design as a science. He says that while natural sciences are interested in understanding nature, design is interested in creating something in the future. According to him, design means everyone who devises courses of action aimed at changing existing situations into preferred ones (Simon, 1996). It was this definition of Simon that changed our perspective about design. This is because design is not only meant for architects or people who design products. As per Simon, design means anyone who designs anything to change an existing situation into a better one. Some concepts were introduced in Simon's theory which are still relevant in design thinking today. These concepts include problem framing, satisficing rather than optimization, iterative decision-making, bounded rationality, and human-centered problem solving. Simon's theory of bounded rationality explains that decision makers never have complete

information all the time. Thus, designers have to function in an environment of uncertainty and make iterative changes.

3.1.2 Horst Rittel and Wicked Problems

During the 1970s, Horst Rittel and Melvin Webber made major contributions to the knowledge about design issues through their definition of the term wicked problem. In contrast to well-structured engineering problems, wicked problems have some features that include lack of clear problem formulation, multiple parties involved, conflicting interests, lack of the right answer, evolution and social and political complexity. These include climate change, poverty, public health issues, education reform, city planning and protection of cultural heritage. Rittel & Webber (1973) stated that scientific ways of solving the problem were inefficient in addressing such an issue because the problem cannot be defined clearly prior to its resolution. Design thinking appeared to be an efficient way of solving the problem since it consists of learning, interacting and experimenting throughout the process. Till now, the idea of a wicked problem has been one of the best theoretical justifications for applying design thinking.

3.1.3 IDEO and the Commercialization of Design Thinking

The process of shifting design thinking from academia to corporate practice took place via IDEO, one of the best innovation consultancies of the world. (IDEO is an abbreviation, which means the combining form of idea – as ideology or ideogram. It was formed by David Kelley, and IDEO created design thinking as a business practice.) IDEO came up with principles that became the main features of design thinking. These are human-centered design, user observations, brainstorming, rapid prototyping, iterative testing, and cross-disciplinary collaboration. IDEO started the design process not with possible technologies but with understanding users' experience.

An example of user observation when designing the shopping cart revealed that empathy can bring more innovations than just using technology.

3.1.4 Stanford University's d.school

One such significant landmark was marked in the year 2005 when the Hasso Plattner Institute of Design was founded at Stanford University, famously known as d.school. The d.school created the design thinking framework through a five-stage process: empathize, define, ideate, prototype, and test. Unlike conventional methods of education that focus on memorization, d.school is all about learning through doing, teamwork, experimentation, creativity, and user-centered innovation. The Stanford model is now one of the most popular models globally in colleges and organizations.

3.1.5 Tim Brown and Strategic Innovation

However, the release of Tim Brown's book "Change by Design" (2009) marked an inflection point in the adoption of design thinking worldwide. According to Brown (2009), design thinking is "an approach to innovation that uses the designer's sensibilities and methods to match people's needs with what is technologically feasible and what a viable business strategy." Brown stressed that the application of design thinking is based on three intersecting factors: desirability (people's needs), feasibility (technological feasibility), and viability (business sustainability).

3.1.6 Design Thinking in the Digital Era

There have been considerable changes to design thinking due to the advent of the Fourth Industrial Revolution. These include innovations such as Artificial Intelligence (AI), big data, cloud computing, Internet of Things (IoT), Virtual Reality (VR), Augmented Reality (AR), Blockchain, and generative AI. These emerging technologies are changing the way firms get insights on their users, ideate solutions, prototype designs, and conduct evaluations. The use of artificial

intelligence technology, for instance, may help with design thinking in the process of collecting large sets of user data, pattern recognition, ideation, quick prototyping, prediction, and customization. Nevertheless, the scholars insist that AI is not to substitute human creativity, empathy, and ethics.

3.2 Design Thinking in Developing Countries

In countries like Ghana, Kenya, India, and South Africa, where economic conditions are less developed, design thinking is becoming an important tool for solving socio-economic problems. Design thinking is used by governments, universities, and non-governmental organizations to innovate solutions to educational and digital learning systems, agricultural innovations, healthcare delivery, financial inclusion, digital entrepreneurship, sustainability, and heritage conservation. Design thinking in Ghana would prove useful in creating AI-based multimedia systems to record indigenous knowledge, craftwork, festivals, stories, and endangered languages. Such examples show how design thinking concepts could be adapted to local cultures. The history of the development of design thinking shows how it has transformed from being a design tool into a full-fledged methodology of innovation.

In today's world, design thinking acts as a link between creativity, technology, and the decision-making process. The combination of design thinking with artificial intelligence and technology makes the concept increasingly relevant, especially for resolving society's complex problems and developing sustainable innovations. For researchers and professionals, learning the history of the development of this concept is necessary for solving modern issues.

4.0 Theoretical Foundations of Design Thinking

Not only is design thinking a methodology but an elaborate theory taken from many scientific areas such as design, cognitive psychology, education, systems theory, organizational behavior, management science, and human-computer interaction. Design thinking can be called effective because of these theories. Design thinking does not only utilize the analytical thinking but applies creative thinking, empathy, collaboration, experimentation, and reflective learning in order to find innovative solutions to problems. In order to realize the importance of design thinking, one needs to be aware of the theories behind it as they form the theoretical base of the use of design thinking in research, organizational change, digital transformation, and technological innovations. The most important theories of design thinking are design science paradigm, human-centered design, constructivist learning theory, experiential learning theory, systems thinking, creative cognition theory, reflective practice, wicked problem theory, diffusion of innovation theory, and activity theory.

4.1.1 Design Science Theory

Design thinking has a number of theoretical bases that have been formulated to guide it in the past. Among the early theories that form the basis of design thinking is Design Science, suggested by Herbert Simon in his book "The Sciences of the Artificial" in 1969/1996. In separating design from natural sciences, Simon says that while science seeks to explain the world as it exists, design is a way through which people will create future worlds through actions. According to Simon (1996), design is the approach through which people design actions that change their present situations into more desirable situations. This definition makes the concept of design broader than the conventional areas of architectural and product design, and expands it to include management of organizations, education, health care systems, software development and public policies. Some of

the contributions of Design Science to design thinking include design as solution-oriented instead of being problem-oriented. Innovations involve the creation of new things or designs that make existing things better. Information in decision-making is always constrained, as decisions are made under bounded rationality.

4.1.2 Human-Centered Design Theory

Among other theories which serve as the theoretical framework of design thinking, there is Human-Centered Design. Being a combination of ergonomics, psychology and human computer interactions, HCD places a lot of emphasis on the importance of having a starting point in human beings and not the technology itself. Good design, according to Norman (2013), arises as a result of understanding the behavior, emotions, capabilities, and limitations of human beings. Human-centered design involves a set of key principles such as user empathy, user involvement throughout the whole design process, contextual understanding of the environment of users, usability testing, and iterative improvement.

Empathy is a designer's capacity to understand the users' experiences from their perspective. Instead of using only surveys and quantitative methods, the design approach makes use of interviews, observation, ethnography and contextual inquiries in order to understand the latent needs of users. In education, human-centered design allows for developing curriculums that are student-centered and take into account the differences in the learners' abilities and cultures. Also, in health care, HCD is essential for innovation to be patient-centered.

4.1.3 Constructivist Learning Theory

Another crucial theoretical base for design thinking is constructivism. According to the theory of constructivism, knowledge is actively constructed through experience and interaction rather than

being transmitted from the instructor to learners. According to Piaget (1972), individuals develop mental frameworks through interaction with their environment. Vygotsky (1978) highlighted the role of social interaction and collaboration in cognitive development. Some of the key elements that are common between design thinking and constructivism include construction of knowledge by learners through problem solving, construction of knowledge through experimentation, collaboration as an effective learning strategy, reflection to develop concepts, and contextualized learning experiences. The process of designing involves iterative stages of prototyping and testing that coincide with the principle of constructionism that suggests construction of knowledge through reflection of the experience. Design thinking encourages innovation in higher education as learners actively participate in the learning process.

4.1.4 Experiential Learning Theory

ELT, which is formulated by David Kolb (1984, 2015), represents another robust theory underpinning design thinking. According to this theory, learning is an ongoing process that involves four major phases of concrete experience, reflective observation, abstract conceptualization, and active experimentation.

This learning cycle closely parallels the iterative stages of design thinking:

Experiential Learning	**Design Thinking**
Concrete Experience	Empathize
Reflective Observation	Define
Abstract Conceptualization	Ideate

Experiential Learning	Design Thinking
Active Experimentation	Prototype and test

The cyclical nature of both models reinforces the idea that innovation develops through repeated experimentation and reflection rather than through one-time problem solving. Experiential learning also encourages tolerance for ambiguity and failure, both of which are essential characteristics of successful innovation.

4.1.5 Systems Thinking Theory

There are many issues facing us in contemporary society, including climate change, provision of health care services, digitalization, education reforms, and conservation of cultural heritages. Systems thinking is a theoretical approach to comprehend how these interrelated issues affect each other. As Meadows (2008) asserts, systems thinking involves studying the interactions of the parts instead of analyzing the parts themselves. The design thinking process includes systems thinking through ensuring that designers think about stakeholder interactions, social relations, organizational structure, technology ecosystem, environment, and culture. An illustration of such thinking would be the creation of an artificial intelligence platform to preserve the indigenous knowledge of Ghana.

4.1.6 Reflective Practice Theory

The concept of Reflective Practice by Donald Schön in 1983 has greatly impacted the development of design thinking. According to Schön, professionals always learn while working on practical problems through two types of reflection. The reflection-in-action and reflection-on-action. Reflection-in-action happens when the professional reflects while working on practical problems.

On the other hand, reflection-on-action happens after the problem is solved and allows the professional to assess whether he has been successful or not. Design thinking incorporates both forms of reflection through Prototype Evaluation, User Feedback, team conversations, iteration and improvement.

4.1.7 Wicked Problem Theory

Wicked Problem Theory is among the most significant conceptual frameworks in design thinking theory. In contrast to tame problems, wicked problems have specific attributes. First, they are hard to define. Second, they have multiple stakeholders, and any solution creates another problem. Third, there is no right solution and all solutions are contingent on the context. Examples of wicked problems include poverty, digital divide, climate change, healthcare policy changes, regulation of artificial intelligence, and preservation of indigenous knowledge. In wicked problems, design thinking is very efficient since it involves empathy, cooperation, trial-and-error approach, and engagement of stakeholders.

4.1.8 Creative Cognition Theory

Creativity plays an important role in the design thinking process. According to Creative Cognition Theory, creative cognition is defined as the way in which people can generate new and innovative ideas through a combination of already available information in a manner. As stated by Finke, Ward, and Smith (1992), there is one such theory, namely Geneplore Model, that includes two stages. The first stage is the Generative Phase, where people create multiple mental images and different ideas, while the second stage is the Exploratory Phase, where people evaluate and modify their ideas.

4.1.9 Diffusion of Innovation Theory

Whereas design thinking concentrates mainly on innovation creation, Diffusion of Innovation Theory provides a theory on how innovations diffuse in organizations and society. Five elements contribute to the adoption of innovations according to Rogers (2003). Relative advantage, compatibility, complexity, trialability and observability. The adoption of innovation is improved through design thinking since prototype development enables the potential users to test innovations before actual implementation in organizations.

4.1.10 Activity Theory

Design thinking can be analyzed using yet another theory known as Activity Theory proposed by Vygotsky and later extended by Engeström (1987). Activity theory holds that human activities take place in a socio-cultural context mediated by tools, language, rules, and community. The main elements of activity theory are subject, object, tool, community, rules, and division of labor. Design thinking is also based on the assumption that innovation happens in the wider context of social, organizational, and cultural settings. This is evident in the design of education technology for schools in Ghana.

5.0 The Design Thinking Process

Design thinking methodology is a well-structured approach that enables the solving of complex problems through the development of innovative solutions. Contrary to other linear methods used in problem solving that emphasize analysis before implementation, design thinking advocates exploration, experimentation, collaboration, and iterations throughout the innovation life cycle. The methodology acknowledges that wicked problems, which are not fully comprehended prior to

the solution being offered, require redefinition and improvement (Brown, 2009; Rittel & Webber, 1973).

Contemporary design thinking process was made popular by Hasso Plattner Institute of Design (d.school) and the global innovation firm, IDEO. Though different companies may have variations in the process description, the Stanford process, comprising Empathize, Define, Ideate, Prototype, and Test stages, has emerged as the most popular model among academics and practitioners (Plattner et al., 2011). The strength of design thinking lies not merely in its stages but in its underlying philosophy of empathy, experimentation, multidisciplinary collaboration, and iterative learning. Organizations including Apple, IBM, Google, Microsoft, Airbnb, SAP, and Procter & Gamble have successfully incorporated design thinking into their innovation strategies to improve customer experiences, accelerate product development, and foster organizational creativity (Liedtka, 2018).

5.1 Stage One: Empathize

5.1.1 Understanding Users and Their Needs

Empathize is the first step of the design thinking framework. Empathizing is all about developing a profound understanding of the users, their environment, experience, feelings, and unfulfilled needs. Empathy allows designers to get out of their own assumptions and discover something that users do not even realize about themselves. According to Brown (2009), empathy is a basis for innovation because companies often fail in creating new products when they make assumptions from within their organization and do not understand user experience. Empathy includes knowing what users say, what users do, what users think, and what users feel.

5.1.2 Empathy Research Methods

Several qualitative research techniques are commonly employed during this stage.

5.1.2.1 User Interviews

Semi-structured interviews allow researchers to explore users' experiences, motivations, expectations, and challenges.

5.1.2.2 Observation

Observing users in their natural environments provides valuable insights into behaviors that interviews alone may overlook.

5.1.2.3 Ethnographic Studies

Ethnographic research enables designers to understand users within broader social and cultural contexts.

5.1.2.4 Contextual Inquiry

Researchers observe users while simultaneously asking questions regarding their activities and decision-making processes.

5.1.2.5 User Journey Mapping

Journey maps visually represent users' interactions with products or services, identifying moments of frustration, satisfaction, and opportunity.

5.1.2.6 Empathy Mapping

Empathy maps classify user observations into four sections: says, thinks, does, and feels. These types of maps help with synthesizing the results of qualitative research. Outputs from the Empathize stage deliverables include user personas, empathy maps, journey maps, stakeholder

analysis, observations, and interviews. These outputs serve as the base for evidence-based problem definition. Outputs from the Empathize stage deliverables include user personas, empathy maps, journey maps, stakeholder analysis, observations, and interviews. These outputs serve as the base or evidence-based problem definition.

5.2 Stage Two: Define

5.2.1 Framing the Right Problem

Define is the phase where the output from qualitative research gets translated into the problem statement. Perhaps one of the biggest contributions of design thinking is its realization that innovation does not take place as much because of poorly framed problems being solved by organizations. Dorst (2015) emphasizes that reframing problems can lead to innovations rather than enhancing products and services.

5.2.2 Synthesizing User Research

Design teams analyze qualitative data collected during empathy research by identifying recurring themes, behavioral patterns, pain points, user goals, environmental constraints, and opportunities for innovation.

5.2.3 Problem Statements

Problem statements should focus on users rather than organizational objectives. For example, a traditional statement, students are not completing online courses, design thinking statement

University students need engaging, flexible, and interactive learning environments that accommodate diverse learning preferences. This formulation broadens the innovation space.

5.2.4 "How Might We" Questions

Design teams often convert problem statements into "How Might We" (HMW) questions. Examples include how might we improve digital literacy among rural communities? how might we preserve indigenous technologies using artificial intelligence? ow might we increase access to multimedia learning resources? These questions encourage creativity while maintaining user focus.

5.3 Stage Three: Ideate

5.3.1 Generating Creative Solutions

Following problem definition, the Ideate stage encourages the generation of multiple possible solutions before selecting any particular approach. The objective is not immediate feasibility but maximizing creative possibilities. According to Guilford (1967), creativity involves divergent thinking characterized by fluency, flexibility, originality, and elaboration.

5.3.2 Divergent Thinking

Design teams intentionally postpone judgment while generating ideas. Common techniques include Brainstorming, Brainwriting, Mind Mapping, SCAMPER, Six Thinking Hats, Storyboarding, Role Playing, and Crazy Eights. These methods encourage participants to challenge assumptions and explore unconventional possibilities.

5.3.3 Convergent Thinking

Once numerous ideas have been generated, teams evaluate alternatives according to User desirability, technical feasibility, Economic viability, Environmental sustainability, Ethical

considerations. Brown (2009) emphasizes that innovation emerges through balancing these competing dimensions rather than optimizing only one criterion.

5.3.4 Importance of Multidisciplinary Teams

Effective ideation depends on collaboration among individuals possessing diverse expertise. Typical participants include Designers, Software engineers, Educators, Business managers, Cultural experts, End users, and Artificial intelligence specialists. Diversity enhances creativity by introducing multiple perspectives.

5.4 Stage Four: Prototype

5.4.1 Transforming Ideas into Tangible Solutions

Prototyping converts abstract concepts into physical or digital representations that users can evaluate. Unlike traditional development methodologies where testing occurs near project completion, design thinking encourages rapid prototyping throughout the innovation process.

Kelley and Kelley (2013) argue that prototyping promotes experimentation while reducing fear of failure because ideas remain inexpensive to modify.

5.4.2 Objectives of Prototyping

Prototypes enable teams to visualize ideas, explore alternatives, validate assumptions, gather user feedback, identify weaknesses, improve usability, and reduce innovation risk.

5.4.3 Types of Prototypes

Different projects require different prototype fidelities.

5.4.3.1 Low-Fidelity Prototypes

Low- Fidelity prototypes examples include paper sketches, storyboards, wireframes, cardboard model. Low-Fidelity prototypes advantages include inexpensive, rapid development, and easy modification

5.4.3.2 High-Fidelity Prototypes

Examples of High-Fidelity prototypes include functional mobile applications, interactive websites, multimedia demonstrations, virtual reality simulations, and artificial intelligence interfaces. Advantages of High-Fidelity prototypes include realistic user experiences, and detailed usability evaluation.

5.4.3.3 Rapid Prototyping

Rapid prototyping encourages continuous experimentation by allowing multiple alternative solutions to be tested simultaneously. Organizations increasingly employ digital prototyping tools such as Adobe XD, Figma, Sketch, Unity, Blender, and AI-assisted design software to accelerate development.

5.5 Stage Five: Test

5.5.1 Evaluating User Experiences

Testing evaluates how effectively prototypes satisfy user needs and expectations. Rather than determining whether solutions are "correct," testing seeks to generate learning that informs subsequent iterations. According to Plattner et al. (2011), testing should occur repeatedly throughout the innovation process rather than only at project completion.

5.5.2 Objectives

Testing aims to evaluate usability, assess accessibility, validate assumptions, identify unexpected problems, improve user experiences, and generate additional insights.

5.5.3 Testing Methods

Several evaluation methods may be employed.

5.5.3.1 Usability Testing

Users perform representative tasks while researchers observe performance.

5.5.3.2 Interviews

Participants describe their experiences after interacting with prototypes.

5.5.3.3 Focus Groups

Group discussions identify shared experiences and recommendations.

5.5.3.4 Observation

Researchers examine behaviors rather than relying solely on self-reported opinions.

5.5.3.5 Eye-Tracking

Eye movement analysis reveals visual attention patterns.

5.5.3.6 Analytics

Digital platforms generate quantitative usage data that complement qualitative findings.

5.5.3.7 Iteration Following Testing

Testing frequently reveals new insights requiring teams to revisit earlier stages. For example, additional empathy research may be necessary, problem statements may require revision,

alternative ideas may emerge, and new prototypes may be developed. Thus, testing does not conclude the process; rather, it initiates another cycle of innovation.

6.0 The Iterative Nature of the Design Thinking Process

Iteration is among the key characteristics of design thinking. Despite being shown linearly, the process of iteration occurs due to emerging evidence as designers loop through the five stages. Iterations can be such that designers move back from the test stage to the empathy stage because they have learned that there was a misunderstanding of the user needs, changes of the problem statement due to feedback received from the stakeholders, and redesigning of prototypes due to failures in the testing stage. Iteration allows companies to minimize uncertainty and enhance innovation quality at the same time.

7.0 Integrating Artificial Intelligence into the Design Thinking Process

The emergence of artificial intelligence (AI) has significantly enhanced design thinking by supporting decision-making, creativity, and data analysis throughout the innovation process. I assist by performing sentiment analysis, mining customer feedback, analyzing behavioral patterns, and processing large qualitative datasets. Natural language processing algorithms identify recurring themes and prioritize user needs. Generative AI supports brainstorming, alternative concept generation, design visualization, and scenario simulation. AI-powered tools rapidly generate interface designs, multimedia content, interactive prototypes, software code, and virtual environments. Machine learning algorithms evaluate user engagement, accessibility, navigation behavior, performance analytics, and predictive user preferences. Despite these capabilities, AI cannot replace human empathy, cultural understanding, ethical reasoning, or contextual judgment.

Consequently, AI should be viewed as an augmentation technology that strengthens rather than replaces human-centered innovation (Verganti et al., 2020).

8.0 Applications of the Design Thinking Process

The design thinking process has been successfully applied across numerous disciplines. Organizations employ design thinking for product development, customer experience design, digital transformation, and service innovation. Healthcare applications include Patient-centered care, medical technologies, Telemedicine, and Healthcare workflow optimization. Educational institutions use design thinking to develop digital learning environments, AI-powered tutoring systems, multimedia instructional materials, and curriculum innovations. Governments apply design thinking to Citizen-centered service delivery, Smart cities, Digital governance, and public policy innovation.

For developing countries such as Ghana, design thinking provides opportunities to develop AI-driven multimedia systems for documenting indigenous knowledge, traditional technologies, oral histories, festivals, languages, and cultural artifacts.

9.0 Design Thinking and Artificial Intelligence

The speedy growth of AI technologies is radically changing the way organizations innovate, address issues, and add value. AI is gradually finding its place within the design thinking framework to increase creativity, improve decision-making, speed up product development, and provide users with highly personalized experiences. Although design thinking focuses on empathy, human-oriented problem solving, and iterative innovation, AI brings computational intelligence, forecasting, automation, and the ability to handle large quantities of structured and unstructured data. Instead of diminishing human creativity, AI supplements design thinking, helping humans to

do things better. This allows designers, researchers, educators, engineers, and business leaders to make more rational decisions in the course of innovation. The combination of AI and design thinking is thus a whole new paradigm of human-AI cooperation, in which machines support analysis while humans take care of empathy, ethics, context, and creativity. This is crucial for doctoral researchers in multimedia, education, information systems, health care, and cultural heritage conservation to understand since the innovations of tomorrow will require an AI-aided design approach.

9.1 The Relationship Between Design Thinking and Artificial Intelligence

Although AI and design thinking originate from different disciplines, they share a common objective: solving problems and improving human experiences.

However, they approach problem-solving differently.

Design Thinking	**Artificial Intelligence**
Human-centered	Data-centered
Empathy-driven	Algorithm-driven
Qualitative insights	Quantitative insights
Creative exploration	Pattern recognition
Iterative experimentation	Predictive analytics
Collaboration	Automation

Design thinking focuses primarily on understanding human needs, emotions, motivations, and social contexts, whereas AI excels at analyzing large datasets, identifying hidden relationships, recognizing patterns, and generating predictions. When combined, the strengths of both approaches produce more robust innovation processes. Brown (2009) argues that innovation succeeds when human desirability, technological feasibility, and business viability are integrated. AI strengthens technological feasibility while design thinking ensures that technological innovations remain meaningful to users.

9.1.1 AI in Multimedia Design Thinking

In the field of multimedia production, AI alters content production. The use of Artificial Intelligence (AI) has revolutionized the realm of multimedia design by totally changing the way content is designed, produced, distributed, and assessed. The process of multimedia design involves incorporating elements like text, graphics, audio, video, animations, and interactivity. The implementation of AI in multimedia design thinking takes the multimedia design concept a step further.

Design Thinking offers a human-centric framework for multimedia development by making sure that digital products are designed based on user needs, preferences, and experience. Artificial Intelligence supports design thinking as it contributes computational intelligence to make the creation process faster, more creative, and decision-making more informed by data. Instead of eliminating the role of multimedia designers, AI serves as an intelligent partner that boosts human creativity and innovation. The combination of AI and design thinking is especially relevant in the age of Industry 4.0 because of the increasing importance of digitalization, immersive experiences, and intelligent systems in the process of multimedia production.

9.1.2 Multimedia Design Thinking

Multimedia design thinking applies the principles of design thinking to the planning, creation, implementation, and evaluation of multimedia products. Unlike traditional multimedia production, which often emphasizes technical execution, multimedia design thinking begins by understanding users' experiences and contextual needs. The multimedia design thinking process typically involves understanding audience needs, defining communication objectives, generating creative multimedia concepts, developing multimedia prototypes, testing user interaction, and refining products through continuous feedback. This process ensures that multimedia products are not only visually appealing but also meaningful, accessible, interactive, and effective. According to Mayer (2021), effective multimedia learning depends upon understanding how individuals process visual and auditory information. Design thinking complements multimedia learning theory by emphasizing learner-centered content development rather than technology-driven production.

9.1.3 Artificial Intelligence in Multimedia Content Creation

One of AI's most significant contributions to multimedia design is automated content creation. Generative AI technologies now assist multimedia designers in producing high-quality digital assets with remarkable speed. AI supports the creation of digital illustrations, photorealistic images, videos, audio narration, background music, three-dimensional models, motion graphics, and interactive animations.

Generative AI models such as diffusion models, large language models, and transformer architectures enable designers to rapidly explore multiple creative alternatives before selecting final designs. Rather than replacing creativity, these technologies allow designers to spend more time refining concepts and improving user experiences. For example, a multimedia designer

developing educational content may use AI to generate illustrations, character animations, interactive diagrams, voice narration, and assessment questions. This dramatically reduces production time while maintaining creative flexibility. For multimedia researchers, AI accelerates production while allowing designers to focus on creativity and user engagement. In educational multimedia, AI supports adaptive learning environments that respond dynamically to learners' progress.

9.1.4 AI and Cultural Heritage Preservation

Artificial intelligence presents significant opportunities for preserving indigenous knowledge and cultural heritage. AI applications include digitization of historical documents, automatic language translation, speech recognition for endangered languages, multimedia archiving, virtual museums, intelligent search systems, three-dimensional reconstruction of artifacts, and pattern recognition in traditional textiles and symbols.

For Ghana, AI can facilitate the preservation of oral traditions, traditional technologies, blacksmithing, kente weaving, adinkra symbolism, festivals, indigenous languages, and historical archives. Design thinking ensures that these technologies remain culturally appropriate by involving local communities throughout the design process.

9.1.5 Relevance to Ghana and Developing Countries

For developing countries such as Ghana, integrating AI with design thinking presents transformative opportunities. Potential applications include AI-powered educational platforms, digital agriculture, healthcare diagnostics, smart governance, financial inclusion, indigenous language technologies, cultural heritage preservation, tourism promotion, and multimedia archives.

For example, doctoral research on AI-driven multimedia preservation of traditional blacksmithing, weaving, pottery, or oral histories aligns naturally with design thinking because local communities actively participate throughout the innovation process. Such initiatives contribute directly to sustainable development while preserving cultural identity. The integration of design thinking and artificial intelligence represents one of the most significant developments in contemporary innovation. While design thinking contributes empathy, creativity, collaboration, and human-centered problem-solving, AI provides computational intelligence, predictive analytics, automation, and data-driven insights. Together, they enable organizations to design solutions that are more responsive, efficient, and innovative.

However, AI should be regarded as an augmentative technology rather than a replacement for human designers. Empathy, ethical judgment, cultural understanding, and contextual reasoning remain uniquely human capabilities that ensure innovations are socially responsible and meaningful. As AI continues to evolve, the future of innovation will depend increasingly on effective human–AI collaboration. For doctoral researchers, particularly in fields such as multimedia, education, digital transformation, and cultural heritage preservation, mastering the integration of design thinking and AI is essential for addressing complex societal challenges and creating sustainable, user-centered solutions.

10.0 Challenges of the Design Thinking Process

Even with these benefits, there are various implementation problems facing organizations, including organizational resistance to change, lack of stakeholder involvement, resource problems, measurement problems with the success of innovations, balance between being creative and

feasible, ethics in the AI-supported design process, and continuous user engagement. Successful implementation will need good leadership, organizational learning, and experimentation.

11.0 Conclusion

Design thinking is an innovative concept that offers a novel way of innovation, where people's needs become central to problem-solving. In contrast with traditional analytic approaches to problem-solving, design thinking is marked by embracing uncertainty, creativity, experimentation, and collaboration. The iterative process of design thinking allows organizations to address challenges posed by constantly changing technology and society. Integrating artificial intelligence into design thinking has led to new opportunities for innovation through faster data analysis and idea prototyping. However, empathy, ethics, and contextual understanding are skills unique to humans and not replicated by AI.

For nations like Ghana, the benefits of design thinking in helping deal with problems in areas such as education, health care, agriculture, governance, and cultural preservation are immense. The adoption of design thinking by incorporating AI and multimedia technology will provide an avenue for Ghanaian institutions to innovate in an inclusive, sustainable, and culturally relevant way. Design thinking is not only a process but also an approach that encourages problem solving and value creation in society.

The Design Thinking Process is a holistic tool for problem-solving through empathy, collaboration, innovation, experiments, and learning. The five interrelated stages of empathize, define, ideate, prototype, and test provide businesses with a powerful method of dealing with uncertainties while creating innovative products, services, systems, and policies. With the introduction of artificial intelligence, digital technologies, and multimedia, the Design Thinking

Process has become even more effective because of new opportunities for collecting data, prototyping, and evaluating users. However, empathy, ethical evaluation, and cultural awareness remain essential human skills that ensure meaningful innovation. With the rising complexity of challenges, the design thinking process will continue to be a crucial approach for encouraging sustainable innovation in various domains, including businesses, education, health care, governance, and culture preservation.

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