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Capability Assessment Framework for Artificial Intelligence and Blockchain Adoption in Public Sector of United Arab Emirates (UAE)

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***Abstract*—This is an ongoing study with the aim to develop a maturity model for efficient deployment of Artificial Intelligence (AI) and Blockchain (BC) in the United Arab Emirates (UAE) public sector. The organizations would leverage this maturity model to assess their efficacy of deploying AI and BC technologies in their operations, highlighting their capabilities for successful integration of these technologies while underscoring their incompetency and directing their attention towards areas of improvement. To achieve this aim, initially the conceptual framework is proposed which would act as primary frame of reference for conducting empirical research in this prospect and developing a maturity model. This study presents the conceptual framework, which highlights the essential dimensions and factors that should be assessed and enhanced for successful implementation of AI and BC technologies. The framework also introduces five stages of maturity/development to mark the progress of each dimension of conceptual framework. This conceptual framework is 4x5 grid which vertically presents four dimensions and horizontally it presents five stages of maturity. Strategy & Governance, Technology, People, and Process are dimensions of framework whereas initial, developed, defined, managed and optimized are stages of maturity.**

***Keywords*—Conceptual framework; Artificial Intelligence; Blockchain; maturity model**

I. Introduction

Artificial Intelligence (AI) is the computers or machine's ability to imitate the mental capabilities of human behaviour while improving its own performance or it can be defined as the ability of machines to leverage human-like mental intelligence to perform different tasks. Computers or machines with AI capabilities exhibits their minds instead of their body to perform different tasks such as operating cars and playing games. AI is the intersections of various domains such as machine learning, deep learning, computer vision, natural language processing, expert systems and data mining and considering its effective applications, various industries around the globe have adopted this technology which include science, engineering, education, medicine, business, accounting, finance, economics and law [1].

BC technology is a distributed database or consensus which exists or operate on multiple computers simultaneously [2].

The pioneers like [3] considered the BC as "digital asset transaction exchanged online" in which each transaction is represented as unique block. It is a distributed ledger system in which transactions are transparently recorded across a network of computers where no third party can manipulate these transactions which enables this technology to ensure data integrity and provide tamper proof record of transactions. Decentralization, cryptographic security, consensus mechanisms, immutability and transparency are key components of this technology. As the world is being digitalized, the personal account information and transactions are being secured and decentralized through BC technology [4]. BC is considered as the safest method on money exchange between two individuals with no intermediaries. Other block chain implementation globally includes the introduction of digital passport and instantaneous ship tracking, and logistics management are already there on track [5].

Considering the potentials of both AI and BC technologies, efforts are being directed to integrate/combine these technologies to yield enhanced transparency & trust, data security & privacy, efficiency & scalability, and monetization of data [6]. Many studies have been conducted to highlight such benefits. For instance, a review provided by [7] illustrated that how integration of AI and BC technologies can be used to train n number of self-driving cars simultaneously instead of training each car individually, where n can be a very large number. In this approach, reinforcement learning which is a subfield of AI is suggested to train car for autonomous driving and by deploying BC, multiple cars can be connected to a shared public ledger which would serve as a platform for various cars to exchange their experiences, enabling all connected cars to learn from experience of single car. This approach would enable cars to collectively enhance their understanding of driving for example when to drive and when & where to stop, based on various experiences shared on public ledger. According to [8], BC, as being distributed storage, can be used to identify citizens and provide their various records such as birth certificates, migration history, jobs pursued and many other records, whereas AI can be leveraged in analysing this information of population to frame policies and informed decision making. Similarly [9] has illustrated that when both technologies are applied in banking sector, each of them provides significant benefits and results in enhanced banking services. For instance,

in banking sector, AI can be used in customer's credit analysis, providing them advice for trading and investment, ensuring 24/7 customer services via chatbots, and detecting frauds & suspicious activities by leveraging various machine learning models such as SVM, Random Forest and Decision Tree. Moreover, BC can be used to provide protection against hacking and online theft of customer's data. It can also mitigate cybersecurity risks by deploying highly encrypted digital ledger platforms which can only be accessed by authorized peers.

The integration of AI and BC technology can significantly enhance supply chain traceability. For instance, AI can be used to analyse huge amounts of data to identify trends, inefficiencies and anomalies in supply chain whereas BC can be used to track information, goods and materials in supply chain [10].

Motivated by potentials of both technologies, the United Arab Emirates (UAE), after the federation of nation undergoes histrionic growth in the implementation of these technologies among the Arab nations. Although UAE is far ahead of many nations in technological advancements, still with aim of driving digital transformation in UAE, the government has started many initiatives which include the use of AI and BC technologies in many industries, to provide citizens with most satisfying and enhanced services. Many government authorities are working with private and government entities of country to implement advanced technology relevant projects. Digital Dubai is example of such authority which has setup more 130 initiatives to accelerate digital transformation of city. Dubai BC strategy, Artificial intelligence Principles & Ethics, AI, Data first and Happiness Agenda are to name few [11]. The author in [12] aim to transform UAE into a world leader in AI by 2013. By this initiative the government aim to create new opportunities in education, social and economic sector, government development, energy, tourism and many more to gain full extent automation in processes which is expected to yield AED 335 billion extra growth leading to 26% increase in economic output. [13] UAE also introduced Emirates BC strategy 2021, which aimed to capitalize BC technology for conducting 50% of transactions by 2021. From this initiative the government expected to save AED 11 billion invested in routine processing of documents and transactions, 398 million annual printed documents and 77 million annual work hours. According to [13] there are more than 40 government entities and 120 BC companies in UAE which are covering 200 plus such initiatives in both government and private sectors of country.

Despite of technological advancements being adopted within UAE, there is a significant gap in the existing literature suggesting, a comprehensive business model which provide a guide to effectively implement these technologies for efficient service transactions in the UAE. Considering the above-mentioned gap and necessity of comprehensive business model for implementation of these technologies, the study aimed to develop a new maturity model to thoroughly guide the implementation of these technologies. To achieve this aim, initially the conceptual framework is proposed which would act as a primary frame of reference for conducting empirical research to develop a maturity model. This framework provides a guide that how AI and BC technologies can be successfully implemented to enhance government services.

II. Literature Review

Researchers have investigated BC and AI in isolation, as well as their applications in many sectors and enterprises [14]-[17]. The integration of AI with BC, as well as the consequences of such integration on the way we live, work, interact, and transact, has been examined in few studies [18]. In rapidly evolving landscape of AI & BC technology deployment, to assess and guide the deployment of these technologies, researchers have provided various model and frameworks. A model is proposed by [19] for small and medium enterprises (SME's) to self-assess their maturity level for either starting or feeding their AI technology adoption journey and providing them guidelines in this prospect. The model was developed based on state-of-the-art review and direct interviews of SME's managers, which were used to identify the existing gaps in models and tools that should be available to support organizations in evaluating their AI-readiness. Although the research methodology (conducting literature review and interviews), can be considered appropriate but the study conducted only two interviews, which offered a very limited sample size to provide diverse challenges and perspectives of AI adoption across different SME's. Similarly, a BC readiness assessment framework was proposed by [20] to assess the regulatory readiness of organization for deploying BC technology in healthcare sector. To develop this framework, the study considered finding major regulatory issues associated with BC applications, impacts of data laws on BC adoption and determining how regulatory readiness of BC can be examined. The framework is developed based on literature review of BC structure, its applications, and regulatory issues affecting the adoption of BC. To systematically conduct literature review, Scopus database was used while specifying some inclusion and exclusion criteria, and 23 articles were reviewed to gain the conceptual and theoretical foundation for the proposed framework. The framework's applicability was outlined by applying the proposed framework in Portugal's healthcare sector and is claimed that the proposed framework is adaptable to several other sectors but how this framework can be customized for applicability in other sectors or suggestions regarding its scalability, have not been provided. The study has also not explained the mechanisms for selecting key dimensions and stakeholders from literature, which raises ambiguity in development process of model. Besides, applicability, the proposed framework or model has not been empirically validated.

From literature review, it was noticed that, for deployment of AI and BC technologies, various models and frameworks have been proposed, but these models or research studies have certain limitations. The research studies have proposed frameworks or models to assess the deployment of these technologies within only specific sectors or domains of government or e-government services and do not provide guidance for their general applicability or specific models for deployment of such technologies in overall government operations or for entire private sector organizations [19]-[20]. As these technologies are continuously evolving, no measures have been provided to keep the deployment process up to date.

Furthermore, these studies suggest models for independent deployment of either AI technology, or only BC technology and there are very few studies, which suggest models to assess the deployment of both technologies collectively [1], [19]-[22].

III. Research Methodology and Design

Processes as being fundamental to functioning of organization, are adopted to achieve organizations objectives, manage risks, and to deliver value to stakeholders. Majority of organizations also adopt process management strategies which include various methodologies, frameworks, and techniques to optimize and improve organizational processes to yield better outcomes. From literature review, it can be found that, various process management maturity models have been proposed such as capability maturity model (CMM), Business process maturity model (BPMM), Seven tenets of process management and many more, to ensure that processes are efficiently applied, managed and controlled across the organization. The CMM developed by Software engineering institute (SEI) for software implementation processes, consists of five levels of maturity (initial, managed, defined, quantitatively managed, and optimized), where each level has its own capabilities. The CMM evolved into capability maturity model integration (CMMI), which used same five levels of maturity of CMM with focus on five main factors which included: goals, commitment, ability, measurement, and verification. BPMM is another process management maturity model, which focuses on improvement of business process management. This model used the same five levels of maturity of CMM and focuses on three main factors/elements related for enhancing process management which include culture of performance, improvement and management excellence [23]. To assess the maturity of BC adoption, BC maturity model (BCMM) is proposed. This model also adapted five stages of maturity of CMM to measure the level of adoption of BC. This is a 4x5 grid model, which presents five stages horizontally and four crucial elements of BC adoption are presented vertically. The four main elements considered for BC adoption include Networks, information systems, computing methodologies, and security & privacy. This model provided a roadmap for assessing the adoption of BC corresponding to its four main elements, where the progress of adoption of these elements can be measured/marked according to five stages (initial, repeatable, defined, managed, optimizing) adopted [24]. As the implementation of AI and BC technologies in various operations of organization, itself is a detailed process, so inspired by above mentioned various process management maturity models the researcher (proposed initial framework) decided to add 5 stages of maturity in conceptual framework, which include Initial, developed, defined, managed and optimized stages. These stages would help organizations in determining their stage of maturity / progress to integrate these technologies. Because AI and BC technologies are intricate and multifaceted, applying them calls for an understanding of the interdependence of many organizational components. Four interrelated change dimensions comprising Strategy & Governance, Technology, People, and Process along with their variables and factors have been identified from literature. Organizations must enhance and assess these dimensions/elements for successful integration of AI and BC technologies in various operations. The entities implementing these technologies can mark their status of progress in five stages of maturity corresponding to each vital dimension of framework.

IV. Model Dimensions

For organizations to benefit from the combination of AI and BC, they must alter the ways they think, act, and learn. The dimensions proposed by framework must evolve separately and jointly in order to properly raise an organization's overall stage of maturity for AI and BC. Business leaders can expedite their overall organizational maturity and unlock progress for AI and BC projects by enhancing capabilities in less developed dimensions.

A. Strategy and Governance

Strategy & governance provides a broad frame of reference for all plans and choices made across all organizational departments [25]. Successful implementation of AI and BC technology is not just based on technical expertise, instead it also requires a comprehensive strategy and governance framework. The organizations should have well defined strategy to ensure that organization’s vision, mission and objectives are aligned with broader initiatives of AI and BC. This dimension will assess to what extent there is a well-defined strategy and vision that act as a road map for achieving organizational goals and objectives. An organization strategy should always be clear about the broad goals it pursues. Finding out what the organization's goal should be is the next step. Organizational objectives must consider Usability, Accessibility and Effectiveness [26]. As the implementation of these technology also poses serious concerns regarding data privacy & security, biasness, and vulnerabilities, the organizations should have robust governance frameworks to identify and mitigate these risks. The existence of proper governance mechanisms would ensure establishment of new rules & regulations to properly handle and govern citizens data which is used by these technologies and complying with existing data privacy & security regulations and many other regulations.

B. Technology

The implementation of AI requires various technologies such as Graphics Processing Units (GPUs), Natural Language Processing (NLP) tools, deep learning libraries, data processing and analytic tools etc. Similarly, the implementation of BC also requires distributed ledger technology, BC development tools such software development kits (SDK), application programming interface (APIs), and BC platform etc. Thus, technology dimension being fundamental to implementation of AI & BC technologies, provides foundation to successfully implement and manage AI and BC by providing necessary tools, hardware, software and storage. According to [27]-[28], the research work should be conducted empirically to ascertain the technological factors influencing the adoption of both AI and BC technologies. As he success of AI and BC deployment is determined by the technological environment of organization, including underlying technological infrastructure, storage mechanisms such as databases, compatibility of available technology, and how it’s being accessed and used by different users. The researcher considered Compatibility,

Databases Integration, and Technology infrastructure, and usability & accessibility to be vital factors of this dimension which are further explained in later sections. Thus, to successfully implement AI and BC technologies, organizations must analyse technology dimension along with its factors.

1) People: The existence of a human workforce equipped with essential skills and knowledge of AI & BC technology is indispensable to successfully implement these technologies. The People dimension focuses on coordinating change management and leadership to make sure that people are capable of using AI and BC technologies. If people do not have required digital skills and competencies, even the cleverest AI and BC solutions will fail. According to [29]-[30], the implementation of these technologies requires that executive leaders as well as all other employees to have knowledge and awareness of AI and BC technologies and their implications. Executive leaders must assist business and technical teams in delivering these technologies and utilizing them successfully. In order to always provide people with the best guidance and make decisions, when necessary, leaders themselves must have a solid understanding of the implications of AI and BC for their organization. Staff members also require awareness, training, competencies and even certification Courses in the process of building and deploying AI and BC solutions if they are to successfully construct and work with these technologies. While the implementation of AI requires a strong domain knowledge and expertise in data science, machine learning, mathematics, statistics, and programming, the implementation of BC also requires expertise in BC development, smart contract development, distributed systems, and familiarity with BC frameworks and platforms such as Corda, Polkadot, and Ethereum etc. Thus, training & awareness, digital skills, and competencies are considered important factors of people dimension.

2) Process: As AI and BC technologies are implemented to drive efficiency and effectiveness in overall organization process, so Process is considered important dimension. When implementing these technologies, it is important to consider how activities and tasks are managed on a daily basis, including how they are planned, communicated, organized, monitored, and controlled. Another body of literature examines how processes become more sophisticated and mature as an organization matures. The Capability Maturity Models describe many stages of process maturity that an organization goes through as it develops, beginning off without process disciplines and ending up as a developed organization where all processes are documented, automated, optimized, measured and controlled [31].

C. Model Stages

1) *Initial*: At this stage, organization's main objective is to understand and explore AI & BC technologies. The organization also explore the areas/process of organization where these technologies can be implemented and what would be the impact/benefit of implementation of these technologies to organization. To understand their feasibility and use-cases, organizations might conduct pilot projects or proof of concepts. The organization does not have proper AI & BC model at this stage and the implementation is confined to only specific department or use-case.

2) Developed: The organizations begin to integrate AI & BC technologies into existing systems and processes. The entities also begin to expand the implementation across various departments or process and enhance their foundational infrastructure and resource allocation to successfully implement these technologies for various purposes such as automating routine tasks, enhancing data analytics capabilities and predictive analytics. There are more sophisticated AI-powered applications and BC networks leveraging distributed ledger technology, used in organization.

3) Defined: Organizations have clearly defined process or use-cases for implementing AI & BC technologies. The implementation of these technologies expands to cover more business functions or systems which facilitates complex human-based interactions, provision of personalized services, optimized business processes and enhanced transparency and efficiency of business transactions. Putting AI & BC solutions into production at a larger scale still requires significant organizational work at this stage.

4) Managed: The organizations intend to scale AI & BC Solutions deployment efficiently as the number of Deployed AI & BC models increases. The organization is approaching a factory of standardized AI & BC model production, with a focus on optimizing the processes to maximize efficiency, security and reliability. Organizations implement robust monitoring and management systems to track performance, ensure compliance of implementation with regulatory policies and frameworks, and mitigation of risks. Organizations focus on continuous improvement in management of these technologies, emphasizing transparency and accountability of these solutions.

5) Optimized: Organizations have innovative level of implementation of AI & BC technologies and intends to drive new business models by leveraging highly advanced and collaborative AI & BC systems. Highly advanced AI & BC systems facilitate interoperability across multiple sectors and jurisdictions. The organizations focus on continuous learning and adaptation of emerging trends and technological advancements in these technologies, striving for sustaining competitive advantage and long-term success.

D. Results

As a result of the undertaken research, a conceptual framework is proposed which is presented & illustrated as follows:

1) Conceptual framework: The conceptual framework is presented in Fig. 1, which consists of a 4x5 grid to illustrate the relationship between the organizational dimensions and the various stages of maturity that businesses might process through to successfully implement AI and BC technologies.

The conceptual framework vertically presents the four dimensions that organizations must assess and work on their progress, and horizontally are five stages of maturity to mark the progress of organizations in each dimension. The five stages are key points in the development & evolution of these dimensions and filled ellipse under each stage indicate the progress of dimension corresponding to that stage. As organizations direct their efforts to enhance each of these dimensions, these dimensions would evolve/progress step by step from initial to optimized stage as indicated by arrow. For instance, filled ellipse next to Strategy & Governance dimension and under initial stage, indicates that strategy & Governance for implementing AI & BC technologies are at initial stage of development, which after progressing would reach at developed stage (as indicated by arrow) and then so on.

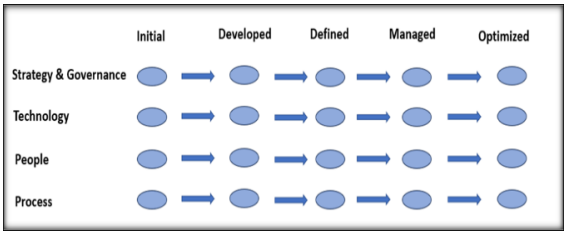

Fig. 1. Conceptual framework

Each dimension of maturity model is based on several factors which should be assessed and enhanced to optimize the overall progress of dimension. Each dimension can be progressed from initial to optimized staged if various factors of particular dimension are analysed and optimized. Fig. 2 presents the factors of each dimension of conceptual framework, which are further explained as follows.

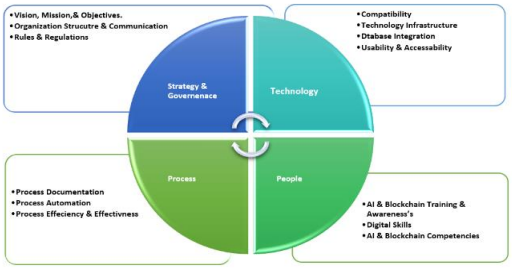

Fig. 2. Conceptual Framework along with its factors

2) Strategy and governance: The strategy and governance dimension can be assessed and enhanced based on its three crucial factor which include 1) Vision, mission and objective, 2) Organization structure & communication, 3) Rules & Regulations.

a) Vision, Mission, & Strategic Objectives: A vision states what the organization aspires to become in the future (Lead to adopt AI & BC). A mission reflects the organization's approaches and philosophy and resources that would be utilized to achieve the vision. Objectives are the more specific aims that organizations pursue to reach their visions and missions.

b) Organization Structure and Communication: Organization's structure and communication determines the manner and extent to which roles, power, and responsibilities are delegated, controlled, and coordinated, and shows how information flows between the levels of management and what sort of tools and mechanisms are used for communication. Organizational structure can boost coordination of communication, decisions, and actions.

c) Rules & Regulations: As the implementation of AI and BC technology raise serious legal and ethical concerns so various rules and regulations have been introduced to mitigate risks of these technologies. Therefore, it is essential for organizations implementing these technologies to comply the implementation process with government regulations and internally define regulations to protect mitigate risks and protecting citizen's information.

E. Technology

To assess and enhance the technology dimension of organization for successful integration of AI & BC technologies, vital factors related to technology that need to be considered include Compatibility, Technology infrastructure, Database integration and Usability & Accessibility.

1) Compatibility: Compatibility is the capacity of existing technology (both hardware and software) to implement and utilize AI & BC without going through extensive alterations in its infrastructure. For instance, various compatible software or applications might use the same data formats, such as compatible word processor applications enable the user to open read and modify word document files in either word application or editor. Thus, organizations should assess the level of compatibility of its existing technology to implement AI and BC.

2) Technology infrastructure: Technology infrastructures are components or systems comprising of both hardware and software which facilitate the effective functioning various operations/processes of organizations. As the implementation of AI requires infrastructure in terms of development tools, computational resources, data storage and management, APIs, and software development kits. and similarly, the implementation of BC requires nodes/computers, Peer-to-peer networking protocols, BC SDKs, storage infrastructure and BC mining hardware, etc. so organizations must assess and improve their technological infrastructure for deploying AI and BC in its processes.

3) Database integration: Database integration is the process used to aggregate information from multiple sources, like social media, sensor data from IoT, data warehouses, customer transactions, and more, and share a current, clean version of it across an organization. The existence of well-defined and managed databases is also crucial for successful implementation of AI and BC technologies.

4) Usability & accessibility: Usability refers to the quality of a user's experience when interacting with technology, applications or systems. Accessibility means that everyone can use the exact same application or system, regardless of any disabilities or impairments they might have. Thus, during the implementation of AI and BC the organizations should consider

usability and accessibility factor of their proposed solution.

F. People

As the implementation of AI and BC requires a workforce with strong knowledge, expertise and experience of these technologies, so people are another important dimension of conceptual framework. To assess and enhance competencies and capabilities of manpower to successfully integrate AI and BC technologies, factors such as AI & BC Training and Awareness, Digital skills, AI & BC competencies should be focused.

1) AI & BC training and awareness: If workforce involved in AI and BC related implementation projects is sufficiently aware of its implications and have comprehensive knowledge for implementation process of these technologies, the target of successful implementation would be achieved more easily. So, training and awareness regarding AI and BC should be provided to all employees, leaders and stakeholders involved in implementation process.

2) Digital skills: Digital skills are capability of employees to efficiently understand, use and navigate various digital technologies and tools which might include having basic computer literacy, data and information literacy, internet proficiency and many high-level expertise relevant to specific domain. As the implementation of AI and BC projects requires frequent interaction with technology so it is expected that employees have at least basic digital skills so that they can be trained to acquire AI and BC competencies. Thus, organizations must assess and enhance digital skills of their employees to successfully implement these technologies.

3) AI & BC competencies: The AI & BC Competencies are the basis of knowledge, skills and abilities in AI and BC technology. People involved in AI and BC implementation projects must possess subject relevant digital skills which might include proficiency in programming languages, training AI models, proficiency in BC platforms, smart contract developments and many other skills. Organizations must assess the level of competency of their employees relevant to these technologies before initiating the implementation process.

G. Process

To integrate AI and BC in organizational process, its essential to assess and enhance the mechanisms in regards of process documentation, process automation and process efficiency & effectiveness which are considered as the vital factors of this dimension. Process documentation, Process automation and Process Efficiency & Effectiveness are vital factors of this dimension which are defined as follows.

1) Process documentation: Process documentation is the act of capturing or documenting all the steps in a particular task. Ideally, it should happen in real time. As employees perform a task, they should document each step they take.

2) Process automation: Process Automation is the use of software to automate repeatable, multistep business transactions. In contrast to other types of automation, BPA solutions tend to be complex, connected to multiple enterprise information technology (IT) systems, and tailored specifically to the needs of an organization. The organizations must identify the processes which can be automated by AI and BC.

3) Process efficiency and effectiveness: Process efficiency is essentially "the amount of effort or input required to produce your public sector transactions that lead to provide customers with most efficient government services. Process Effectiveness is defined by achieving public sector targets, such as Customer Happiness, Positive Impact of Government Services, and fully Integrated Digital Services. Thus, organizations must assess the level of efficiency and effectives of its processes and should direct its efforts to improve least efficient and effective processes.

V. Conclusion

In this paper, a conceptual framework is proposed to assess the efficacy of organizations to successfully implement AI and BC technologies in their operations. This framework depicts four dimensions including strategy & governance, technology, people and process, where each dimension has various potential factors that could influence the acceptance and implementation of AI and BC. In this framework, the researcher has proposed five stages of change consisting of initial, developed, defined, managed & optimized to assess and mark the efficacy of organization corresponding to each dimension, to successfully implement AI & BC technologies.

Future Work

Further the researcher plan to get this conceptual framework validated by conducting interviews and employing qualitative data analysis to yield detailed insights and improve the conceptual framework according to results of analysis. The improved version of conceptual framework turned into maturity model which would also be validated in later stages of this research journey.

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