The Emergence of a Fintech Ecosystem: A Case Study of the Vizag Fintech Valley in India

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Abstract

Fintech ecosystems (FE) are characterized by heterogeneous, non-linear, dynamic and complex network of agents that interact with each other to provide a wide array of financial products and services to end customers. With the rise of myriad complementary technologies, the complexity of Fintech ecosystems is increasing exponentially as new players are emerging and new connections are formed. Despite the widespread attention Fintech ecosystems have attracted from both academia and practice, rather little is known about how such an ecosystem emerge. Toward addressing this knowledge gap, this research paper draws on complex adaptive systems (CASs) theory to examine the emergence of a global self-sustaining ecosystem: The "Fintech Valley" in Vizag, India. In doing so, our findings offer insights into the dynamics of FE emergence that is transforming the financial landscape globally, and may be helpful to practitioners who are looking to effect organization-wide cultural change and the 'compliant by design' approach.

Keywords: Ecosystem Emergence, Fintech, Complex Adaptive Systems, Case Study, India

INTRODUCTION

Financial technology (Fintech) is the application of technology to provide innovative products and services in the financial sector. It is an emergent market disruption impacting conventional business models and financial structures by integrating modern technology and finance (Smith 2015). The development of the Fintech market has provided innovative solutions to consumers by enhancing customer experience in the provision of diverse and efficient financial services (Gozman et al. 2018). The global financial crisis in 2008, coupled with the use of contemporary technological innovations, such as social media, artificial intelligence (AI) and data analytics, provided the impetus for Fintech to evolve into a new paradigm (Lee and Shin 2018).

The Fintech ecosystem (FE) consists of five elements that work together synergistically to stimulate the economy, enhance customer experience and promote social inclusion: start-ups, technology firms, government, customers and traditional financial institutions like banks (Lee and Shin 2018). The emergence of Fintech is fundamentally disrupting the way traditional firms operate and hence it is one of

the most critical developments (Gozman et al. 2018). Due to Fintech companies having a substantial impact on the financial sector, every financial firm needs to develop their capabilities to stay competitive in the market as 83% of the traditional players perceive that various aspects of their businesses are at risk from emerging Fintech start-ups (PwC 2016).

Most financial firms have started to forge partnerships with Fintech start-ups to co-develop strategies for offering value-added services to consumers. However, because there is a huge proliferation of Fintech start-ups globally, policy makers need to understand the interdependencies of different components that make up the FE and how it emerges, as the failure rate of Fintech start-ups is predicted to be extremely high (Dietz et al. 2015).

Our knowledge of the Fintech landscape is limited due to at least two gaps in the literature. First, although there is a growing body of work on Fintech (Gozman et al. 2018; Leong et al. 2017), there is a paucity of research specifically on the initial emergence stage. Knowledge of the emergence of an FE may be crucial as the majority of ecosystems tend to fail at the emergence stage due to a lack of accumulated resources (Diemers et al. 2015). Second, in studies of ecosystems, scholars have focused primarily on well-established ecosystems, determining the core attributes of high-profile and successful ecosystems (Bahrami and Evans 1995). For instance, the core attributes of the Silicon Valley ecosystem consist of research labs, huge venture capital and knowledgeable labor. But there is a lack of research on the context of emerging ecosystems. This is an important gap because if existing research mostly addresses the context of established financial ecosystems (e.g., Isenberg 2010), then the prescriptions and arguments underpinning those studies and how they were formed may not be fully understood.

This paper documents a study that seeks to address the above gaps. The study explores the Fintech phenomenon from a complex adaptive system (CAS) perspective and contributes to a process model of FE emergence. In addition to being empirically grounded in data obtained from an FE in India, our study generates insights into the stages of ecosystem emergence to reveal how a global self-sustaining ecosystem emerges. Accordingly, the research question that this study aims to address is: How did the process of FE emergence unfold in an emerging Fintech landscape characterized by complex non-linear interactions among the diverse ecosystem entities?

This study is one of the earliest attempts to contribute to information systems (IS) research by providing a conceptual framework to explore the FE emergence process by applying the key tenets of CAS theory. CAS theory facilitates researchers to gain insight into the diverse non-linear interactions among myriad stakeholder groups resulting in the formation of a macroscopic structure. By mapping the attributes of CAS to FE emergence concepts, a process model of FE emergence is presented. The proposed process model facilitates a systematic and consistent approach to explore the complexity of FE emergence.

LITERATURE REVIEW: EXISTING PERSPECTIVES ON FINTECH

The digitalization of financial services deflects financial information flows away from established conventional financial infrastructures and traditional financial institutions and thereby reduces the

stability of established financial ecosystems (Gozman et al. 2018). For instance, local bank branch offices are being replaced by challenger banks, internet banks, mobile banks and peer-to-peer payments that help users to perform fund transfers between themselves to bypass payment infrastructures collectively built and funded by established banks. The introduction of Fintech-enabled financial delivery mechanisms is thus creating turbulence in established financial market structures (Hedman and Henningsson 2012). According to a report published by PwC (2017), more than 80% of incumbents are increasingly concerned as Fintech players are taking away their revenues and 82% of incumbents would like to forge partnerships with Fintechs in the next 3–5 years.

An FE comprises technologies that are interrelated and in a continual state of evolution aimed at enhancing product, process and managerial performance (Clemons and Weber 1998). Within the ecosystem, as new technological innovations are introduced, unsuccessful or outdated technological combinations are rendered obsolete (Adomavicius et al. 2008). Financial innovations that build on novel and nimble platforms are breaking down conventional barriers of financial information access and asymmetric information. For instance, crowdfunding platforms have come into existence because it is complex for entrepreneurs to raise funds owing to asymmetric information between lenders and borrowers leading to adverse selection (Bruton et al. 2015).

The reorganization of financial information flows has facilitated the adoption of online banking (Gomber et al. 2017) and some forms of financial innovations have created new channels of financial information flows including networks, standards and messaging protocols. For example, application programming interfaces (APIs) have the potential to generate personalized customer-centric experiences and facilitate "banking as a platform" innovations (Zachariadis and Ozcan 2016). Challenger banks are now a global Fintech phenomenon and have attracted millions of customers with their mobile-centric offerings. For instance, NuBank, from Brazil, is the world's largest challenger bank with a total of 15 million customer accounts (Fintechnews Singapore 2020).

With the emergence of the Fintech phenomenon, institutionalized models are becoming disrupted, leading to reorganization of financial information flows. This is facilitated through novel financial technological innovations that enable reintermediation which refers to the insertion of new financial intermediaries (Sen and King 2003). For instance, Stripe is a Fintech firm that uses cryptocurrencies to process payments without the need for conventional payment infrastructures, systems and banking networks. Digi.me is another example that fosters cooperation between users and incumbent banks to effectively use personal data.

THEORETICAL FOUNDATION: COMPLEX ADAPTIVE SYSTEMS (CAS)

Frames of reference from other disciplines such as social and natural sciences provide a suitable theoretical foundation for understanding business and other complex networked phenomena (Moore 1993). Using recent advances gained through the investigation of networks and complex network

dynamics in the fields of physics and biology, an ecosystem perspective of inter-network structure proves to be a useful lens for understanding economic organization. A key attribute of such an ecosystem is its ability to adapt, emerge and evolve to changes internal and external to it. Thus, complex systems exhibit emergent behavior and are composed of dynamic entities called agents that adapt and evolve (Rouse 2007).

Research on CAS has emerged in the last few decades to understand the behavior of myriad, interconnected processes and agents from a system-wide perspective. This interdisciplinary branch of scholarship, referred to as complexity science (Manson 2001), suggests that CASs are systems in which macro-level behaviors both stem from and influence micro-level interactions of the elements of the system. A CAS is inherently multi-level in nature, facilitating exploration of collective macro-level behavior. The patterns of action stemming from one level both emerge from and are influenced by processes operating at different levels, a characteristic referred to as complexity (Arthur 1999). As a special branch of complexity theory, CAS is used to explore how complex systems adapt to the environment they are operating in and how innovation surfaces from the complex interaction of the system components (Vidgen and Wang 2006). Although CAS gained attention in the field of evolutionary biology, many of its core principles have been applied in multiple disciplines to understand the non-linear and dynamic behaviors of complex systems, such as organizational learning (Kane and Alavi 2007), self-organization and evolution (Casti 1994) and supply chain networks (Choi et al. 2001).

The adaptability of agents to the environment is a result of both micro- and macro-level interactions in the FE (Nan 2011). The actions of the agents both help create macro-level system rules and at the same time are influenced by the rules. The macro system adaptability emerges from the interactions that happen at the micro-level (Holland 2002). For instance, start-up firms may realize that their FE lacks skilled tech talent for software code development which may restrict their ability to create emerging technology firms. As the firms collaborate with other agents, they will have an opportunity to communicate the gap which may attract the attention of regulatory or government bodies to address the problem. For example, the government may implement programs by partnering with educational institutions to develop tech skills within the system. If the initiatives by government are successful, it signifies a change in the system behavior which in turn increases the range of possible behaviors in the FE and makes adaptation possible.

There is no universal perspective and theory of CAS (Vidgen and Wang 2006), nonetheless scholars imply that a CAS is composed of agents that interact and continuously adapt and organize themselves within an environment. Holland (2006)) suggests a definition of a CAS as a single coherent system that emerges over time from the interactions of its agents and adapts itself within the space in which the elements or agents reside. The discussion is therefore framed around these key attributes while drawing on insights from key attributes of CAS (see Table 1 below for an overview).

Table 1: Key attributes of CAS

CAS Attributes	Description
Emergence	There is no one single global controller directing the ecosystem and the ecosystem emerges as a result of non-linear relationships between the CAS's entities and a form of synergism among them (Mihata 1997).
Adaptation	A CAS not only exhibits a non-linear behavior, but also proactively adapts to turn surrounding circumstances to its advantage (Holland 2002).
Agents and interaction	The basic entities conducting actions in a CAS may take the form of objects, organizations and humans and are termed *agents*. *Interactions* represent the action of agents and the mutual adaptive behavior of agents and their environment (Nan 2011).
Environment	Represents the space for all agents to interact within (Nan 2011).
Self-organization	Refers to a process in a complex system whereby new emergent structures, patterns and properties arise without being externally imposed on the system (Goldstein 1999). Change and evolution are inherent characteristics exhibited by complex systems and they self-organize in order to evolve and adapt when required. The response and adaptation happens within complex systems in response to external stimuli (Johnson 2011).
Non-linearity	Refers to the relationship between the components of the system and the whole. In such case, a small change in a component can lead to a substantial change in the whole (McCarthy et al. 2006).
Dissipative structures	Introduction of new technologies can trigger radical changes in the internal structure of an economy (Harvey and Reed 1994) and a system becomes dissipative when confronting major shifts in the nature of relationships with the operating environment (Schieve and Allen 1982).
Adaptive tensions	Internal states of tension that are triggered by an external source and motivate a positive response by an entrepreneur (Lichtenstein et al. 2007).
Behavioral rules	Encapsulates the process for agents to enhance their fitness in response to feedback and information from other agents and the environment. They produce interactions among agents and improve the likelihood of survival (Cohen et al. 1999).
Emergent structuration	Outcomes of some groups of agents are contingent on other groups and a structure of similarity emerges among agents selecting the same outcome (Miller and Osborn 2008).
Degree of coherence	Degree of association between the components of a CAS that causes them to aggregate into a group rather than remain independent and isolated (Manrubia and Mikhailov 2004).
Control parameters	Exogenous forces of a CAS that can steer the system and its agents into different behaviors and influence coherence (Rickles et al. 2007).
Order parameters	Endogenous forces that increase system coherence and influence agent and system behaviors (Goldstein 1999).

Outcomes for a certain group of agents depend on other agents. For instance, a solution developed by a start-up could be capitalized by other start-ups resulting in increased coherence among the agents thereby increasing the likelihood of their survival (Cohen et al. 1999). By competing and collaborating with each other, the agents followed simple rules that governed their interaction among each other, called behavioral rules, resulting in a similarity of structure among them (Miller and Osborn 2008).

The individual micro-interactions among the agents get coalesced into an aggregate group by increasing the degree of association between the components of a CAS, called the degree of coherence, that increases with increased interactions among the agents (Manrubia and Mikhailov 2004). Certain outside forces termed control parameters push the CAS and its agents into different behaviors and influence coherence (Rickles et al. 2007). The internal forces that influence agent and system behaviors are the order

parameters (Goldstein 1999) resulting in the participants of the ecosystem interacting with one another and increasing the coherence among agents.

Fintech Ecosystems as Complex Adaptive Systems

FEs can be suitably conceptualized as CASs for the following reasons. First, emergence of FEs is not controlled by a central authority, an organization or a global controller (Isenberg 2010). For instance, government can play a critical role in promoting FEs, however, the order that emerges in an FE is largely from the coherent, coordinated actions of multiple agents and not from a centralized authority. Although some agents such as investors may be more powerful and influential (Feldman and Zoller 2012), there is no particular entity that controls the agents' behaviors and activities and it implies that the macro-level systems are emergent and arise from self-organization rather than from top-down control (Nicolis and Prigogine 1977). In other words, an FE is a macro-level system that emerges from the micro-level interactions of its individual agents, which collectively leads to the formation of an aggregate CAS. Attempts to control and direct the development of an FE can prove detrimental to its healthy functioning and cohesiveness (Feld 2012). An FE is composed of government, industry, start-ups, customers, tech vendors, universities and research institutions, investors and incubators, accelerators and innovation labs. The agents of an FE are heterogeneous in their attributes, in their interactions with other agents outside the FE and in their interactions with the environment. Despite the heterogeneity among the isolated agents in the ecosystem, they exhibit similarities in behaviors, intentions and activities which allow them to be assigned to a specific category (Lichtenstein 2011). In a CAS, agents are not role-exclusive and can play multiple roles. For instance, an investor may also be an entrepreneur (Holland 2006).

A suitable theoretical foundation needs to address the cross-level nature of the ecosystem dynamics (Burton-Jones and Gallivan 2007) and the collective outcome from each level. The complex multi-level interactions need to be decomposed and analyzed by considering the interactions and the interdependencies (Nan 2011). These interactions capture the FE in terms of organizational entities (customers, vendors, partners etc.) and technological resources. In this study, we use the key tenets of CAS to deepen our understanding of ecosystem emergence. The CAS theory has drawn widespread attention from researchers in the IS field (Merali and McKelvey 2006). In the CAS context, aggregate structures arise not from a global or central controller, but from the interactions among interdependent agents that are goal-seeking based on local knowledge and feedback loops. Hence CAS theory provides a suitable framework that facilitates generation of new concepts and promotes formal modeling (Morel and Ramanujam 1999) as it allows us to see the contribution of individual agents and their interactions with the environment in the emergence of an FE (see Figure 1).

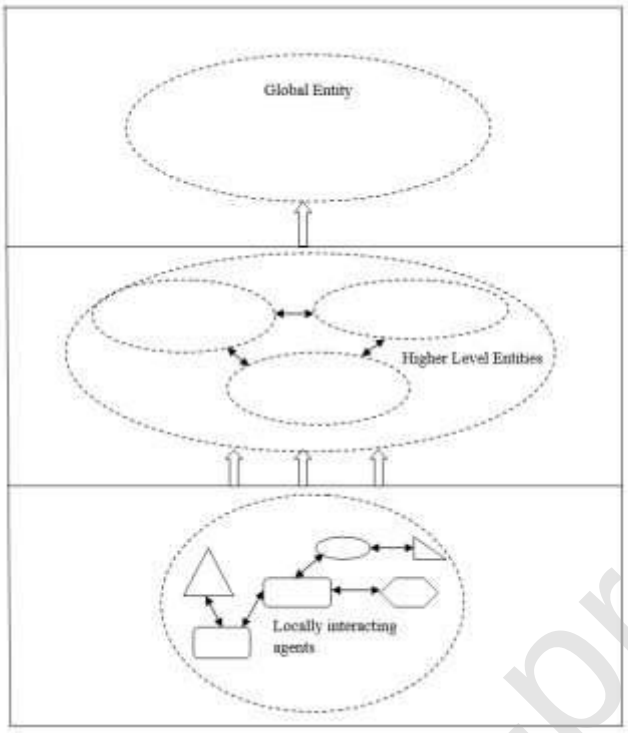

Figure 1. An Overview of CAS Theory

The CAS model of FE emergence is used to define and characterize the key attributes and mechanisms underlying the emergence. The key tenets of CAS provide analytical advantages in investigating the diverse factors and dynamics involved in the FE emergence process (see Table 2). It is developed here to offer a theoretical perspective for investigating the process of FE emergence whereby micro-level interactions among the ecosystem entities collaboratively create a macroscopic structure. The previous section established that FEs are conceptualized as CASs. The following sections accentuate the key tenets of CAS theory and the different facets of emergence to provide a better understanding of FE emergence processual mechanisms.

Table 2: Key attributes of CAS in the context of FE emergence

Attribute	Contextualization and Description
Emergence	There is no one single global controller directing the FE. The ecosystem emerges as a result of non-linear relationships between its entities.
Adaptation	Mutually adaptive behaviors of the agents in response to stimulus from the broader operating environment.
Agents and interaction	FEs comprise government, industry bodies, start-ups, customers, tech vendors, universities and research institutions, investors and incubators, accelerators and innovation labs. Interactions within the FE involve interactions between the diverse stakeholder groups and the mutually adaptive interactions with the overall FE.
Environment	The socio-cultural context in which the agents are exhibiting mutually adaptive behaviors in accordance with societal norms, rules, regulations and culture.
Self-organization	A process whereby emergent governance structures arise organically among agents without deliberate intervention by the influential entities within the FE.

Non-linearity	Relationships among the entities of an FE and the whole, such that the actions of one entity can have ramifications for the entire network.
Dissipative structures	Internal structural change in the economy triggered by the introduction of new technologies such as blockchain, social media and cloud computing.
Adaptive tensions	Internal conflictual states among agents that are triggered by injection of resources into the FE by policy makers or influential entities.
Behavioral rules	Implicit rules and norms emerging from interactions among agents and the environment in an FE.
Emergent structuration	Interdependencies among agents in an FE result in the formation of a structure of similarity.
Degree of coherence	Degree of association between the agents in an FE that causes them to aggregate into a group.
Control parameters	Exogenous forces such as global technological innovations influence the FE and its agents into different behaviors and promote coherence.
Order parameters	Endogenous forces such as government rules and regulations, and implicit rules arising from interactions among agents that increase system coherence.

Agents

As explained earlier, an FE is an interconnected network of diverse agents that display mutually adaptive behaviors in response to stimuli in the operating environment and the system of agents (Holland 2002). In the context of FE emergence, agents could be human actors such as entrepreneurs and objects such as technological artifacts. In an FE, self-organization and emergence occur as a result of decisions that are made by the agents that lead to the emergence of collective system behavior over time. As the network connectivity among the entities increases, the complexity of the web of agents increases, leading to increased coherence (Manrubia and Mikhailov 2004). The reactions of a particular agent can have far-reaching impact owing to the non-linear relationships within the broader system (McCarthy et al. 2006) and the agents can play changing or diverse roles as the FE evolves and the environment changes.

The actions of individual agents facilitate generation of FE level rules and, in turn, are influenced by such rules (Cohen et al. 1999). The entrepreneurial activities of the agents not only cause them to engage in similar activities and behaviors such as developing solutions for real-world industry problems, but also result in mutual goals such as creating a "collaborative business friendly community" (Cromie 1987; Epstein and Axtell 1996). An FE's agents share common values (such as cultural and societal) which create coherence (Roundy 2016) and a common set of behavioral rules adopted by agents (such as knowledge sharing and cooperation), which operate as a portfolio of important heuristics and are acquired by observing the actions of other agents (Axelrod 1997).

Interaction

Self-organization emerges in an FE through multiple forms of close interaction in which the stakeholder groups share knowledge and collaborate to achieve project outcomes (Goldstein 1999). This mutual learning process has the reciprocal effect of reinforcing the emerging structures of interaction and collaboration among Fintech start-ups. For example, the continuous gathering of cases from industry

partners and working with start-ups to develop solutions to address real-world problems provides start-ups with opportunities to learn from each other and foster innovation which is fed back into the system. The technological resources co-evolve with the human agents interacting with them. Together, this demonstrates the co-evolution of technology, process, products and people reflecting the self-organization and emergent behavior of the entities (Holland 2002).

Earlier studies highlighted that technological resources not only include technical information technology (IT) artifacts such as software and hardware, but also encompass key intangible resources such as information, values, culture and norms (Byrd and Douglas 2000; Kumar 2004). These resources are salient to the FE emergence process. Agents in the FE must channel the contributions continuously to evolve or sustain interpersonal interactions. Through the perspective of CAS theory, the diverse stakeholders such as government, industry, start-ups, customers, tech vendors, universities and research institutions, investors and incubators, accelerators, innovation labs and technological resources can be viewed as agents and the implicit non-linear relationships among them as conduits of knowledge transfer. In addition to the complexity that stems from the non-linear interactions of an FE's agents, such interactions can generate adaptability (McKelvey 2004). Through interactions with one another, the actions of FE agents will generate continuous modifications to the system, which determines how the system reacts to the exogenous and endogenous forces and allows it to adapt to changing conditions (Messier and Puettmann 2011).

Environment

The socio-cultural contexts form an agency for the agents to interact with each other. An FE does not evolve independently from its surrounding environment and the other major systems in which it is nested but rather it co-evolves. The relationship between the environment and the FE results in emergence owing to myriad interactions and the self-organization of agents (Holland 2002). The FE becomes robust and resilient owing to its interaction with the environment. FEs are unique in their ability to adapt rapidly to stimulus from the environment and enhance their capacity to diversify their strategies (Holland 1992). For instance, an adaptive response could be altered or new strategies, innovative learning and knowledge sharing mechanisms and work-around changes developed. By enhancing the complexity, the agents in an FE were able to change creatively (Marion 1999) and process information (Lewin 1999).

Environmental structures are inherently linked to other elements of FE emergence processes and they can alter the actions and interactions of agents. For example, organizational structure, business strategy and organizational culture are inextricably linked to the behavioral rules (Cohen et al. 1999) of FE agents in capturing the mutually shaping relationships between contextual structures and the FE emergence process. FE agents including human actors and intangible resources such as knowledge and information, user–system interactions and the environment jointly generate macro-level interactions.

RESEARCH METHOD

Although quantitative methods like agent-based modeling have been the dominant approach to studying CAS in other disciplines, qualitative methods are suitable for the study of FEs as CASs (Holland 2002) for several reasons. First, FE is a multifaceted and intrinsically complicated phenomenon, and the richness of qualitative data can facilitate researchers to unpack the temporally unfolding characteristics of FEs and investigate the phenomenon by teasing out the shared interpretation of the relevant stakeholders (Klein and Myers 1999). Second, qualitative data are particularly effective in illustrating complex and abstract ideas and making conceptual frameworks comprehensible (Graebner et al. 2012).

We adopted the case research method because most IS theories, including the CAS model of FE emergence, require "some form of realist ontology, as constructs in theoretical statements can refer to entities in the real world" (Gregor 2006, p. 631). The strengths of case study design lie in exploring "how" research questions (Walsham 1995), processes that are deeply intertwined with their contexts (Pentland 1999), and under-studied phenomena (Siggelkow 2007)—all conditions that are relevant to our study. The case data provided the empirical grounding for the development of the CAS model of FE emergence. Based on our research objectives, two conditions formed the basis of case selection. First, the FE we study must be in the very early stages of emergence, to allow us to capture the initial conditions, activities, entities, events, agents and their interactions and to explore the phenomenon at multiple levels. Second, the FE we select must have a wide array of entities across diverse sectors to explore the phenomenon more holistically. The Vizag Fintech Valley in India is particularly appropriate for our study as it seeks to become a world class Fintech hub for innovation by capitalizing on the opportunities brought by global technological trends, such as blockchain, financial analytics and cybersecurity.

Case Background: The Fintech Valley in Vizag, India

Visakhapatnam, also known as Vizag, is the most populous city and the financial capital of the Indian state of Andhra Pradesh. It is one of the 100 fastest growing cities in the world with its output gross domestic product (GDP) of US$43.5 billion making it the ninth largest contributor to India's overall GDP in 2016 (Haritas 2018). In 2016–2017, the IT sector in the city had tremendous growth with an increase in turnover to US$790 million with 34,000 employees in 350 firms. With Andhra Pradesh driving India's digital economy, the state government is keen on transforming Vizag from a tier 2 city to a prominent Fintech hub (Patnaik 2017). The Fintech Valley is an Andhra Pradesh state government initiative launched in December 2016 to promote business infrastructure in the state and attract visitors and corporations to invest in the state. Vizag was chosen as the city for the Fintech Valley project due to its size, potential and established industrial base. The Fintech Valley project was announced as part of broader state strategic goals titled "Sunrise Andhra Pradesh Vision 2029" (Press Trust of India 2016).

In 2014, the state of Andhra Pradesh was divided into Andhra Pradesh and Telengana and during this partition the well-established IT sector in the city of Hyderabad became part of Telengana. In 2014, the year of division, Hyderabad founded 340 start-ups, but in 2017, it had a total of 1895 start-ups as it had

the advantage of leveraging already established infrastructure and the IT industry (Bansal 2017). The chief minister of Andhra Pradesh, Mr. N. Chandrababu Naidu, focused on Vizag and a few other cities to repeat the transformation he achieved for Hyderabad when he was the former prime minister of the united Andhra Pradesh (Raval 2018). He is the chief architect for Fintech Valley Vizag and as of 2017, Fintech valley has attracted US$900 million and created 5,500 jobs (Haridas 2018).

To accelerate the growth of the Fintech sector, the government launched a host of programs, such as the "Fintech valley accelerator program," to act as a catalyst in the growth of Fintech start-ups by linking them to the leading FE players in the market. With a potential of 50 million Fintech users in the state of Andhra Pradesh, the state government is enabling market access through banks, other financial institutions and promoting self-help technology platforms with Fintech solutions (Businesswire India 2019).

Data Collection

To answer the research question, the Vizag Fintech Valley ecosystem was chosen as the unit of analysis. Case access to Fintech Valley in Vizag was granted in July 2018. Data collection occurred in two main phases—a preparatory phase and a fieldwork phase. The focus of the preparatory phase was to collect and analyze data from diverse secondary sources to gain an understanding of the emerging Fintech phenomenon, while the emphasis of the fieldwork phase was to collect data specific to our research question and explore in depth the various stages of FE emergence (Pan and Tan 2011). Interviews were the primary means of data collection during the fieldwork phase (Myers and Newman 2007). A total of 18 informants were identified via chain referral sampling (Biernacki and Waldorf 1981). The informants were referred to us incrementally by the "gatekeeper" (Pan and Tan 2011, p. 165) who granted us case access based on the interview questions we formulated in an emergent manner across the various iterations of data collection and analysis. These informants consisted of government officials, start-up owners, academia, Fintech Valley representatives and an incubator within the FE, and the Andhra Pradesh Electronics and IT Agency (see Table 3).

Table 3: Summary of interviews

Organization	Informants	Interview Themes
Gandhi Institute of Technology and Management (GITAM) An institute of higher education that offers 109 programs at undergraduate, postgraduate and doctoral levels.	Chancellor Pro-Vice Chancellor Professor	Role of academia in FE, academic initiatives on Fintech, partnership with government and global consultants.

Govin Capital Provides help to accelerate start-ups from ideation to growth via novel mentorship model that creates new market opportunities.	CEO Manager	Opportunities and challenges in Vizag for incubators, strategies for growth, selection and exit criteria of start-up firms.
National Association of Software and Services Companies (NASSCOMM) Not-for-profit apex body for the US$154 billion IT business process management industry in India.	Manager	Challenges in mentoring and coordinating the start-ups, growth strategies and opportunities in Fintech Valley.
Incremint Provides financial advisors a platform to cross-sell products to their clients.	Founder	Opportunities and challenges in Vizag for start-ups, strategies for growth, business model, client engagement.
Andhra Pradesh Electronics & IT Agency (APEITA) An autonomous society of government of Andhra Pradesh established to develop the electronics and IT agency.	Founder	Opportunities and challenges in Vizag for start-ups, strategies for growth, business model, client engagement.
FortyTwo Labs Provides innovative solutions to address problems in cyber security, large-scale enterprise systems and high performance computational systems.	Strategic Director Product Manager	Opportunities and challenges in Fintech Valley, concept development, business model and strategies, reason for choosing Vizag.
Fintech Valley Fintech Valley Vizag is an initiative of the government of Andhra Pradesh to promote business infrastructure in the state, and attract investors and multinational corporations to set up offices.	CEO	Strategic reasons for setting up Fintech Valley, challenges in attracting investors and stakeholder groups, promotional strategies.
Alykas Innovations Provides blockchain solutions to enterprises.	Founder	Opportunities and challenges in Fintech Valley, concept development, business model and strategies.
Belfrics Global Offers an exchange, a wallet and a payment platform, among other services to the cryptocurrency industry.	Founder	Opportunities and challenges in Fintech Valley, concept development, business model and strategies.
Government of Andhra Pradesh (AP) Democratically elected body that governs the state of Andhra Pradesh, India.	Cabinet Minister of Information and Technology Special Representative for IT	Fintech Valley promotional strategies, strategies to attract investors, ecosystem developmental strategies.

Each interview was conducted with the help of a semi-structured interview guide (Myers and Newman 2007) and questions were open-ended (see Appendix A), with a focus on guiding the conversation rather than maintaining a closed structure. The guides were drafted based on the relevant themes in the FE and CAS literatures (Pan and Tan 2011). Each interview guide consisted of a key set of questions relevant to the emergence of ecosystems, challenges and outcomes that resulted from the initiatives taken by

government officials. Each interview, which took an average of about 90 minutes, was digitally recorded and subsequently transcribed for data analysis. There were a total of 218 pages of interview transcripts. Each researcher from the team reviewed the data independently, and regular meetings were held throughout the development of the study to ensure a congruous interpretation of the data (Klein and Myers 1999).

Data Analysis

Grounded theory techniques are particularly suited for the analysis of our data because they provide the means to identify and develop concepts and their inter-relationships that form the building blocks of theory from qualitative data (Glaser and Strauss 1967). More specifically, we adopted the techniques from the Straussian tradition (Strauss and Corbin 1990) of the grounded theory method because of our epistemological assumption that it is more feasible to "create (rather than to discover)" (Kenny and Fourie 2015, p. 1274) theory using an initial theoretical lens as the starting point of our inquiry (Pan and Tan 2011). In addition, this approach has the benefit of enabling "theoretical sensitivity" (Chakraborty et al. 2010, p. 219), which helped us to recognize the relevance of raw data to our theorizing efforts, and better focus on the abstraction (as opposed to the description) of our empirical materials.

From the concepts derived from our review of the literature on Fintech and CAS theory, we first constructed an initial theoretical lens consisting of a number of theoretical dimensions and themes (see Table 4). With each instance of data collection, such as conducting an interview or acquiring a new secondary document, the data collected were then coded based on the structure presented by our theoretical lens using the techniques of open, axial and selective coding (Strauss and Corbin 1990).

Table 4: Dimensions and themes of our initial theoretical lens

Dimensions	Themes
Agents	Fintech firms, incumbent financial institutions, investors, borrowers, government authority
Interactions	Emergence, adaptation, self-organization, non-linearity, adaptive tensions, emergent structuration
Environment	Dissipative structures, behavioral rules, degree of coherence, control parameters, order parameters

Open coding was first used to apply conceptual labels to the relevant excerpts of our interviews to form first-order concepts (see Gioia et al. 2013; Van Maanen 1979). The first-order concepts were then grouped into second-order themes via axial coding. In particular, if the first-order concept fitted an existing second-order theme within our coding structure, the concept was assigned to the theme directly. Conversely, if the fit was not exact or if the concept related to a theme that did not yet exist, an existing or new second-order theme was modified or created accordingly (see Gioia et al. 2013) before coding was restarted based on the changes made. Finally, selective coding was used to further abstract the second-order themes into a number of aggregate dimensions. This was done to establish the relationships

between the second-order themes (see Strauss and Corbin 1990) with new dimensions incorporated into our coding structure, or the existing dimensions modified, where needed. A sample data structure (see Gioia et al. 2013) is presented in Appendix B to illustrate how our interview data were labeled, categorized and abstracted into the relevant first-order concepts, second-order themes and aggregate dimensions via our coding procedure.

Next, we applied a visual mapping strategy to present the concepts, themes and dimensions that were derived from coding and capture our theoretical ideas in a diagrammatic form (see Figure 2 in the following section). We also applied a narrative strategy to construct a coherent "story" that represented our account of the case study. (For an in-depth description of the visual mapping and narrative strategies, please see Langley 1999). Both the visual maps and narrative created were verified with a number of key informants and iteratively refined to ensure the validity of our interpretation and theoretical ideas. In addition, we made sure that each of our findings was validated by at least two distinct sources of data in line with the principle of triangulation. The measures adopted to ensure the rigor of our research method, using the criteria of credibility, transferability, confirmability and dependability as proposed by Lincoln and Guba (1985)), are summarized in Table 5.

Table 5: Measures to ensure research rigor (adapted from the work of Lincoln and Guba 1985)

Criteria	Measures Taken
Credibility	Data were collected from a variety of external and internal data sources to enable triangulation (Klein and Myers 1999). Semi-structured interview guides (Myers and Newman 2007) were prepared with open-ended questions that are relevant to the phenomenon under study.
Transferability	The process theory that emerged from the case data was iteratively compared with existing research to establish theoretical generalizability (see Lee and Baskerville 2003).
Confirmability	Interviews were conducted by a team of five researchers, and data were analyzed jointly to ensure the validity of observations and interpretations (see Pan and Tan 2011).
Dependability	All the interviews were transcribed and the interview data were compared with the multiple primary and secondary sources to ensure accuracy (see Klein and Myers 1999). Emerging theoretical constructs and process models were verified repeatedly with the informants to ensure theory–data–model alignment (see Pan and Tan 2011).

Data analysis unfolded concurrently with data collection such that the insights gained from one iteration of analysis guided the collection of further data, until the state of theoretical saturation was reached (Eisenhardt 1989). This state refers to the point where our emergent process model was able to account fully for any additional data collected, and there were no further findings that would augment or require modifications to our process model (Glaser and Strauss 1967).

FINDINGS

Overview

Our analysis indicates that the emergence of an FE in Vizag was initiated as part of the broader strategic vision of the government to stimulate economic growth, promote business infrastructure, fast track digitalization, attract global investors to the state and provide impetus for the Fintech community. This research proposes a process model (see Figure 2) of how an FE emerges in a rapidly changing technological landscape. Emergence, the "process by which patterns or global-level structures arise from interactive local level processes" (Mihata 1997, p. 31), is central to complexity science (Lichtenstein 2011). The theoretical framework consists of three key stages of ecosystem emergence related to establishing a self-sustainable global FE: (1) The *Envisioning* stage, where the government sets a strategic vision to promote digital governance and technology enabled job creation in the state, (2) the *Enacting* stage, where the government executes the strategic plan by fostering partnerships with established global Fintech hubs to leverage best practices appropriate for local setup and establishing fundamental conditions for the ecosystem and (3) the *Enlivening* stage, where interconnection among the agents of the ecosystem is facilitated to build symbiotic synergies and promote operational efficiency. As depicted in our process model, ecosystem emergence was triggered by the strategic vision set up by the government in response to the global emerging technological trends and the national IT agenda. The following subsections present the empirical case evidence used to construct our process model and describe more fully how the model was developed.

Stage 1: Envisioning

The first step towards understanding the emergence of an FE is to identify the system's key agents, the forces influencing the agents and the levels at which these forces operate (Bonabeau 2002). Evidence from our case study suggests that the global emerging technological trends and the national IT agenda stimulated the formation of a *loosely connected* ecosystem where potential agents began to come together but had not yet formed connections. The key agents were government, educational institutions and the Andhra Pradesh Electronic & IT Agency (APEITA). At this stage, the agents were interested in coming together, but had not yet connected with one another. This resulted in the formation of structures that are context-dependent, where the ecosystem structure formed in response to the environment in which it is built, termed the "**contextual structures**." The government provided a purpose-built facility at subsidized rates to foster growth and promote business infrastructure in the state. The government partnered with academia to support the Fintech community and nurture a skilled workforce. APEITA was entrusted with the task of designing "blueprints" for the Fintech Valley initiative at Vizag with plans to promote the "Advantage Andhra Pradesh" brand among top global players in the IT and electronics manufacturing sector.

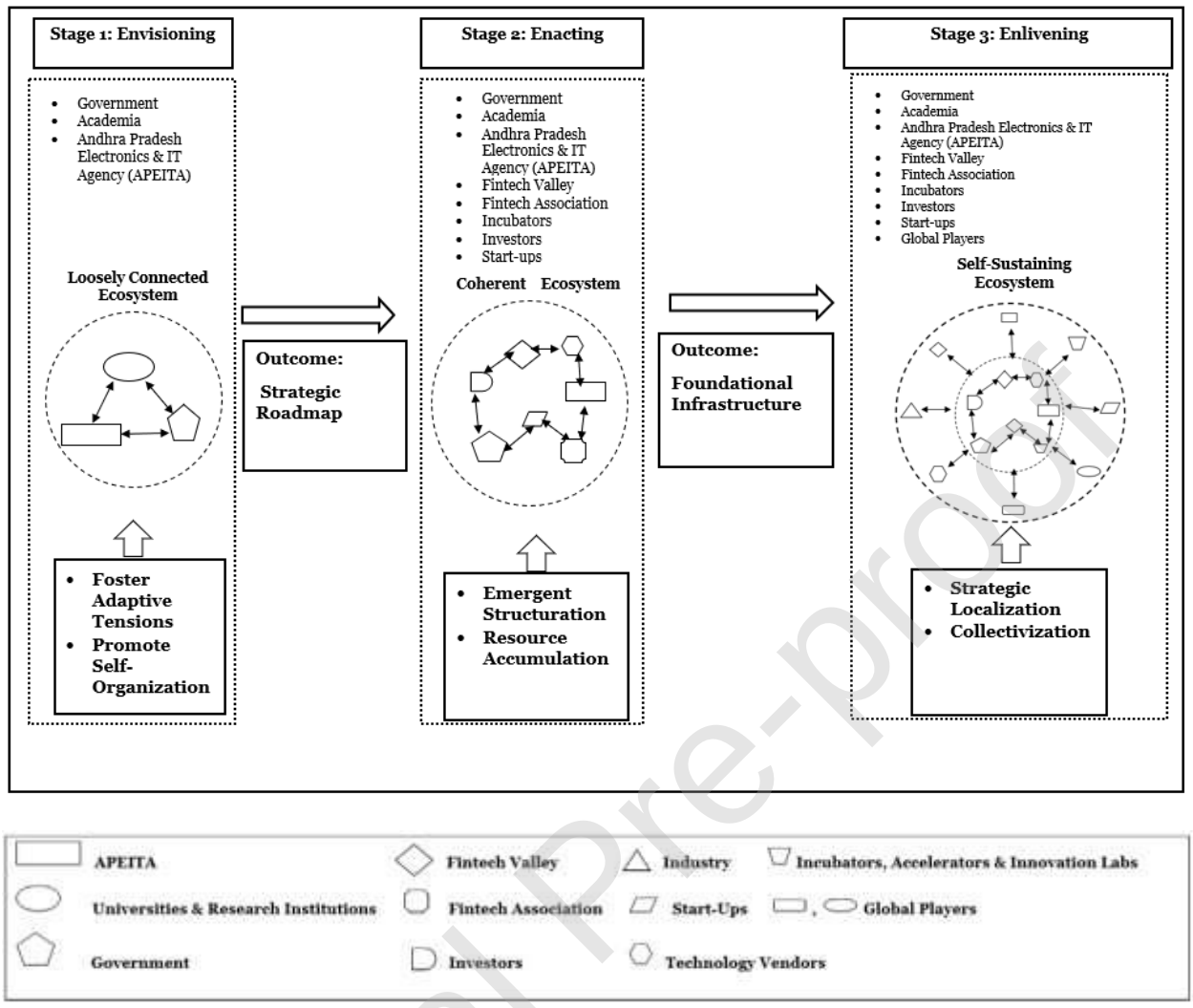

Figure 2. A Process Model of FE Emergence

Although there are several agents at play in the FE, we contend that the intentionality of the Chief Minister of the Andhra Pradesh government (Muñoz and Encinar 2014) for "the tendency towards a goal that first appears in the individual's mind as a purpose" acted as a key driving force and contributed to FE emergence. However, government is not the sole entity that acted as a controller (Mihata 1997). These forces operated at the regional level and emerged in response to emerging global technological trends.

The broader strategic vision of the state government triggered the Fintech Valley initiative to put the state on a trajectory of growth and development. It entailed extensive brainstorming sessions, stakeholder consultations and ratification of the vision document from influencers and community representatives of the state assembly. Fintech was chosen as it opens up opportunities to cater to the unmet needs and latent demand for financial services (Leong et al. 2017). Growth markets present unique problems that have never been faced by mature markets and also present fertile ground for innovation and creativity. With the advent of Fintech, a gamut of entities such as start-ups, technology companies and non-bank players compete and collaborate to offer value-added services (Khan 2016).

Visakhapatnam, also known as Vizag, was chosen to host the Fintech Valley because of its potential to attract investors and its size. Vizag had an annual IT turnover of US$276 million in 2016 and is the largest city in Andhra Pradesh with a robust industrial base (Patnaik 2016). The objective of the initiative was to build Vizag into a thriving finance and technology ecosystem. In the context of the FE in Vizag, the government created opportunities and provided access to a new pool of resources such as allocation of funds and workspaces which resulted in energy differentials (Lichtenstein 2011) between the start-ups pursuing new opportunities and the available resource pool. This fostered internal states of tension that were triggered by an external source (government) and motivated a creative response by the start-up firms (Merali and McKelvey 2006) termed "**adaptive tensions**" (Lichtenstein 2011). As a result of adaptive tensions, the start-up firms were motivated to set up their venture in the Fintech Valley. The government facilitated co-operation and collaboration among the start-ups and provided access to a huge knowledge base by co-locating the start-ups in the Fintech Valley. This resulted in the changing of the internal structure of the system to adapt to its environment and the system organized from within, in response to the stimuli which promoted "**self-organization**" among the agents (Johnson 2011). The collaboration among the agents resulted in the formation of simple rules called *behavioral rules* that governed the interaction among the agents resulting in coherence (Cohen et al. 1999).

We term this initial stage the *Envisioning* stage as it is characterized by the outlining of clear objectives by the leadership of the government to propel the state economy into a higher growth trajectory by adopting innovative growth models. Also, it involved analysis and identification of existing resources and capabilities and assessment of the current state of affairs. The diverse agents such as the government, entrepreneurs and academia acted due to the adaptive tensions (Lichtenstein et al. 2007) that were created in accordance with the behavioral rules (Cohen et al. 1999) which led to the tangible outcome of creating a strategic vision. The *Envisioning* stage culminated in the charting of a **strategic roadmap** to establish a self-sustaining global FE that is required to capitalize on the emergent business opportunities (Doz and Kosonen 2010) and promote digital governance. This stage is the first stage of emergence and is critical as it establishes the foundation for FE emergence by clearly outlining the objectives to set up a self-sustaining global ecosystem (The Hans India 2018). The aggregate dimensions and second-order themes (Gioia et al. 2013) that were found to be vital in this stage, and their corresponding case evidence, are presented in Table 6.

Table 6: Representative quotes underlying second-order themes in the Envisioning stage

Aggregate dimensions and second-order themes	**Supporting evidence**
Contextual structures Loosely connected Agents coming together to plan the set up of a global self-sustaining ecosystem	"*Financial services have length and breadth so the attempt of technology in those financial services was very limited. Now people had started to use technology to give a transparent and speedy and better service to the customers. That's where policy makers are finding the gap … The services are so many … financial services, but the technology usage to those services is very much limited. And here and there something is*

	happening. There is no integrated approach to take care of all these services which are there in the financial sector." (Pro Vice Chancellor, GITAM)
Interaction Foster adaptive tensions States of tension created to pursue solutions for real-world problems motivating start-ups to provide the right solution	"*We would love to work with Andhra Pradesh because they have lots of problems and they had business opportunities for us to work on so it not only stays but it was groundbreaking problems they had … because start-ups like us, we are not hungry for space and we have 10 to 15 people when we start and we can work from anywhere but what we are really hungry is for us to showcase our solution to have the right set of problems.*" (Strategic Director, FortyTwo Labs)
Promote self-organization Agents coalesce in the course of interactions with other agents and the environment.	"*We as start-ups can discuss with other start-ups what they are doing there is some ecosystem building in this start-up. Because when I came here, I came to know a lot of things here: How other start-ups are working, how they are managing teams. So there is a chance here. If I am alone in the city in a separate office, so that is not the right place to sit. Once I am established that is different but in the initial stages we need to collaborate with a lot of people and understand what they are doing while we are moving ahead. Is this the right direction or not? We need some people to discuss that. So this is the place where a lot of companies are working, a lot of start-ups are there. It's easy to mingle with them and collaborate with.*" *(*Founder, Alykas Innovations)
Agents Actors represent diverse entities such as start-ups, corporates, investors and academia.	"*There are start-ups, there are big corporations that are trying to get hold of some of these emerging technologies in a most efficient way which is through either acquisitions or working with them on a project basis. And then there is always the academic institutions who are trying to figure out what kind of talent that they need to produce to meet the demand that is coming from this. And then of course investors who are trying to identify what's the best way to grow the ecosystem. So…we are trying to attract all of them into this one place, where we can go into the next wave of technology.*" (CEO, APEITA)
Environment Promote positive and collaborative work context.	"*We never said to anyone to leave Vizag or leave the campus just because we gave the land on the subsidy rate, you didn't fulfill what is your commitment. We never asked them to go but instead we are trying to find new companies where both of them collaborate, that is how the designated technology park concept has come. So whoever has a facility and they couldn't use, maybe they couldn't get projects or they couldn't get the manpower, any new company that is trying to come, we are asking them to use their facilities or share their land and that's how we are taking but we never said anyone to leave. ".* (Manager, APEITA)
Outcome *Strategic Roadmap* Blueprint for transformation of the state A detailed document with specific and measurable goals and targets to remold the state into a "happy and globally competitive society" by 2029.	"*Andhra Pradesh has the lowest per capita income in south India. By 2022, it will be in top 3 states in per capita income and by 2029 it aims to be in the top in not only per capita income but also in happiness and by 2050 in south India states and compete with Singapore and Malaysia and this is a background to create a knowledge and innovation reliant society.*" (Cabinet Minister of Information Technology, Government of Andhra Pradesh)

Stage 2: Enacting

Following the *Envisioning* stage, our findings suggest that the next stage of Fintech emergence is brought on with the entry of start-ups, incubators and investors and with the formation of a Fintech association and the Fintech Valley. The Fintech association and Fintech Valley are the higher order entities that were set up to promote the FE and provide the right infrastructure and process to facilitate the entry of Fintech firms, investors and incubators. These entities adopted diverse strategies to attract investors, start-ups firms and industry partners by providing them access to subsidized infrastructure, plug and play facilities and market taxes.

The interaction among the agents was further facilitated by partnering with financial institutions and technology partners to build a use case repository. These use cases were presented as real-world industry problems to the start-ups to build the right solutions. These strategies adopted by the Fintech Valley helped diverse agents to operate in accordance with a set of common values, methods and behaviors (Lichtenstein and Plowman 2009). The degree of correlation across the diverse agents' activities was enhanced which shaped the ecosystem to a coherent whole and led to what we term **resource accumulation**. It is defined as the coalescing of diverse resources and channeling them synergistically to deliver specific outcomes. It caused the agents to aggregate into a system that remains autonomous (Manrubia and Mikhailov 2004).

Solutions that are created by the start-ups can produce coherence in agents' actions (Muñoz and Encinar 2014). For instance, an internet of things (IOT) solution introduced by a start-up was replicated and reused by other start-ups in an FE who needed this functionality, which is a form of **emergent structuration** (i.e., a structure of similarity emerging among a group of agents leveraging a functionality; Miller and Osborn 2008). The key agents and the degree of coherence among them promoted resource accumulation that led to the establishment of the **foundational infrastructure** and the creation of a *coherent* FE. A coherent FE is an ecosystem in which there is an increased degree of coherence in the individual micro-interactions of the agents and the environment. The patterns of action generated at one level are influenced by processes operating at different levels and the overall behavior of the system (Lissack and Letiche 2002). The foundational infrastructure comprises the basic physical and non-physical structures that support the emergence of the FE. This includes the IT facilities, data centers, network infrastructure, platforms, colocation and cloud computing hardware and human capital.

We term this next stage of FE emergence the *Enacting* stage as it is characterized by the degree of coherence that is shaping the ecosystem, aided by the active collaboration of the government with global consultants, industry experts and academia to create a world class ecosystem. In the *Enacting* stage, the connections and interactions between the agents are facilitated by the government devising a myriad of strategies. In some instances, the outcome of one group of agents is contingent upon the success of other groups. For example, an investor's success is contingent on the success of the start-up firms who fall

under their umbrella (Hochberg 2016). Also an innovation from one start-up firm could be leveraged by other firms in the Fintech Valley and the ecosystem's agents may follow and exhibit common values which also created coherence among them.

The aggregate dimensions and second-order themes (Gioia et al. 2013) that were found to be salient in this stage, and their corresponding case evidence, are presented in Table 7.

Table 7: Representative quotes underlying second-order themes in the Enacting stage

Aggregate dimensions and second-order themes	**Supporting evidence**
Contextual structures *Coherent* Connections facilitated among diverse stakeholder groups by bridging the gap between real industry problems and start-up ideas	"*When we started discussing with the start-ups it is more like a product centric. They wanted to sell their products, it may not solve the problem of actual industry. So that is the one thing we observed, that's why we started taking the use cases from the industry and then helping the start-ups. So that the corporates can actually mentor them as well, they will be solving the problem of the corporate and the start-up will be getting the market taxes and money. So we partnered with almost 40 corporates, most of the banks, insurance companies, mutual funds, all of them joined together and they are giving us their use cases and they are also having their accelerator programs and innovation programs through which they are funding their start-ups.*" *(*Manager, Fintech Valley*)*
Agents Stakeholders represent diverse entities such as start-ups, corporates, investors and incubators.	"*We publish problem statements from multiple banks to different start-ups and whoever can come up with the solution and then we have them pitched to the companies that put out these problem statements. And then based on that selection process they can go up with them and do pilots and POCs and then that enables them to sort of test out and then they also get the … start-ups get the mentorship they need. Because these are problems from the corporates, they understand the business very well.*" (CEO, Fintech Valley)
Interaction *Emergent structuration* Structure of similarity emerges among agents based on outcomes of certain groups of agents	"*By interacting and trying to solve these problems and working with the corporate, the start-ups get a lot of critical thinking that's needed for them because they get a broader perspective.*" (CEO, Fintech Valley)
Resource accumulation Agents in FE gain coherence and build knowledge base by collaboration and cooperation.	"*We coordinate with Vizag government and the response from them was tremendous. In fact as I said that we deal with multiple governments and multiple start-ups from many regions, so this is one of the best so far we have seen and we have got lots of support from others but the Vizag one is the best so far than any other.*" (Founder, Belfrics

	Global)
Environment *Promote entrepreneurial atmosphere* Foster a conducive entrepreneurial atmosphere for the diverse agents to work collaboratively.	"*There is work happening in Fintech, Big data analytics in terms of hackathons, centers of excellence. We are working with the Confederation of Indian Industry (CII) for IOT Centre of excellence for agriculture. Andhra Pradesh is the only state which uses IOT for agriculture which is really exciting. As a state we need to be an example that all the entrepreneurs are doing so well.* " (Cabinet Minister of Information and Technology)
Outcome *Foundational infrastructure* A solid foundation and fundamental conditions for the formation of an ecosystem is developed.	"*I think a year and half is a good time that we have, and now we have what we are calling is Fintech Valley 1.2 is sort of coming to a conclusion in the next few months when we are doing our first big flagship event called Vizag Fintech festival, that sort of like marking like you know. It's officially on, this is going to be an annual event from now onwards. This is the first one but every year we look forward to showcasing the progress we are making.*" (CEO, Fintech Valley)

Stage 3: Enlivening

Followed by increased coherence among the agents in the ecosystem in the *Enacting* stage, evidence from our case suggests that the next stage of FE emergence that unfolded was the *Enlivening* stage. In this stage, connections among the agents were strengthened further and vibrancy was introduced in the system by the diverse initiatives adopted by the government such as the Vizag Fintech Festival, One Million USD Global Challenge and Startup Market Connect Demo Day. Vizag was promoted as a global Fintech hub to attract global players to the FE. The government devised diverse initiatives in adapting financial products and services delivery to local market conditions in response to the global emerging technological trends leading to **strategic localization**. It refers to strategy designed to address local market conditions, help accelerate time to market and ensure that the services delivered comply with all the applicable regulatory requirements. The allocation of workspace at subsidized rates and financial capital for firms working on emerging technological trends are some of the internal aggregating forces in the FE (Goldstein 1999) that influence the system agents and system behaviors at multiple levels. For instance, the injection of financial capital for the incubators stimulates interconnections with similar agents and these micro-interactions further influence the system behavior and give structure to the emerging FE.

Specifically, as the start-ups, government, incubators and investors in the FE respond to forces or to the introduction of resources into the system, the network that connects the agents itself can change. These changes penetrate across various levels of the system (Seo and Creed 2002) and establish non-linear

relationships among agents (McCarthy et al. 2006). For instance, one key function of the incubators in an FE is to strengthen the start-up firms' networks and connect the start-ups to the right resource providers. This enhances the range of actions of the start-up firms, thereby influencing the overall adaptability of the system (Holland 2002). This led to the **collectivization** of the resources in accordance with the changes operating at the micro- and macro-levels. Collectivization refers to the organization of and increased coherence of resources in response to the changes occurring at multiple levels of the ecosystem.

We term this third stage of emergence the *Enlivening* stage as in this stage various initiatives were adopted by the government to promote the Fintech Valley in the global market and encourage vibrancy in the ecosystem. In the *Enlivening* stage, our case evidence suggests that the combination of system and agent level forces creates coherence among the start-up activities and continued supply of resources into the coherent ecosystem stimulates further coherence among agents. Thus, the degree of association among the different agents, their responses to the internal and external forces operating at the micro- and macro-levels of the system and their relationships produce a complex set of interactions out of which a **self-sustaining global FE** emerged. This final stage of emergence is important as it sets the stage for the ecosystem to reach a state of self-sustenance. A *self-sustaining ecosystem* is an emergent ecosystem, which has reached a state from where it can continue to grow without outside assistance. The aggregate dimensions and second-order themes (Gioia et al. 2013) that were found to be prominent in this stage, and their corresponding case evidence, are presented in Table 8.

Table 8: Representative quotes underlying second-order themes in the Enlivening stage

Aggregate dimensions and second-order themes	**Supporting evidence**
Contextual structures *Emergent* Connections strengthened among ecosystem participants by adopting diverse strategies.	"*We have 3 categories of work of the Fintech association. One is promoting the Fintech eco-system, looking at the right products, the commercial market access, mentoring the requirements needed for the successful start-ups. Now understand there are a lot of people with a lot of access to money but what the Fintech association does is to provide the right infrastructure and right process to get it done very quickly.*" (Special Representative, Government of Andhra Pradesh)
Agents Wide array of entities interacting with each other to provide a positive and collaborative atmosphere	"*On the level of support from Fintech Valley, I can comment on the support the start-ups are getting from the government of Andhra Pradesh which is extremely positive and the government of Andhra Pradesh is a start-up and investor friendly state. They are helping us in basically providing world class infrastructure and resources for the ecosystem to thrive.*" (CEO, Govin Capital)
Interaction	"*Mr J.K. Chowdary (IT Advisor and special Chief Secretary to the Chief Minister) is very*

Synergistic collaboration Structure of similarity emerges among agents based on outcomes of certain groups of agents.	*instrumental in new age companies that have new thinking altogether, so he invited us and helped us set up at remarkable speed. We are successfully working with the Andhra Pradesh government for the past two years and many more years to come.*" (Founder, FortyTwo Labs)
Environment *Strategic localization* Strategic initiatives by government that pushed the system and its agents into different behaviors and influence coherence.	"*There is a big gap. When the technology is going to be useful in all walks of life, why can't we use this technology in financial services? And which is a very vast area across the globe. So then we thought that it is going to be the future.*" (Pro Vice Chancellor, GITAM)
Collectivization Internal forces that influenced the degree of coherence among the agents.	"*We ran the first accelerator cohort with ICICI bank and Mahindra finance. We have received applications from around 100 start-ups and through lots of scrutiny we have selected 8 start-ups. Those 8 start-ups have received funding both from the corporate partners as well as from the government and got the infrastructure support and they got use cases from around all the 25 corporate partners that we have.*" (Manager, Fintech Valley)
Outcome *Self-sustaining global FE* A vibrant and nascent self-sustaining ecosystem emerges.	"*Ecosystems can self-sustain, you know, because of the idea behind with all the globalization and being able to contribute to work or growth from anywhere, so you can have the ecosystems everywhere, trying to specialize in something and then have universities and academic institutions that are supplying the manpower to the ecosystem. Similarly there are investors who are supplying that ecosystem. It's a self-sufficient place and then the market does not have to be limited to this. Because they can be supplying the technology to any place in the world but all the players that are living here coexisting can be self-sufficient.*" (CEO, Fintech Valley)

DISCUSSION

A Process Model of FE Emergence

The framework presented earlier in Figure 2 represents the concepts, themes and aggregate dimensions uncovered in our study. A common pattern that emerged among the aggregate dimensions, in particular, was that the "contextual structures" of each stage provided an "environment" for "agents" and their "interactions" that produce an "outcome". By exploring the connections among the emergent concepts, we facilitated theoretical insight generation leading to the development of the complete process model of FE Emergence (see Figure 2). More specifically, in the Fintech Valley, Vizag India, growth in the number of investors, industry partners and Fintech start-ups is reflective of Vizag's FE emergence from a *loosely connected* ecosystem into a *coherent* ecosystem and then to a *self-sustaining* ecosystem along a trajectory of progression that was propelled by multiple factors. Our findings show that the FE in Vizag developed through three stages of emergence from the *Envisioning* stage, the *Enacting* stage and finally to the *Enlivening* stage. In each stage, we could unpack the system and agent-wide interactions, environment and the nature of the agents' interconnectedness resulting in specific outcomes.

More specifically, while an increasing body of the existing literature on ecosystems has examined and identified the components of ecosystems (Bahrami and Evans 1995) and connections among them, our research complements those studies by suggesting that, for an emergence to unfold, it has to begin with an *Envisioning* stage. This stage is spurred by the global emerging technological trends and the broader national-level IT framework that triggered an internal change in the structure of the existing system (Harvey and Reed 1994) thereby pushing the agents to self-organize (Goldstein 1999) and adapt to the changed conditions of the system (Holland 2006). In response to the external stimuli, the government drafted an action plan to transform Vizag into a global digital hub by leveraging technological capabilities in the financial industry. This stimulated the formation of a *loosely connected* ecosystem to bring together academia, government and APEITA (Mihata 1997) to brainstorm and bridge the gap between the many financial services and products and the limited use of technological capabilities in those services. However, the mere presence of an external stimuli in the external or internal FE does not suffice. Our model suggests that, in the context of FE emergence, several interventions need to be carried out and they should be applied in a specific sequence.

First, the emergence of global technological trends triggered radical changes in the regional economy and the system became dissipative when dealing with changes in the nature of relationships with the environment (Schieve and Allen 1982). In the case of Vizag, for example, the forces that triggered the *Envisioning* stage are the intentionality (Muñoz and Encinar 2014) of a key agent, the government, the availability of untapped resources and the gaps in the current financial services value chain.

The *Envisioning* stage is marked by the analysis of emerging global trends which triggered radical changes in the internal structure of the state (Harvey and Reed 1994), the identification of existing gaps as well as the key resources required to bridge those gaps. This nascent form of *loosely connected* ecosystem emergence is characterized by simple, ad hoc connections among the key agents to bridge the gaps in the system. The key agents during this stage are academia, government and APEITA, who came together to outline the strategic vision of setting up a global Fintech hub in Vizag. In the *Envisioning* stage, the government worked with the academia and APEITA in multiple brainstorming sessions to establish a charter for the growth and transformation of the state. In response to the emerging global trends and the broader national IT agenda, the state government drafted a vision document to lead the state to a digital economy. The *Envisioning* stage should be the first stage in the process of emergence, as this stage entails systematic research of the existing global Fintech hubs, knowledge gathering from global financial industry experts, identification of technologies as they emerge and gap analysis to tap into the large opportunities for growth in the emerging sector. This is an example of how the different agents in the FE self-organized (Garud et al. 2006) to capitalize on the potential business opportunities (Doz and Kosonen 2010) and adapt to the changing global financial landscape.

Following the *Envisioning* stage of FE emergence, the next stage of emergence unfolded which is the *Enacting* stage in which the strategic roadmap outlined in the *Envisioning* stage was executed. This stage is a significant stage of emergence and should follow the *Envisioning* stage as this stage entails creating incentive mechanisms, generating funding channels, facilitating market access and enhancing connectivity to strengthen connections among the agents and foster growth of the ecosystem. The government provided opportunities, easy access to resources and a speedy onboarding process for start-ups to set up in the Fintech Valley which are forms of **adaptive tensions** (Lichtenstein et al. 2007) to enhance the degree of coherence (Manrubia and Mikhailov 2004). The start-up firms in turn identified and responded to market opportunities and created action plans in response (Zapkau et al. 2015) which promoted **self-organization** (Goldstein 1999). The start-up firms' guiding rule sets and outcomes were influenced by other agents in the FE such as accelerators and incubators leading to **resource accumulation**. The start-up firms leveraged the use case repository provided by the corporate partners to come up with solutions for the industry problems which led to the formation of a more *coherent* ecosystem. This stage is characterized by the strengthened connections among the agents of the ecosystem, aided by the collaborative networks and a coherent structure that is emerging based on the shared values and rules of the ecosystem agents leading to **emergent structuration** (Cohen et al. 1999).

The government promoted certain individual level activities and macro-level system activities. Specifically, our process model suggests that start-up firms should be motivated to implement experimentation based venture development which can introduce innovations into the FE. Similarly, at a broader level, cultural rules such as mentoring and knowledge sharing were encouraged to increase

system coherence. Policies were designed to be nimble and flexible to facilitate easy onboarding of new ventures to promote interaction among agents.

With such a higher degree of coherence (Manrubia and Mikhailov 2004) among the agents in the ecosystem, the range of actions from the start-up firms increased which in turn influenced the overall adaptability of the system (Holland 2002) which resulted in the final stage of emergence which is the *Enlivening* stage. The *Enlivening* stage should follow the *Enacting* stage because, for the ecosystem to develop further, **foundational infrastructure** needs to be established and the connections among the agents must be strengthened. In the case of Vizag, when start-up firms realize the lack of a talent pool to work on an emerging technology, such as blockchain or AI, it may initially limit their ability to form those ventures. As the start-up firms connect with others in the Fintech Valley, they have an opportunity to present this human capital gap. A growing number of agents in the FE communicating about the topic attracts increasing attention to the topic from the government which addresses the problem by initiating various programs as part of its **strategic localization.** These include holding initiatives such as hackathons and innovation challenges to attract global and local players with the requisite human capital or implementing new courses in academic institutions to develop talent. By implementing these programs, the required human capital will be enhanced and eventually lead to **collectivization** of the ecosystem agents and increase their adaptability in the environment (Holland 2002). In the *Enlivening* stage, a combination of government strategic localization plans, system level attributes and continued supply of resources into the emerging coherent ecosystem triggers further coordination among agents. This in turn enhances the emergent structuration (Miller and Osborn 2008) and collectivization of the FE. Therefore, the degree of correlation among the system agents and their response to the internal and external forces operating at the agent and system level of the complex system produced the set of interactions out of which a nascent **self-sustaining global FE** emerged.

Theoretical Implications

This study makes several important theoretical contributions. It is one of the earliest attempts in theorizing the FE emergence and the impact of the Fintech phenomenon in financial markets at a broader level which has been a complex but an important problem (Kauffman et al. 2015).

First, prior studies are typically based on a technology ecosystem perspective (Adomavicius et al. 2008), and some studies have focused on technology-based financial innovations from a firm perspective (Lyytinen and Rose 2003). These existing works investigate how technology changes production in the IS landscape, based on interactions among different kinds of technological artifacts. However, this approach only underscores the external forces and how the introduction of technological innovations can lead to the initiation and dispersion of innovations (Kauffman et al. 2015). On the other hand, our study examines the Fintech phenomenon from an ecosystem perspective which is better aligned with its multi-faceted nature (LevyBencheton 2016). This view encompasses not only IS, but also socio-cultural characteristics,

geographical boundaries and the organizational and regulatory environment. It also takes into account diverse stakeholders such as regulators, banks, policy makers and Fintech firms, as well as the implications of their actions in FE emergence, by investigating the complex interconnectedness among the diverse stakeholder groups, stages and the resulting outcomes.

Second, this study contributes to our knowledge of financial markets and business ecosystems by presenting a multi-fold view of the emergence of FE that underscores the importance of the stakeholders or agents in transforming the conventional product or service offering from a product-dominant to a customer-centric approach. Technological innovation is an exogenous force, but the more complex characteristics tend to arise around the agents and their interactions with the operating environment, who act as consumers of these technologies (Kauffman et al. 2015). There is scant research to date that has investigated the complex interplay between agents, technology, regulatory regimes and financial markets (Anagnostopoulos 2018). This research builds on an approach that complements the business ecosystem literature (e.g., Iansiti and Levien 2002; Kandiah 1998) by taking into account agents, interaction and environment by unpacking complex relationships among various factors by bringing out the analytical richness of the phenomenon. For instance, existing research on business ecosystems has provided generic prescriptions without focusing on a singular context (see Boudreau 2010; Power and Jerjian 2001). This study provides prescriptions specifically for FEs, their emergence and how they enable value creation and distribution through the coordinated action of diverse stakeholders. To comprehend such strategic dynamics, CAS theory provided a starting point for understanding the micro-foundations present in the context of the financial services sector. This gives a clearer sense of how FEs should be designed, structured and governed in a nascent sector, which has received widespread attention (Hannah 2015). Using CAS theory as our theoretical lens, our study provides a deeper understanding of the characteristics of non-linearity (Mihata 1997), self-organization (Goldstein 1999) and emergence (Mihata 1997) in the context of FEs. Moreover, by identifying the outcomes that are created in each stage of emergence and relating them to the agents (Vidgen and Wang 2006), their interaction among them (Arthur 1999) and with the environment, our study has unpacked the interdependencies among the components that make up a CAS.

Third, in presenting a detailed process model that reveals the nomological network surrounding FE emergence and sheds light on its primary mechanisms, our study can serve as the foundation for operationalizing the constructs identified, deriving propositions that can be subsequently validated, or establishing boundary conditions for our theoretical arguments. In addition, the CAS approach also provides a procedural and a theoretical basis for analysis of the future unfolding of FEs and the implications of diverse stakeholder actions. This study proposes a conceptual framework to assess and analyze how financial IS can be explicated based on the complex interplay among agents, interactions, technologies and outcomes.

FUTURE WORK AND PRACTICAL IMPLICATIONS

Limitations and Future Research

This paper has proposed a CAS framework as a robust framework for researchers to investigate the emergence of FEs. This work seeks to understand the different stages of FE emergence and suggests the means to achieve them. Therefore, the emphasis is on the direct relationships of the different agents toward an emergent FE. The framework offers a conceptual framework for researchers to formulate pathways underlying FE emergence. The study could be extended further to provide insight on how to operationalize the CAS model allowing researchers to gain more real-world insights.

This study is not without its limitations. First, although the process model appears to be linear and predictable, we must emphasize that the emergence of ecosystems may neither be sequential nor follow a defined trajectory as myriad factors can give rise to diverse outcomes and the nature of the stages may vary with the unpredictable contextual conditions in different markets. Future studies can focus on examining whether the trajectory of FE emergence may unfold differently (perhaps in a different sequence) and whether there are other decipherable patterns that can be observed over a period.

Second, the nature of our research question is retrospective. Thus, for instance, our question about what leads to FE emergence may not be able to tease out all possible paths of FE emergence. But by selecting a successful case study, we were able to identify the relevant steps of the emergence process. Developing robust theories in the presence of emergence, self-organization and adaptation presents a daunting task. In an ecosystem with diverse sets of entities with changing policies, meticulous analysis of the impact of complex inter-relationships is required.

Third, an emerging and multifaceted phenomenon such as Fintech evolves at multiple levels, and must be captured at the ecosystem, topology and organizational levels. For example, investigation of micro-interactions among agents would require simultaneous consideration of ecosystem level metrics such as institutional stability, efficiency and robustness. Empirical studies of this nature focused on investigating dynamic and self-organizing behavior inherent in FE emergence will need novel approaches to integrate key constructs based on data collected from multiple levels.

Implications for Policy and Practice

In terms of practical implications, our theorizing is one of the earliest attempts at conceptualizing FEs as CASs (Lansing and Kremer 1993). Any change to an ecosystem can have substantial far reaching effects from not understanding emergence from complexity. Creating regulatory framework and effective policies for FEs requires a holistic view that recognizes their complexity. Although CAS theory is largely based on concepts and theories that seem abstract and cut off from activities and events in ecosystems, complex

systems based conceptualization of FEs has a number of implications for practice, in particular, for the policy makers seeking to establish and nurture an FE.

First, in the ever-changing "data economy" characterized by FEs dominated by digital platform models which has the capacity to mobilize diverse stakeholder groups, there is a possibility of mismanagement and communication breakdown among firms (Anagnostopoulos 2018). Hence Fintech firms need to understand the patterns of FE emergence, the pace of technological change and the innovations that are likely to impact the financial landscape. Recent advances in technological trends and regulatory regimes have challenged the conventional vertically integrated financial product and services delivery mechanisms, traditional business models and hierarchical governance structures (Gomber et al. 2017). The process model presented here is an important step for managerial decision-making processes on FE emergence allowing practitioners to effectively manage Fintech firms and stakeholder expectations.

Second, the intersection of evolving customer expectations, business models, technology and data is undergoing a tectonic shift at a global scale presenting a multitude of opportunities for firms in the financial sector and also provides diverse challenges for policy makers and investors (Gozman et al. 2018). This research serves as a blueprint for practitioners to assess and analyze the stages of ecosystem emergence, different agents, the complex inter-relationships among them and the environment enabling them to adopt organization-wide culture change, novel data governance mechanisms and technological and business strategies underpinned by a "compliant by design" approach.

Third, current regulatory regimes aim for financial stability by focusing on singular joints in a network termed the *fallacy of composition* (Llewellyn 2014) which is not an optimal approach as it does not protect the solidity of the entire network. The unitary approach towards regulation will not help new Fintech entrants as it can make it difficult for them to compete with the incumbent financial institutions (Anagnostopoulos 2018). This research highlights the need for a new regulatory management framework where the regulation needs to be dynamic, agile and proactive based on a mix of different approaches by considering the market conditions, consumer demands and different types of market players.

CONCLUSION

This paper presented a case of a CAS framework for the process of FE emergence. The CAS process model of FE emergence offers empirical grounding and concepts for researchers to outline and evaluate propositions on FE emergence process. Practitioners and scholars can leverage the CAS framework to better comprehend FE emergence mechanisms and appreciate the significance of micro-interactions that lead to macroscopic global structure through the perspective of CAS theory.

In the case of an FE, an ecosystem is an affiliation (Lee and Shin 2018) where conventional boundaries between industries are blurred, leading to symbiotic relationships among the diverse agents of the ecosystem. India's Vizag Fintech Valley is a case of successful establishment of an FE which helped reveal

the three different stages of unfolding, the dynamics among diverse actors of the ecosystem who have different motivations and respond differently to changes (Kumaraswamy et al. 2018), and specific outcomes from each of the three stages. We hope this study stimulates greater interest in novel application of a CAS framework in embracing the multi-faceted nature of technology (Akhlaghpour et al. 2009) and creates new avenues for advancement of the IS field.

Author statement

Priyadharshini Muthukannan: Data collection and analysis, writing–original draft preparation

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Barney Tan, Daniel Gozman: Supervision, writing–reviewing and editing

Leben Johnson: Data collection, case access and review.

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Appendix A: Sample Interview Guide

Objective: To obtain informant's background information

Interviewee Background

(1) Can you briefly describe your company and its products/services _____?
(2) How/why did you get involved with _____?
(3) Can you briefly describe your role at _____?

Objective: To draw out information on organizational background

Platform/Organisation Background

(1) What is the main purpose of _____?
(2) How did start?
(3) Why did you choose to start?

Objective: To elicit information on the emergent states of the Ecosystem

Emergence of the Ecosystem

(1) Can you briefly describe the conception of the ecosystem idea and the journey of setting it up?
(2) What were the main challenges that _____ faced in setting up the ecosystem?
(3) How do you attract investors to the region?
(4) Why was Vizag chosen as the destination for the ecosystem?

(5) How do you work towards cooperation/partnership with other platforms/organizations in the ecosystem?

Objective: To generate information on the strategic priorities of government?

Value of the Ecosystem – Boosting regional economy

(1) What are the priorities of the ecosystem?
(2) How is the ecosystem helping its participants and contributing to the economy?
(3) What sort of businesses get targeted at?

Objective: To obtain information on the innovative outcomes of the Ecosystem

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Innovation and Entrepreneurship

(1) Is the ecosystem supporting new ways of doing business (i.e. new business models)? If yes, how?
(2) Are there new enterprises that get created primarily to join the ecosystem? How do they normally do that?
(3) Do you have mechanisms for supporting the new ventures?
(4) How are the policies designed to attract new ventures?
(5) What are the incentives you offer for the new ventures?
(6) How do you screen the new ventures from the pool of applications?

Objective: To elicit the developmental strategy of the Ecosystem

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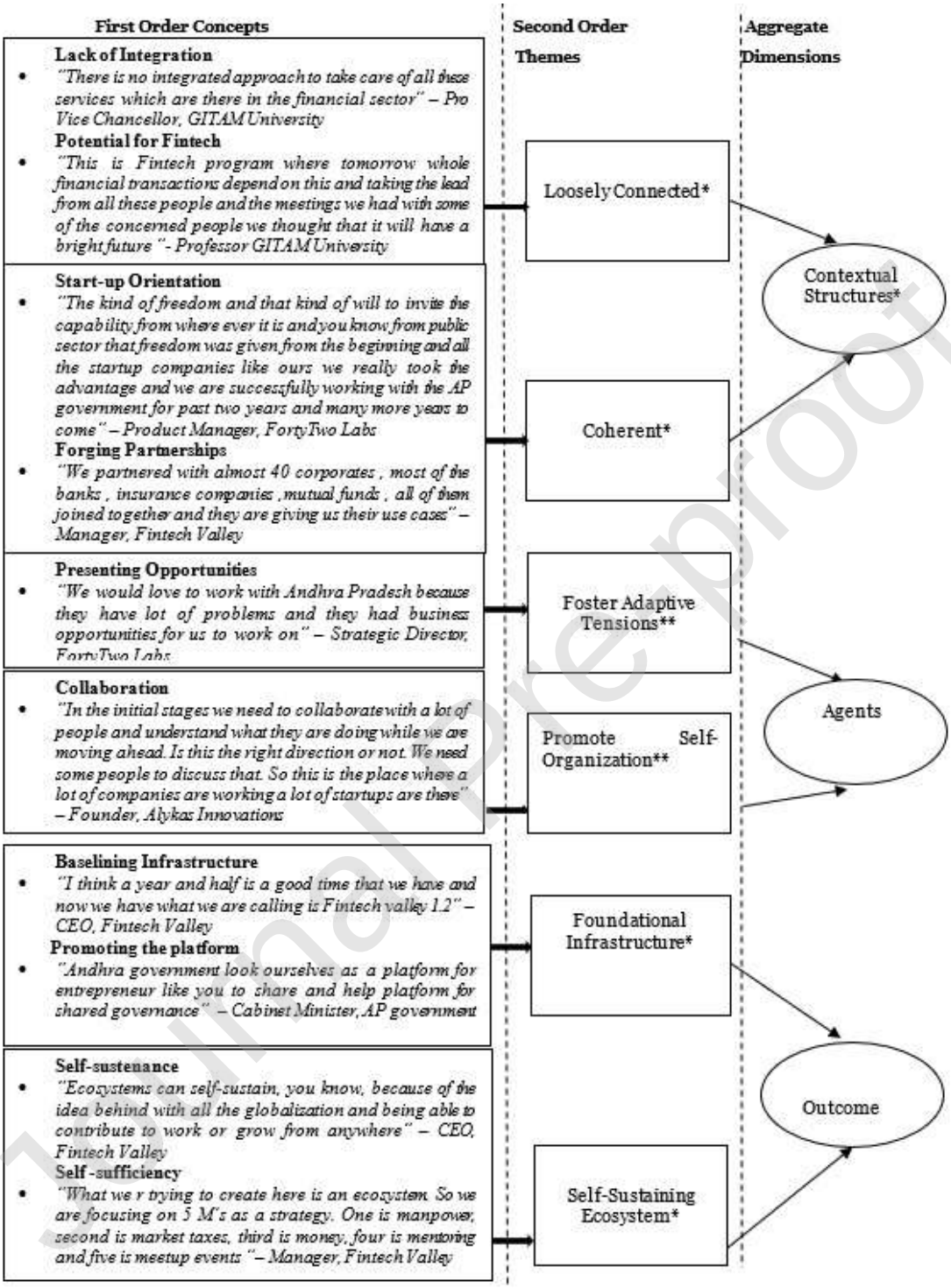
Strategy and Governance

(1) In the ecosystem development strategy, do you actually use, development strategy of any other places or any other IT hub as a template?
(2) With the competition becoming increasingly global, how does your ecosystem actually intend to differentiate itself?
(3) How do you evaluate the progress of the development of the ecosystem?
(4) What are some of the critical success factors of the ecosystem?
(5) Do you have different levels of support for different types of start-ups in the ecosystem?
(6) Which agency is responsible for developing which part of the ecosystem?

Appendix B: Sample Data Structure



* New, inductively derived second-order theme or aggregate dimension that was not part of our initial theoretical lens

** As adaptive tensions refer to the "internal conflictual states among agents that are triggered by injection of resources into the FE by policy makers or influential entities.", and self-organization refer to the "process whereby emergent governance structures arise organically among agents without deliberate intervention by influential entities within the FE" (see Table 2), we have mapped these actions to the Agents Dimension