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# The Evolution of Causal Mechanisms that drive the Diffusion of Platforms: Investigating Corrective Mechanisms

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**Abstract.** This study investigates the evolving nature of causal mechanisms driving the evolution of a digital platform. By drawing from a rich dataset representing the evolution of a thriving FINTECH platform (i.e. HP-EFS) over a period of 7 years, we propose to a) identify the causal mechanisms responsible for its evolution, and b) further understand the dynamic nature of these causal mechanisms. We integrate the existing literature on Generative Mechanisms with the theoretical streams of Socio-technical systems and Systems theory to address the research question. The contribution of this paper is to propose and elucidate a class of causal mechanisms, ‘Corrective Mechanisms’ for future IS research. We anchor this approach amongst existing IS ‘Generative Mechanisms’ research and argue it’s utility in complementing existing research when explaining digital platform evolution.

**Keywords:** Generative Mechanisms, Fintech, Platforms, Evolution, Causality, Corrective Mechanisms, Critical Realism, abductive reasoning.

## 1 Introduction

The emergence of platforms as building blocks for innovation redefining industry structures of products and services is a key trend defining the modern economy [1], by disrupting how organizations create and deliver value [2]. A platform is increasingly seen as an organizational form in the literature [3]–[5] with two key aspects: 1) technology, comprising of the core modules, interfaces and extensions to bridge with complementors [1], [6] and 2) social processes, involving such factors as governance mechanisms to coordinate the actors and interactions between them in the platform’s associated ecosystem [4], [7]. These two aspects feed into each other to shape the evolution of a platform and its ecosystem, such as in social networking and P2P platforms (e.g.

Facebook, Airbnb) etc. The first aspect, technology, combines two modules: a) a stable module with a set of components providing basic utilities, commonly referred to as the platform core, and b) a complementary module with a set of components providing varied uses [8]. Such a configuration combines stability with variety to make platforms extremely evolvable. Consequently, the underlying ‘mechanisms’ driving their evolution is a source of intrigue for the research community.

Literature on Platform design can broadly be categorized into three approaches: (a) top-down or functional [9], (b) bottom-up or product consolidation [10] and (c) evolutionary or redesign approach [11]. Given the path-dependency nature of platforms (i.e. evolution is connected to their initial design) [12]–[14]) and the rapidly evolving nature of platforms within volatile environments and uncertain future states (e.g. Fintech, Smart city), the evolutionary ‘redesign approach’ is most fruitful to studying such platforms, yet drawn on by few studies when identifying the generative mechanisms driving platform success. As such, a recent overview of IS platform research advocated the need for longitudinal studies [15], with research examining the evolution of a) Platform’s core and b) Proprietary platforms even scarcer given challenges in gaining access to empirical data [15]. Based on these identified literature gaps, whereby an understanding of the causal mechanisms driving successful platform evolution can give crucial insights for their governance that influences adoption and diffusion, we formulated the following research question: *What is the nature of evolving causal mechanisms driving a proprietary digital platform?*

More specifically, we are interested in the evolution of a proprietary platform core in context and relation to its boundary resources (e.g. APIs), periphery (e.g. complementors) and overall ecosystem (e.g. customers). Thus, we seek to both identify the causal mechanisms responsible for its evolution and understand the dynamic nature of these causal mechanisms. To address the research question, we selected and investigate the ‘Hewlett Packard Enterprise Financial Services’ (HPE-FS) platform across a 7-year period. The platform started as a piece of software to simplify and coordinate sale transactions and evolved into a thriving industry platform composing numerous complementors and a rich ecosystem supporting \$6.2 billion in transactions annually.

The study adopts a Critical Realist view by applying abductive reasoning for developing a configurational perspective of Platform evolution. The research design drew together the theoretical and methodological guidance of a) Henfridsson and Bygstad [16] seminal work on Generative Mechanisms, and b) on socio-technical representations [17] and evolutionary process models [18]. To better understand the causality behind these key change events, we further looked to c) Systems Theory for relevant theoretical underpinnings. The contribution of this paper is to formatively propose (based on initial case analysis) that the ‘second order’ evolution i.e. changing nature of causal mechanisms driving platform evolution, means prevalent IS research on Generative Mechanisms alone is insufficient in painting a complete picture. By following the process of abductive reasoning, we also encountered what we refer to as ‘Corrective Mechanisms’, seen as a complementary lens to the existing IS focus of Generative Mechanisms. The latter currently more concerned with causal patterns behind key change events in digital platform evolution.

The paper is organized as follows – we start with a discussion on the emergence of Generative Mechanisms and its roots in Critical Realism. The subsequent sections integrate theoretical streams of Socio-technical systems and Systems Theory to the literature on Generative Mechanisms. The final two sections present the research design and discuss the initial results and the future work.

## 2 Emergence of Generative mechanisms as an Analytical Lens

Critical Realism (CR), as a scientific endeavor rooted in the philosophy of (social) science, seeks to bridge the dichotomous positivism-interpretivism divide, by lending a 'middle path' addressing inherent limitations in separately pursuing positivism or interpretivism alone [19], [20]. It acknowledges a real world independent of our perception and knowledge of it [21], i.e. a realist ontology, yet rejects pure empiricism as capable of understanding the world through observation alone. Instead, it contends that reality is layered (i.e. the real, the actual and the empirical domain) and comprised of often unobservable mechanisms at work that produce and thus explain events, changes or outcomes. These mechanisms are the causal structures (e.g. social or economic competition, 'self-fulfilling prophecy' etc.) that explain certain phenomena [21]. The layers entail the real domain that includes social, cultural, psychological and physical structures and processes, and the mechanisms that emerge within/from them. The actual domain consists of 'events' that occur as a result of mechanisms from the real domain. Finally, the empirical domain includes the subset of the events occurring in the actual domain that can be perceived and experienced, i.e. observed [20]. Thus, mechanisms tend to be unobservable as we cannot perceive and experience all layers of reality. This is why the interpretivist tradition is valued for its methods of enquiry in critical realism despite not fully subscribing to their philosophical roots. In critical realism, the central task is explaining the causality of events or effects (i.e. dependent variables), by identifying causal "mechanisms" at play, considered middle-range theories or explanations.

In IS literature, the term Generative Mechanism (GM) is used in CR based studies, as it's defined as the "*causal structures that generate observable events*" [16]. The concern is to grasp, 'the real, manipulatable, internal mechanisms at the heart of CR accounts of why things are as they are' [22]. As such, generative explanations are the 'causal agent(s)' [21] assumed to have generated the relationship between entities/variables being analysed. In the case of Generative Mechanisms, what has generated (i.e. caused) the relationship between two variables (e.g. between an initial condition (independent variable) and the 'event', i.e. condition in effect (dependent variable)) is the emergent property of the mechanism at work (i.e. the parts, processes, relationships of the mechanisms structure) [23].

The search for Generative Mechanisms is a search for the most plausible explanations for distinguishing true causality (i.e. why we observe what we observe) amongst the indicators, correlations, co-incident or spurious associations we tend to make. Searching for plausible patterns behind observable events [24], changes or outcomes, is how we surmise the mechanisms that 'explain, likely endure and can generalise'[25].

Thus, according to Mingers & Standing [25] these “mechanisms are relatively enduring in respect of the events they cause but their absolute timescale may vary immensely”.

In relation to levels of analysis, Henfridsson & Bygstad [16] describe generative mechanisms as a composite of interconnected mechanisms at varying levels acting in context. The compositional view suggests micro (individuals), macro (society or organization) or both levels of analysis to describe causality [25]. It’s based on Hedström and Swedberg’s [26] distinction of; a) ‘situational mechanisms’ linking macro level (society or organization) to micro level (individual) (i.e. the whole influences actions of parts); b) ‘individual action mechanisms’ linking desires and beliefs with action opportunities at micro level (i.e. combining individual actions generate specific actions) and; c) ‘transformational mechanisms’ linking individual actions (micro level) into wider effects at the macro level (i.e. micro actions interact to generate macro actions) [26].

As an IS research inquiry, the focus of GM studies using evolutionary process theories tend to be on searching for patterns of ‘punctuation’ or revolutionary change events to its deep structure (as is evident from deviations to stable periods of a platform’s life) [18]. This is because much IS research is particularly interested in a platform’s ‘generativity’ in terms of its own capacity to change [27], and/or its capacity to enable periphery and ecosystem change [28], [29]. Here it should be noted that a platform’s generativity is critical to its adoption & diffusion potential, though does not necessarily always equal positive outcomes [16]. Finally, IS research also looks to generative mechanisms as a composite of lower order mechanisms, on self-reinforcing mechanisms, as well as possible configurations of generative mechanisms at play[16].

A well-cited example of a generative mechanism is the ‘self-fulfilling prophecy’ based theory [30]. The premise is that “an initially false definition of a situation evokes behaviors that eventually make the false conception come true” [30]. A key example is a run on a bank (i.e. initial event) started by a false rumor of insolvency. This causes depositors to withdraw savings, which reinforces the belief in the rumor as (1) withdrawals damage the financial situation of the bank and (2) signal to others that something is wrong with the bank. As this situation cyclically self-reinforces, an initially solvent bank may go bankrupt (i.e. final event) when enough depositors withdraw. Thus, a false initial belief in a situation causes the situation to become true in effect. In this case, a ‘belief formation mechanism’ [26] is at work, unobservable but plausibly explaining the event observed.

### 3 Evolution of Socio-technical Systems

Leavitt’s (1964) decomposition of a socio-technical system comprises of four sub-systems in the form of actors, task, structure and technology that together (intertwined) form a complex ensemble. While they have been isolated for analytical convenience, there is an implicit acknowledgement the sub-systems are not intended to be isolated when determining causality of a socio-technical action [31]. Leavitt’s [17] simple yet generic and inclusive model has been widely used to represent a range of socio-technical systems in IS literature. We adopt Leavitt’s socio-technical view to represent platforms, themselves increasingly seen as organizational forms.

To represent the evolution of platforms, IS literature broadly branches into two paradigms – a) continuous, incremental change characterized by a slow stream of Darwinian mutations and b) episodic punctuations followed by periods of stability characterized by incremental events to bring back equilibrium in the system [12], [32], [33]. A key difference is that the former paradigm perceives change to be always progressive, while the latter explicitly states that systems are prone to both cycles of progression and deterioration along evolution. This study adopts the latter, i.e. episodic, punctuated paradigm to interpret evolution of platforms because it's more suited to the characteristics of the digital platform evolution of interest.

Further, we refer to Lyytinen and Newman's [18] seminal work, Punctuated Social IS Change (PSIC) model to explore the evolution of the HPE-FS platform. Gersick [12] suggests changes in a system's 'deep structure' are central to understanding the entirety of evolution. Deep structure refers to the set of fundamental choices a system has made in terms of its organizations, principles of interaction and activity patterns that are critical to maintain its existence [12]. These deep structures manifest themselves by providing the system with properties of memory and path dependency. This is all the more pertinent for a platform configuration where the technological core is kept relatively invariant by design. The focus on and the processes behind generating network effects is another aspect that corresponds to the deep structure in a platform setup.

Gersick's [12] and Lyytinen and Newman's [18] definitions of a punctuation although differ somewhat semantically, both emphasize the impact a punctuation has on the deep structure of a system. A successful punctuation reconfigures the deep structure with a configuration comprising new pieces while retaining some pivotal old pieces [12]. The deep structure is connected to the periods of stability systems go through. During these periods of relative stability, systems undergo limited adaptations that are generally responses to environmental perturbations [18]. These periods of stability are sustained by inertia due to routinization, cognition, motivation and obligation and the benefits of a stable environment [33]. These incremental adaptations are critical in maintaining the balance between the four sub-systems of a socio-technical system. The PSIC model offers methodological guidance in identifying these critical incidents that result in gaps which are addressed by the support systems (referred as the building system in the PSIC model) in place. These interventions result in one of the four possible outcomes – failed, incremental, punctuated interventions or further destabilization.

#### 4 Theoretical Underpinnings of Systems Theory

Concepts such as causality, emergence, autopoiesis, homeostasis or the systemic and holistic representations that embody Critical Realism are also firmly rooted in Systems Theory [34]. Considered an output of the later phase of development in systems thinking, System Dynamics' [35] core tenets particularly align to a Critical Realist perspective. Sterman's [36] work builds on a basic premise of "behavior follows structure" to unravel underlying patterns of causal relations through which systemic behavior emerge. Further, Senge's [37], 'The Fifth Discipline' (a cornerstone publication in Systems Dynamics) proposes the idea of system archetypes which are generic templates of

causal structures comprising balancing and reinforcing feedback loops, that when dominant produce patterns of systemic behavior such as “limits to growth”, “eroding goals” etc. These archetypes are tantamount to mechanisms in Critical Realism [25].

Further, a mechanism in the Critical Realist view can only be recognized in the real domain on the basis of events it generates in the actual domain that in turn need to be observed in the empirical [21]. Moreover, from a systems thinking perspective, underlying causal structures are continuously at play and the net effect of these supporting and counteracting forces is responsible for the manifestation of observable events which in turn are analysed empirically to mine out mechanisms that explain systemic behaviour. Systems thinking proposes a technique called Loop Dominance Analysis (LDA) [38], [39] where the behavior of variables of interest are viewed as a sequence of atomic behavior patterns by repeatedly (de)activating sections of the causal structure.

## **5 Research Design**

### **5.1 Abductive Reasoning and Retroduction**

The Critical realist approach to mechanism-based research generally follows the abductive reasoning approach [40]. Abductive Reasoning is a form of logical enquiry that moves back and forth between deduction and induction. It starts with empirical observations and then tries to find the simplest and most plausible explanation for these observations, similar to a doctor trying to diagnose a group of patients with an acute and possibly unknown illness. Iterating through various cycles of theory matching, the researcher identifies relevant variables, conceptual relationships, develops plausible hypotheses to arrive at a provisional theory accounting for the original anomaly [41]. In the case of mechanism based research, hypotheses are formed as ‘potential causal mechanisms’ at work proposed to explain the phenomena observed [21], [25]. For example, a previously unknown virus and its spread (epidemiology) caused the illness in a group of patients several thousand miles from its origin. This process of enquiry often takes the form of Retroduction [21], [25], whereby, ‘events are explained by postulating (and identifying) mechanisms which are capable of producing them’ [42]. Specifically, the researcher starts with a description of significant variables or features associated with the event observed, then ‘retroduces’ the possible causes, eliminating less plausible alternatives and finally identifying the most plausible explanation generating the event(s), i.e. the Generative Mechanism(s) [21]. Importantly the process of hypothesizing possible causes is a weighty endeavor involving careful data collection and analysis, that can contextualise long periods of time before the event in question. In the case of the virus example given, several generative mechanisms are at work, in the severity of illness amongst patients, and in its spread to and amongst patients.

### **5.2 Case selection and data collection**

To address our research question, we selected and investigated the digital FINTECH platform of HPE-FS over a 7-year period between 2013 and 2019. This platform was

selected because the HPE-FS platform is ‘proprietary’ and provided appropriate accessibility to sufficient case data and people, thereby enabling an excellent opportunity to learn about the complexities of the phenomena of interest [43]. Secondly, this accessibility was granted over a suitable longitudinal period of data collection, whereby a researcher (co-author) was embedded in the project during this duration. Finally, the platform offered an ideal candidate for studying ‘path dependency’ in ‘platform redesign’ as it began as a piece of software to simplify and coordinate sale transactions and evolved into a successful industry platform in that it now: a) supports \$6.2 billion in transactions, b) enables 3rd party services from Adobe, FICO etc., and c) connects customers, partners, HPE and other products from other suppliers such as Dell, Apple etc.

The challenges faced in our attempts to collect the data to represent and analyze the 7-year evolution was in identifying the boundaries and defining the unit of analysis and drawing out the critical incidents/change events along the evolution of this platform.

Figure 1. outlines our methodological approach to address the research question (see introduction). We started the abduction process via observation of the case selected across the period of data collection and began to move back and forth between the data and theory to find plausible explanations (i.e. generative mechanisms) of evolutionary change by ‘reproducing’ observed events. However, through this process, we began to observe through the data activity and processes in the platform development not directly connected to change events observed, but yet were crucial to the platform’s stability and sustainability over time. In other words, they generated changes in the platform that were much more opaque or invisible to see, but yet crucial to its continuing success.

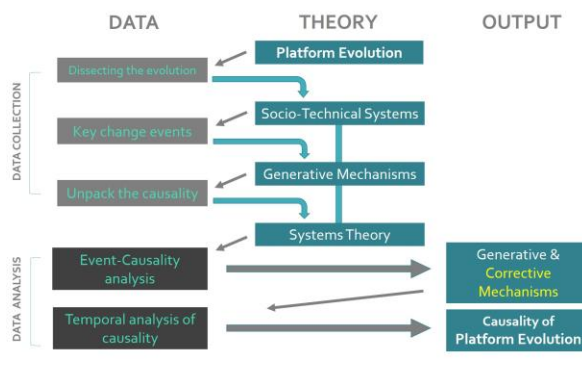


Fig. 1. Research Design: Abductive Reasoning

## 6 Initial Results and Future Work

As we unpacked the causal forces behind the HPEFS platform evolution based on critical realisms fundamental stratification of reality into the domains of the “real”,

Commented [SM1]: This doesn't mention system thinking/theory



“actual” and “empirical” [21] - the causal mechanisms retroduced from the empirical base of observed events, i.e. the generative mechanisms began to emerge [16], [23].

However, we also unexpectedly identified a class of causal mechanisms constantly bubbling underneath the surface without ever generating any overt empirically observable change events, but yet helped account for the platform’s stability and sustaining over time. We subsequently refer to these as ‘Corrective Mechanisms’, which we tentatively define as, *causal mechanisms that ensure periods of platform stability (keeping the deep structure intact) and/or incremental improvement without reconfiguring its underlying deep structure*. We illustrate an example from the initial results as follows:

Analysis showed that one of the significant mechanisms behind the successful evolution of HPE-FS platform was primarily driven by Data. The platform’s growth in the later years was largely driven by vast amounts of data captured from various sources igniting self-reinforcing processes leading to an increased platform appeal. While the data-driven mechanisms of its evolution became more significant in the events they produced, they had actually been in operation since the beginning. The scale, shape and purpose of data captured in the earlier years was smaller, was primarily solicited from customers by sales and marketing, and specifically used to maintain the platform’s stability. As such, we see this as a mechanism that started as a Corrective Mechanism, but later observed that they had further transitioned into a Generative Mechanism as greater data was collected and exploited to evolve the platform. This is because, as the data-driven approach increased in scale and volume, it eventually went on to drive significant and clearly observable event changes, contributing to the platform’s generativity.

To summarize, we propose Corrective Mechanisms as a research enquiry to explain how a state of equilibrium is ensured or re-established between/amongst the technology, actors, tasks and structural components of a socio-technical system. Further examples of activities and process revealed through case abduction which demonstrate restoration of equilibrium (between 2 or more subsystems) but yet not tied to clearly observable events include; a) adjusting (or fixing) customer matching accuracy after implementation of credit scoring, b) restricting visibility (used for internal reconciliation) of certain invoices to avoid confusing customers, c) adjusting the product type selection granularity to customers from the HPEFS partners, and d) adjusting how the eSignature step could be implemented across multiple but connected documents.

Structures to support ‘*Corrective Mechanisms*’ include a set of resources to enact housekeeping routines and processes [44] and even carry out incremental adaptations succeeding punctuations [18]. They play a crucial but understated role in preserving stability, often exemplified in IS terms like ‘maintenance’ or ‘normal project operation’ [45], [46]. The ‘events’ produced as a result of these mechanisms do not necessarily surface at an empirical level, hence escaped attention of studies deploying a Generative Mechanism lens.

It is also worth noting that, homeostasis, the system property responsible for maintaining a stable equilibrium between interdependent elements [47] is an emergent property from actualization of Corrective Mechanisms. We appreciate the difficulty in capturing such mechanisms without the convenience of starting from the empirically observed events. We believe a holistic understanding of the causal structures [35], system archetypes [37] and aspects of the socio-technical system viewed in relation to the

purpose/task [17] operating in the system could all prove useful in identifying Corrective Mechanisms. As mentioned in section 4, Loop Dominance Analysis (LDA) in conjunction with all the above could potentially provide further methodological guidance. Finally, as this is a study in progress, further work is needed by the authors and the IS community to elaborate and refine methods for identifying corrective mechanisms and their application in understanding the evolution of information systems.

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