Technology Disrupts Employment Relationships and Brings Chaotic Turbulence in High-tech: A Multiple Case Study Approach

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Abstract: - We conduct a multiple case study of technology disrupting employment relationships in the early era of the automobile (1903-1912), of e-business (1995-2000), and of data science (2010-now). In each era, technology experts used their expertise of a new high-demand technology to bring chaos and redefine interaction boundaries between them and their employers, thereby gaining significant benefits and redefining relationships with their employers. Through a structured literature review, we identified six key concepts and a pattern of the disruption. Based on the findings, we provide a critical review of technology-enabled disruption theories, the structuration theory framework, the chaos theory and the turbulent environment theory. We finally propose a full map that technology enables the employment relationship disruption harnessed by experts and managers, bringing chaos and turbulence.

Key-Words: - socio-technical transformation, disruptive technology, employment relationship, structuration theory, chaos theory, turbulent environment, multiple case study

1 Introduction

Can individuals use a scarce expertise as an advantage to significantly restructure the relationship with their employers? And how does *technology* disrupt the relationship between technology experts and their employers? These questions are urgent and important as technology assumes a more critical role in business success, and increasingly faster technology changes appear to create ever faster cycles of change. We seek to answer these questions by identifying a pattern of disruption of employment relationships brought about by rapid technology change.

In recent years, information technology has enabled the disaggregation of work processes in space and time [1] as never before. The IT-enabled reduction of collaboration and coordination costs has enabled gig work and micro-task crowdsourcing. Such disaggregation comes with a decline in employee bargaining power, as worker replacement has become much easier. At the same time, those possessing the programming knowledge to develop the high-tech disaggregation platforms (e.g., Amazon Mechanical Turk, eLance, Uber, or Deliveroo), appear to be in continued high demand, commanding top-of-the-market salaries and employment conditions. It is this group of individuals this article will focus on. Our purpose is to understand the relationship between the expertise holders and their employers in high technology employment situations. Specifically, we seek to explain how sudden demand increases for a scarce technology affect the relationship between technology experts and their employers, what the pattern or structure of the relationship change is, and what the dynamics of the relationship changes are. Using cases studies from three eras, the beginning of the automobile, e-business, and data science, we look for commonalities that may offer insights that can help explain future technology disruptions and provide guidance on how to resolve them.

Unsatisfied with merely identifying the general pattern from the cases, we detailedly reviewed the technology-enabled disruption theories. They are disruptive technology theory, disruptive innovation theory and the job-to-be-done theory. We identified the multi-level characteristics of the technology-enabled disruption, which penetrates the labor market and the labor market. We also introduce the structuration theory framework to integrate our empirical findings with technology-enabled disruption theories and illustrate how experts and managers harness the disruption process. Finally, we point out the technology-enabled disruption brings chaos and turbulence to the employment system.

2 Research Background

Technological changes have transformed traditional manufacturing for hundreds of years [2, 3], resulting in fundamental shifts of how work is completed in society and valued by it. Skilled labor frequently lost, with skilled craftspersons, for instance, being replaced by high-precision machines and those able to program them. Craftspeople out—CNC programmers in. These replacements are not new. New, however, is the speed and impact of technology changes. When both speed and impact are high, they create discontinuities, often referred to as technology disruptions or, at an even larger scale, “industrial revolutions.”

As pointed out by Christensen [4], technology frequently serves as an enabler of a new business model, creates a new value network and leads to business disruptions. Usually, the incumbents fall sharply while the newcomers rise quickly and intensely. This process is named after “disruptive innovation.” Inspired by this theoretical insight, we are interested in three topics:

Q1: What’s the social impact of the technology-enabled business disruption? Namely, is it possible to extend the disruptive innovation theory's findings into a socio-technical field?

Q2: Is there any general pattern of the socio-technical disruption?

Q3: Is there a group of agents who understand this general pattern of disruption, deliberately deploy disruptive technology to trigger a disruption?

To answer the three questions, we look at these disruptions at the scale of employer and (expert) employee to understand their dynamics and repetitive patterns that allow for theorization and prediction. To do so, we will look at three phenomena of the last 100 years, namely the rise of the automobile and the corresponding demand for chauffeurs (drivers) in the early twentieth century, the rise of e-business and the demand for programmers around 2000, and finally the recent rise of machine learning and the corresponding demand for data scientists.

3 Research Design

Our research is exploratory in nature. Its objective is to understand the relationship between technology experts and their employers when a sudden technology shift creates a hyper-demand in the expertise. We seek to identify a relationship pattern that applies to technology disruptions in general. As this research is exploratory, we adopt the case study method, informed by a literature search. We draw on three cases from about 100 years past, 20 years past, and the present to create a generalizable pattern.

3.1 Deriving the a priori model

An a priori model was derived from a literature review. It ostensibly reflected a set of technology and employment relationship disruption indicators. Fig.1 depicts the resultant a priori model. The model does not purport to reflect causality among constructs but only identifies the overall technology and employment relationship disruption constructs.

Technology here refers to a product or package that manifests the systematic application of all sources of organized knowledge for practical practical construction [5]. It works as a tool and a part of one solution to organizations' management and operations [6]. The employment relationship is a complex concept. We break it down into three primitive constructs: behavioral phenomenon, demand, and supply for expertise. Employees are employed for their expertise to create value for the employers. The law of demand and supply works here. However, not limited to abstract economic law, we include behavioral phenomena between employees and employers. “Disruption” means a change or shift of one construct. In our study, it will be manifested by the change of employment relationship constructs.

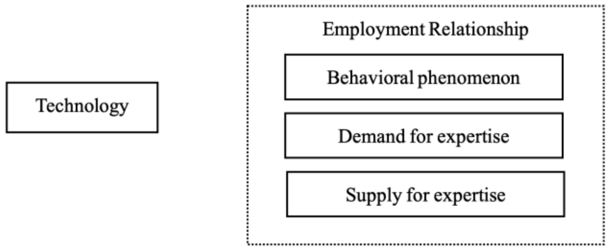

Fig.1 A priori model

3.2 The use of case study and its design

The methodology of this research is grounded theory. It is a reliable choice to serve our theory-building purpose [7]. The method used to approach the research question is an exploratory multiple case study conducted by reviewing and analyzing literature, including academic and industrial ones. Yin [8] pointed out that a case study may be exploratory if we are interested in "what" questions. The case study can be single for in-depth investigation of the phenomenon and collecting a detailed description if it is unique or revelatory or represents a critical case for testing a well-formulated theory. One case may be adequate, but multiple cases will make the theory more constructed and rich [9]. Therefore, we conduct multiple case study to answer the research question.

This research draws on three cases: the chauffeur (driver)—car-owner relationship during the early automotive era, the programmer—employer relationship during the dotcom bubble, and the emerging relationship between data scientists and their employers in the present machine learning boom. In each case, the new technology creates significant opportunities, but a shortage in technology expertise creates challenges for employers to exploit the opportunities effectively. Therefore, we call these three cases the "chauffeur problem," the "programmer problem," and the "data scientist problem." Table 1 provides descriptive information about the three cases summarized by the authors.

Our choices may seem arbitrary, but Yin [8] points out that the "classic" design is acceptable for unusual, critical, or revelatory cases. As we recognize how automobile technology and e-business technology have changed the world like few others, they appear to be good choices to demonstrate technology disruption. The data science case may not be as significant as the former two since its impact is yet to be seen. To note, we do not look for the impact of the technology on consumers. We look for the impact on the relationship between experts in the underlying technology and their employers. In this context, we note a reported shortage of data scientists in the USA of approximately 150,000 for 2019 [10], following a a 2017 analysis [11] that predicted high demand growth and a significant salary differential for individuals with data science expertise. We included this case, to pattern not only the past, but also the present, and possibly the future of technology disruption. A short narrative for each case follows.

Chauffeur problem. With the rise of automotive technology, cars became an attractive replacement technology for horse carriages. While cars had many advantages, they initially lacked an appropriate eco-system of gas stations, repair stations (mechanical problems were frequent), parking garages, and individuals who could operate them. “Chauffeurs” (drivers) with mechanical skills to perform repairs, and logistic skills to source parts and supplies were scarce. Consequently, chauffeurs saw a rapid upgrade in their employment situation vis-à-vis the traditional horse carriage drivers. Chauffeurs could negotiate employment contracts with unheard-of compensation and privileges, and reports of drivers who abused the relationship with their employers were widespread. This led to the introduction of numerous mechanisms to solve the chauffeur problem, including the creation of auto clubs, the build-up of infrastructure, and initiatives to increase car reliability.

Programmer problem. The late-1990s saw a dramatic shift in the use of information technology. Computer end users were given access to company computer systems to gather information, complete transactions, and even purchase goods and services. To create the necessary computing infrastructure required new programming paradigms and new programmer skills at a large scale. Programmers who had these new skills were scarce and highly sought after. They commanded high salaries, company shares, and a dramatic change in work conditions, including for instance casual work dress or work from home, thereby challenging the traditional employer-employee power relationship. This led to massive changes in education, immigration policy and further technology development.

Data Scientist Problem. With the maturing of e-Business technology, companies (as well as other organizations) began to generate vast amounts of data. Making sense of this data to improve performance became an imperative but also a challenge. New analytic (machine learning) techniques made this possible and thus instantly created an unexpected demand for experts in this area, i.e., data scientists, with a similar impact as previously seen with programmers during the dotcom bubble. As the US economy alone appears to be facing an annual shortfall of about 200,000 data scientists, it is yet to be seen how the data scientist problem will be resolved and what changes it will ultimately bring to the relationship between these experts and their employers.

3.3 Case study design

Rowley and Slack [12] suggested that we performed an excessive search on various materials and websites, such as academic research publications, archives of magazines and newspapers, and practitioner publications, to iteratively collect the first wave of keywords synonyms related to our topic. Secondly, the first author discussed the keyword list with the other researchers to refine and confirm the keywords based on the first wave keywords. We then finalized the list of keywords and their synonyms to set up a sufficient keyword pool covering a wide range of topics. For example, when looking for materials about the e-business technology disruption, the chosen keywords and synonyms included "e-business technology” "e-business expert", "e-business programmer", "employ*", "work", "labor", "disruption", "change", "shift", "transform*" ("*" is a wildcard to match the variance of the keywords). In automobile technology and data science technology, keywords related to the technology were adapted to each context.

Since the material sources were practitioner articles, newspapers, and magazines, we mainly relied on the ProQuest database. We also searched archive databases (e.g., Internet Archive and The Washington Post Archive) and academic databases (e.g., Web of Science). These databases are authoritative literature databases, covering various subjects within multifarious disciplines [13]. We performed the keyword-based search on the databases with the identified keyword pool to extract relevant articles by their titles, abstracts, and keywords (if any). We only pulled articles in English and initially obtained 262 articles. Next, we screened and filtered these articles applying the inclusion and exclusion criteria (See Table 2 below). After filtering and duplication removal, we finally retained 32 articles covering the three cases. Three articles described the "chauffeur problem," twenty the "programmer problem," and nine the "data scientist problem."

Table 2. Filtering Criteria

Inclusion Criteria	**I1**	The publication is an article with the empirical, technical, or theoretical focus
	I2	The article covers at least one employment relationship construct
Exclusion Criteria	**E1**	The paper is a manual introducing detail about the specific technology
	E2	The employment relationship is not relevant in the paper (say, employment relationship was only mentioned)

Table 1. Three Cases of Technology Disrupting Employment Relationships

Name	**The "Chauffeur Problem" (CP)**	**The "Programmer Problem" (PP)**	**The "Data Scientist Problem" (DSP)**
Time	The beginning of the 20th century (1903-1912)	1995-now; Typically, dotcom period (1995-2000)	2010-now
Employee	Chauffeur	Programmer	Data Scientist
Employer	Motorists (car owners)	E-business companies	Data-driven business firms
Power Relationship	Chauffeurs' ability to redefine their employment relationship with motorists	Programmers' ability to redefine their employment relationships	Data scientists' ability to redefine their employment relationships
Technology	Automobile Technology (e.g., automotive engineering)	E-business technology (e.g., Java, SQL)	Data science technology (e.g., machine learning)
Demand	High and unbalanced demand	High and unbalanced demand (e.g., 10% of jobs unfilled in 1998 and 1999)	High and unbalanced demand (e.g., 15% discrepancy between job postings and searches in 2018)
Behavioral Phenomena (Employee behaviors)	1.Significantly high salary 2. Latitude in fiscal operations (including commissions) 3. Refusal to wear a uniform 4. Refusal to do menial jobs 5. Privilege to sleep in a room separate from the car (whereas coachmen had slept in the horse stable) 6. Unauthorized use of cars	1. Significantly high salary 2. Expectation of stock options and grants 3. Dress code relaxation 4. Highly flexible work schedule requests 5. Benefits (e.g., free food, car washes at employer site, free snacks and drinks, dog-friendly policy)	1. Significantly high salary 2. Equity and bonus package 3. Benefits (e.g., free snacks, training courses) 4. Flexible work schedule 5. Free access to data science automation software
Supply	1. Retraining trusted coachmen to become chauffeurs 2. Training new chauffeurs	1. Recruiting of outsiders (e.g., teenagers, colleges students with associate degrees) 2. Creation of new Computer Science Programs. 3. Hiring of talent from abroad	Recruiting of outsiders (e.g., college students with a close major)

4 Findings

Seeking the concepts that would define employer-employee relationships in three cases of technology disruptions, we carefully analyzed all 32 articles for references related to technology or disruption of the employment relationship. The references were noted, grouped and combined or integrated whenever possible. The analysis found seven unique concepts, which were embedded into a concept matrix [14]. The concept matrix (Table 3) contains our three cases on the left, the seven concepts across the top, and tick symbols in the middle section. Ticks identify the reference of a particular concept within an article. For instance, if an article related to the chauffeur problem mentioned the presence of new technology, a tick was marked in the corresponding box. Articles that contributed to multiple concepts received multiple ticks in Table 3.

An explanation of the seven concepts is now in order. **TECH** (the abbreviation of "technology") refers to a description of the technology linked to the disruption, including the technology itself, specific solutions, or tools related to it. **DEMAND** refers to mentions of the need for the expertise of the disruption-causing technology in the article. It is usually manifested by the number of job openings and the rise or fall of it. **COMP** (for "compensation") means the package of monetary and non-monetary rewards the employer gives to an employee. It may include basic salary, its rise, profit-sharing plans, and fringe benefits. **BC** refers to "bargaining capital," which is defined as the resources, skills, or social capital that underly a party's power to effect joint decision making or decline an offer. Its level can be determined by objective indicators such as the number of open positions for each qualified individual seeking a position, or by subjective indicators such as the attitudes between employers and employees. **IB** refers to "interaction boundaries." The concept reflects that in the employer-employee relationship, each side has certain decision rights (e.g., the right to determine a certain level of compensation, or the right to choose work clothing). If these decision rights move from one party to the other one, interaction boundaries will have changed, and hence **IB** is disrupted. **IB** or the shift in decision rights can manifest itself in many ways, such as through the addition of an employee representative on a company's board of directors. **SUPPLY** refers to the supply of qualified individuals to engage in the employment relationship, and to descriptions of mechanisms or actions that affect the expertise pool and thus satisfy existing demand. It is usually manifested by strategies such as outsourcing, training, and education. **RULE** refers to the laws and regulations of the government related to the problem. Depending on the case, laws and regulations may bind employees, employers, or other stakeholders.

Overall, the concept matrix reveals that throughout the relevant literature, technology disruptions of employer-employee relationships can be patterned along with seven concepts. The matrix further identifies that the concepts are relevant and widely recognized, with articles referring to 4.6 concepts on average.

5 Interpretation of findings

5.1 Pattern identification

The goal of our research is to find the general pattern of employment relationship disruption through technology. Drawn from a structured literature review, the resulting concept matrix was found relevant and comprehensive. However, not all concepts may be adequate or indispensable. To determine adequacy and indispensability, we apply the logic of the minimum viable product (MVP) [15], attempting to remove dispensable constructs.

All 32 articles in the matrix refer to **TECH** and **DEMAND**. These two concepts thus appear indispensable. Similarly, **COMP** (25) and **SUPPLY** (26) are mentioned in the vast majority of articles and thus appear almost indispensable in explaining technology-based disruptions of employment relationships. Furthermore, in the chauffeur problem, all articles mentioned **COMP**, **BC**, and **IB**, making these concepts indispensable. In contrast, the concept **RULE** was least widely recognized. Only five articles mentioned **RULE**, and for none of the case studies, **RULE** was mentioned by all related articles. We thus may remove **RULE** from the list.

Thus, six concepts remain indispensable in defining technology-based disruption of employment relationships.

5.2 Proposed sequence of disruption

Not merely satisfied with a list of concepts that define disruption, we want to identify the relationship between the concepts. Since disruption is a process, we assume a sequential relationship. The simplest sequence is linear, as shown in Fig.2. Concepts are aligned based on whether the literature mentions their relevance early in the disruption or later. In the historical timeline of articles, some concepts were recognized earlier than others.

Accordingly, we derive from the depiction shown in Fig.2. For the convenience of narrating, five characteristics of technology have been introduced to describe the **TECH**. They are complexity, changeability, scarcity, inimitability, and monetization potential, as Rogers [16] suggested. We use the programmer problem to contextualize the model in Figure 2, as follows.

Table 3 Concept Matrix of the Three Cases

Case	Article	Concept						
		TECH	**DEMAND**	**COMP**	**BC**	**IB**	**SUPPLY**	**RULE**
CP	New York Times [17]	√	√	√	√	√	√	
	Borg [18]	√	√	√	√	√	√	√
	HAYES [19]	√	√	√	√	√		√
PP	Lohr [20]	√	√	√		√	√	
	Butler [21]	√	√	√	√		√	
	Comello [22]	√	√	√			√	
	Behr [23]	√	√	√	√	√	√	
	EGAN [24]	√	√	√	√	√	√	
	Garner [25]	√	√	√	√		√	
	Glass [26]	√	√				√	
	Johnston [27]	√	√				√	
	McGee [28]	√	√	√	√	√	√	
	Source Services Corporation [29]	√	√		√		√	
	Wee [30]	√	√	√		√	√	√
	Alexander [31]	√	√	√	√	√	√	
	Cribb [32]	√	√	√			√	
	Haggerty [33]	√	√		√	√	√	
	Inman [34]	√	√	√			√	
	Kaiser [35]	√	√				√	√
	Richtel [36]	√	√	√	√	√		
	Stettner [37]	√	√					
	Virginia [38]	√	√	√		√	√	
	Hewitt Associates LLC [39]	√	√	√		√		
DSP	Davenport [40]	√	√	√	√		√	
	Communications [41]	√	√	√			√	
	DuBois [10]	√	√	√			√	
	Forum [42]	√	√	√			√	
	Violino [43]	√	√				√	
	Wallen [44]	√	√	√		√	√	√
	Ayar [45]	√	√	√			√	
	GALVANIZE [46]	√	√	√				
	Kolakowski [47]	√	√	√				
Total Count		32	32	25	13	14	26	5

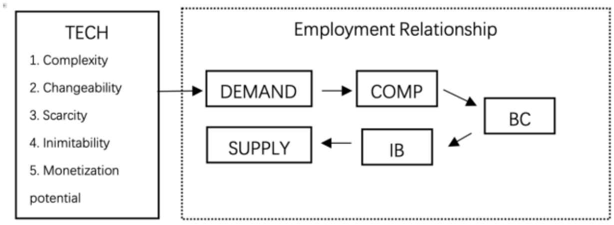

Fig. 2 A linear model of technology disrupting employment relationship

E-business technology entered the U.S. economy in 1995 and became a disruptor for multiple reasons. Technology for e-business programming was complex compared with the previous programming and changed fast. The code base was new, scarce, and hard to imitate. At the same time, e-business benefited the business by enabling automation and cutting costs. This triggered instant demand for e-business programming expertise. The rule of the business game has been rewritten. For example, it's no longer show your commodities to sellers on television channels, attracting customers to dial the telephone number to put an order. Instead, companies should create value by letting customers browse the products and check the inventory by themselves on the website. Such a change of value dimension demanded innovation enabled by the new e-business technology (although the specific set of disruptive technology components may not be totally new, the association was never there before). The new e-business technology demanded expertise far from what was called for before, and the supply of such expertise was necessarily low in this field.

Since the supply of qualified programmers had not yet increased, the sudden high demand led to a privileged compensation being given to e-business programmers as employees. Well-resourced by high compensation, programmers acquired bargaining capital and increased their bargaining power over the employers quickly. This enabled programmers to shift the boundaries of interaction with employers, allowing employees to establish new decision rights. For example, programmers refused corporate dress codes, replacing formal clothes with casual attire. While employers sought to fight back, i.e., through importing foreign experts or expanding computer science degree programmes, none of these measures brought short-term relief on the supply side and thus cemented the new employee powers.

Whereas the above narrative suggests a rather linear disruption of the employment relationship, it is reasonable to assume that more turbulence would exist in the interaction between **COMP**, **BC** and **IB**, as illustrated in Fig.3. Correspondingly, compensation adjustments may often be the starting point of redefined employment relationships, but changes in interaction boundaries and decision rights may precede compensation changes. For example, some companies may find it easier to let employees define their own work hours or dress code instead of paying higher salaries. In summary, we define technological disruption of employment relationships as a non-linear process caused by a technology shift that leads to hyper-demand of the new technology. It causes changes in employee compensation, bargaining capital, and interaction boundaries, whose undesirable outcomes (for employers) trigger supply changes that ultimately lead to a rebalancing of supply and demand and stabilizing employment relationships. Employment relationships may revert to their old equilibria but more likely tilt to new equilibria, reflecting the changed bargaining capital between expert employees and their employers.

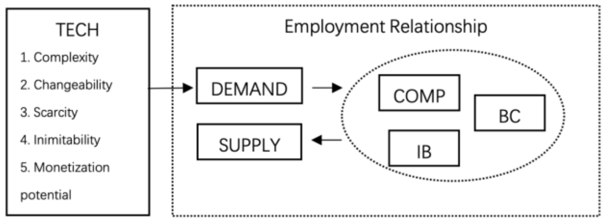

Fig.3 A non-linear model of technology disrupting employment relationship

6 Theoretical discussions

6.1 Theories related to technology-enabled disruption

6.1.1 A framework of technology-enabled disruption

Since the topic is technology-enabled disruption, the most inspiring theories are those majorly contributed by Clayton Christensen. We start from his theories of disruptive technology and disruptive innovation.

The latest definition of disruptive innovation says it creates a new market and value network and eventually disrupts an existing market and value network, displacing established market-leading firms, products, and alliances [48]. But initially, the disruptive innovation describes a process by which a product or service, powered by a technology enabler, initially takes root in a simple application at the low end of a market -typically by being less expensive and more accessible – and then relentlessly moves upmarket, eventually displacing established competitors [49]. The disruptive technology, namely the technology enabling the process, is first proposed in 1997 based on the disk-drive industry study [4]. Later, Christensen [50] clarified that it is not the technology but the business model enabled by the technology, paralyzing the incumbents and creating disruption. The disruptive innovation theory was then proposed to corporate the disruptive technology and business model. These three are closely connected.

On the other hand, Markman and Waldron [51] improved the disruptive innovation theory by pointing out a disruption may not necessarily come from the "low-end" of a given value dimension. It could come from an entirely new market, with a different dimension measuring a product's performance. Christensen and Raynor [52] later integrate this finding into the disruptive innovation theory. By pointing out the price and accessibility are the "third dimension," we may conclude that disruptive innovation is always bringing different dimensions for measuring performances enabled by disruptive technology, initiating low-end disruptions or third-dimension disruptions. And it is the disruptive innovation that creates new markets, beats the non-consumption, and brings growth to an organization.

Although the disruptive innovation theory is influential in depicting the relative relationships between technology and growth, it lacks prediction of where the next disruption happens. Neither did it answer **why** the disruption happens. And it is silent on how managers create products or services that customers want to buy. Therefore, the theory of "jobs to be done" is proposed to complement the disruptive innovation theory. A job-to-be-done is the process a customer goes through whenever one aims to transform the existing life situation into a preferred one but cannot because constraints stop the customer [53]. To remove the constraints and achieve the preferred one, one will "hire" a product or service to "get the job done." This desire of the person under the context indicates potential innovations. If there is a product doing the job well, it will attract customers and bring business success. The job-to-be-done theory inspires us that it's crucial to understand the multi-dimensional need of customers, the choices they have in hand, and the range of consumers the product covers.

The job-to-be-done theory and the disruptive innovation theory (and the disruptive technology theory implied) build a theoretical framework for analyzing the employment relationship disruptions enabled by technology, as shown in Fig.4. Before the disruption, the background technology enables a particular dimension measuring the performance. The

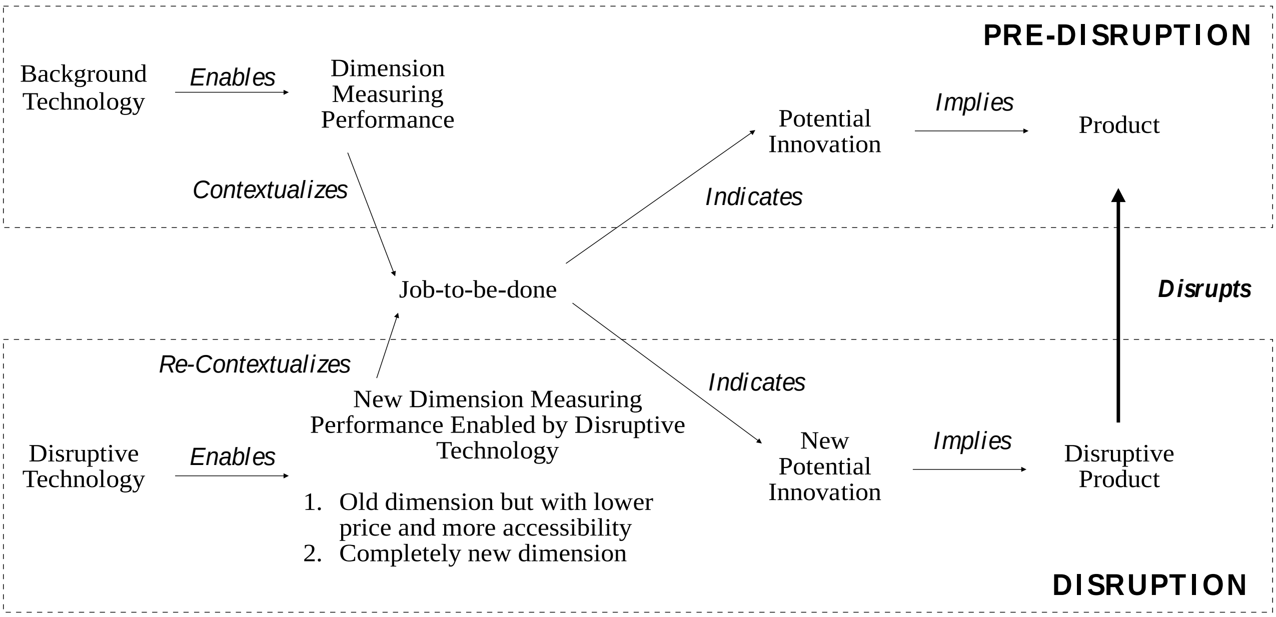

Fig.4 A framework of technology-enabled disruption

dimension, contextualized with the job-to-be-done, indicates the potential innovation, which implies a particular product as a realization. There are usually efficiency innovations to cut costs for the product maker, or sustaining innovations make the product perform better under the dimension. However, when disruptive innovation comes in, it enables a new dimension measuring the performance. It may be through the old dimension but with a lower price and more accessibility or completely new dimensions. The job-to-be-done, which is relatively stable and usually doesn't change frequently [52], gets contextualized under the new situation with the disruptive technology. The result indicates a new potential innovation which implies a new product. Finally, the new product disrupts the previous one and usually beats the incumbents.

6.1.2 The multi-level disruptions: primary and secondary

It is not hard to use the framework to interpret the stories of disruptions made by automobile technology, e-business technology and data science technology. However, it only depicts the disruption directly caused by the disruptive technology. It tells how technology disrupts consumption products but remains silent on other stages of a supply chain. By definition, the supply chains are a series of interconnected activities that involve the coordination, planning and controlling of products and services between suppliers and customers [54]. Only the last stage of value chains, namely producing the product, is covered in the model. We may title it with the **primary disruption**. It is still unclear what happened to other stages such as the raw materials, capital goods or other intermediary products, namely the **secondary, tertiary or quaternary disruptions**. Such a chained together multi-level disruption resonates with Carl Menger's findings that goods in different orders form a particular structure [55]. We will use the "programmer problem" as a case to illustrate the idea, shown in Fig.5.

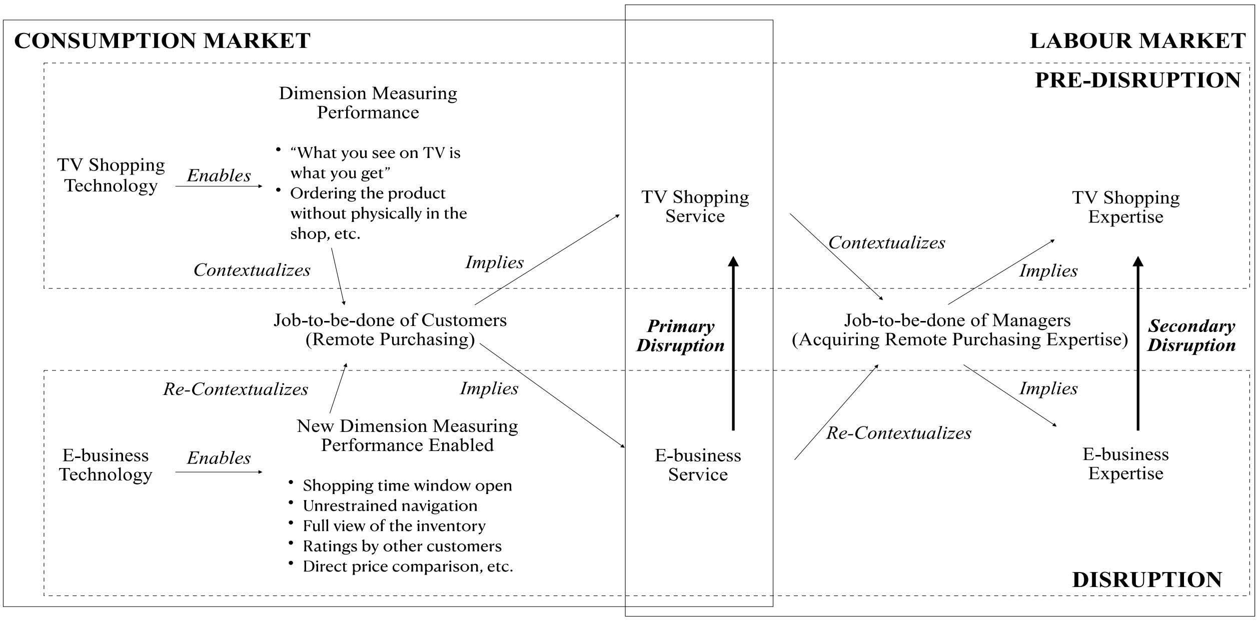

Fig.5 Primary and secondary disruption enabled by e-business technology

We would like to frame the "programmer problem" within the remote-purchasing market. For the customers, the job-to-be-done is remote purchasing. One wants to place an order without going physically to the shop. Since disruption is always relative [49], we notice one example of the market's competitive products is TV shopping by calling or sending pure-text emails to the stores. Including the final product, the sellers (in our case, TV shopping service companies) provide services to customers for the business. It is a primary relationship in the market, namely between the customers and sellers.

However, the seller usually refers to an organization that includes multiple occupations. For simplification, there are merely two members within the organization, namely managers and experts. Managers have the job to be done. They have to function in the TV shopping business by acquiring the necessary expertise. Therefore, they employ experts and pay for their expertise. To summarize, there are at least three groups of people in the remote purchasing market and two crucial relationships. The first one is customer-managers and the second one is managers-experts.

When e-business technology came in, it provided new affordances that enabled a third value dimension disruption. Unlike TV shopping with a limited time window, e-business enabled buyers to browse the products however long they want. There was free navigation instead of limited by the TV host. Buyers may have a view of all inventories instead of asking the receptionist one by one. For some e-business services, buyers may see the ratings of one product given by other buyers. They may even compare the prices of one product among varied sellers or different periods. The e-business technology enabled a new and better way to do customers' jobs, and people prefer paying for e-business services instead of previous ones. By creating a new market and beating the non-consumption, e-business technology has disrupted traditional TV shopping, which is proved by empirical evidence. A **primary disruption** has occurred. Companies who stick with TV shopping mostly were replaced by e-business ones. Few survived. And some turned themselves into e-business ones.

A **secondary disruption** followed the primary one. For the managers, the job remained the same to get the expertise to function remote purchasing business. However, under the new situation, those the managers will hire to do the job were no longer TV shopping service experts but e-business experts. The value dimension for deciding hire or not was no longer saying how good one is answering the phone from potential buyers, but how good one designs and realizes an e-business software system. In the relationship between managers and experts, the managers are buyers. The different kinds of expertise are products. By enabling a new value dimension and primary disruption, e-business technology now disrupts the TV shopping experts through the business relationship between customers and managers. It doesn’t bring new value dimensions through direct affordances of technology in the labor market, but the customers’ dimension changes. Since TV shopping expertise was no longer valuable under the new metrics of managers (which ultimately resulted from the value dimension change of customers enabled by e-business technology), they were disrupted, and most of them lost their job. Some might teach themselves to e-business experts or be trained by their former employers who were also jumping into e-business.

Now we may contextualize this disruption framework with the three cases, as shown in Table 4 below. In each case, the disruptive technology is pointed out with the primary and secondary disruptions enabled. In each disruption, we provide one assumption of the job-to-be-done, the previous value dimension for buyers to choose which product to hire for the job, the new dimension enabled by disruptive technology and the disruptors with disruptees. The primary disruption has happened in the first-order trade, namely between final customers and service providers. However, the secondary disruption is happening in the second-order trade, between the service providers and experts with skills or knowledge crucial to the service.

The development of multi-level disruption is indispensable. Previous theories mainly focus on the consumption market, which only mentions how technology disrupts the direct relationship between customers and companies. It remains silent to the labor market, not indicating how technology disrupts the demand and supply of labor accordingly. Our critical review of job-to-be-done theory and disruptive technology theory paves the path from disruptive technology to the labor market for further discussion of employment relationship change.

6.2 Structuration Theory

6.2.1 A brief introduction of the structuration theory

Structuration theory, proposed by Anthony Giddens, discusses how a structure is established, destroyed and re-established in a society. Structuration is a process concerning the shifting of structures. The fundamental concepts of structuration theory are structure, agency, and the duality of structure. The structure is defined as "rules and resources, recursively implicated in the reproduction of social systems [56]. The structure includes the rules of routine social interaction. They are guidelines for social interaction and limitations or regulations upon agents in society to some extent. Agency refers to the capacity and characteristics of taking actions in an active role or producing a specific effect. As Giddens sees it, individuals are not robots or passive pawns in society in response to the structure. The third key concept, the duality of structure, links concepts of structure and agency. The duality of technology refers to the recursive and dynamic interaction between social structures and information technologies [57, 58]. It means that the structure is the medium or given of individual practices on the one hand, and it is the outcome of prior practices as well. This process recursively happens, and it means the rules and resources that make up the social structures are guidance for human social interactions and the outcome of knowledgeable human agency [56]. Agents are always able to challenge or reshape the structures. The ideal of the duality of structure is illustrated in Fig.6 below. In the flow of time, agents consistently reproduce or transform the social structure, and social structure is enabling or constraining the agents concurrently. The social structure can be the condition or the result of human actions.

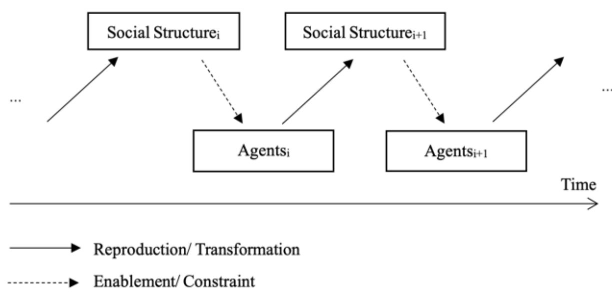

Fig.6 Duality of Structures

6.2.2 Integrating structuration theory with theories of technology-enabled disruption

Individuals can learn society and its structure and intentionally utilize or change them for specific purposes. These individuals with an agency are called agents.

The structuration theory provides a framework for us by pointing out the three key concepts in a structuration process. Based on the multiple case study, we identified the disruption process from technology to employment relationship variables. Although it shows huge business profits leads to soaring demand for technical expertise, it’s still unclear how technology links to demand. The disruptive innovation theory shows how disruptive technology enables a new value dimension, creates a new business model and creates business profits through disruption. Although the relationship is linear and quite naïve, we have proposed a pathway to connect these crucial social structure concepts.

However, one should note that all these social structures are closely related to agents. Within a bargaining process, there must be agents acting to make the process exist. As suggested by the structuration theory, we notice that the different agents share the same action pattern in the three cases. The agent intentionally adopts disruptive technology, demands privileged compensation packages with companies, accumulates bargaining capital, reshapes the interaction boundaries, and impacts the specific expertise's supply. The structure-agent framework interpretation is illustrated in Fig.7 below.

Here is one contextualization. In the “programmer problem,” individuals intentionally adopted disruptive technology (i.e., e-business technology). As shown in the previous sections, e-business technology has enabled multiple affordances and new value dimensions, resulting in business success. Such a disruption of profits pushed the managers to demand e-business expertise crazily, which means the technology-enabled disruption pierced not only the e-business consumption market but now the e-business labor market. Such a path is assured by the multi-level disruption framework developed in the previous section. With supply almost not changed timely, the unbalanced demand brought an attracting compensation, and it granted bargaining capital to the e-business programmers. With such bargaining capital, programmers were capable of shifting the interaction boundaries between the managers and them. The data empirically proved such a shift of interaction boundaries into programmer-favored ones, and it would trigger the supply by attracting more people to become e-business programmers. The increased supply was finally supposed to affect the compensation package backward.

Despite our literature review started with an investigation mainly on experts, we should not forget that managers also will yield their agency during the secondary disruption. Actually, the disruption already happened. Experts have reshaped the interaction boundaries along with other variables in the structure. Managers must take action to gain an advantage back. As shown in Table 1, managers almost always increase their supply immediately as an emergent response to the disruption. That partly explains why there was a piece of news titled “Need for Computer Experts Is Making Recruiters Frantic” in 1999 during the “programmer problem” era [36].

This franticness of the employers (managers) is fundamentally **inevitable**, and it’s expected to see in every disruption, at least in the beginning. By definition, one disruption must incorporate a new dimension of measure which was not valued before but crucial now. Usually, a company is always optimizing its human resources and profits, facing the given dimension of measuring performances with its resources and capabilities as constraints. On the other side of the coin, it means the company’s flanks are incredibly vulnerable when these heterodox dimensions suddenly dominate the business competition rules. What's more, the enabling technology, the new dimensions and their disruptive effects are usually unpredictable. Therefore, incumbents in a market almost always overlook the potential disruptions or deliberately ignore them because they assume there won't be any significant troubles. This scenario is the famous innovator's dilemma [4].

Managers want new technology expertise from previous loyal employees because the interaction boundary may remain the same, which is beneficial to the managers. However, the old employees and the training program they received are inevitably optimized in the old dimension, not compatible with disruptive technology's new dimension [32, 59]

Table 4. Interpreting the Three Cases with Primary-and-Secondary Disruption Framework

Name		The "Chauffeur Problem" (CP)	The "Programmer Problem" (PP)	The "Data Scientist Problem" (DSP)
Disruptive Technology		Automobile technology (e.g., automotive engineering)	E-business technology (e.g., Java, SQL)	Data science technology (e.g., machine learning)
Primary Disruption	Job to Be Done (of Customers as Consumption Buyers)	Enjoy the excitement of high speed traveling; relish trouble-free driving / riding experience	Remote purchasing (place an order and get something without going physically to the shop)	Analyzing the customers to improve the profits
	Previous Value Dimension	How fast the carriage and horse go; the stability of the carriage; the health of the horse	Capability to present product information; place an order; system functionality for employees	Capability to generate knowledge from focus groups, case study and other sources
	New Value Dimension	How fast the car goes; reliable operation of an unreliable product in a fragile ecosystem	Time window open; free navigation; complete view of inventory; ratings; price comparison	The ability to collect, store and analyze big data
	Disruptor (New Sellers)	Automobile service providers	E-business companies	Big-data-driven companies
	Disruptee (Old Sellers)	Horse-driving service providers	Previous remote purchasing companies (e.g., TV shopping)	Companies only dealing with small data
Secondary Disruption	Job to Be Done (of Mangers as Labour Buyers)	Get the expertise of driving and delivering	Get the expertise to realize remote purchasing profits	Get the expertise to analyze data of customers
	Previous Value Dimension	Knowledge of caring for the horses; Expertise in carriage driving; Servant-appropriate behaviour.	Expertise in remote (e.g., TV) shopping; Programming for static enterprise inventory management; "Let the operator see our product".	Expertise in conducting customer research (e.g., through focus group, case study and basic statistical analysis); "small data" expertise.
	New Value Dimension	Mechanic and engineering expertise; Automobile driving skills; Network of auto parts suppliers and maintenance centers.	Programming for dynamic user-oriented business, e.g., "Let the customers see our product and buy."	Management and pattern extraction from "big" data with significantly larger volume, variety and velocity.

	Disruptor (New Sellers)	Chauffeurs	E-business programmers	Data scientists
	Disruptee (Old Sellers)	Horsemen	Programmers for traditional static programming	Traditional business analysts

Companies can retrain their loyal old employees into new disruptive technology experts, but such transformation takes time and not necessarily succeeds. Instead of employing the aggressive domestic new experts, managers usually use offshore labor force [60, 61] and marginal labor force to enlarge the supply quickly with a minimum level shift of interaction boundaries [26, 27, 30, 62-64]. Also, managers may attack other stages of the chain as responses to the disruption. A manager may redefine the compensation, bargaining capital and interaction boundaries with the firm leadership or other outside forces. However, disruptive technology is always there enabling. Attacks from stages mentioned almost always work only in a limited time with a limited degree. The expert-oriented disruption is generally unstoppable.

The pull-the-plug strategies are attacking the demand for the new expertise and directly the disruptive technology. Managers reduce their demands for expertise by modularizing tasks and outsourcing. By giving off some of the work to trustful partners, managers may reduce their reliance on disruptive technology's expertise and undermine the experts' disruption. One more revolutionary strategy is to attack disruptive technology. Usually, with more resources than experts, managers and the companies they work for may make the disruptive technology easier to use. It is a low-end disruption aiming at disruptive technology. Making the tool, namely the technology, easier to use, there will be more supply of expertise. Since disruptive newcomers usually beat the incumbents, it is estimated that the low-end disruption, which the managers dominate, will replace the disruptive technology in experts' hands. In this way, managers could again control the source of disruptions and ensure the whole structure.

6.2.3 Disruptive Technology Creates Chaos and Turbulence: A Complex System Perspective

The structuration theory also presents a perspective of the complex system. By investigating the varied structures and the transformations among them, such a perspective leads us to think about how a socio-technical system evolves and the complex interactions between its components. The structuration theory suggests multiple definitions:

Definition 1: A structure is a state of technology and employment relationship within a society at a particular time and place. A structure is either in equilibrium or disequilibrium.

Definition 2: A structure is in equilibrium (abbreviated to EQ) IFF none (or all) of the structural components are disrupted.

Definition 3: A structure is in disequilibrium (abbreviated to DEQ) IFF part of the structural components is disrupted (i.e., some structure components are changed while the others remain unchanged).

Definition 4: A transition is a directional change between states.

Structures (in equilibrium or disequilibrium) and transitions enable us to describe technology disruptions. Fig.8 provides visualization for description. The rounded rectangles are states, and the arrows are transitions. The title "EQi" of the rectangle on the left suggests it is a state of equilibrium. The stick below the title box is called the "disruption bar." Concepts above the "disruption bar" have been disrupted, while those below are not disrupted yet. Therefore, none of the six concepts in the state "EQi" are disrupted. By definition, the state "EQi" is in equilibrium.

Similarly, the state "EQi+1" is in equilibrium since all six concepts are above the "disruption bar" and are disrupted. The rectangles in the middle of the picture, with titles from "DEQ1" to "DEQ5," are a sequence of states in disequilibrium. The "disruption bar" shows in each state what concepts have been disrupted.

Fig.8 has turned our findings of the linear model among concepts in Fig.2 into a chain reaction among structures. It shows disruptive technology impacts society's general situation in society and triggers a series of instability until the final new equilibrium state is established.

One shall not forget that in a structure where a disruptive technology emerges, both the manager and the expert could adopt it to launch the employment relationship disruption process as agents. Each may also attack other stages of the opponent's process to jam it. The ultimate goal is always to make the structure beneficial to oneself.

These actions of the manager and the expert, aiming at different stages of the disruption chain, have different progress. Even within the manager or expert group, their members do not necessarily walk at the same steps. Not to mention there will be many unexpected actions emerging. All these factors intertwine with each other and make the structure complex and turbulent.

In the employment relationship disruption enabled by disruptive technology, experts almost always aim at introducing explosive instability into the structure to accumulate bargaining capital and extend their interaction boundary. Such an extension enables more bargaining capital to be accumulated. Therefore, there is explosive positive feedback in the system. On the other hand, the managers are in a dilemma. They adopt disruptive technology by hiring experts and reap profits. Such a process is also positive feedback to the power of experts. But managers are also worried about their shrinking interaction boundary, sending negative feedback signals to the experts. As pointed out in the previous sections, managers may attack the different stages of the disruption to undermine the power of experts. Such negative feedback may emerge from the experts' interaction boundary going too far, and no managers will hire them. In summary, the simultaneous and unbalanced presence of positive and negative feedback from multiple sources makes the system chaotic [65]. Fig.9 presents the chaotic system that resulted from entangled positive and negative feedbacks of disruptive technology.

Turbulent conditions are characterized by frequent and unpredictable market and technological changes within an industry, accentuating risk and creating an inability to forecast accurately [66]. Ansoff and Sullivan [67] proposed a 5-level scale of turbulence by measuring the discontinuity, unpredictability and instability. The discontinuity has two dimensions, namely complexity of the environment and the novelty of change. The unpredictability has two dimensions as well, namely the rapidity of change and visibility of future events. The instability, as a result, is depicted by different levels of turbulence the frequency of the level shift. By bringing the technology's characteristics as the external variables, we propose a hypothetic model of these characteristics and the environmental turbulence, as shown in Fig.10.

Despite not empirically testified yet, we would like to use this model to answer one question: how do we predict the end of the everlasting battle between managers and employers enabled by a specific disruptive technology? Why chauffeurs failed the battle, lost their identity as mechanicals and became pure drivers now? Instead, why e-business programmers are still hot now? What will be the future of data scientists?

Here are our assumed interpretations. The result of the employment relationship disruption ultimately depends on the speed discrepancy of the disruptive technology and managers' evolution. As long as the technology evolves much faster than the business organizations, these organizations will always meet a miserable demand for disruptive technology expertise and undesirable interaction boundary shrink. But if the technology falls behind, the organizations would finally control the situation and extinguish the struggle of experts. What's the role of experts in this evolutionary battle between technology and organizations? They may actively catalysts the evolution of disruptive technology to maintain a privileged status.

Let's compare the "chauffeur problem" and the "programmer problem" as examples. One had to know basic engineering to become a chauffeur at that time, which was different from the knowledge set of a horseman. But, such basic engineering was not hard to catch up with later since it's not evolving so fast. But e-business programming has constantly been been evolving [68]. Almost every 2-3 years, there is a breakthrough in e-business, from e-commerce to e-payment and mobile payment. E-business is scarce and inimitable. It has great monetization potential compared to those of automobile technology. But more importantly, e-business is constantly evolving to maintain these advantages, always far ahead of the organizations. These everlasting and everchanging characteristics of e-business technology determine the environment (or structure in our research) is discontinued, unpredictable and fundamentally turbulent at a high level. It is because of this that chauffeurs quickly lost their privileged status in the 20th century. On the other side, e-business programmers were hot in Java and PHP and still hot in the era of Python and Ruby On Rails. However, since the system is discontinued and unpredictable, it's hard to anticipate the ending in detail or to anticipate how long such turbulence will last.

At this moment, we want to answer the three research questions proposed at the beginning:

Q1: What is the social impact of the technology-enabled business disruption? Namely, is it possible to extend the disruptive innovation theory's findings into a socio-technical field?

A1: The social impact of the technology-enabled business disruption is a chain reaction among structures with six key variables. Therefore, it is possible to extend the findings of business disruption into a socio-technical disruption.

Q2: Is there any general pattern of the socio-technical disruption?

A2: Yes, and the general pattern is that agents intentionally adopt disruptive technology and trigger the disruption process in multiple stages for their privileges.

Q3: Is there a group of agents who understand this general pattern of disruption, deliberately deploy disruptive technology to trigger a disruption?

A3: Yes, both managers and experts almost always intentionally adopt disruptive technology to launch a whole disruption process or attack the opponent's disruption process at varied stages. The result is to make the employment relationship system chaotic and turbulent.

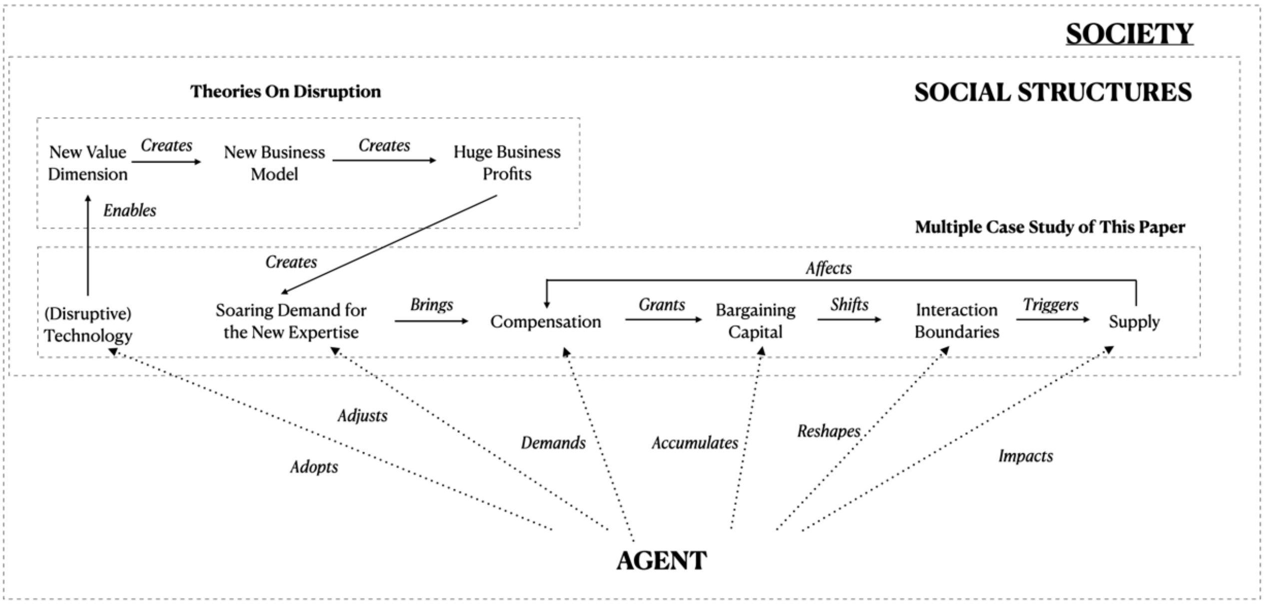

Fig.7 Interpreting Case Study Findings with Theories of Disruption and The Structuration Theory Framework

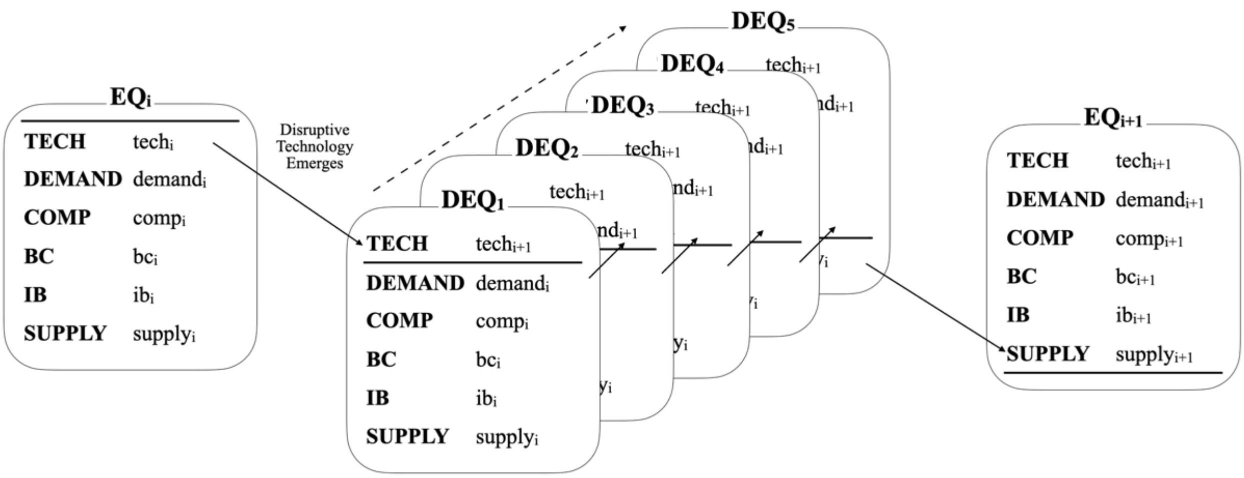

Fig.8 Visualizing States and Transitions

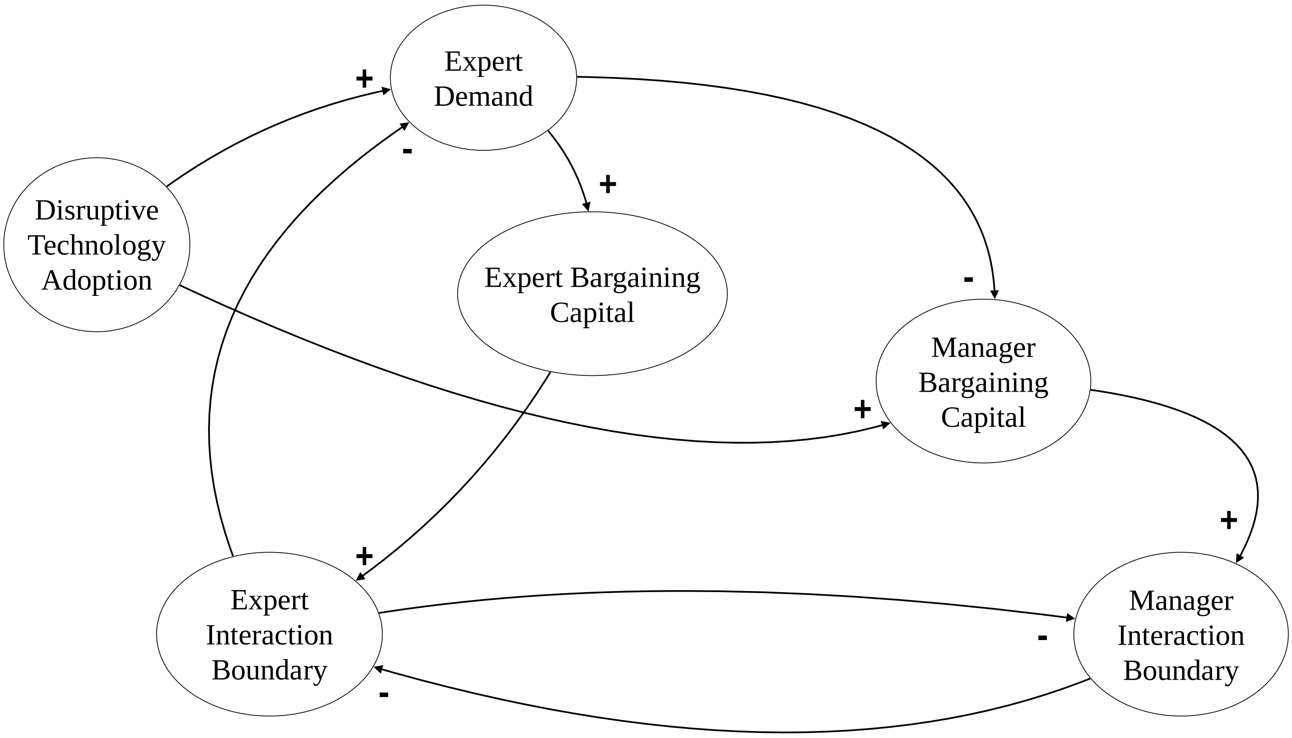

Fig.9 A Chaotic Employment System Created by Disruptive Technology

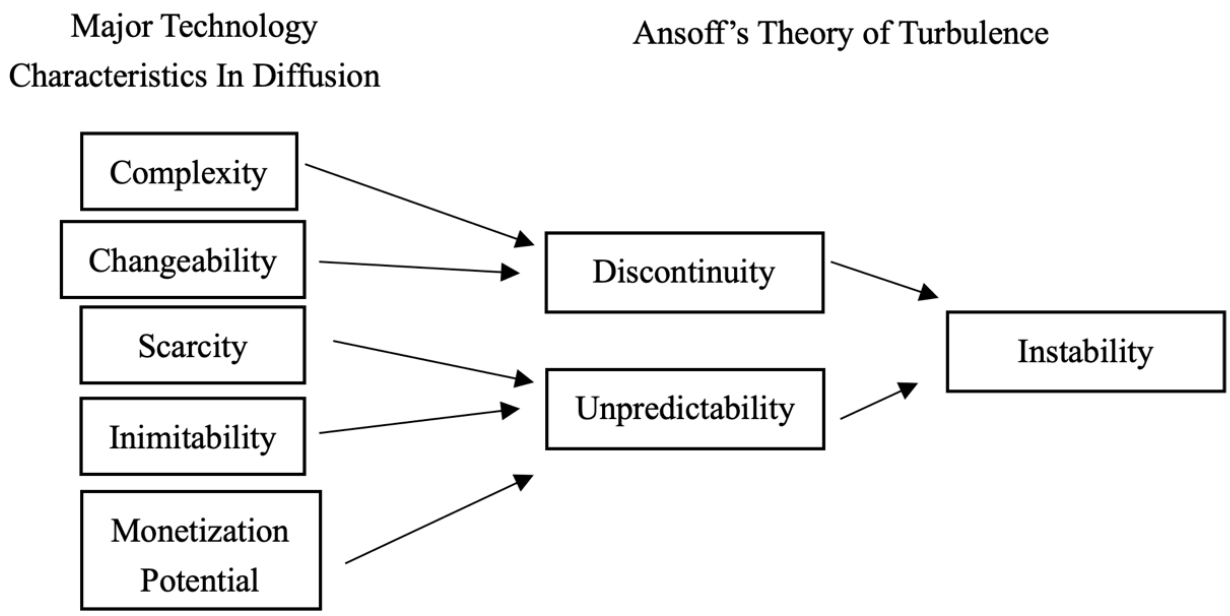

Fig.10 A Hypothetic model of Technology Characteristic and Environment Turbulence

7 Conclusion

Our study sheds new light on the changes in employment relationships caused by technology disruption. First, we identify technology disruption as a pattern that repeats with a similar impact on employer-employee relationships independent of technology and time. Six concepts appear to define the disruption pattern indispensably. The intermediate outcome appears to be an accumulation of bargaining capital among (expert) employees, a shift in interaction boundaries that gives employees more decision rights and improved compensation. The sequencing of these impacts may vary, yet all will lead to countermeasures designed to increase the supply of expert employees to satisfy demand and rebalance employer-employee relationships. The value of our model lies in its potential ability to explain technology disruptions independent of time and technology, strictly based on the employee-employer relationship and the concepts that define it. By referring to existing theories of disruption and power relationships, our model extends the insights of business disruptions into a socio-technical transformation context and introduces multiple frameworks to investigate the responding strategies under the disruption of Christensen, et al. [69].

The model and interpretation we are presenting here are speculative and not without shortcomings. In this paper, we assume that experts and managers are homogeneous in each group. But individual characteristics should be important in the employment relationship, not to mention multiple occupations in a company (e.g., CEO, recruiters, department managers). Future research may dig deeper into the disruption process among varied groups of people.

Next, we only consider three cases of technology disruption in developing our conceptual model and only 32 relevant research accounts. Arguably, with more disruption cases, one would expect a more comprehensive model to emerge, even though many indispensable concepts may remain close to the current set. Third, our current model reveals little about the relationship between bargaining capital, interaction boundaries, and compensation. While we hypothesize alternate sequences of their interaction, further research will be required to determine actual sequences and the factors that determine these.

Also, we proposed the hypothetic model between technology characteristics in diffusion and the theory of turbulence to give assumptions of what determines the ending. Future research may empirically test the model to support the argument.

We did not differentiate the impact of different kinds of structuration. Giddens suggests three kinds of structure-interaction pairs: signification-communication, domination-power, and legitimation-sanction [56]. It's reasonable to argue that different technology types will trigger different structuration processes and change the employment relationship uniquely. This area deserves more investigation.

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