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.

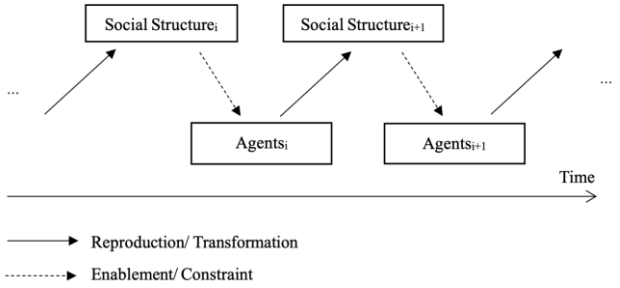

Fig.6 Duality of Structures

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.

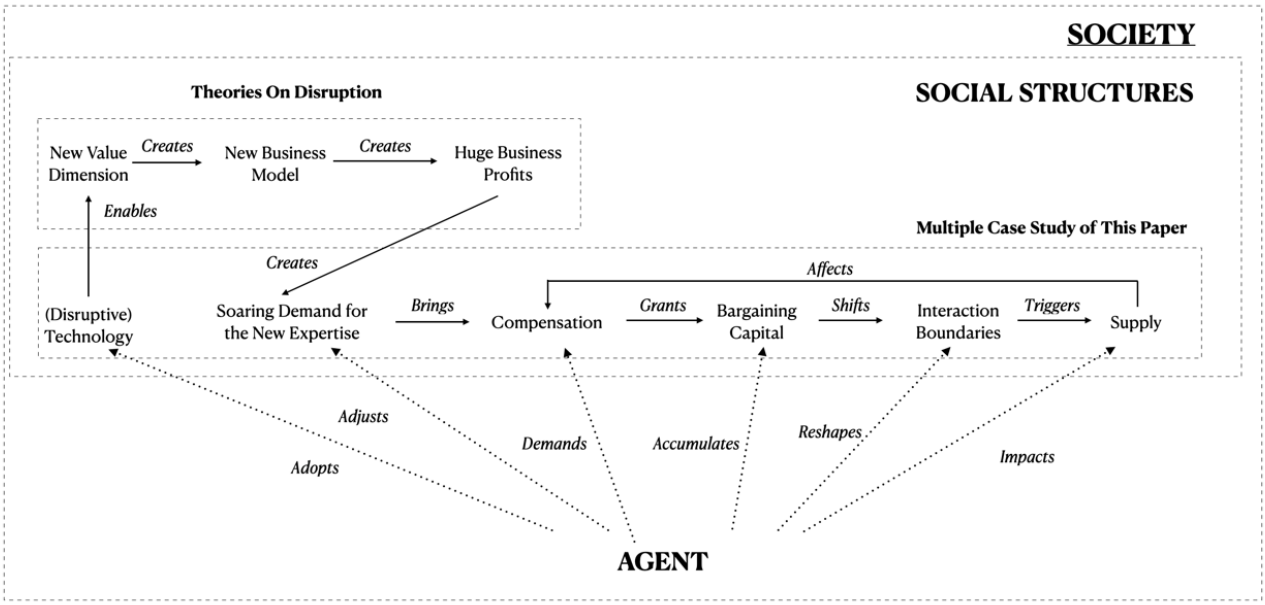

Fig.7 Interpreting Case Study Findings with Theories of Disruption and The Structuration Theory Framework

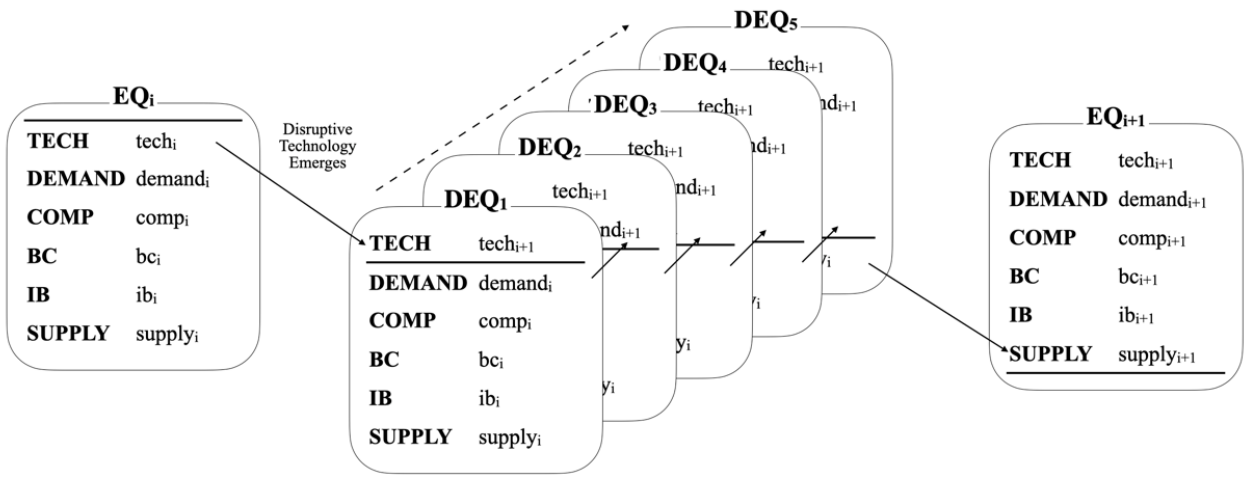

Fig.8 Visualizing States and Transitions

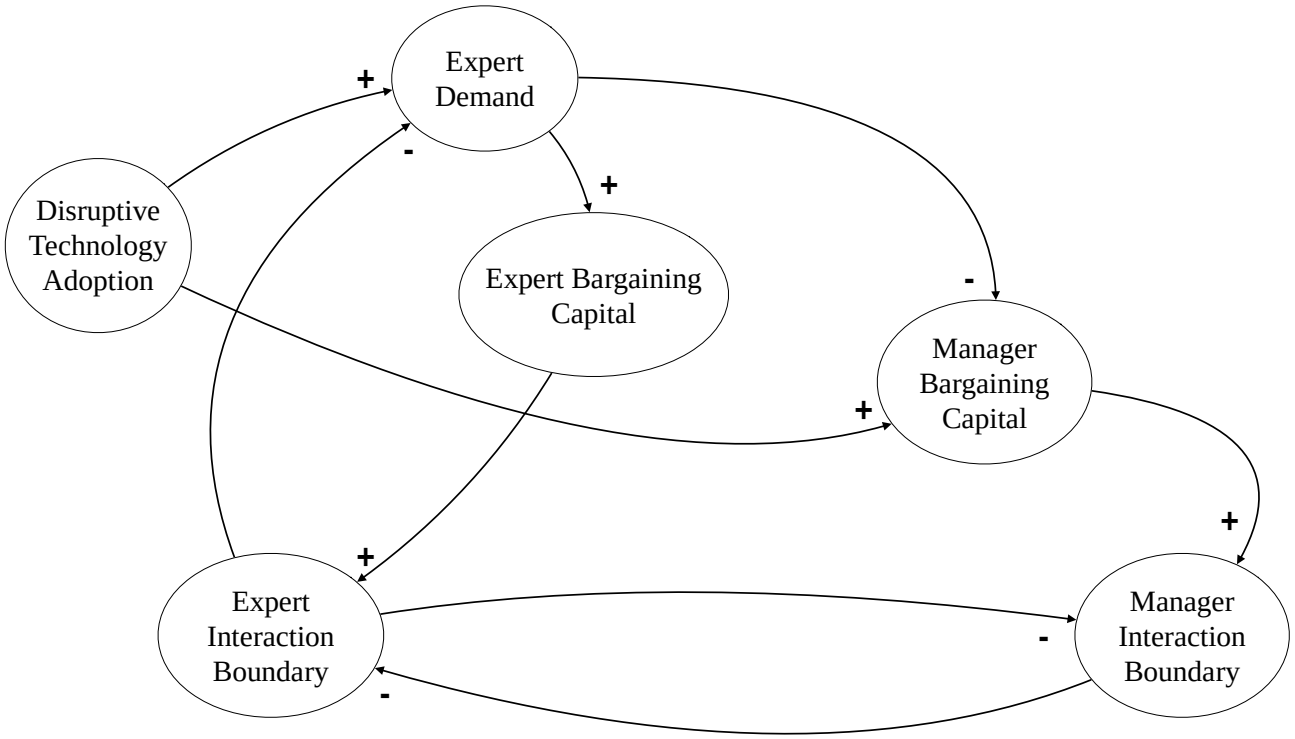

Fig.9 A Chaotic Employment System Created by Disruptive Technology

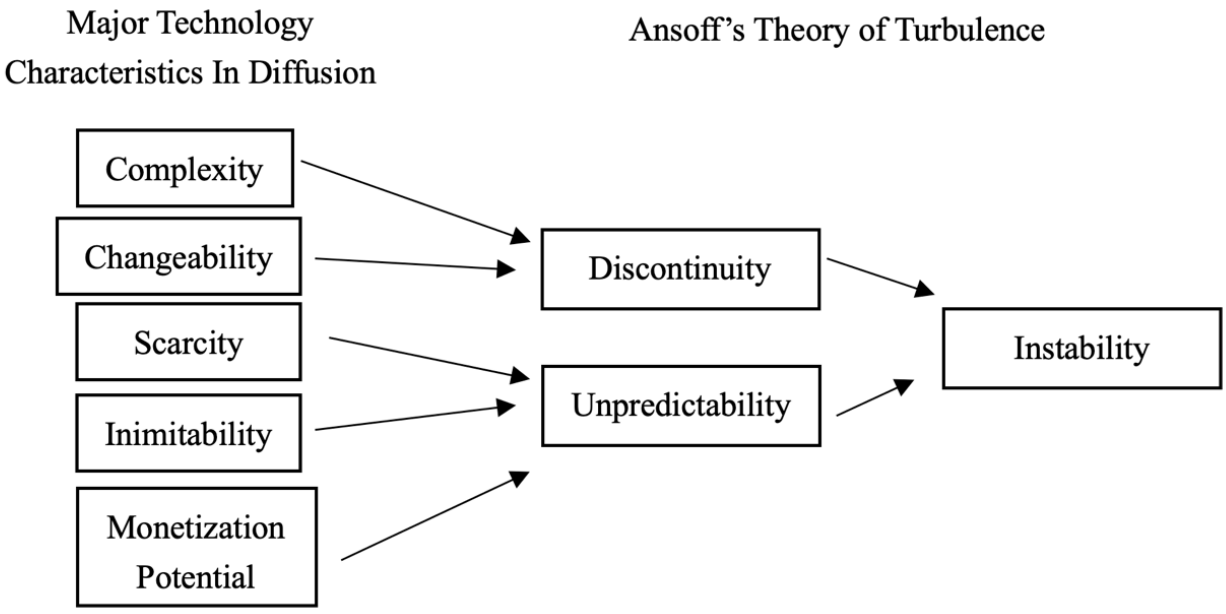

Fig.10 A Hypothetic model of Technology Characteristic and Environment Turbulence

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.

References:

[1] K. G. Dau-Schmidt, "The impact of emerging information technologies on the employment relationship: New gigs for labor and employment law," *U. Chi. Legal F.*, p. 63, 2017.

[2] R. M. Henderson and K. B. Clark, "Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms," *Administrative science quarterly*, pp. 9-30, 1990.

[3] J. L. Bower and C. M. Christensen, "Disruptive technologies: catching the wave," 1995.

[4] C. M. Christensen, *The innovator's dilemma: when new technologies cause great firms to fail*. Harvard Business Review Press, 2013.

[5] R. Luppicini, "A systems definition of educational technology in society," *Educational Technology & Society*, vol. 8, no. 3, pp. 103-109, 2005.

[6] J. Y. Thong and C.-S. Yap, "CEO characteristics, organizational characteristics and information technology adoption in small businesses," *Omega*, vol. 23, no. 4, pp. 429-442, 1995.

[7] J. Corbin and A. Strauss, "Grounded theory research: Procedures, canons, and evaluative criteria," *Qual Sociol*, vol. 13, no. 1, p. 24, 1990, doi: 10.1007/BF00988593.

[8] R. K. Yin, *Case study research and applications: Design and methods*. Sage publications, 2017.

[9] K. M. Eisenhardt, "Building theories from case study research," *Academy of management review*, vol. 14, no. 4, pp. 532-550, 1989.

[10] J. DuBois. "Is There a Data Scientist Shortage in 2019?" https://quanthub.com/is-there-a-data-scientist-shortage-in-2019/ (accessed 5 Aug, 2020).

[11] S. Miller and D. Hughes, "The quant crunch: How the demand for data science skills is disrupting the job market," *Burning Glass Technologies*, 2017.

[12] J. Rowley and F. Slack, "Conducting a literature review," *Management research news*, 2004.

[13] L. I. Meho and K. Yang, "Impact of data sources on citation counts and rankings of LIS faculty: Web of Science versus Scopus and Google Scholar," *Journal of the american society for information science and technology*, vol. 58, no. 13, pp. 2105-2125, 2007.

[14] J. Webster and R. T. Watson, "Analyzing the past to prepare for the future: Writing a literature review," *MIS quarterly*, pp. xiii-xxiii, 2002.

[15] D. R. Moogk, "Minimum viable product and the importance of experimentation in technology startups," *Technology Innovation Management Review*, vol. 2, no. 3, 2012.

[16] E. M. Rogers, *Diffusion of innovations*. Simon and Schuster, 2010.

[17] New York Times. "Chauffeurs Lord it Over Their Employers." New York Times. https://www.nytimes.com/1906/08/12/archives/chauffeurs-lord-it-over-their-employers-big-salaries-turn-the-heads.html (accessed.

[18] K. Borg, "The" chauffeur problem" in the early auto era: Structuration theory and the users of technology," *Technology and culture*, vol. 40, no. 4, pp. 797-832, 1999.

[19] J. HAYES. "The Insolent Chauffeurs of America's Early Automobile Era." https://www.atlasobscura.com/articles/chauffeur-problem-joyrides (accessed 14 Dec, 2020).

[20] S. Lohr. "An After-School Job That's Not Kids' Stuff;Wanted: Web Designers and

Programmers; $25/hr.; Need Parents' Consent." The New York Times. https://www.nytimes.com/1996/05/06/business/after-school-job-that-s-not-kids-stuff-wanted-web-designers-programmers-25-hr.html (accessed August 5, 2020, 2020).

[21] S. Butler, "GOOD COMPUTER JOBS GO BEGGING IN MAINE COMPANIES NEEDING PROGRAMMERS PUT PROJECTS ON HOLD, OR HIRE LESS QUALIFIED WORKERS OR EXPENSIVE CONSULTANTS," in *Portland Press Herald*, ed, 1997.

[22] V. Comello, "Programmers needed most," *Research & Development*, vol. 39, H-I, 1997, 09 1997. [Online]. Available: https://www.proquest.com/docview/205331142?accountid=10134.

[23] P. Behr, "Getting it right on the money; an online survey of salaries for technology workers reveals a career field in flux: [FINAL edition]," in *The Washington Post*, ed, 1998.

[24] D. EGAN, "College grads rejoice -- employers begging for workers; computer programmers and business majors particularly in demand by recruiters; recruiters are begging for workers," in *The Salt Lake Tribune*, ed, 1998.

[25] R. Garner, "Pressure Gap: Transforming the IT workforce," *Computerworld*, 1998.

[26] A. J. Glass, "Divergent views are offered on high-tech worker shortage," in *Austin American Statesman*, ed, 1998.

[27] M. Johnston. "Report calls for more training to alleviate computer worker shortage." http://www.computerworld.com/home/online9697.nsf/all/980109report1BB92 (accessed April 12, 2020).

[28] M. K. McGee, "High demand, soaring pay," in *InformationWeek*, vol. 682, ed, 1998, p. 12.

[29] Source Services Corporation, "Hold on to those valuable high tech employees! source services offers tips for retaining these hard-to-find employees," in *PR Newswire*, ed, 1998.

[30] E. L. Wee, "Teens with `tech talent' rise to top," ed, 1998.

[31] S. Alexander, "High demand for hot skills," *Computerworld*, vol. 33, no. 39, pp. S4-S6, 1999. [Online]. Available: https://www.proquest.com/docview/216064212?accountid=10134.

[32] R. Cribb, "Companies crying for high-tech workers ; A third say skill shortage stunting growth," in *Toronto Star*, ed, 1999.

[33] N. Haggerty, & Schneberger, S., "IT labour shortage? what IT labour shortage? [inadequate state of statistics gathering]," *CIO Canada*, vol. 7, no. 8, pp. 36-40, 1999. [Online]. Available: https://www.proquest.com/docview/217438914?accountid=10134.

[34] P. Inman, "Jobs: Rethink to ease programmer famine," in *The Guardian*, ed, 1999.

[35] R. Kaiser, "IT firms send work overseas: U.S. job drain reverses brain-drain flow: [final edition]," in *The Ottawa Citizen*, ed, 1999.

[36] M. Richtel, "Need for computer experts Is making recruiters frantic," *New York Times*, vol. 18, 1999.

[37] M. Stettner, "How To Nab Information-Technology Jobs," ed. Los Angeles: Investor's Business Daily, Inc., 1999, p. A01.

[38] B. H. Virginia, "DEMAND INCREASES FOR COMPUTER PROGRAMMERS: [FIVE STAR LIFT EDITION]," in *St.Louis Post - Dispatch* ed, 1999.

[39] Hewitt Associates LLC, "Dot coms doling out mega-salaries and perks in race to attract and retain top talent," in *PR Newswire*, ed, 2000.

[40] T. H. Davenport, & Patil, D. J. , "Data scientist: The sexiest job of the 21st

century," in *Harvard Business Review* vol. 90, ed, 2012.

[41] L. C. Communications. "August LinkedIn Workforce Report: Data Science Skills are in High Demand Across Industries." https://news.linkedin.com/2018/8/linkedin-workforce-report-august-2018 (accessed.

[42] W.-W. E. Forum, "Data science in the new economy: A new race for talent in the Fourth Industrial Revolution," *Insight Report*, pp. 1-22, 2019.

[43] B. Violino. "6 ways to deal with the great data scientist shortage." https://www.cio.com/article/3397137/6-ways-to-deal-with-the-great-data-scientist-shortage.html (accessed 5 Aug, 2020).

[44] J. Wallen. "Can Outsourcing Data Science Fill The Jobs Shortage? Fayrix Believes So." https://www.forbes.com/sites/joewalleneurope/2019/03/26/can-outsourcing-data-science-fill-the-jobs-shortage-fayrix-believes-so/#3ae9e2e8bce7 (accessed 5 Aug, 2020).

[45] M. Ayar. "This is What Data Scientists are Undergoing in 2020." https://towardsdatascience.com/this-is-what-data-scientists-are-undergoing-in-2020-cb137ddfc6dc (accessed May 28, 2020).

[46] GALVANIZE. "Signing bonuses and other perks for data scientists." https://blog.galvanize.com/signing-bonuses-and-other-perks-for-data-scientists/ (accessed 5 Aug, 2020).

[47] N. Kolakowski. "Data Scientist Salary: Starting, Average, and Which States Pay Most." Data Scientist Salary: Starting, Average, and Which States Pay Most (accessed 4 Aug, 2020).

[48] A. Ab Rahman, U. Z. A. Hamid, and T. A. Chin, "Emerging technologies with disruptive effects: a review," *Perintis eJournal*, vol. 7, no. 2, pp. 111-128, 2017.

[49] C. M. Christensen and K. Dillon, "Disruption 2020: An Interview With Clayton M. Christensen," *MIT Sloan Management Review*, vol. 61, no. 3, pp. 21-26, 2020.

[50] C. M. Christensen, "The ongoing process of building a theory of disruption," *Journal of Product innovation management*, vol. 23, no. 1, pp. 39-55, 2006.

[51] G. D. Markman and T. L. Waldron, "Small entrants and large incumbents: A framework of micro entry," *Academy of Management Perspectives*, vol. 28, no. 2, pp. 179-197, 2014.

[52] C. Christensen and M. Raynor, *The innovator's solution: Creating and sustaining successful growth*. Harvard Business Review Press, 2013.

[53] A. Klement, "When coffee and kale compete," ed: NYC Publishing, New York, 2016.

[54] G. Büyüközkan and F. Göçer, "Digital supply chain: literature review and a proposed framework for future research," *Computers in Industry*, vol. 97, pp. 157-177, 2018.

[55] A. M. Endres and D. A. Harper, "Carl Menger and his followers in the Austrian tradition on the nature of capital and its structure," *Journal of the History of Economic Thought (Cambridge University Press)*, vol. 33, no. 3, 2011.

[56] A. Giddens, *The constitution of society: Outline of the theory of structuration*. Univ of California Press, 1984.

[57] G. Walsham and C.-K. Han, "Structuration theory and information systems research," 1990.

[58] W. J. Orlikowski, "Using technology and constituting structures: A practice lens for studying technology in organizations," *Organization science*, vol. 11, no. 4, pp. 404-428, 2000.

[59] G. Africa. "Need for high-tech workers outpaces supply." https://www.proquest.com/docview/408694975?accountid=10134 (accessed.

[60] J. Clausing. "Use of Work Visas by Technology Companies Is Under Fire." https://www.nytimes.com/1998/04/20/business/use-of-work-visas-by-technology-companies-is-under-fire.html (accessed.

[61] E. Juliet, "More Visas for Techies?

Lawmakers Want to Ease Curbs on Foreign Workers: FINAL Edition," *The Washington post*, 2000.

[62] P. Behr, "Getting It Right on the Money; An Online Survey of Salaries for Technology Workers Reveals a Career Field in Flux: [FINAL Edition]," in *The Washington Post*, ed. Washington, D.C., 1998, p. F12.

[63] L. Steve, "An After-School Job That's Not Kids' Stuff," *The New York Times*, p. D1, 1996.

[64] P. Inman, "Jobs: Rethink to ease programmer famine," in *The Guardian*, ed. London (UK), 1999, p. T039.

[65] G. S. Dhillon and J. Ward, "Chaos theory as a framework for studying information systems," in *Advanced Topics in Information Resources Management, Volume 2*: IGI Global, 2003, pp. 320-337.

[66] R. Calantone, R. Garcia, and C. Dröge, "The effects of environmental turbulence on new product development strategy planning," *Journal of product innovation management*, vol. 20, no. 2, pp. 90-103, 2003.

[67] H. I. Ansoff and P. A. Sullivan, "Optimizing profitability in turbulent environments: A formula for strategic success," *Long range planning*, vol. 26, no. 5, pp. 11-23, 1993.

[68] CLERK.IO. "The Evolution of E-commerce Technology." https://blog.clerk.io/the-evolution-of-e-commerce-technology (accessed.

[69] C. M. Christensen, R. McDonald, E. J. Altman, and J. E. Palmer, "Disruptive innovation: An intellectual history and directions for future research," *Journal of Management Studies*, vol. 55, no. 7, pp. 1043-1078, 2018.