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Evolution of Traceability and Sharing Economies

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Evolution of Traceability and Sharing Economies

Jiro Kokuryo (Keio University)

Abstract:

An analysis is offered on the relationship between traceability and sharing economy. Here, sharing economy is synonymous with "expansion of the right of use licensing (as opposed to ownership transfer) business model." Traceability is defined as "a state where the principle owner of property rights or product liability for some physical or intellectual property is able to continuously confirm the state of the property and who is using it." Under low traceability environments, businesses have no choice but to use the ownership sales-oriented business model. However, if advances in ICT realize high traceability environments, they will be able to adopt a model in which products are not sold and transferred, but in which only use rights are granted for a specified time in various form including rentals. Impact of barcodes and mobiles devices are analyzed to illustrate how traceability increased the level of sharing in supply chains.

1. Toward an Internet of Things (IoT) Society

In this thesis, I analyze the role that the increase in the level of traceability of objects and people brought about through ICT (information and communications technology) has been playing in the expansion of sharing economies. Although a more rigorous definition will be provided later, this thesis generally states that "expansion of sharing economies" is synonymous with "expansion of the right of use licensing business model," as opposed to the ownership transfer business model. In addition to intermediation for personal property loans to others, the right of use licensing business model also includes vendor property rental, outsourcing, and licensing. While the conversion of sales businesses from ownership to right of use can also be expressed as the conversion of businesses into services, it could also be argued that this conversion is the result of improved traceability brought about through ICT. Although it is easier to imagine tangible objects, the same phenomenon is also occurring with intangible ones. An example is how music that was once sold on CDs is now sold through services that allow consumers to listen to all the music they want for a fixed monthly fee although, strictly speaking, what was sold was the medium [plastic discs], while the music itself functioned as a license to use the CD; as a business model, however, this is extremely close to a transfer of ownership rights, and therefore is classified as such here.

The basic logic underlying how traceability will expand the right of use licensing business model is explained as follows. With low traceability, when a company provides a product to a customer, the company is unable to gain a clear understanding of the product after it is handed

over, and is often unable to trace it even if the customer's whereabouts are known. In such a case, the company has no choice but to use the ownership transfer business model, in which it transfers all product disposal rights (ownership rights) to the customer in exchange for money or some other form of compensation. However, if advances in ICT allow providers to maintain an understanding of who is using a product, they will be able to adopt a model in which products are not sold and transferred, but in which only use rights are granted for a specified time, and then can be provided to another user at a different time. Although vendors have been able to apply this model to certain products in the past, the development of mobile technologies and the like has expanded the scope of traceability, resulting in the birth of services which act as intermediaries between individuals loaning personal assets, and in the expansion of the applicable scope even in the business marketplace. It is clear that new, major developments have occurred due to present conditions.

When the right of use licensing model can be applied and products can be used by multiple users, prices tend to grow comparatively slowly for users while revenues tend to increase for product providers, in order to increase the usage efficiency of the product (asset). As the technology and cost potential expands, so does the usage of these products. The right of use licensing business model has been implemented for some time—one example would be rental vehicles. However, it would be more correct to state that advances in ICT and reduced costs have expanded the scope of model application.

It is worth analyzing this process now, as this may suggest hints on future developments and on what kinds of issues will remain when traceability will be further improved by IoT—which is likely to continue to spread rapidly.

In this thesis, traceability is defined as “a state where the principle owner of property rights or product liability for some physical or intellectual property is able to continuously confirm the state of the property and who is using it.” Although this differs slightly from the traditional definition of traceability (such as tracing the movement of ingredients as a safety measure for food products), both concepts share the meaning of tracing the physical and logical positions of physical things (objects) being moved between multiple subjects. Some of the references cited in this thesis use traceability to refer to managing the state of use of intellectual property in order to safeguard privacy. Starting from this, I will analyze this concept in order to produce a definition more and more compatible with the aim of this thesis.

2. Technology and Business Model Co-evolution

In order to provide a systematic analysis of the relationships between ICT, related traceability, and business models originated from it, it is necessary to create a more general model of the relationship between technology (business models included) and social structures. In this respect,

many models have been proposed. For example, classical technical technological determinism treats technology as an independent variable and social structures as dependent variables. Social constructivism, instead, focuses on the process through which societies apply social characteristics to technology in order to establish how the latter should function. In this thesis, I refer to the results of these models while constructing a model from the process by which technology and society co-evolve, and then analyze it. This section is devoted to model description.

2.1. Relational Analysis of Technology and Business Models Using Intervening Variables (Technology and Business Characteristics)

This thesis focuses on traceability (which, strictly speaking, is not a technology but rather a related function) and analyzes changes to business models through intervening variables. While it is difficult to associate such technologies as sensors and networks, directly to business models, functional concepts such as traceability can be recognized as the primary factor that enable business models. In constructing the model, first I consider how technology has improved traceability, and then to what degree traceability has brought about changes in business models. Figure 1 demonstrates how, rather than having a unidirectional relationship, a force could establish a business model by working in the opposite direction of technological development.

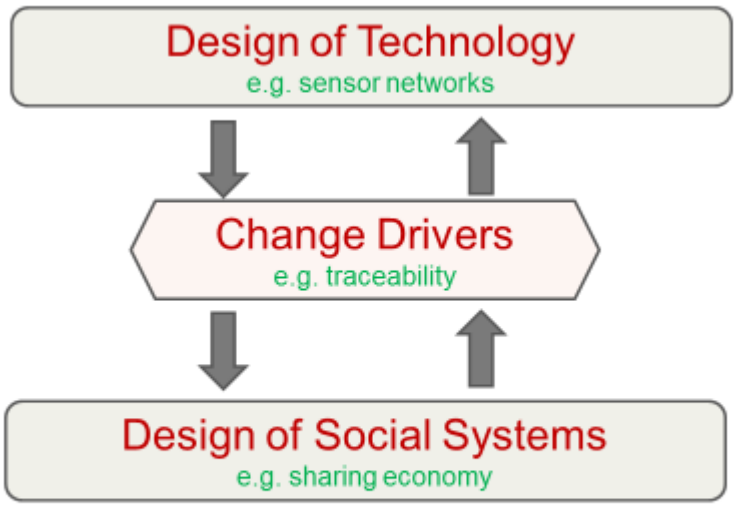

Figure 1: Technology-Society Interaction

2.2. Co-evolution of Technology and Social Systems via Bottlenecks

The issue when conducting analysis using an intermediary relies on the choice of such intermediary. This thesis adopts the approach by Spector (2011), which focuses on constraints as the determining factors for business models. It is likely that loosening such constraints could lead to gradual improvements, make them no longer serve as limiting conditions, and ultimately cause the change of the entire system when other limiting conditions become the new constraints. Here, I consider constraints that could determine the structure and the performance of these types of systems as "bottlenecks."

Figure 2 shows the process by which technology and social systems co-evolve, while using bottlenecks as intermediaries. This can also be thought of as a model in which innovation causes the society to evolve (Euchner and Henderson, 2011). First, bottlenecks resolving social issues (i.e., achieving goals) are identified (top left of Figure 2). Then, methods to eliminate these bottlenecks are sought and discovered (bottom left). Applying this technology causes the technology itself and the social models to change. This eliminates or loosens existing bottlenecks, and allows the society to advance a step further (bottom right). However, one characteristic of this model is that it does not imply that complete bottleneck resolution at this stage. Rather, likely new bottlenecks will need to be resolved in order to reach further evolution (top right). Awareness of these new goals and bottlenecks is raised, and then further methods are designed to achieve goals or eliminate bottlenecks. This is a disequilibrium dynamic model in which the society never reaches an equilibrium point.

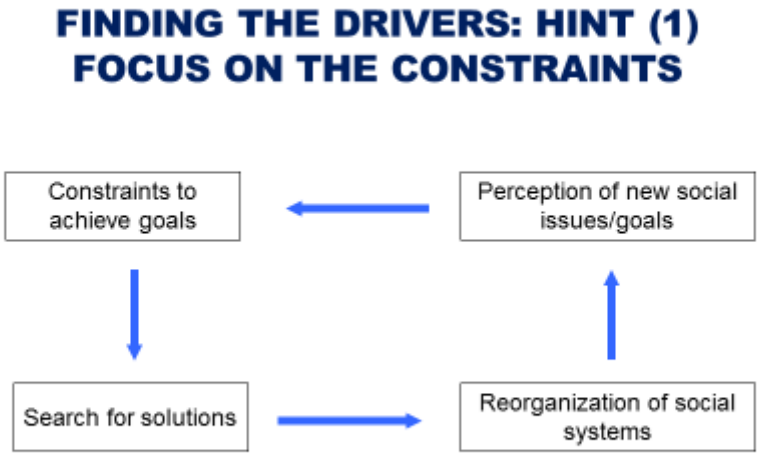

Figure 2: Bottleneck Driven Model of Co-Evolution

In this model, every issue is considered with the aim of finding out where the bottleneck elimination phenomenon driving social change is located and with what kind of technology it can be realized—when it is likely that technology is bringing about some kind of social change. From this perspective, technology is an enabler for social change (Venkatraman,, 1994; Love and Gunasekaran, 1997).

This model suggests that there may be no impact on society, and technology may not be adopted unless it has an effect on social bottlenecks—no matter how revolutionary the technology may be. This also means that abandoned technologies may attract attention as means to eliminate bottlenecks at other instances.

When the approach of enabler technologies that can eliminate bottlenecks and create new business models is applied to the context of this thesis, the questions concern the identification of bottlenecks and of the technologies capable of eliminating them, as well as what kinds of new business models would be created by bottlenecks elimination in industries wherein the ownership transfer business model has been the mainstream until now. When this is applied in the context of traceability, eliminating the bottleneck of customers being invisible and unable to be traced (i.e., no traceability) will make it possible for even more subjects to use the same assets efficiently, and to increase revenue for providers while decreasing costs for users. The significance of this will be examined in the next section.

3. The 20th Century Mass Consumption Society Bottlenecks of Visibility and Connectivity

Kokuryo (2013) identifies visibility and connectivity as drivers that could enable information technology to drastically change business models. This thesis combines and treats them as traceability. In line with this thesis perspective, it is clear that the important intermediary for traceability to transform business models is the most significant bottleneck created by the mass production/mass selling business model that developed in the 20th century: the lack of visibility and connectivity—in other words, the lack of traceability.

3.1. The Bottleneck of (In)visibility Created by the Mass Production/Mass Sales Model

Based on historical records, Chandler (1977) suggests that products in bulk could be sold reliably when, in the process of modern management entities creation, the railroad and the telegraph made it possible to sell products over a wide area. This allowed to invest in large-scale equipment more easily, and accelerated the birth of today's big businesses. It was the arrival of the mass consumption society. The impact brought about through economic expansion under this model was massive—even in Japan where it played a major role in increasing per-capita income from

97,000 yen in the 1955 fiscal year, to 3.968 million yen in the 1995 fiscal year (Cabinet Office, 2011).

In the conceptual pattern of this thesis, the railroad and the telegraph eliminated a bottleneck (i.e., narrow business areas). This process can be said to have opened the possibility of mass production initiated during the Second Industrial Revolution. The impact was so massive that it profoundly changed social structures.

Although the mass consumption society model of mass production and sales created huge value, its tremendous impact also created another significant bottleneck, that is, invisibility (Kokuryo, 2013)—or in the context of this thesis, the lack of traceability. Specifically, prior to the expansion of business areas, manufacturers and consumers tended to be physically close. This implied that producers had an understanding of who was buying their products and where. Symmetrically, consumers knew the origin of the products. This relationship is lost when mass transport makes it possible to ship products over long distances. A similar phenomenon relates to stores. Once customers are able to visit from afar by railroad or automobile, the relationship between store and customer grows weaker.

Another example of this invisible relationship concerns business conditions in a supermarket, where customers select products from a huge selection stocked in aisles, place their products in a basket, pay without stating their names to anyone, and then disappear. This means that the seller does not know when and how buyers use their products. Conversely, even in this kind of relationship without any traceability, the entire system has been created in order to make transactions possible.

3.2. Traceability/Bottlenecks and the ownership transfer Model

The lack of traceability creates two social issues: it destroys continuous relationships between sellers and users, and it makes it difficult to establish trust. This foundation was lost for customers who trusted a product provider because they knew the producer or seller well. Without trust, it can be difficult to transact.

Many innovations have been created in order to overcome this bottleneck and reap the benefits of selling in wide area. For example, one sales technique which is taken for granted today is to package a certain amount of products together, choose a brand name, and then advertise the product over mass media. This technique was developed in order to enable sellers to sell products over a wide area, and to eliminate the trust gap created due to the distance with consumers. Instead of trusting people (producers or sellers), consumers began to gain a sense of affinity and trust for companies by watching their commercials on TV.

Another method developed to build trust is the ownership transfer model, in which all product disposal rights (ownership rights) are transferred to the purchaser, and the entire value of the

product is paid at once in cash or the like. If a shop and a purchaser are able to establish a continuous relationship, other purchasing options (such as sale on credit) could become available. However, this model is the safest in situations where the purchaser and her/his whereabouts are unknown. It is true that expensive products could also be sold in installments after the customer's identity or credit is established, or purchased on credit using an external mechanism such as a credit card. However, these selling methods are expensive for the seller and have a limited scope of use. It could be argued that this model of making economic transactions through exchanging ownership rights and cash is the most characteristic method of the modern market economy. For this reason, it can also be acknowledged as a symbol of an open society where anyone can participate in social activities regardless of her/his origins.

3.3. The Arrival of the Non- ownership transfer Business Model

Although the ownership transfer model has had a massive presence until now, its characteristic bottleneck of low traceability has created a range of problems.

The foremost example in the context of this thesis is the effect this bottleneck has had on curtailing the operating ratio for products. For example, Mizuho Bank (2016) estimates that “the operating time per day for an automobile in Japan is 28 to 37 minutes.” In other words, the operating ratio is just slightly above 2%. Although shared use would have helped solve this, low traceability until now has meant that, under the use rights sales model, rental vehicles have not been efficiently allocated because consumers cannot make use of the services unless they go out of their way to get to rental shops. This has created a strong tendency among consumers to feel that they cannot use these services when they actually need them, limiting utilization. Further, individuals have been unable to loan out their own vehicles, as most insurances do not assume this type of business arrangement if an accident occurs.

On the other hand, in the content industry, the difficulty of billing has become a major issue. The ownership transfer model (in which all disposal rights are sold and transferred) is essentially unsuitable in the music and movie industries, where it is easy for individuals to copy contents. The official stance therefore has been that, when a CD or DVD is sold, the only ownership right that is transferred is for the medium (a plastic disc), while only use rights (with duplication restrictions) are transferred for the actual content recorded on the medium. This business model has been handled through strengthening legal protections. However, without any traceability, it is difficult to stop the duplication of diffuse contents, generating concerns over piracy and the like. This issue has become even more serious with the introduction of digital content, which does not deteriorate when duplicated.

In contrast with this, an example worth mentioning is about online karaoke, which was introduced in 1991 (All-Japan Karaoke Industrialist Association, 2016). The industry in this case

utilized online technologies to keep track of song usage and to build a framework for distributing payments collected from room fees and the like based on how often songs are played (Japanese Society for Rights of Authors, Composers and Publishers, 2017). This is a typical example of utilizing network communication to establish traceability in order to diverge from a business model dependent on hardware ownership rights sales, and to develop a business model based on frequency of use.

The number of business models that use network communication and that do not rely on ownership rights sales will continue to increase. According to the interesting literature survey by Burkhart et al. (2011), although the concept of business model can be first traced back to the 1950s, it began being suddenly covered around 1995. This can be thought of as a process where improved traceability had the effect of forming business models that were simply not implementable when the ownership transfer model was the only choice. Another effect was the application of such models to other industries, which led them to become the subjects of research and implementation.

4. The Evolution of Traceability

This section examines technologies to establish traceability. As it will be shown shortly, traceability is not a single technology, but rather the result of the combination of multiple technologies. Further, it is not something that is either there or not there; rather, it is something that develops gradually, where the ability to trace people and things increases as technology evolves. Finally, the scope of traceability tends to grow gradually—for example, the location might define whether traceability can or cannot be ensured. It is clear that the usage license business model has also expanded gradually together with the gradual development of technology.

4.1. Traceability

Although the literature on traceability in the information systems field can be retrieved back to the 1990s, its amount increased rapidly during the mid-2000s in the context of RFID (radio frequency identifier: digital tag) utilization (Moe, 1998). Much of this literature regards food safety, and involves efforts to utilize traceability quickly to trace food distribution, prevent accidents, and recover products when problems have occurred, as concerns over food safety have grown due to illnesses such as foot-and-mouth disease and bovine spongiform encephalopathy (Regattieri et al., 2007). The literature categorizes traceability into two forms—trace forward (understand where products go after shipping) and trace back (trace the route a product took after being delivered)—and involves attempts to use RFID and database technology to establish traceability. Although the use of RFID was initially limited to food distribution, the technology

can now be used in a wide range of fields, including logistics and facility room entry/exit management.

These existing concepts of traceability focus more on products while emphasizing the tracing of product whereabouts. Therefore, traceability has often been defined accordingly. In contrast, traceability began being considered from the perspective of rights holders and administrators in the content industry. With increasing amounts of digital content, it is becoming difficult to verify content rights due to duplication. In order for the content industry to verify that users accessing content have paid for it and have legitimate use rights, efforts have continued to make progress in tracing content distribution and verifying the identity of users (Zhao and Zhang, 2012). This perspective allows a clearer analysis of business models. Therefore, this thesis defines traceability as "a state where the principle owner of property rights or product liability for some physical or intellectual property is able to continuously confirm the state of the property and who is using it," and focuses on those with rights and responsibility.

One very interesting point in the context of the relationship between technology and social needs is how two-dimensional barcodes—which were thought to be old fashioned and eventually to be replaced by RFID—have seen new use in fields such as logistics and payment due to their ease of use and how readily available scanners (including smartphones) are. In this respect, one relevant business undergoing rapid growth in China is bicycle sharing, in which only use rights for products (bicycles) are sold. Users pay by using their smartphones to scan QR codes attached to bicycles. This is a perfect example of demand resulting in the repurposing of an existing technology in order to eliminate a bottleneck.

4.2. Traceability Technology

Although the method for selecting actual technologies varies depending on the nature of the asset, this section presents a summary of what kinds of technologies are necessary to establish traceability on a slightly abstract level, and what technologies are being used to do so.

4.2.1. Identification, Qualification, and Authentication Confirmation Technologies

A major premise for tracing objects and people is that the subjects being tracked and granted usage must be uniquely identified. Additionally, when a customer attempts to use a product, it must be confirmed that she/he has qualifications to do so. It must also be possible to confirm that the subject being traced is legitimated to use the product.

Identification is generally performed using some methods to scan an ID (identifier) that has been assigned. In supply chain management, product codes (such as Universal Product Codes) that were developed during the barcode era are evolving into EPCs (Electronic Product Codes) that carry more information and are compatible with RFIDs and the like. While companies generally

assign their own unique product serial numbers, logistics operators tend to assign package numbers for logistics use. True traceability is established when these many IDs are associated together (for example, a system that can confirm that product number x is located in package number x). In the digital content industry, links on the Web called permalinks are used to assign identifying codes to digital editions.

Further, associating products IDs with user IDs is an important requirement in the context of the usage license sales business model discussed in this thesis. In other words, a certain product must be associated with a certain user ID when that user begins using the product, and then the association must be canceled when the user has finished. Although it was possible to make such associations prior to the development of mobile devices, this was limited in scope to inside vendor sites, and these constraints served to narrow the scope of sharing economies.

Determining whether an individual is qualified to use a product is mostly done through payment systems. Some common examples include systems to prove that payment has already been made, or systems to confirm that a credit card company has approved someone's credit. One example from the public sector would be a system used to prove someone's existence and age (such as a certificate of residence).

Confirming authenticity is crucial in preventing identity fraud. When confirming someone's identity using a password or the like, or when a higher level of security is required, a typical method is to store a digital certificate in an IC card and to deliver a key to the user who will prove her/his legitimacy—such as in the Conditional Access System (CAS) for digital TV. Cookies are sent to clients to keep users logged into websites (i.e., authenticate them). These may serve as another method to prove authenticity.

4.2.2. Sensors & Control Networks

In order to trace moving products, it is crucial to have sensor and control network functionality that tracks the state of products after they have been moved, sends information to rights holders, and—if needed—unlocks products and performs other remote operations.

A typical example of sensor would be a reader capable of scanning barcodes, RFIDs, or IC cards that contain IDs (as mentioned in the previous section). As image recognition technology continues to evolve, biometric authentication using fingerprints or veins is becoming more popular as a method to identify users. Another example is facial authentication, which uses standard cameras.

Advanced control methods are also being implemented. Some examples include methods where a shared product contains communication functionality that allows it to be unlocked remotely, or methods that send an unlock code to users. Using a fixed code tends to result in license violations in the latter method. As shown by software licenses of the past and today's bicycle sharing systems,

having products online is a requirement for establishing a true sharing economy—which is why expectations are growing for IoT to realize this functionality.

Networks have developed since the appearance of the Internet. Societies all over the world continue to come closer to reach a state where wireless communication technology can be used to ensure inexpensive Internet access—anywhere, and at any time. Nowadays, the Internet of Things (IoT) is a topic of much speculation, as the society imagines a future in which everything is connected. Connecting everyone through wireless devices will make it possible to understand when and where products are shipped—and by whom they are being used. This will free society from the bottlenecks created by the ownership transfer business model, and expand the range of fields in which the right of use licensing business model can be applied.

5. Evolution of the Sharing Business Model

This section examines what kinds of sharing economies have evolved through the elimination of bottlenecks by technology. Here, sharing economies are defined as "societies in which have spread a business model in which information technology enables multiple users to use the same assets." Although this definition is slightly different from the more general one, using it should make it easier to understand the processes involved. More explanation will be provided in the next section.

5.1. Effective Utilization of Assets via Computerization

"Sharing economy" has not a consolidated definition (Oh and Moon, 2016). Although the concept has expanded in recent years in the wake of Airbnb, Uber, and other services that act as intermediaries when consumers loan their own assets, services that have existed for a long time—such as rental services—could be included in the sharing economies. In terms of social theory, many see this as a revival of the concept of common ownership (as opposed to modern private ownership) from collective societies. This could also concern online societies that have existed since Linux was a public space. Heylighen (2017) highlights major trends that include sharing economies in environments capable of quickly matching supply and demand at a micro level following the evolution of underlying computerization, and suggests a transformation of the exchange economy based on money. Focusing on consumption, Botsman (2010) refers to this major trend as "collective consumption."

On the other hand, Habibi et al. (2017) argue that ownership of shared products has not disappeared, and that, because online systems and the like are accelerating usage only, the concept of ownership itself has neither disappeared (not exclusive possession) nor is being transformed into sharing. Therefore, the common points of sharing that are actually making progress are "pooled resources" and "the use of online platforms to arrange payments."

Price Water House (2015) takes a more business perspective, stating that, “sharing economies allow individuals and groups to make money from underused assets. In this way, physical assets are shared as services.” According to this definition, it will naturally become possible to apply the concept of sharing to services for consumers and businesses alike. Although this literature focuses on services for consumers, it also introduces some interviews with companies that are conducting business while using an EMS (i.e., an outsourced production vendor). This way of thinking enables a more direct view of the relationship between technology and business models, which is why it is adopted in this thesis. The discussion will continue using the definition of, “societies which have spread a business model in which information technology enables multiple users to use the same assets.”

5.2. Expansion of the Sharing Model Following Advances in Technology

Having established a conceptual framework for the relationship between traceability and sharing economies, this section analyzes several important past developments.

5.2.1. Barcodes and the Expansion of the Sharing Model in Supply Chains

The impact of barcodes cannot be overlooked while considering the relationship between technology, traceability, and business models. Barcodes were patented by Norman Woodland et al. in 1949, and were first applied on a trial basis in the railroad industry. IBM then combined the technology with a distribution code system in 1971. Since then, the technology has supported supply chains and brought about major transformations (Scanlon, 2003; AINIX Corporation, 2017). The technology has helped to advance visibility throughout the entire supply chain. One typical example is the point of sale (POS) system, which combines a barcode reader with a cash register. First introduced in Japan by 7-Eleven in 1984, these systems quickly spread throughout Japan, providing retail chains and the like with detailed information on high selling products. It could be argued that these systems played a decisive role in establishing today's distribution business model.

More importantly for this thesis, barcodes have been adopted as crucial technologies to realize shared use in a variety of fields, including logistics and distribution systems. Underlying this development were increasing requirements for environmental measures—and, at the same time, the increasing need to ship multiple products at varying frequencies. In order to resolve this contradiction, there was increasing and expanding demand for multiple companies needing to load packages mixed on trucks.

This type of cooperative distribution naturally requires the strict management of products from various companies loaded on the same truck. The issue is how to accomplish this. Upstream (where lots are larger), it is possible to manage products using paper slips when multiple

companies are using the same truck together. However, as shipment frequency gradually increases, we get closer to the downstream part of the process, where package units are smaller and management costs increase. This requires a system in which barcodes for each destination are attached to products shipped out from the factory, and which is capable of streamlining distribution center work and confirming (tracing) product passage through each logistic stage (Fig. 3).

The example of one specific method follows. At the factory shipment stage, when everything up to the store is specified, products are shipped from the factory to the distribution center (assuming that products will be temporarily stocked there). The distribution center then sorts products by store (i.e., picking) and delivers them accordingly. During each stage of this type of shipment, products are inspected upon receipt as barcodes are scanned so that sales can be recorded. This is crucial to establish cooperative distribution. Here, barcodes serve as an enabling technology to eliminate bottlenecks and make it possible to share logistics systems. This has also led to the simultaneous development of logistics service outsourcing (i.e., third party logistics).

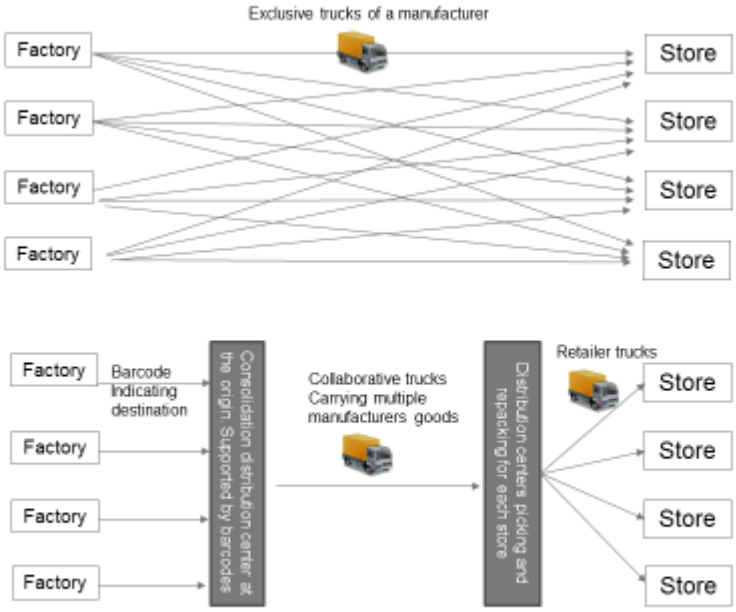

Figure 3: Collaborative Logistics with the Use of Barcodes

5.2.2. The Sudden Rise of Mobile Devices and Sharing Services for Consumers

For a long time, barcodes had served their final main purpose with the development of POS systems (i.e., cash registers in stores). Accordingly, the majority of sharing systems using barcodes tended to be limited to vendor operations. Even when consumers were involved, user identification and qualification/authenticity confirmation had to be performed at the vendor's physical site.

This situation is undergoing major transformations due to the spread of mobile devices like smartphones. Mobile devices have had the effect of rapidly bringing sensor networks into consumers' lives. Smartphones are also capable of identification and qualification/authenticity confirmation. What is lacking is a system to lock and unlock products and perform remote control. If these functions could be installed on the products themselves, it would be possible to provide products as sharing services without locational constraints. Further, if control rights could be granted to consumers, it would also be possible for consumers to share.

Removing locational constraints will serve as a major factor behind mobile technology greatly extending the sharing economy business model. When products and users can be associated, users identified, and qualification/authenticity confirmed anywhere, a new range of services will become available. For example, a user could use her/his smartphone to unlock a bicycle, or to leave it on the street when she/he is not needed anymore.

Many articles have been published on the sudden rise of Internet-enabled services such as Airbnb and Uber. Although the topic is not central to this thesis, it is particularly worth noting that these services use systems in which users review one another to resolve the constraint of trust that is a bottleneck impeding sharing. Along with the diffusion of sharing models that leverage the trust accumulated in payment platforms making rapid progress in China, major bottlenecks are being gradually eliminated.

In the digital content field, the diffusion of fixed monthly fee models that use mobile devices is one form of sharing. Music has been sold for some time now in the form of audio sources and licenses downloadable on a computer or other devices. However, factors such as the spread of piracy have led to growing concerns. In response, services that provide music libraries to traceable devices are constructing business models in which users dispose of an environment in which they can enjoy music whenever they like, while the revenue is distributed to rights holders according to use. It is clear that this model will free the market from a pseudo- ownership transfer model involving tangible items such as paper or plastic discs, and accelerate the transformation to a model where music is shared as an asset among many people.

6. What Lies Ahead

It has been argued in the past that traceability would serve as a mechanism to expand sharing economies. However, it could be claimed that traceability is just starting to expand. Further, as traceability develops, possible social issues could serve as new bottlenecks, as exemplified by privacy issues. To conclude this thesis, I now provide a simple examination of possibilities and issues to be considered for the future.

6.1. The Expanding Scope of Traceability via IoT

IoT is expected to increase traceability in all aspects of economic societies. Provided that the analysis presented in this thesis is accurate, this is also likely to expand sharing economies. A major transformation from the ownership transfer model that was established in the 19th century and prospered during the 20th century is likely to bring about other drastic transformations in how business is done. Moreover, marketing and management methods (including accounting) developed over the last century within the ownership transfer model will likely undergo massive transformations to suit new business conditions. All these changes represent an endless source for future research.

6.2. Big Data and Knowledge Traceability

Although the situation is expected to greatly advance, it is important to realize that there are still many fields in which there is not yet any expectation of ensuring traceability. One important field is data traceability. For example, there has recently been much research on the use of artificial intelligence to conduct big data analysis on user purchase histories stored in the cloud, in order to create intellectual property of economic value (such as music). Although this intellectual property was meant to be created from data submitted by each individual user, there is currently no way to identify which data contributed to what economic value. Technically speaking, technologies such as permalinks (in which fixed addresses are attached to each piece of content) or Rich Site Summary (RSS) and Atom Syndication Format (which are used to distribute content on blogs and the like) are now being used in fields such as web marketing to trace the effectiveness of advertising, pay customer introduction commissions, and so on. However, it is undeniable that true knowledge sharing economies cannot be formed yet. Lyytinen et al. (2016) raise spatio-temporal traceability of knowledge as one of the five factors behind the four processes by which digital transformation creates innovation, and predict a future breakthrough.

6.3. Toward Resolving Privacy Issues

Curtailing privacy while realizing the benefits of traceability has been a persistent issue in this field, and it will continue to be so in the future. The issue until now has involved mostly large vendors gaining a detailed understanding of the conditions of individuals. However, assuming that sharing between individuals (for example, loaning a private automobile) expands and there are more opportunities for owners to track users, it is easy to imagine that we will face issues of an entirely different nature than those seen before.

The discussion will likely shift to knowledge traceability, in which the status of information distribution and access is understood and managed appropriately. On the other hand, it will be necessary to trace and record the access to information flows in order to allow only those with right. Technological development will likely focus on solving this paradox.

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