

Creating new urban commons; Governing the micro-scale transportation system

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Introduction

According to the general terms of Economics (Mankiw 2016)¹, transportation systems in urban mobility mostly can be defined as Public Goods(e.g. bus, train), Private Goods(e.g. private car) or Club Goods(e.g. rental car) but not the Commons. However, as categorized the type of new commons (Hess 2008)², transportation systems have a positive possibility to become a part of 'infrastructure commons' as the new commons which also can be combined with 'Innovation Commons' that represents a higher order form of information and knowledge based on new technology as a subspecies knowledge commons (Allen, Potts 2016)³

On the one hand, transportation systems in the urban mobility confront huge emerging arguments with the 'Sharing Economy(SH)' phenomenon because of obvious problems such as "protests by laborers in fear of losing their jobs," "heightened insecurity for those that rely on incomes" (Kaun 2015)⁴. Moreover, there is various criticism that accelerates the speed of consumption rather than providing a sustainable consumption, for example, Sascha Lobo, one of the German Columnists, claimed the contribution of commodification by SH which changes all aspects of our lives depending on 'Platform Capitalism.' (Lobo 2014)⁵.

It seems that if we continue to develop new transportation systems in urban only based on the current SH phenomenon, its next systems would be substituted by the complexly-privatized public

¹ N. Gregory Mankiw, *Principles of microeconomics* (Nelson Education, 2016), 215-217

² Charlotte Hess, "Mapping New Commons" (Paper presented at The Twelfth Biennial Conference of the International Association for the Study of the Commons, Cheltenham, UK, July 14-18, 2008).

³ Darcy W.E. Allen and Jason Potts, How innovation commons contribute to discovering and developing new technologies. *International Journal of the Commons* 10(2), (2016):1035–54, accessed January 02, 2017, DOI:<http://doi.org/10.18352/ijc.644>

⁴ Anne Kuan, "After the Crisis: The Sharing Economy Our Saviour?," *The London School for Economics and Political Science – Euro Crisis in the Press*, October 9, 2014, accessed January 02, 2017, <http://blogs.lse.ac.uk/eurocrisispress/2014/10/09/after-the-crisis-the-sharing-economy-our-saviour/>

⁵ Sascha Lobo, "Auf dem Weg in die Dumphingölle", *Spiegel Online*, September 03, 2014, accessed January 02, 2017, <http://www.spiegel.de/netzwelt/netzpolitik/sascha-lobo-sharing-economy-wie-bei-uber-ist-plattform-kapitalismus-a-989584.html>

and club goods which have extremely excludable features.

For the reason, this study investigates the effect of psychological ownership and endowment effect which is directly linked to attachment (Baxter et al. 2015a)⁶ to understand sharing behavior in urban mobility through literature review and ethnographic research for development of a practical case of infrastructure commons <a prototype micro scale peer-to-peer (p2p) bicycle sharing system> in Cologne, Germany. The micro scale transportation system will adapt design principles leading collective action (Ostrom 2014)⁷ to implement on the specified local as the new commons.

For the conclusion, this study would suggest a way to build a micro-scale transportation system as a new commons which organized by citizen themselves through governance with various stakeholders. Moreover, it will also provide the first guideline for designing local transportation commons by bottom-up and autonomous action.

Transportation (infrastructure) systems as new urban commons

Mankiw (2016) suggests four different types of goods which can be classified private goods, public goods, club goods, and public goods according to two characteristics excludability and rivalry. The theoretical typology can be adapted to understand transportation system in urban areas. For example, private goods are excludable and rivalrous such as private cars, private motor bikes, and private bicycles. Club goods are non-rivalry and excludable. For example, rent cars, sharing cars and p2p sharing bicycles which can be used by the limited-users temporary through membership. Buses and trains can be defined as Public goods that can be used by citizen whenever they want if they pay a few amounts of money otherwise freely. Moreover, public goods sometimes lead to 'free rider problems' which means that when someone pays money to use the public transport, a few of others does not pay the cost, therefore, it needs detection to avoid the problem. Interestingly, nothing is called the commons in transport systems which have rivalry and non-excludability in the urban areas. However, Hess (2008) suggested that transportation infrastructure would be elaborated as the new commons which is not traditional commons such as agriculture, fisheries, or forests. Since the infrastructure (roads, airports, seaports) cannot exist without its transportation (mobility objects; cars, buses, and bicycles), we also need to deeply understand its types of goods regarding new commons. For example, the

⁶ Weston L. Baxter, Marco Aurisicchio, and Peter RN Childs, "A psychological ownership approach to designing object attachment," *Journal of Engineering Design* 26.4-6 (2015a): 140-156.

⁷ Elinor Ostrom, "Collective action and the evolution of social norms," *Journal of Natural Resources Policy Research* 6.4 (2014): 235-252.

transport system in the commons would be opened for anyone, but it will be competitive to use it. The following

[Figure 2] indicates four different types of transport system in terms of types of goods (Mankiw 2016).

	Rivalry	Non-Rivalry
excludability	private goods e.g. Ice-cream cones clothing Congested toll roads	club goods e.g. Fire protection Cable TV Uncongested toll roads
non-excludability	the commons e.g. Fish in the ocean The environment Congested nontoll roads	public Goods e.g. Tronado siren National defence Uncongested nontoll roads

Figure 1. Four types of goods (Mankiw 2016)

	Rivalry	Non-Rivalry
excludability	private goods e.g. Private cars Private motor bikes Private bicycles	club goods e.g. Rent cars Sharing cars p2p Sharing bicycles
non-excludability	the commons ?	public Goods e.g. Bus Train (Ubahn, Sbahn, ..)

Figure 2. Types of transportation in terms of [Figure 1]

As we examined above, transport system can be classified into four different types of transportation goods/services. However, it is difficult to obviously separate into one category since many cases are combined to maintain the system in reality. For example, although public goods have excludability and rivalry characters in the theory, it needs to adapt some part of club goods' system to avoid 'free-riders.' Moreover, over the last decade, Digitalization and the Global

Financial Crisis 2008 strongly affected the norm of consumption and ownership (Thomas 2015)⁸ changed 'access based consumption' or 'access-over ownership' such as uber, lyft and airbnb. And the norm represents not only the essential scheme of 'Sharing Economy' phenomenon but also 'Innovation Commons' which Allen and Potts (2016) defined as a higher order form of information and knowledge based on new technology as a subspecies knowledge commons. Interestingly, it makes blurred-barriers between each category of the transport system. The following [Figure 3] shows the complex typology of the transport system in Huerth-Efferen(suburban) and Cologne(urban) in Germany. What we can obviously empathize is 'sharing bicycles' organized by local government or companies do not exist and the less number of public transportation in the suburban. The study will discover possibilities to design new commons for the issue.

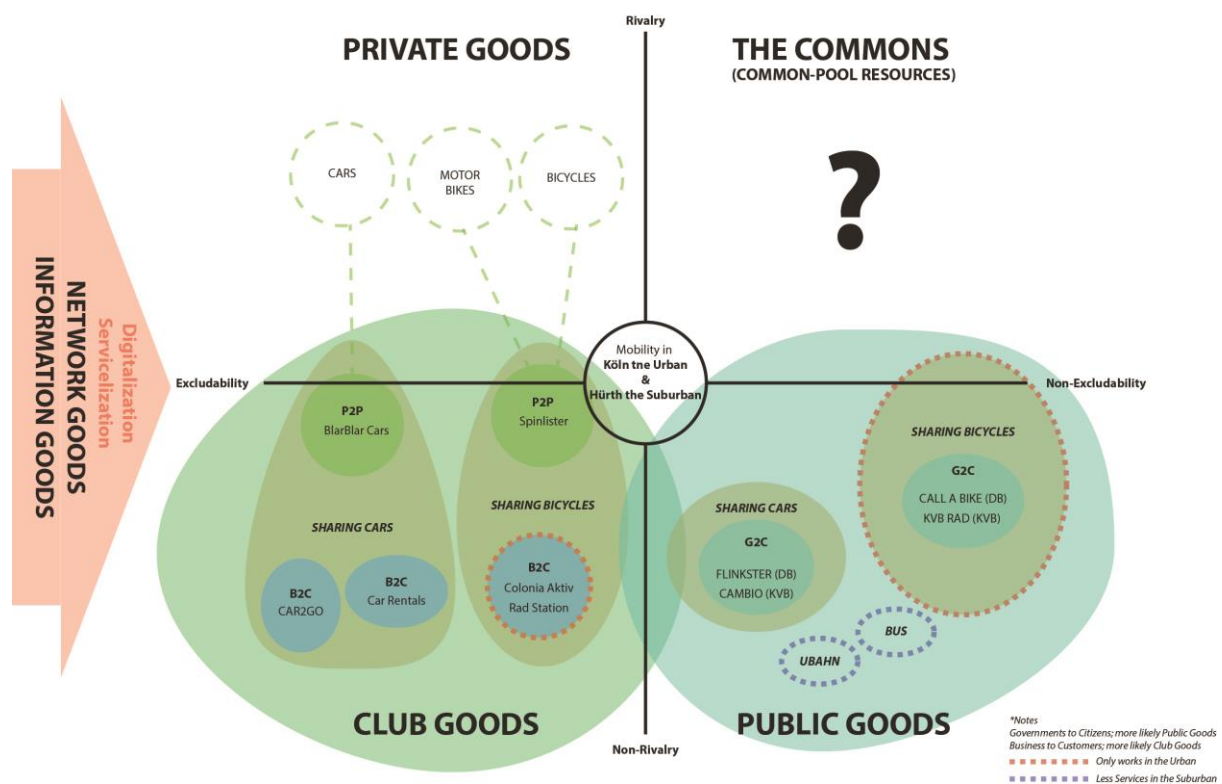


Figure 3. Types of transport system in Efferen and Cologne

⁸ Thomas Doennebrink, "The Civic Economy," in chapter 3 - Old Economy versus New Economy, (european urban knowledge network, 2015), 38-48.

Pros and cons of current 'sharing economy'

Generally speaking, Sharing Economy represents the new type of consumption. "Examples vary from car- or bike-sharing (Zipcar, Barclays Cycle Hire), peer-to-peer car or accommodation rentals (RelayRides, Airbnb), online borrowing for bags, fashion and jewelry (Bag, Borrow or Steal, Rent the Runway, BorrowedBling), to pure sharing and gifting platforms (Couchsurfing, Freecycle, BookCrossing)" (Fleura 2014)⁹. It seems like customers can reduce their consumption through access-based consuming behavior instead of possession. However, it only changes consuming process not consuming amounts if it is not pure sharing and gifting platforms. For example, when we use the sharing bicycle system, we should pay the cost to use it temporarily. Moreover, when the many of sharing economy startups advert their services, they emphasize the use of the surplus value of their assets such as vacancy, mobility, tools and time. It means that we could define the main stream of Sharing Economy, it would be called Sharing 'Market' Economy since there is always the financial transaction.

If we look at the meaning of 'sharing' from dictionaries but also in the practice of our daily life, it does not mean only renting/borrowing. The meaning of 'share' is *"A part or portion of a larger amount which is divided among a number of people, or to which a number of people contribute"* in Oxford Dictionaries, and Korean Dictionaries says *"More than two persons own one thing together."*¹⁰ Which means that the meaning of sharing more likely pursuing collaborative /collective ownership, not private ownership.

What we could see as a possibility from the definition of sharing is there will be a different way to share the bicycles in the urban/suburban if we can define the meaning of ownership. For example, *food sharing, give box, or my little library* [Figure 4] might be an example. However, it is actually, fully taking over its ownership to anonymous or their neighbors who needs. In that sense, we might call it as Sharing 'Gift' Economy according to Cheal (2015)¹¹. Although it represents alternatives way of Sharing 'Market' Economy to elaborate social capital such as altruism / social

⁹ Fleura Bardhi, "Is the sharing economy reshaping consumption models?," Strategic-risk-global, August 19, 2014, accessed January 02, 2017, <http://www.strategic-risk-global.com/is-the-sharing-economy-reshaping-consumption-models/1409583.article>.

¹⁰ The definition of 'sharing' in Korean, Naver Korean dictionary, accessed January 02, 2017, <http://krdic.naver.com/detail.nhn?docid=3372200>.

¹¹ Gift Economy, "A gift economy, gift culture, or gift exchange is a mode of exchange where valuables are not traded or sold, but rather given without an explicit agreement for immediate or future rewards," December 22, 2016, accessed January 02, 2017, https://en.wikipedia.org/wiki/Gift_economy#cite_note-Cheal-1.

cohesion / and indirect reciprocity, the transportation system in the urban needs much evolved solution since it could not be clearly categorized as black and white.



Figure 4. Examples of Sharing 'gift' Economy¹²

Over the last decade, Digitalization and the Global Financial Crisis (2008) strongly affected the norm of consumption and ownership (Thomas 2015) changed 'access-based consumption' or 'access-over ownership.' Moreover, the norm represents the essential scheme of 'Sharing Economy' phenomenon.

However, since then, the phenomenon leads to several controversial issues such as "protests by laborers in fear of losing their jobs," "heightened insecurity for those that rely on incomes" through the sharing economy (Anne 2014). Moreover, there is more critical argue that it accelerates the speed of consumption rather than providing a sustainable consumption, Sascha Lobo, one of the German Columnists, claimed the contribution of commodification by Sharing Economy which changes all aspects of our lives depending on 'Platform Capitalism.' (Sascha 2014). It also reminds the blurred meaning of 'sharing' whether it means 'Impossibility of ownership' or 'unnecessary of ownership.'

Cameron Tonkinwise, Professor of Carnegie Mellon School of Design, said *"It is certainly true that*

¹² Food sharing; <https://foodsharing.de/> , Give and take box cologne; <https://www.facebook.com/GiveboxCologne/> , My little library; <https://littlefreelibrary.org/>

the quickest way to authenticate a sharing economy is to design (or redesign) the systems for shared control: collective or cooperative ownership of platforms” (Cameron 2014)¹³. Professor Trebor Scholz (2014)¹⁴ of The New School, NYC also claimed the truth of owners behind successful sharing economy business such as Uber and AirBnB. He suggested the importance of customers or employees-owned digital platform so-called ‘platform cooperativism’ (e.g. Drivers-owned Uber). The following [Figure 5] indicates different types of sharing economy models.

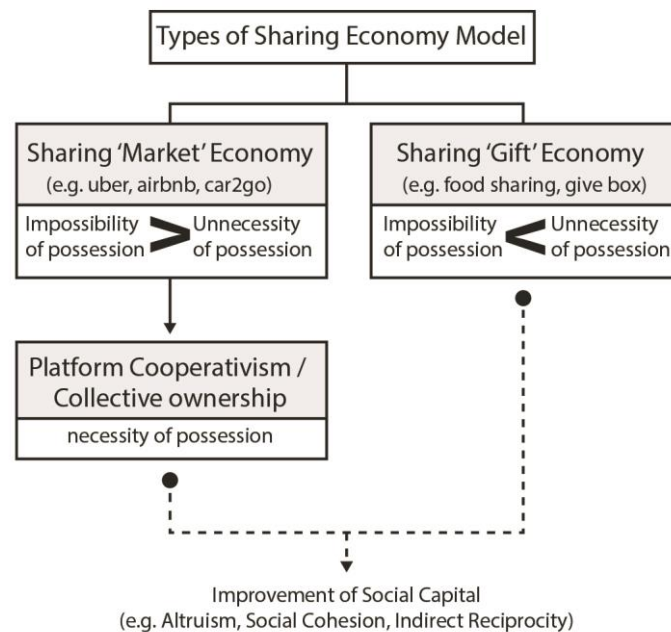


Figure 5. Different types of sharing economy models based on types of its possession

In that sense, privately-owned affordable bicycles in the urban/suburban can be transformed into public products/services as new Commons which represents ‘collaborative ownership’ through Collective Actions, and Self-organization (Ostrom 2014).

We could imagine sharing culture based on ‘collaborative ownership’ in daily life can contribute sustainable and equitable society explained “living well while at the same time consuming fewer resources and generating new patterns of social cohabitation” by Enzo Manzini (Jégou et al. 2008)¹⁵ rather than sharing services based on ‘private ownership’. It will also be able to give

¹³ Cameron Tonkinwise, “Sharing you can Believe in The Awkward Potential within Sharing Economy Encounters,” Medium, July 01, 2014, accessed January 02, 2017, <https://medium.com/@camerontw/sharing-you-can-believe-in-9b68718c4b33#.af4memjd1>.

¹⁴ Trebor Scholz, “Platform Cooperativism vs. the Sharing Economy,” Medium, December 06, 2014, accessed January 02, 2017, <https://medium.com/@trebors/platform-cooperativism-vs-the-sharing-economy-2ea737f1b5ad#.s92gtw8sd>.

¹⁵ Francois Jégou, et al, “Sustainable everyday project,” 2008, accessed January 02, 2017, <http://www.sustainable-everyday->

people more resilient 'Social Cohesion' and 'Altruism' mindset which is not highest sharing motives in current sharing economy services in Germany whether it is based on profit business model or not (Fanny 2015)¹⁶. Moreover, the practice of collaborative ownership might be able to give people an understanding of the power of participation in democratic society as Jeremy Heimans and Henry Timms (2014)¹⁷, through Harvard Business Review, suggested 'New Power' that "gains its force from people's growing capacity – and desire –to go far beyond passive consumption of ideas and goods." The [Figure 6] indicates all speculation explained above.

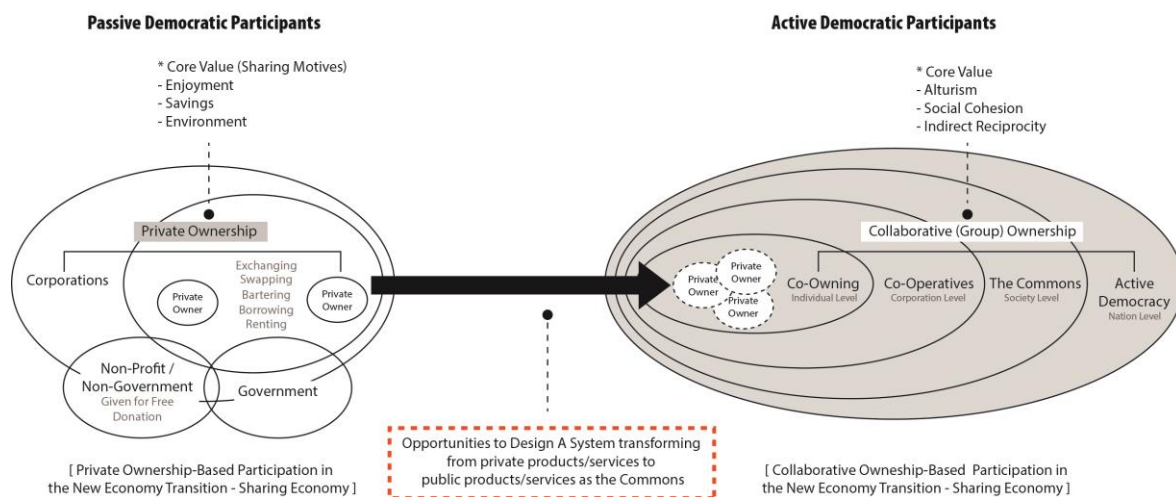


Figure 6. The speculation of ownership evolution

Abandoned bicycles in Germany

It is true that abandoned bicycles are everywhere around us in Germany. For example, almost 2,500 abandoned bicycles in Berlin, 3000 in Hamburg, 1800 in Cologne, and 900 in Münster were collected by public administration in 2014 (Deutsche Presse-Agentur 2015)¹⁸. The number could

project.net.

¹⁶ Fanny Schiel, "The Phenomenon of the Sharing Economy in Germany: Consumer Motivations for Participating in Collaborative Consumption Schemes" (MS thesis, University of Twente, 2015).

¹⁷ Jeremy Heimans and Henry Timms, "Understanding New Power," December issue, 2014, accessed January 02, 2017, <https://hbr.org/2014/12/understanding-new-power>.

¹⁸ "Kommunen Städte kämpfen gegen abgestellte Schrott-Fahrräder," Deutsche Presse-Agentur, May 25, 2015, accessed January 02, 2017, <http://www.kn-online.de/News/Aus-der-Welt/Nachrichten-Panorama/Staedte-kaempfen-gegen-abgestellte-Schrott-Fahrraeder>.

not look serious since it is only a few percentages of all bicycles in Germany. However, it seems like that the number of abandoned bicycles is increasing in Germany, especially in Cologne (about 1600 in 2013, about 1800 in 2015, about 2100 in 2016) (Deutsche Presse-Agentur 2015; Kölnische Rundschau; 2014¹⁹; Sag's Uns 2016²⁰). Unfortunately, there is no clear evidence defined yet, and it causes economic, environment, and social problems because of its unidentified ownership. For example, each municipality has to spend numberless process cost to collect, discard, or recycle it. The recycle rate is extremely low since it is almost impossible to use it again when they can obviously recognize its status as 'abandoned.' (Kölnische Rundschau; 2014) Interestingly, if we see the proportion of abandoned bicycles in one of huge student villages in the suburban, Efferen,

¹⁹ "Umweltzentrum Kölner Friedhof der Fahrradleichen, Kölnische Rundschau," October 10, 2014, accessed January 02, 2017, <http://www.rundschau-online.de/551910>.

²⁰ Analyzed from Sag's Uns, accessed January 02, 2017, <https://sags-uns.stadt-koeln.de/>.

where 1,200 students live, the proportion of abandoned bicycles is about 50 times higher than the nearest city, Cologne.

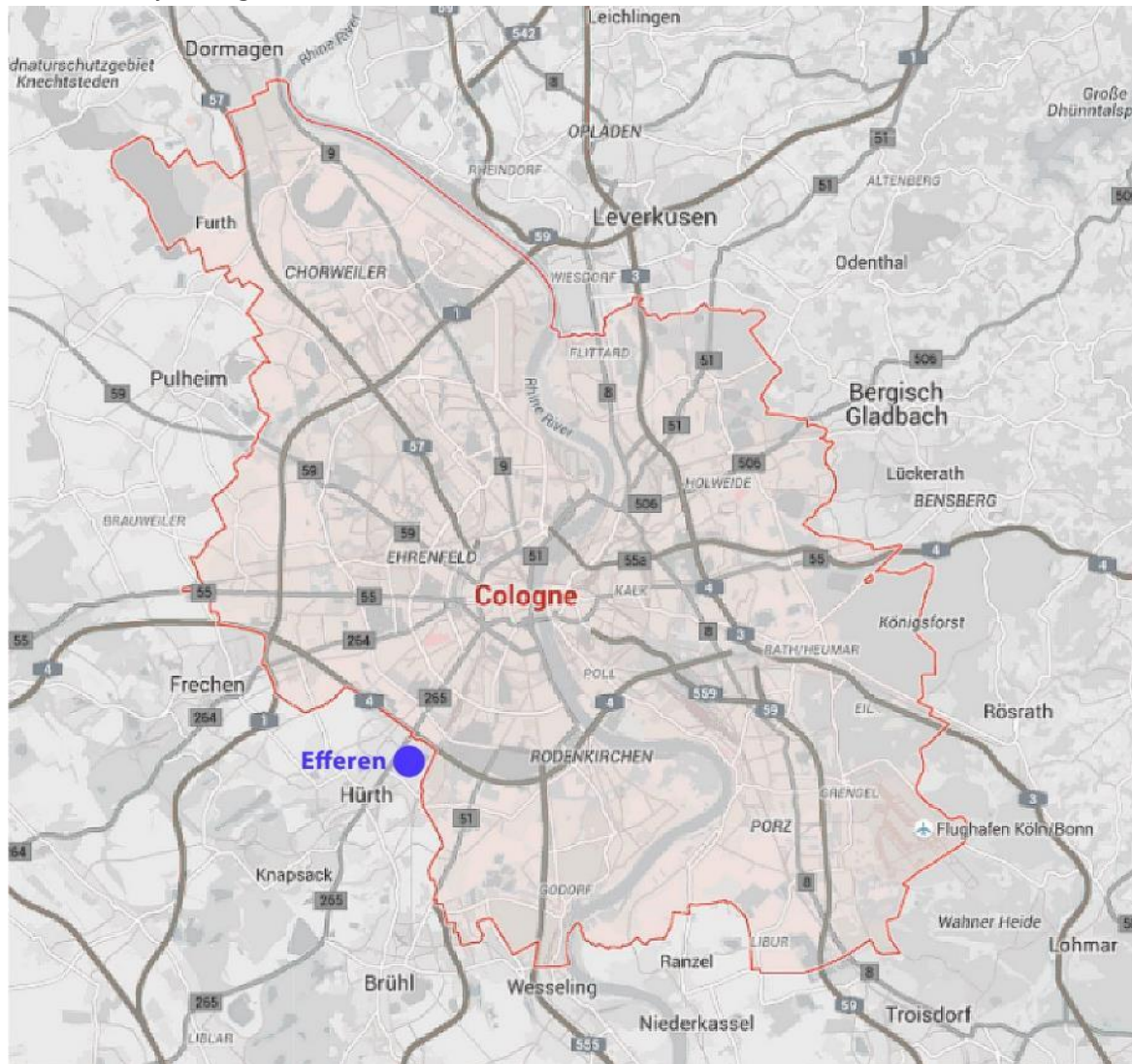


Figure 7. Target place the urban (Cologne) and the suburban (Huerth-Efferen)

Since the study had assumption at the beginning which is transportation system as new commons and the phenomenon above 'Increase the number of abandoned bicycles in Germany,' it needed to define suitable places and users. As we investigated the statistical data of abandoned bicycles including its process and current solutions which contrast obvious difference between the urban (Cologne) and the suburban (Efferen Student Village). Moreover, it will investigate general terms of bicycle use in Germany. Importantly, the study defines the characteristics abandoned bicycles which are 'Affordable' and 'Secured' appearances related to Loss Aversion, Endowment effect, Formal Ownership, and Psychological Ownership. And it will discover the mobility environment in the suburban and the urban to understand its relation with abandoned bicycles which can be the

one significant reason why we need to consider transportation as new commons.

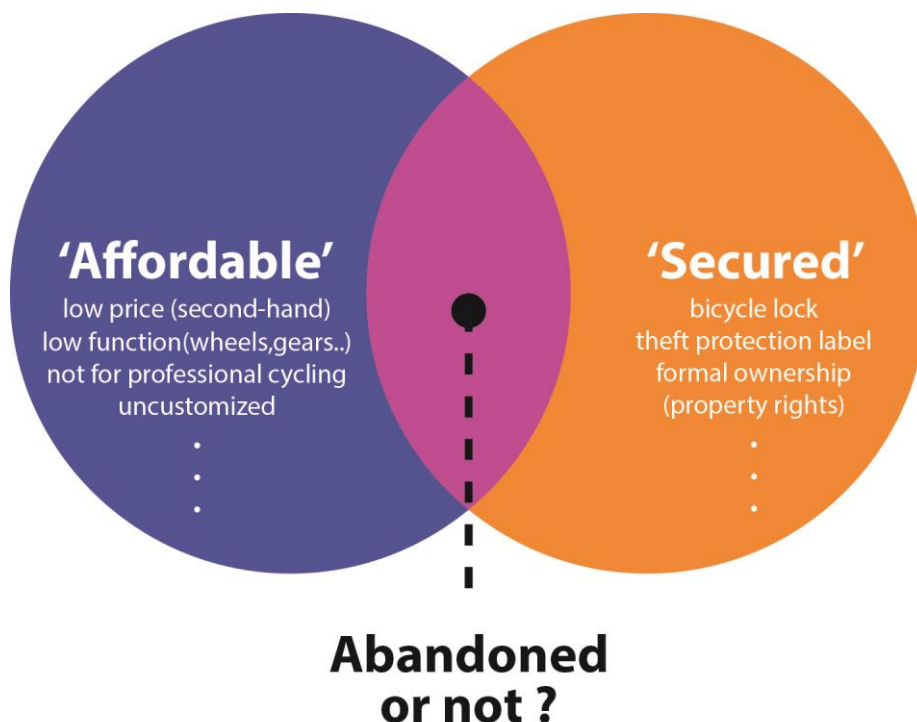


Figure 8. Main appearances of abandoned bicycles.

According to the Research *Cycling for Everyone* (Pucher and Buehler 2008)²¹, average daily km cycled per inhabitant increased between 1978 and 2005: from 0.6 to 1.0 in Germany. Although it is shorter than in Netherlands (1.7 to 2.5) or Denmark (1.3 to 1.6) that have well-developed bicycle infrastructures than any other countries, the bicycle share of trips in Germany are still higher than other countries except only a few North European countries. Moreover, one of the main reason to ride bicycles in Germany is pragmatic purposes such as travel to work or school (22%) and go shopping (22%) while recreation purpose shows 35%. The research also says Bicycle use in European countries tends to shows higher proportion of pragmatic purposes than other reasons while some countries like U.S.A only shows under 5% for the pragmatic purpose.

The following pictures [Figure 9] below were taken between 2015.05~2016.11 in Cologne, in Efferen (the student village), Germany, and other European countries. The most important fact is almost all of abandoned bicycles have two similarities which are 'affordable' and 'secured'

²¹ John Pucher and Ralph Buehler, "Cycling for everyone: lessons from Europe," *Transportation Research Record: Journal of the Transportation Research Board* 2074 (2008): 58-65.

appearances. While its affordability shows only its market value, secured appearances make workers from AWB (waste management company), or other related authorities complicated to recognize its status of property rights. It is because the bicycle lock which always is with the abandoned bicycles and/or the theft protection label represents its legal status. The owner's Formal ownership "a multi-dimensional concept, including property rights, control rights and the right to information" (Pierce et al. 2001)²² is given to the owner when they invest money individually due to legal terms. Other characteristics of abandoned bicycles are such as a disappeared seat post, disappeared wheels, non-customization, obviously broken parts, or rusty chains.

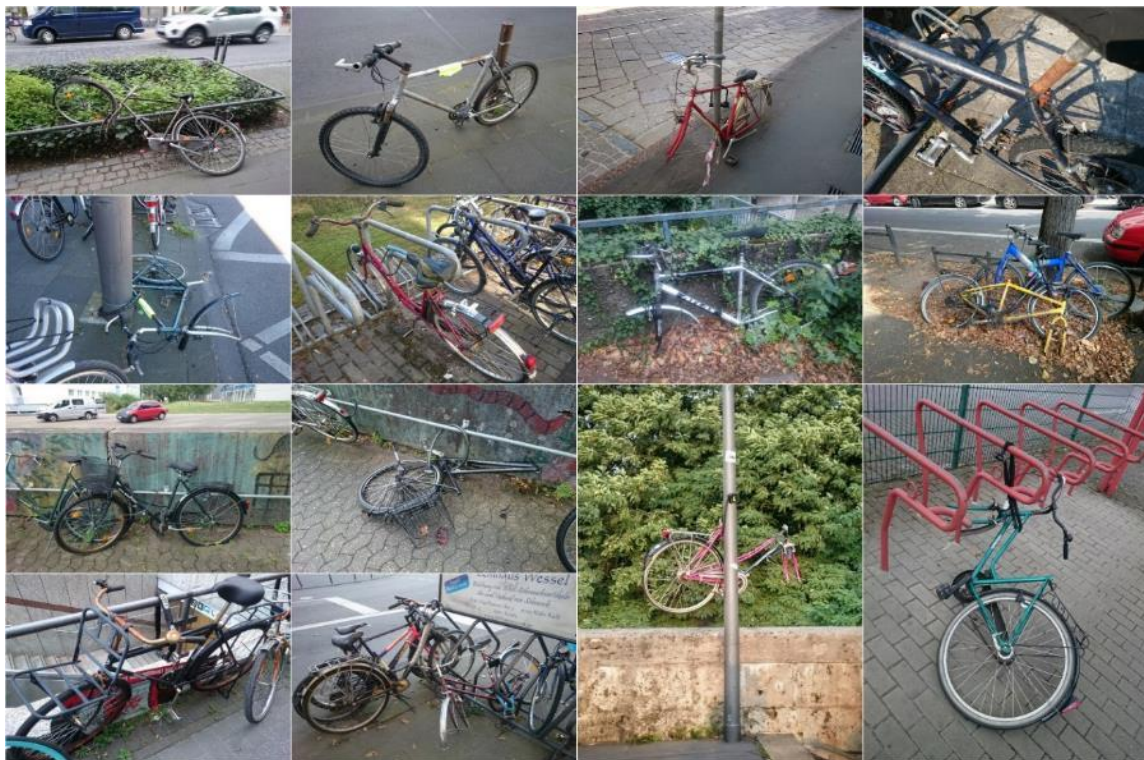


Figure 9. Abandoned Bicycles in Germany and European countries

Loss aversion and Endowment Effect on the abandoned bicycles

As described earlier through observation, it has characteristic appearances which are 'secured' and 'affordable.' For example, the appearances such as low price (e.g.no brand), low function (wheels, gears, and so on.), not for professional cycling, uncustomized can be abstracted as affordability. Moreover, the bicycle lock or the theft protection label which represents the owner's Formal

²² Pierce, Jon L., Tatiana Kostova, and Kurt T. Dirks. "Toward a theory of psychological ownership in organizations," *Academy of management review* 26.2 (2001): 298-310.

Ownership that appears security. Although the study is assuming the students in the suburban as the main potential stakeholder who abandoned bicycles, we need to investigate why being away from them and why they keep possessing it. In this part, we will assume how the two main appearances are related to the abandoned bicycles and why it is away from them through analysis and literature review.

What we can see through the bicycle lock is the Formal Ownership from its unidentified owner. However, why did not the owner just throw their bicycle away without the lock if they already gave up their Formal Ownership? Since it is almost impossible to find the experienced interviewees, the study investigates theories, for example, Loss Aversion including Endowment Effect to understand the users' behaviors. Loss Aversion is "The central assumption of the theory is that losses and disadvantages have a greater impact on preferences than gains and advantages." (Tversky and Kahneman 1991)²³. For example, the affordable bicycle owner might be able to think that it is better not to lose their 50 euro bicycle than to have another 50 euro bicycle. Several studies assumed that losses are psychologically doubly effective than gains (Tversky and Kahneman 1992)²⁴. The theory also directly effects on decision-making behavior which is so-called Endowment Effect but also linked to the mere ownership effect (Beggan 1992)²⁵. It means that the owner asserts more worth to the thing simply because they own it (Morewedge and Giblin 2015)²⁶. It seems like that Loss Aversion, and Endowment Effect can work positively to maintain their bicycle whether their bicycle is affordable or not since it will make the owner being secured. However, it starts negatively effecting on the bicycles when the owner clearly loss his/her emotional attachment for some reason although they have Formal Ownership. We could assume that there will be some issues which effect on the loss of attachment on the bicycles. [Figure 10] explains the relation between abandoned bicycles and its secured characteristic through loss aversion and endowment effect theory.

²³ Amos Tversky and Daniel Kahneman, "Loss aversion in riskless choice: A reference-dependent model," *The quarterly journal of economics* 106.4 (1991): 1039-1061.

²⁴ Amos Tversky and Daniel Kahneman, "Advances in prospect theory: Cumulative representation of uncertainty," *Journal of Risk and uncertainty* 5.4 (1992): 297-323.

²⁵ James K. Beggan, "On the social nature of nonsocial perception: The mere ownership effect," *Journal of Personality and Social Psychology* 62.2 (1992): 229.

²⁶ Carey K. Morewedge and Colleen E. Giblin. "Explanations of the endowment effect: an integrative review," *Trends in cognitive sciences* 19.6 (2015): 339-348.

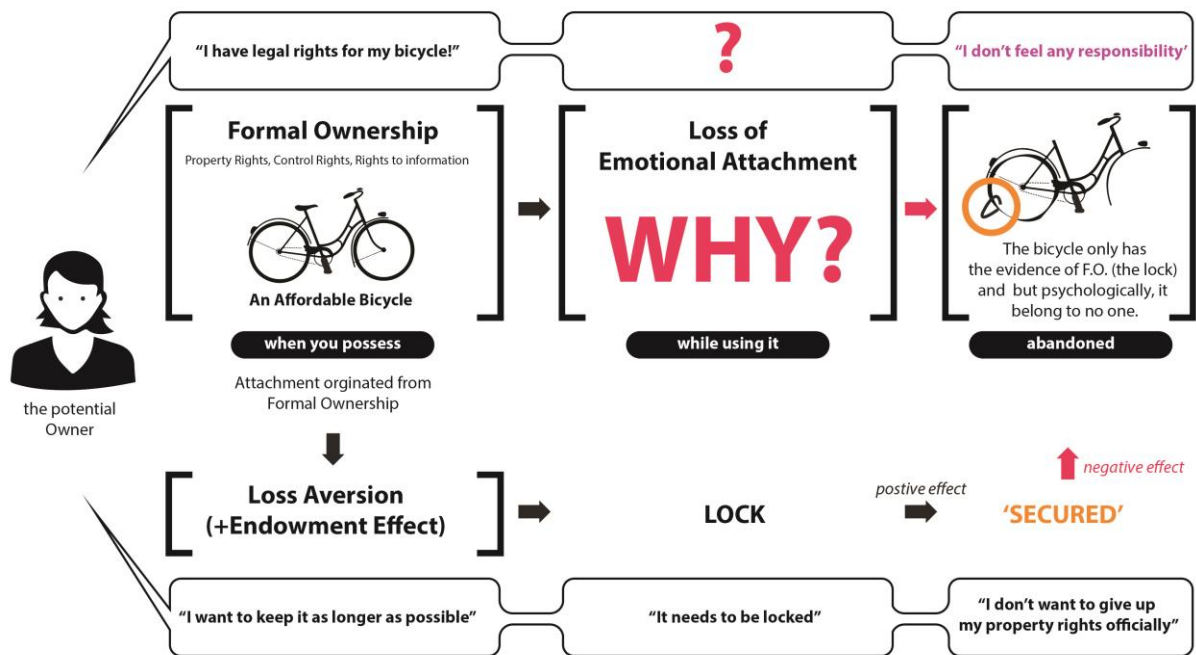


Figure 10. How 'secured' appearances related to the abandoned bicycles

As long as the owner has an emotional attachment on their affordable bicycle, it seems that the lock positively effects on the bicycle to maintain it as the study described already. However, since some reason causes the loss of attachment on the bicycle, the study should clarify it. The one of former studies suggests "*mainly memories and enjoyment* positively effect on the degree of attachment to the objects amongst *enjoyment, memories to persons, places, and events, support of self-identity, life vision, utility, reliability, and market value*" which are identified and measured by their scientific research (Schifferstein and Zwartkruis-Pelgrim 2008)²⁷. It means that the one of the reason would be the lack of memories and enjoyment on the affordable bicycles. However, since the variables are more likely personal experience, we cannot generalize that all the students in the suburban have the lack of memories and enjoyment on the affordable bicycles. For example, some users could acquire their affordable bicycle from his/her friend or family as a gift, or an object freely taken over which can give the student positive memories. We might be unclearly able to assume that it is related the main reason of bicycle use in Germany which is pragmatic purpose but not 100% sure.

²⁷ Schifferstein, Hendrik NJ, and Elly PH Zwartkruis-Pelgrim, "Consumer-product attachment: Measurement and design implications," International journal of design 2.3 (2008).

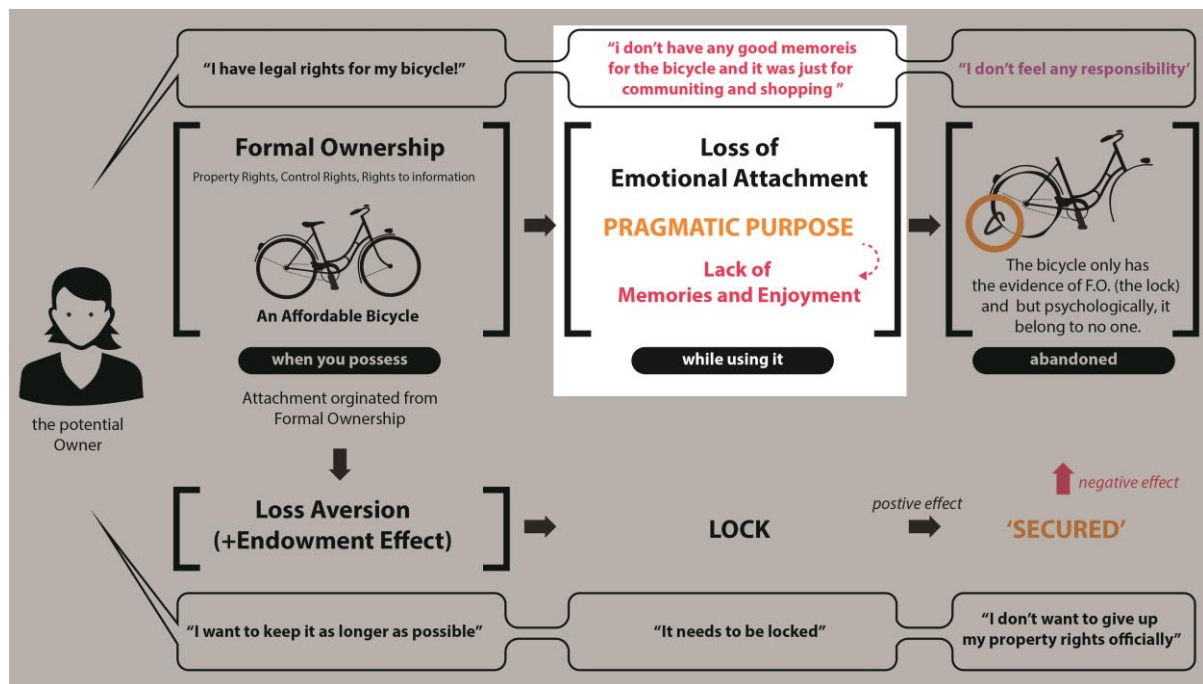


Figure 11. The first potential leading to loss of emotional attachment

As bicycle theft is also emerging issues in Germany, the study investigates its relation with abandoned bicycles. It is not difficult to recognize the feeling of Formal Ownership from the abandoned bicycle which has 'Secured' look and feel from its appearances such as the bicycle lock and the theft protection label [Figure 12] which says it has been officially registered police department already. Since the owners are worried about bicycle theft in general, they always are with the lock. Interestingly, one of the studies shows the number of unsecured bicycles (23.6%) is much lower than secured bicycles (76.4%) in a total number of average stolen bicycles between 2003 and 2009 in Germany (ADFC 2010)²⁸. It indicates [Figure 13] there might be no strong correlation between fully stolen bicycles and abandoned bicycles. It is because if the abandoned bicycles had been fully stolen, it should have been unsecured without the bicycle lock. However, partly stolen bicycles have a possibility to be abandoned since it could decrease the attachment on the bicycle because of its affordability. Although Schifferstein and Zwartkruis-Pelgri (2008) proposes market value is not related to emotional attachment, it seems that unexpected circumstances strongly effect on the attachment of the affordable bicycles. It is because the owner should negotiate to invest his/her efforts economically, and psychologically to fix or not. We could assume like [Figure 14] that the owner does not mind his/her Formal Ownership holding

²⁸ "Auswertung Fahrraddiebstahl," ADFC, September 08, 2010, accessed January 02, 2017, http://www.adfc.de/files/2/135/PKS2009_Auswertung_ADFC-Stand070910.pdf

the bicycle as a lock when they lost their emotional attachment.



Figure 12. The theft protection label and the lock on the abandoned or unidentified bicycles



Figure 13. Fully Stolen Bicycle and partly stolen bicycle

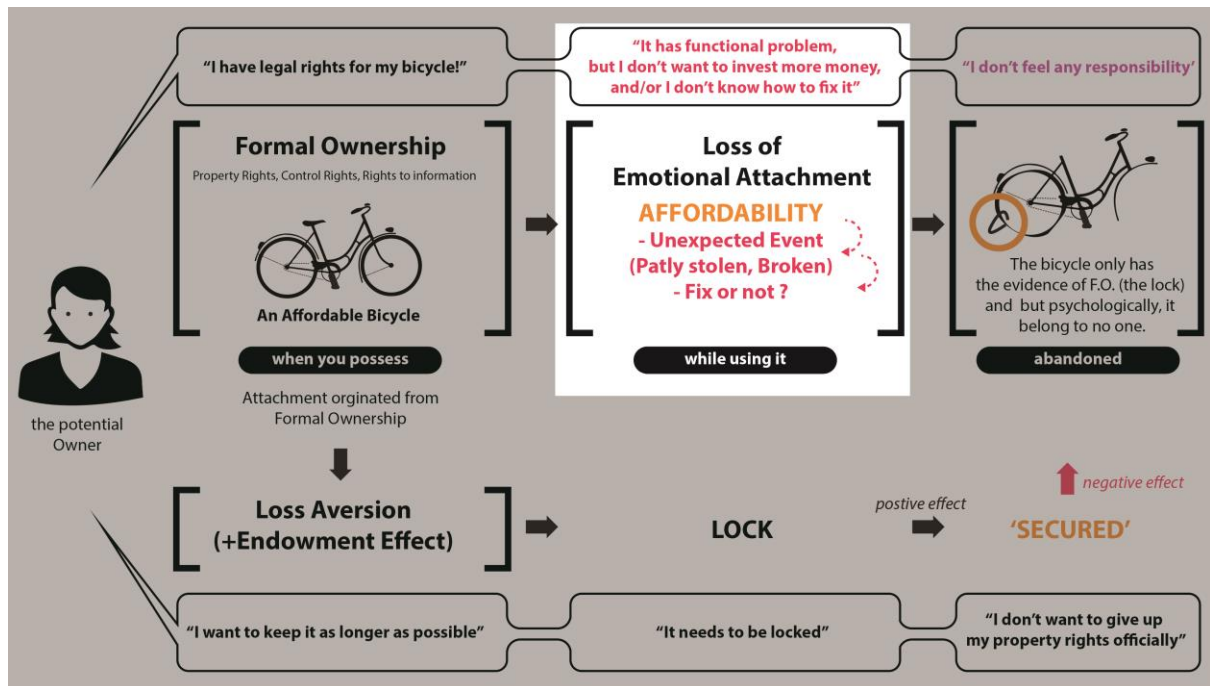


Figure 14. The second potential reason leading to loss of emotional attachment

Understanding 'psychological ownership'

On the one hand, another study (Baxter et al. 2015b)²⁹ researched about emotional attachment to the objects related to Psychological Ownership theory proposes the following [Figure 15] The research portrayed common paths of attachment on the different types of objects depending on time and users' efforts. Baxter et al. (2015b) describe Path B shows a typical path of attachment for an object which increases their attachment through routes of psychological ownership such as control, self-investment, intimate knowledge. It can be a normal bicycle that the users engage in configuring, repairing or researching. Path A is the result of mass customization which the users are on the high level of status in psychological ownership. It would be a well-customized professional bicycle. Patch C might be a bicycle offered by companies or organizations that you did not invest cost or didn't choose by yourself but you will be familiar with over time through 3 routes of psychological ownership. Finally, Path D will be a second-hand bicycle or a sharing bicycle which temporarily accessed with reminders of the previous user. Since the former user's trace are still there, it will take time to have enough attachment. However, the level of attachment will be higher than Path C because you have authority to take control.

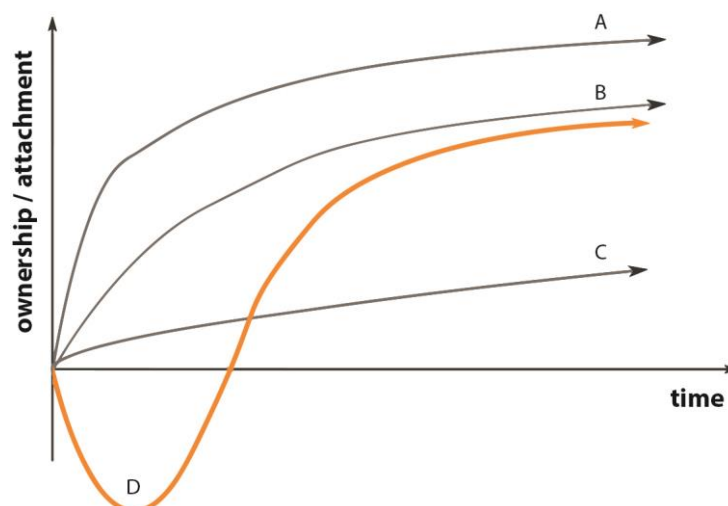


Figure 15. Paths for attachment (Baxter et al. 2015b. p5)

Interestingly, the beginning of Path D illustrates the negative level of attachment which can be the most important moment where the owner can fully lose his/her attachment for the second-hand bicycle if they do not make efforts to engage their psychological ownership on their bicycle. Moreover, we could assume that the abandoned bicycles observed earlier could be at that moment (the beginning of Path D) that surrounded by Unexpected Events (Partly stolen, broken,

²⁹ Weston L. Baxter, M. Aurisicchio, and P. R. N. Childs, "Using psychological ownership to guide strategies for slower consumption," *Product Lifetimes And The Environment* (2015b): 1.

...) or some situations causing lack of memories/enjoyment. However, it also means if we can find the way to improve Psychological Ownership on the affordable bicycle, we might be able to avoid to negative effective which decreases the emotional attachment by Unexpected Events and Lack of Memories / Enjoyment.

The following Figure 27 shows 1) how affordability and pragmatic purpose decrease the emotional attachment, 2) how the lack of efforts to improve Psychological Ownership combined to the emotional attachment, and 3) how the secured appearances originated from Formal Ownership is accidently changed from positive element to negative element due to loss of attachment.

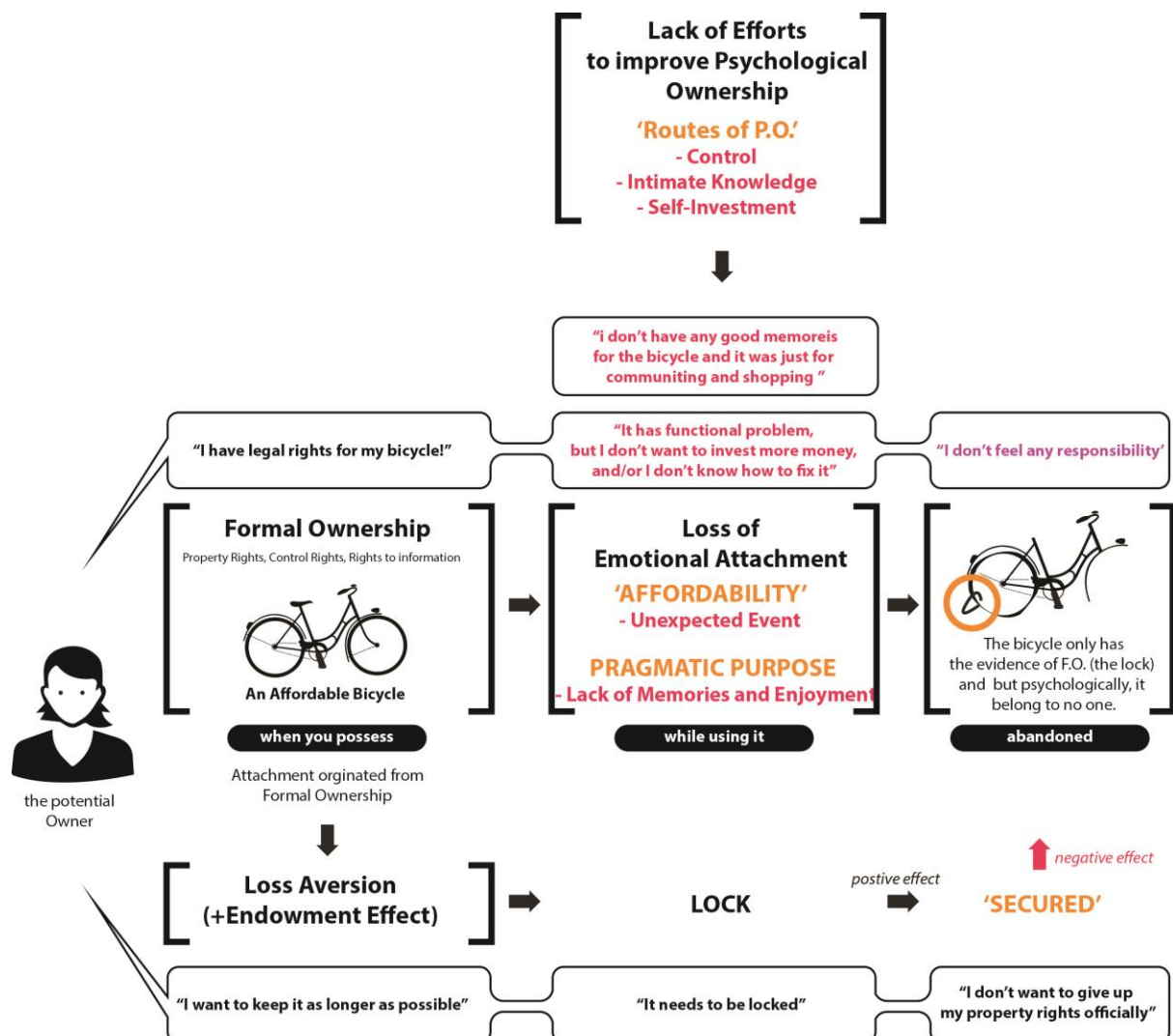


Figure 16. How the affordable bicycles being abandoned

Formal ownership and Psychological ownership

It seems like that if we understand the 'Routes of Psychological Ownership,' the emotional attachment can be increased although the potential negative factors such 'affordability' (related to unexpected events) and 'pragmatic purpose' (unsurely related to memories and enjoyment) are almost given variable for the students in the suburban. In this part, we will examine Formal Ownership (FO) and Psychological Ownership (PO) to discover opportunities to develop a hypothesis.

Pierce, Rubenfeld, and Morgan (1991)³⁰ investigated the failure of ESOP (employee share ownership plan; is an employee-owner program that provides a company's workforce with an ownership interest in the company). It is because there were arguments about ESOP driven companies which share their profit. What they proved through several case studies that many failed ESOP organizations had a low quality of PO although they share its FO which includes control rights, property rights, and the right to information. Control rights mean that the owner has decision-making rights, property rights mean the owner has rights to have its profit. Finally, the right to information means that the owner could access all information under FO. To sum up, with, FO means legal rights on the object or organization.

On the one hand, PO is "*the mental state in which individuals feel that the target of ownership is 'theirs'*" (Pierce et al. 2001). Pierce et al. (2001) describes that PO is originated from self-efficacy, self-Identity, and Having space which is so-called 'roots of PO' as motivation. Self-efficacy is achieved when the individual can control the target of ownership through decision-making rights. Self-Identity is accomplished when the individual can have intimate knowledge. Moreover, Having space means when the individual invests their efforts such as time, idea, and assets on the target, they feel that they belong to somewhere as their 'home.' Moreover, those actions (Control, Intimate Knowing, Self-invest) achieve 'roots of PO' is called 'routes of PO.' Although PO can be achieved without FO, the status of FO could positively contribute being the status of PO. When the individual enters the stage of PO for the target of ownership, it causes positive behaviors including stewardship, loyalty, or increased motivation although it could also lead to negative effects such as resistance to change or territorial behavior. To summarize, we could insist PO represents responsibility about the target object or organization. It can be simply explained the following [Figure 17] on the next page.

³⁰ Jon L. Pierce, Stephen A. Rubenfeld, and Susan Morgan, "Employee ownership: A conceptual model of process and effects," *Academy of Management review* 16.1 (1991): 121-144.

(Pierce et al. 1991; 2001)

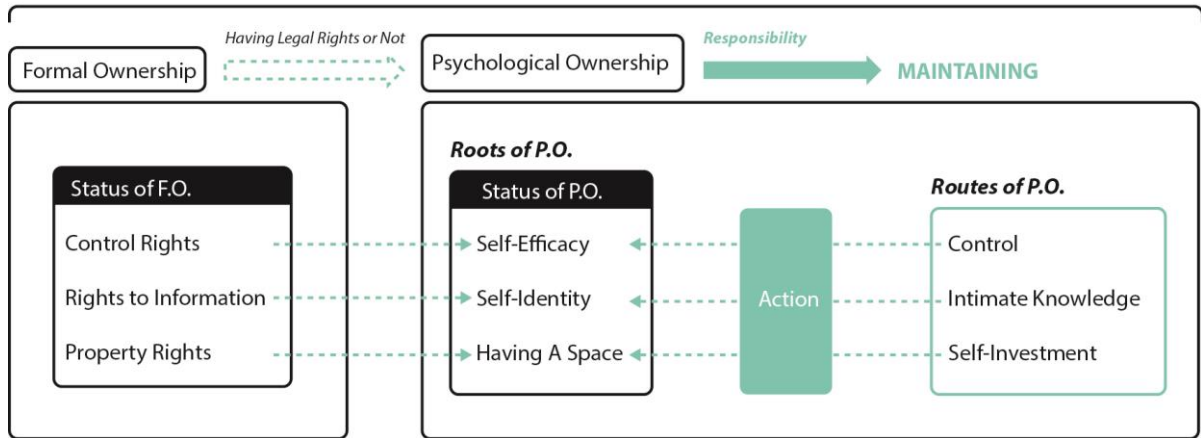


Figure 17. Psychological Ownership and Formal Ownership including its main elements

If we use the understanding of PO and FO, for example, the buying a new bicycle in general (not only for the students in the suburban), it can be illustrated in [Figure 18] below. As it shows its progress, the status of FO causes the status of PO, and it leads to the positive situation while FO triggers loss aversion and endowment effect positively. In that sense, whether there are other efforts to improve psychological ownership or not, the attachment of the target will be maintained.

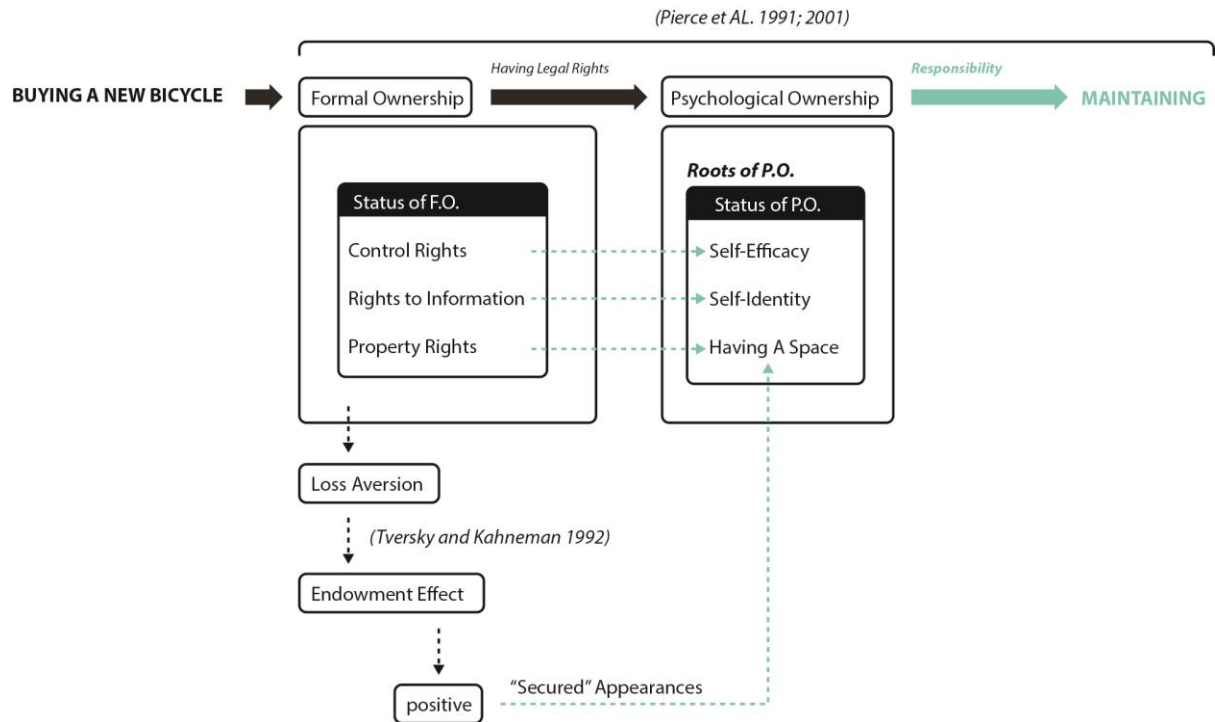


Figure 18. Psychological Ownership in practice for buying a new bicycle

Moreover, Baxter et al. (2015a) suggested 16 Affordances of Psychological Ownership [Table 1] which can be triggers directly linked to 'routes of Psychological Ownership' engaging 'roots of Psychological Ownership' which makes the user being in the status of Psychological Ownership. It is designed for objects originally. However, as Psychological Ownership is related to any targets of ownership, it would adopt to organizations as well. The relation amongst FO and roots/ routes/ affordance' of PO will be illustrated in the following [Figure 19] below.

Affordance Principle	Description
Control	
Spatial	Physically manipulate the object
Configuration	Arrange the object settings
Temporal	Use of the object when desired
Rate	Use as much of the object as desired
Transformation	Change the object as a result of interaction
Intimate Knowledge	

Ageing	Capture stories in object changes as it ages with the user
Disclosure	Convey origins and former experiences
Periodic signaling	Communicate on an event-dependent basis
Enabling	Mediate meaningful experiences
Simplification	Eliminate distractions
Proximity	Communicate through closeness
Self-Investment	
Creation	Bring something or part of something into existence
Repair and Maintenance	Service the object
Repository	Collect and store valuables within the object
Emblems	Signal information about identity
Preference Recall	Remember previously established preferences

Table 1. Affordance principles for control, intimate knowledge, and self-investment (routes of Psychological ownership) from (Baxter et al. 2015a, p30)

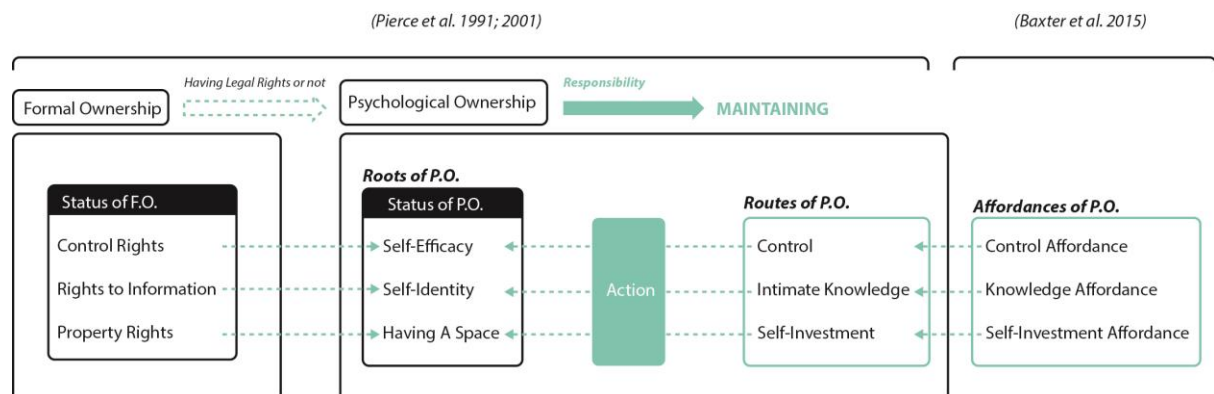


Figure 19. Formal Ownership and roots/routes/affordances of Psychological Ownership

For example, the best case to achieve being in the status of PO is that the user have FO (e.g., The user bought a new/second-hand bicycle has its legal rights) and it will be directly connected to roots of PO (e.g. The user feels self-efficacy, self-identity, and having a space – belongingness). While the user has PO originated from FO, affordances of PO (e.g. given accessories from somewhere) makes the user do actions following routes of PO (e.g. The user install an accessory

on the bicycle). Finally, the user feels self-efficacy and Having a space which represents the status of PO through control and self-investment experience.

When we use the definition of PO and FO in specified situations in the urban/ suburban, we can understand many parts of the complex problems how it leads to the abandoned bicycles. For example, as we already assumed previous part, pragmatic purpose of bicycle use in Germany could cause the lack of memories and enjoyment on the object which affects the loss of emotional attachment if the bicycle is not a gift or freely taken over from friends or family member. On the one hand, when the affordability meets unexpected events also could lead the lack of attachment since its economic value cannot be enough to invest money in fixing it without enough attachment. The bicycle lock originated from the owner's Formal Ownership would be changed to negative factor because of two problems affecting on the emotional attachment. While the given situations to the students decrease their attachment on the affordable bicycle, there will be no events to improve their Psychological Ownership. It is because the affordable bicycles are mostly privately-owned by the students in the village. The holistic based on theories will look like [Figure 20]

The literature review might be enough to design a hypothesis because we could define why the students are abandoning the bicycles. Moreover, we discovered an opportunity how we could increase the emotional attachment through engagement of psychological ownership. However, we need to more know about why the students buy the affordable bicycle through the understating of mobility circumstances in the suburban although we could investigate several reasons related to psychology and behavioral economics.

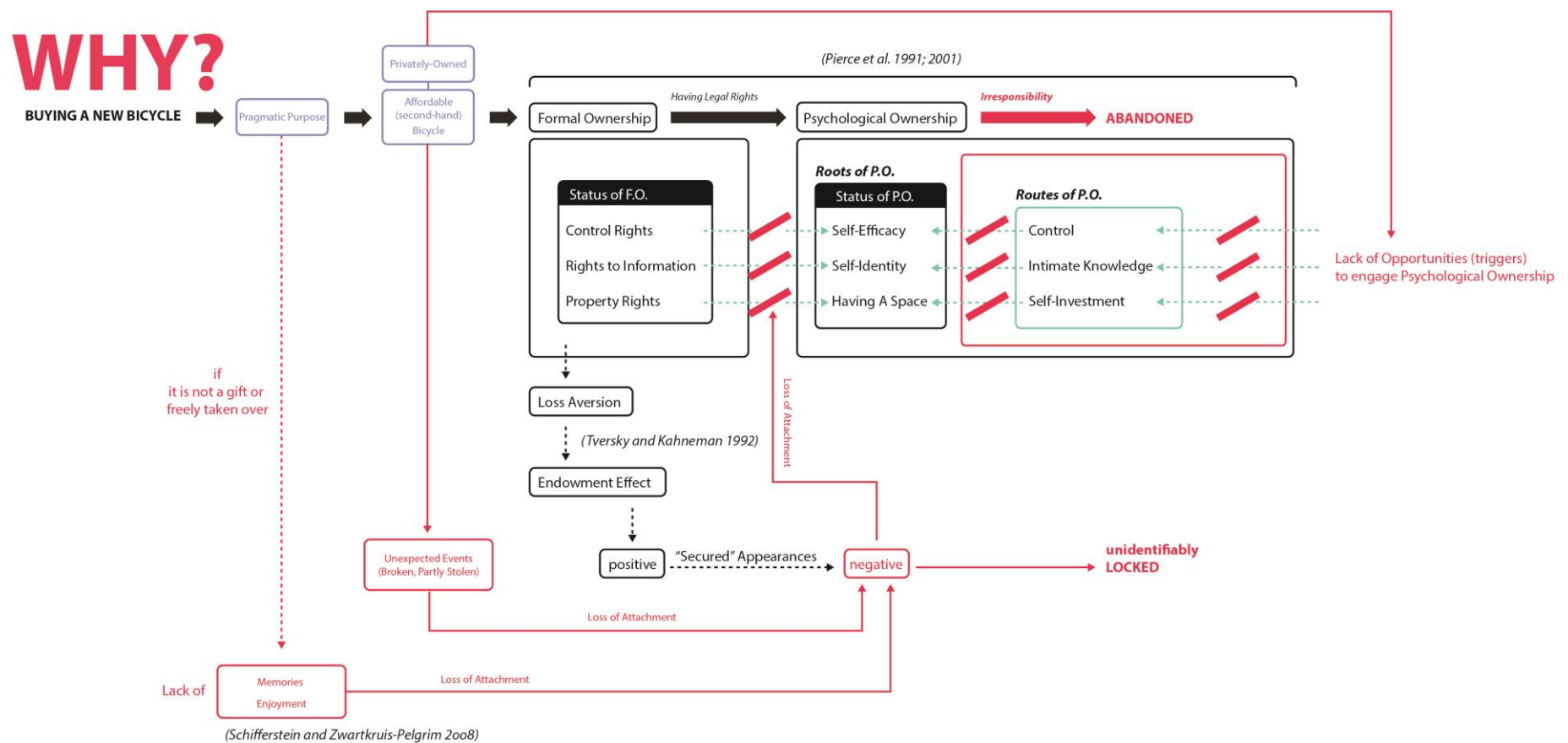


Figure 20. Understanding complex problem through PO and FO in the suburban

Transport Infrastructure between urban and suburban

In this part, we will examine mobility environment near the target place since understating of its circumstances could help to define 'How the abandoned bicycles are related to transport environment and stakeholders (public administration and transport companies).' which also can answer 'why do the students buy affordable bicycles.' As we can see the [Figure 7] above, the student village is directly linked to the boundary line of Cologne. Moreover, the Suburban is one of the closest places to reach the center of Cologne. It seems like that even it is much closer than another part of Cologne, and there will be any differences compared to live in Cologne. However, regarding accountability of public administration, the student village is officially out of public services although almost all of students commute to Cologne. For example, there is Efferen Urban (train) station where is the closest station from the student village is also a station before Klettenberg station in Cologne. As we can see the [Figure 21], it is only 3km from the Student Village in the suburban to Klettenberg station in the urban. Although there is only one train line to go to the urban which is number 18 while no bus services offer to go to the urban, it seems like that there is no problem to live in the village

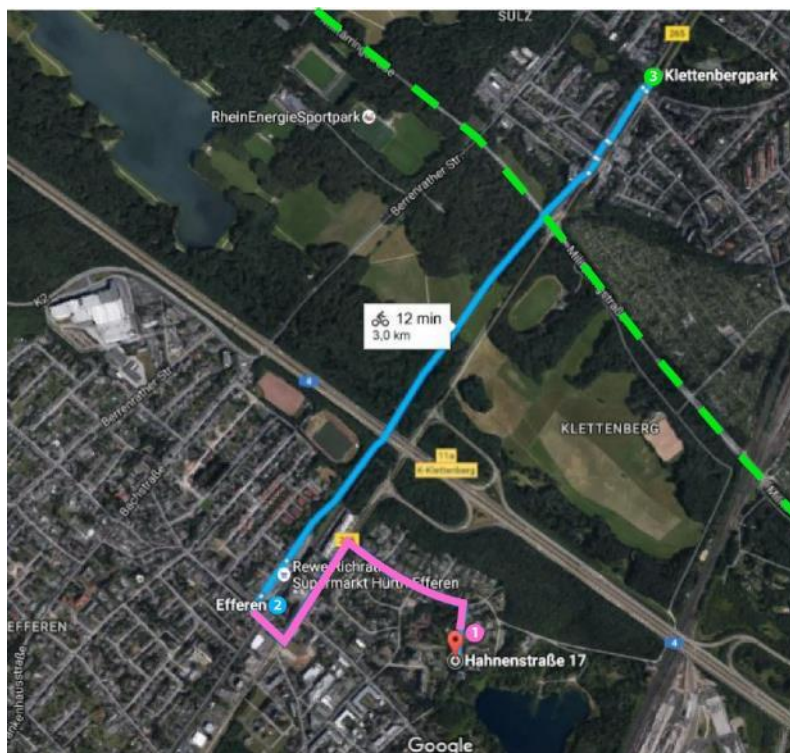


Figure 21. Distance between the student village, Efferen station, and Klettenbergpark³¹

³¹ 1) The student village, 2) Efferen Station, 3) Klettenbergpark station (between 1-2; 1km. 2-3; 2km. 1-3; 3km)

However, if we compare the time table of trains in Efferen station with Klettenberg station [Figure 22], we can realize that the number of working train is twice more in the urban. For example, the students in the village walk to go to Efferen Station for 10-15mins and they wait for a train for next 5-10mins on weekdays. On the other hand, the situation is worse on weekends or unexpected delays. It means they should consume much higher time than the other people commute in the urban or nearby station.

<div> <div>18</div> <div>Richtung Köln Thielenbruch</div> <div>über Klettenberg - Barbarossaplatz - Neumarkt - Köln Hbf - Ebertplatz - Mülheim - Dellbrück</div> </div>			
Abfahrtsstation: Efferen		Gültig ab 11.12.2016	
Uhrzeit	Montag - Freitag	Samstag	Sonn- und Feiertag
0	20 ^h 50 ^h	20 ^h 50 ^h	20 ^h 50 ^h
1	---	52 ^h	52 ^h
2	---	52 ^h	52 ^h
3	---	52 ^h	52 ^h
4	28 48*	22 ^h 42 57	50 ^h
5	08* 28 48*	27 57	20 ^h 50 ^h
6	08* 18* 28* 38* 48* 58*	27 57	20 ^h 50 ^h
7	08* 18* 28* 38* 48* 58*	27 57	20 ^h 50 ^h
8	08* 18* 28* 38* 48* 58*	27 57	20 ^h 50 ^h
9	08* 18* 28* 38* 48* 58*	27 57	27 57
10	08* 18* 28* 38* 48* 58*	27 42 57	27 57
11	08* 18* 28* 38* 48* 58*	12 27 42 57	27 57
12	08* 18* 28* 38* 48* 58*	12 27 42 57	27 57
13	08* 18* 28* 38* 48* 58*	12 27 42 57	27 57
14	08* 18* 28* 38* 48* 58*	12 27 42 57	27 57
15	08* 18* 28* 38* 48* 58*	12 27 42 57	27 57
16	08* 18* 28* 38* 48* 58*	12 27 42 57	27 57
17	08* 18* 28* 38* 48* 58*	12 27 42 57	27 57
18	08* 18* 28* 38* 48* 58*	12 27 42 57	27 57
19	08* 18* 28* 38* 48*	12 27 42 57	27 57
20	07 27 42 ^h 57	12 27 42 57	27 57
21	12 ^h 27 42 57	12 27 42 57	27 57
22	12 ^h 27 50 ^h	12 27 50 ^h	27 50 ^h
23	20 ^h 50 ^h	20 ^h 50 ^h	20 ^h 50 ^h

<div> <div>18</div> <div>Richtung Thielenbruch</div> <div>über Barbarossaplatz - Neumarkt - Dom/Hbf - Ebertplatz - Mülheim - Holweide - Dellbrück</div> </div>			
Abfahrtsstation: Klettenbergpark		Gültig ab 11.12.2016	
Uhrzeit	Montag - Freitag	Samstag	Sonn- und Feiertag
0	24 ^h 54 ^h	13 ^h 24 ^h 43 ^h 54 ^h	13 ^h 24 ^h 43 ^h 54 ^h
1	---	26 ^h 56 ^h	26 ^h 56 ^h
2	---	26 ^h 56 ^h	26 ^h 56 ^h
3	---	26 ^h 56 ^h	26 ^h 56 ^h
4	12 32 42 52*	26 ^h 46	26 ^h 54 ^h
5	02 12* 22 32 42 52* 57	01 16 31 46	24 ^h 54 ^h
6	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 16 31 46	24 ^h 54 ^h
7	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 16 31 46	24 ^h 54 ^h
8	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 16 31 46	24 ^h 54 ^h
9	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 16 26* 31 41* 46 56*	16 31 46 56*
10	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
11	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
12	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
13	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
14	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
15	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
16	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
17	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
18	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
19	02* 07 12* 17 22* 27 32* 37 42* 47 52* 57	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
20	07 11* 17 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*
21	01 11* 16 26* 31 41* 46 56*	01 11* 16 26* 31 41* 46 56*	01 16 31 46
22	01 11* 16 26* 31 41* 46 54 ^h	01 11* 16 26* 31 41* 46 54 ^h	01 16 31 46 54 ^h
23	13 ^h 24 ^h 43 ^h 54 ^h	13 ^h 24 ^h 43 ^h 54 ^h	24 ^h 54 ^h

Figure 22. Urban 18 in Efferen station (left) and Klettenbergpark station (right)



Figure 23. Unexpected delays of train at Efferen station

Since the train passing by Efferen station comes from another suburban (e.g. Bruehl) or urban (e.g. Bonn), they need to decide to walk to the next station Klettenbergpark where doesn't relate to its delays. It is not easy decision to walk or not because they are worried to walk more than 2km to go to the next station in the urban. Also, they do not want to let the postponed train go while they are walking to the station. Moreover, many of them already know there is well-constructed bicycle road between Efferen station and Klettenbergpark station. In that sense, we could easily imagine why the students decide to buy and ride bicycles in that given situations. It also can be explained common bicycle use in Germany which already explained in part 2.1.3.1 Bicycle use in Germany (average daily km cycled 0.6~1km with the practical purpose). What we can assume that the student in the suburban just want to have a better mobility experience, but the bicycle is the only one possibility.

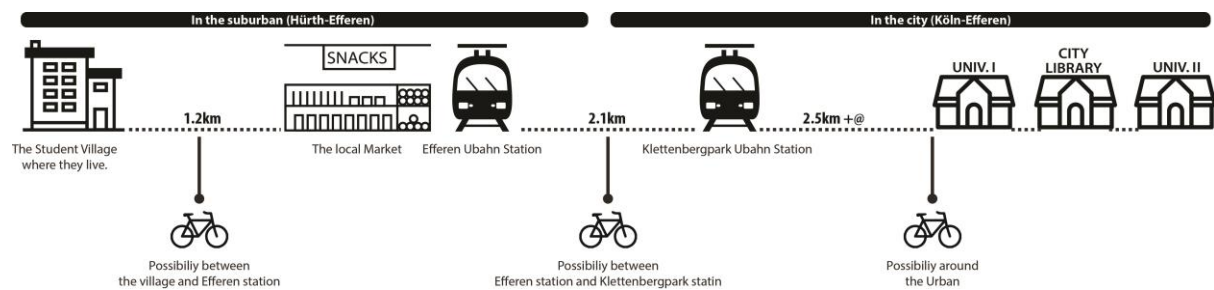


Figure 24. The given possibilities where the students can ride bicycles

It is also true that affordable second-hand bicycles are everywhere in Germany. For example, there are several Flea markets where people can buy affordable second-hand bicycles in person, for instance, Sonntag markt Weissshausstrasse in Cologne [Figure 25]. The cost is about 50~150 euro which is not a big deal for students (It is also investigated through pre-surveys later.). Cologne municipality also offers bicycle auctions randomly which is recycled from abandoned bicycles as we already explain their process. The price is only 10 to 200 euro as well. What we can assume through mobility infrastructure in the suburban is a correlation between abandoned bicycles and lack of suburban mobility from different stakeholders.



Figure 25. A flea market in Weissshausstrasse

Limitation of sharing bicycle system organized by the city government and the company

As we examined already, the students in the village might want a better mobility experience but the given opportunities are marginalized, and it makes them buy affordable bicycles which are exposed high risk being abandoned because of the loss of emotional attachment and the lack of possibilities to improve psychological ownership. The study is going to discover other possibilities which can be better than having a privately-owned affordable bicycle.

The Urban (train) organized by KVB and VRS (the local public transportation agencies in Cologne and VRS area which including Cologne, Efferen and more) is the only option to go to the urban in the student village. Fortunately, there are a few Sharing Car services organized DB (German railway company) and KVB. It would be good to use when the students have to go to the airport or somewhere they cannot get reached by public transportation. However, as students pay semester public transportation fee when they pay tuition fee, it seems like that the other monetized services cannot contribute their daily life mobility experience, for example, commuting. What we can see as an expected option is Sharing bicycle which organized by KBV, DB or other private companies. If we see its target users, cost, and capabilities, it seems like that it can be a better option than having an affordable bicycle. However, it has similar conditions like the sharing cars which are not good enough to use for commuting for the students because of its service price [Table 2] except Call A bike and KVB rad.






Type	Organization	Brand	Target User	Cost	Etc. Green = Adv. Red = DisAdv.
Private	Peer to Peer	 Spinlister The global bike share Spinlister	Tourists, Local Residents	1hour 2~10euro 1day 15~30euro 1week 50~170euro	Web/App booking Security Insurance Service Riding not only in Köln Turn it back to Owner Various types of Bicycles
Public (mixed with club goods)	National Government	 DB BAHN call a bike Call A BIKE	Tourists, Local Residents	>basis (yearly 3euro) ½ hour 1euro 1day 15euro >Komfort (yearly 49euro) ½ hour free (1euro after) 1day 12euro	Web/App booking Security Insurance Service Riding only in Köln (if not, charged over 5~50euro) wherever it can be parked 850 bikes (same design) Offered by BMW (Global Company) Delivery Service
	Local Government	 KVB rad KVB RAD	Tourists, Local Residents	½ hour 1euro 1day 9euro 1year 48euro (*free for the first ½ hour) ½ hour free for Students of Uni Köln	Web/App booking Security Insurance Service Riding only in Köln (if not, charged over 10euro) wherever it can be parked 950 bikes Offered by Nextbike (Global Company)
	Local Business	 Colonia Aktiv	Tourists	3hour 9euro 1day 19euro 1week 60euro	Web/Call booking Security Insurance Service Riding not only in Köln Turn it back to Owner optional equipment
		 Radstation Rad Station	Tourists	3hour 5euro 1day 10euro 1week 49euro	Web/Call booking 50euro Deposit for Security Riding not only in Köln Turn it back to Owner Donation for Refugee

Table 2. Types of Sharing bicycles in Cologne and the Suburban

Call a Bike and KVB rad are organized by nationally and locally. For example, Call a bike is developed and managed by DB (German railway company) which take the main role of German public transportation. On the one hand, KVB (Cologne Transport company) offers KVB rad which is developed and managed by 'Next bike' which is a global company offering public sharing bicycle services as a public transport service. If the customers join annual membership or students from the University of Cologne, the cost will be much affordable for the students in the village.












Value Points	Descriptions	Dominant options
Cost	How much is the sharing cost? Is it efficient for the local residents?	 
Working Area	Is it possible to ride it out of Köln?	  
Capacity	Does it has enough bicycles? Can I ride it whenever I want?	 
Accessibility	Is it located on nearby users? Can users ride it wherever they want?	 
Responsibility	Do I need to take responsibility if I lost it or defected? Can I stop riding the bicycle anywhere? (Do I need to turn it back to strictly marked place? E.g. bicycle station)	 

Table 3. Value comparison of Sharing bicycle in Cologne and the Suburban



Figure 26. The number of sharing bicycles in Cologne (Call a bike and KVB rad)

The number of sharing bicycles also looks good enough to use, and they also offer application which improves accessibilities. Although both Sharing bicycles offer attractive services, there is a serious limitation for students in the suburban. As we can see the [Figure 27], the customers only can ride it in marginalized place in basic cost (1/2 hour 1euro). The customer also can ride it out of the marginalized boundary, but the price goes extremely up that the students in the suburban are difficult to use (The cost rises 5 ~ 50euro, [Table 2]).

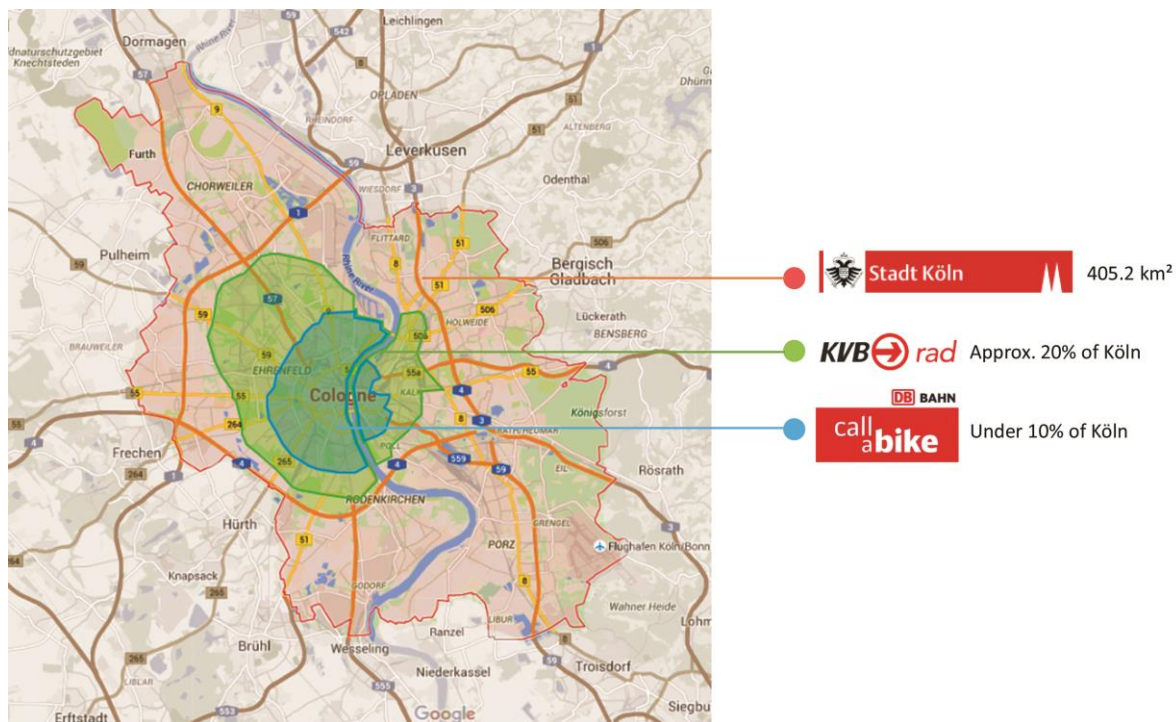


Figure 27. Working areas of sharing bicycle in basic cost

What it is the much more serious problem is some students in the suburban claim the situation like the [Figure 28], but the public administrations do not need to respond since the village is not in Cologne. On the one hand, the service company will not want to extend its working area because there should be enough users, then they can make a profit. Moreover, some students do not know exactly its cost policy and just bring the bicycle to the village. For sure they might pay the unexpected cost, and the bicycles had stayed at the same place more than two weeks whenever it was discovered [Figure 29]. It means students in the village mostly already knew the cost policy, and they do not use it from the suburban to the urban. As long as the students in the village cannot ride it like in the urban, it cannot positively improve the suburban mobility experience. The study investigates to discover another possibility through next part.

Learning from the history of sharing bicycle

We will simply remind about the history of sharing bicycles with its ownership evolution in this part. The first bicycle was invented in Germany and became popular after pneumatic tires were developed around 1,888. And there was no certain characteristic sharing bicycle before the 1960s. However, there were several challenges to make the bicycles as a commons in the city. For example, the white bicycle plan in 1965 was the first sharing bicycles as a part of PROVO movement which is "a radical group in Netherlands that thought to provoke the establishment with playful demonstrations."³² However, since it was obviously free and anyone can access to the bicycles sprayed white color, it was mostly disappeared in several days. After then, there was similar project so-called 'Cambridge Green Bicycle Scheme' around 1,993 which was originally managed by a leader of Cambridge City Council. However, all 50 bicycles had just gone in a day.³³ The city council offered more bicycles later, but it was all disappeared again no one turned it back to public space. It is already explained through 'the tragedy of commons' and 'free-riding.' It was exactly same problems happening on the Commons. After those radical movement's failures, the public administration in several cities such as Lyon and Copenhagen decide to offer registration based bicycle sharing. The system was actively evolved from using a trump card to using a smart application³⁴. Since then, the sharing bicycle is categorized as an important part of public transportation. However, some cities met financial problems to maintain the bicycle. It is because of lack of users and risky efforts to maintain it. Some cities suggest a community-based bicycle so-called bicycle library which are mainly based on booking system and rental system.³⁵ What we can see as a possibility is a micro-scale / self-organized sharing bicycle. It is because most of the sharing movement is controlled by permanent or long-terms residents who are familiar with neighbors and the place. However, students in the suburban seem like that they stay there only a few months up to 1, two years and there is a little gap between temporary residents and permanent residents to participate in the sharing activity. It means that it would be better to have a smaller scale which can make people easily engage without any barriers especially surrounded

³² "Luud Schimmelpennink," Wikipedia, accessed January 02, 2017, https://en.wikipedia.org/wiki/Luud_Schimmelpennink.

³³ "Cambridge Green Bike Scheme," iankitching, accessed January 02, 2017, <http://www.iankitching.me.uk/history/cam/old/green-bike.html>.

³⁴ "The bike share-boom," Citylab, accessed January 02, 2017, <http://www.citylab.com/city-makers-connections/bike-share/>.

³⁵ "Welcome to the Bicycle Library," Bicycle Innovation Lab, accessed January 02, 2017, <http://www.bicycleinnovationlab.dk/bicycle-library>.

by multi local society representing "cosmopolitan-localism"³⁶ like the student village.

³⁶ "Cosmopolitan Localism," P2P foundations, accessed January 02, 2017, http://wiki.p2pfoundation.net/Cosmopolitan_Localism.

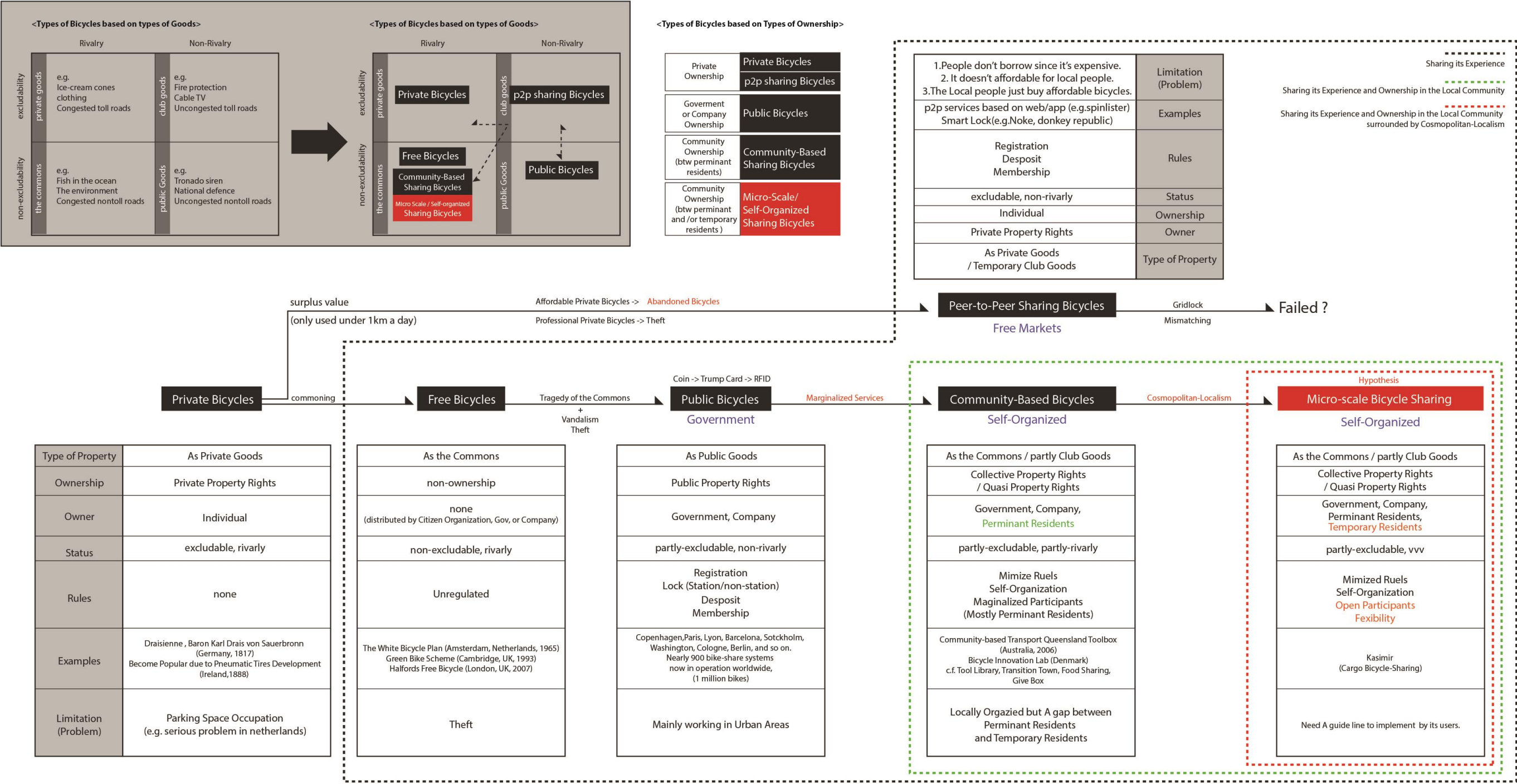


Figure 30. Evolution of bicycle sharing and opportunities

Conclusion

As the study investigated from theory to observation, transportation system in Cologne and its suburban (Huerth-Efferen) have opportunities to be transformed new commons. Although transportation system based on public/ private/ club goods intensively support the mobility environment, there are blinded spot between the urban and the suburban. Moreover, the lack of mobility system in the area could lead external effects such as abandoned bicycles [Figure 31]. What we can discover the most importantly through the study is the understanding of Psychological Ownership could support to create new commons [Figure 32]. Even though the study already designed a prototype micro-scale sharing bicycle system in the area, it needs quantitative research to clearly prove correlation between psychological ownership and attachment on the sharing bicycles. It has a rich possibility as the first scientific research to design the guideline of the transportation system as new commons.

Understanding the Complex Problem

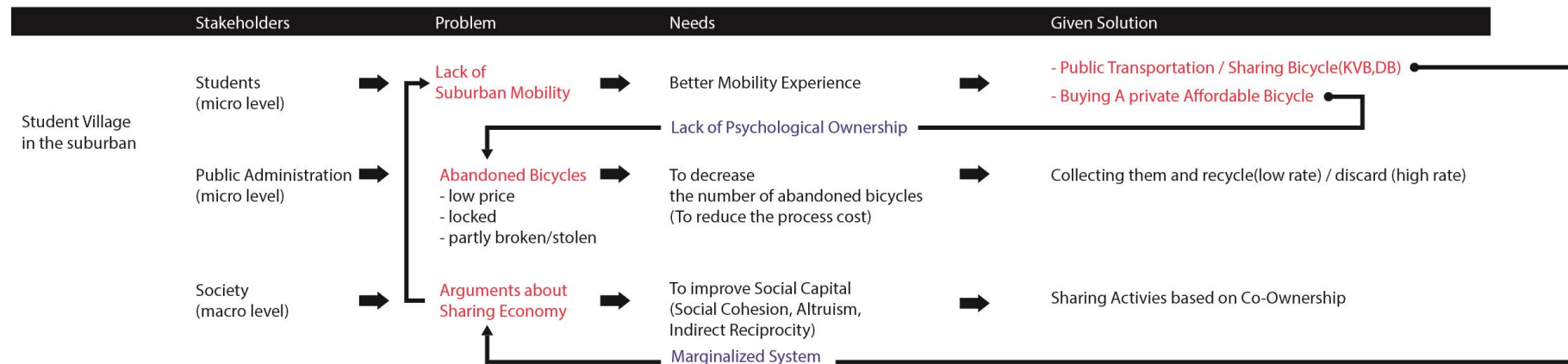


Figure 31. Understanding the complex problem in the local transportation system between urban and suburban

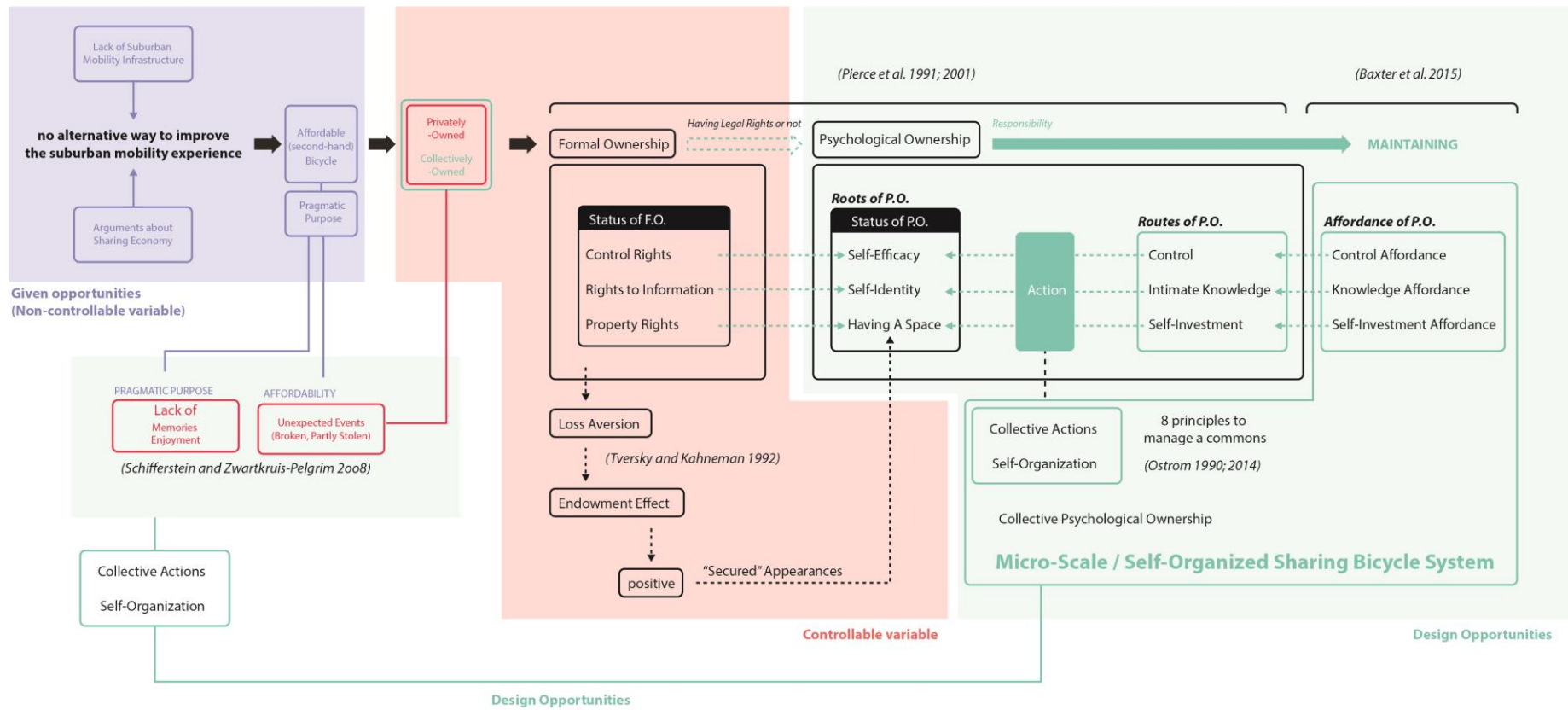


Figure 32. Hypothesis to design a micro-scale/self-organized sharing bicycle system