Dynamic pricing or not? — Pricing models of Finnish taxi dispatch centers under the Act on Transport Services

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Abstract

In 1.7.2018, Finnish government liberalized Finnish taxi markets to create possibilities to introduce new technology, digitalization and new business models into transport sector. Also allowing usage of dynamic pricing in Finnish taxi markets was specifically mentioned. Before the Act on Transport Services came into effect, Finnish regulations specified maximum limits for fares, taxi licenses and operational area where dispatch centers were allowed to operate.

In this study, I will look into how pricing models have evolved after the Act on Transport Services came into effect by collecting data from internet and conducting interviews to understand purposes of the changes more in-depth. Also, I looked into how pricing models have become more dynamic compared to old pricing model, and how dynamic pricing is described in literature. Lastly, I combined list of different aspects that affect to implementation of dynamic pricing.

Currently, none of the Finnish dispatch centers have implemented similar dynamic pricing based on demand and supply in real-time as what Uber uses. But based on results, Finnish dispatch center's pricing models have evolved to be more dynamic even though Finnish dispatch center's do not consider them to be dynamic. Also, there are obstacles related to willingness, technology and regulations why Finnish dispatch centers do not consider dynamic pricing similar to what Uber uses to be currently possible to implement.

Keywords
Pricing model, taxi industry, traditional dispatch centers, dynamic pricing

Supervisor
University lecturer, Adjunct Professor, Karin Väyrynen

Foreword

I ended up working on this topic by applying to trainee position in University of Oulu. That trainee position was supervised by this thesis's supervisor Karin Väyrynen. That work was part of larger research related to taxi industry, and I was happy to contribute to that work, and also learn new things about researchers work in general.

I want to thank my supervisor Karin Väyrynen for supervising and guiding me through this whole thesis' creation process, but also supervising preceding trainee period. Also, I want to thank Marianne Kinnula, who kindly checked this thesis and provided valuable feedback. Special thanks to all interviewees who participated in this study and provided their valuable input. Lastly, I want to thank my family who has given me enormous support throughout my studies.

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Contents

1. Introduction

Taxi markets in Finland have gone through large change as the Act on Transport Services came into effect 1.7.2018 which freed Finnish taxi markets. Finnish government have stated that these regulation changes targeted to "*create possibilities to introduce new technology, digitalization and new business models into transport sector*" which could lead to better suited services for customers (Hallituksen esitys 161/2016). Until 1.7.2018, Finnish government had specified maximum fares that were allowed to use in dispatch center's pricing. Also, every Finnish dispatch center had their own, specifically marked, operational area where they could operate. Because of that, Finnish dispatch centers did not have permission to operate freely everywhere they wished, which created monopoly situation in those operational areas. These reasons led dispatch centers to use only those maximum possible fares, because there was no competition and therefore no pressure to adjust prices to enhance market position. The regulation change affected heavily to that situation. Now dispatch centers are free to operate without operational area restrictions, and they are free to set their prices, and pricing models, to match their competition and operational costs. This study's main focus is on current Finnish dispatch center's pricing models, and will look into how pricing models have evolved since the Act on Transport Services came into effect.

Currently, global taxi markets can be divided into two different main categories. There are *traditional taxi* services and *ride-sharing* services. With *traditional taxi* service providers, company owns resources and controls supply, pricing based on fixed fares and ordering happens by phone or street-hailing. *Ride-sharing* services are opposite of that, as there driver owns resources, supply and pricing is dynamic and ordering happens by mobile application. In case of ride-sharing services, they are digital platforms, where customers order services which platform delivers to freelancer drivers. One of the most known ride-sharing service platforms is Uber. Before the Act on Transport Services came into effect, ride-sharing services could not operate in Finnish taxi markets legally because regulations prevented operating freely, reduced possibilities on pricing and controlled supply by specifying limit on number of taxi licenses. (Asghari & Shahabi, 2018; Guo, Liu, Xu, & Chiu, 2017). In Finland, dispatch centers have been thought as traditional taxi service providers, where dispatch centers receive orders and delivers them to drivers driving under their dispatch center, and before regulation change, under their operational area. This study will compare Finnish taxi service providers business models briefly to those three categories, and tries to find out if they could fit to any of those.

One of the key reasons why Finnish Competition and Consumer Authority's (Kilpailu- ja kuluttajavirasto, KKV) wanted to open taxi markets was to enable possibility to use dynamic pricing as one of the pricing methods in Finnish taxi markets. KKV's definition of dynamic pricing contains pricing that dynamically changes based on demand and supply. According to KKV (2020), dynamic pricing creates market where drivers can benefit as their capacity is on better use, and customers benefit as they get taxi easier because there is more supply (Finnish Competition and Consumer Authority, 2020). The most known company that have implemented dynamic pricing is Uber under branding "*surge pricing*". Main idea behind dynamic pricing is to control network's supply and demand, and to maximize platform's revenue by improving trip completion rate (Battifarano & Qian, 2019). With dynamic pricing, price raises at high demand to encourage more drivers to participate which leads to increased supply, and to encourage

customers to postpone their trips until there is balance between demand and supply (Asghari & Shahabi, 2018; Battifarano & Qian, 2019).

As mentioned earlier, Finnish government's one objective was to make it possible to introduce new technology and create possibilities for digitalization. In Finland, technology have been built to match old requirements created by regulations. That includes mandatory usage of certain type of approved taximeters and pricing chances that match to those only possible business models. Because of regulation change, technology needs to be evolved to match new market situation. Also, the majority of Finnish dispatch centers have started to offer mobile application as a one way to hail taxi for their customers. In this study, I will look into current situation related to technology used in taxi industry in Finland from perspective of problems and solutions related to taxi trip pricing.

According to Finnish government's proposal 161/2016, Finnish taxi markets lacked "*pricing dynamic*" as every dispatch center charged same fare regardless of demand at given time before 1.7.2018 (Hallituksen esitys 161/2016). This study's goal is to compare definition of dynamic pricing from literature to the KKV's definition of dynamic pricing, and to the interviewees understanding of the dynamic pricing. And in addition to that, to see if pricing models implemented after 1.7.2018 are more dynamic based on any of those definitions of dynamic pricing.

This topic is also important to studied because currently most of the research related to taxi industry have been done outside of Finland and research used in this thesis' literature review have been focused on the USA's, India's and China's taxi markets. Finnish taxi markets are in many ways different currently, but also before the Act on Transport Services came into effect, compared to several other countries taxi markets as for example dispatching technology utilized in Finland is much more advanced compared to countries mentioned above. Recent research done in Finland have covered digital transformation (Lanamäki, Väyrynen, Laari-Salmela, & Kinnula, 2020), e-hailing applications in Finland (Väyrynen, Lanamäki & Lindman, 2018; Väyrynen, 2020) and taximeter usage (Lanamäki et al., 2019; Väyrynen & Lanamäki, 2020). However, there have been no prior research on how the Act on Transport Services with ride-sharing services in mind have affected to pricing in Finnish taxi markets.

This study tries to answer primarily to two separate research questions:

1. Are pricing models implemented by dispatch centers more dynamic?
2. What is needed to make dynamic pricing possible in Finland?

This study will also answer to following sub-questions related to Finnish taxi market change:

- What pricing models Finnish dispatch centers have implemented after 1.7.2018?
- How technology affects to dispatch center's abilities to implement pricing?
- How dynamic pricing have been understood by Finnish dispatch centers?

This study is qualitative and is implemented as multiple case study. I collected empirical data from internet using publicly available sources, such as dispatch centers websites, social media and news media. In addition to that, I and my thesis's supervisor Karin Väyrynen conducted eight semi-structured interviews to gain more insights about Finnish dispatch centers reasoning for changes they have done after the Act on Transport Services came into effect. This study's main contribution is to understand if currently implemented pricing models are more dynamic based on definition of

dynamic pricing, and to understand the requirements to implement dynamic pricing in Finnish taxi markets.

The structure of this study is following. In chapter 2, I will define global taxi market situation and business models based on literature. In chapter 3, I will present research method used in this study. In chapter 4, I will present empirical data. In chapter 5, I will present and discuss main findings based on prior literature and empirical data. Lastly in chapter 6, I will conclude this study. Chapter 7 contains list of used references and interview questions are available in appendix A.

2. Prior research

This literature review will look into two main categories of ride-on-demand taxi service providers and their pricing models. First I will introduce and explain *traditional taxi* services and *ride-sharing* services, and then *pricing in traditional taxi industry* and *dynamic pricing*. I will present the literature review methodology in chapter 3.

2.1 Ride-on-demand taxi services

In literature, authors reference to taxi services using different terms. One used term is *mobility-on-demand* (Guan, Annaswamy, & Eric Tseng, 2019; He & Shin, 2019; Papanikolaou & Larson, 2013; Zhang, Kumar, & Ukkusuri, 2017), also *on-demand transport* (Egan, Oren, & Jakob, 2019), *ride-on-demand* (Guo, Chen, Liu, Xu, & Chiu, 2017; Guo, Liu, et al., 2017, 2017; Guo et al., 2018, 2019), and also *for-hire vehicle market* (Brown & LaValle, 2020). Authors use these terms when they are talking about taxi industry and ride-sharing services in general. In this study, I will reference taxi services in general as being *ride-on-demand* services.

According to Guo, Liu, et al. (2017), *ride-on-demand* services can be categorized to three different categories. First category is the *traditional taxi* service, second one is *ride-sharing* services and third one is hybrid of those two called *CFDP* (company-owned-fleet, dynamic pricing). However, I did not find literature about CFDP -type of ride-on-demand taxi services, and therefore I will not focus on that category in this literature review. Key differences between those categories are resource ownership, supply control, pricing model and hailing method. In this case, resource ownership means that *who* owns resources (i.e. vehicles), supply control means that *how* supply (i.e. drivers) are controlled, pricing model means that *what* kind of pricing model is utilized and hailing method means that *what* is the primary way for customers to order a ride.

With *traditional taxi* service providers, company owns resources and controls supply. They use fixed fare based pricing model and hailing methods are calling or street-hailing. *Ride-sharing* services are provided for customers using digital platform who facilitates transactions between drivers and customers. These digital platforms do not own resources themselves, but the actual drivers own resources, and therefore supply is dynamic because drivers are freelancers who can participate on that platform when they wish. Ride-sharing services employ dynamic pricing and hailing happens using mobile application. *CFDP* is hybrid of traditional taxi and ride-sharing. It is similar to traditional taxi as company owns resources and similarly they have fixed supply. Then, CFDP is similar to ride-sharing because their pricing is dynamic and hailing happens using mobile application. Table 1 showcase differences between these ride-on-demand services.

Table 1. Key differences between traditional taxi, ride-sharing and CFDP based on Guo, Liu, et al. (2017).

	Traditional taxi	**Ride-sharing**	**CFDP**
Resource owner	Company	Driver	Company
Supply control	Fixed	Dynamic	Fixed
Pricing	Fixed fares	Dynamic	Dynamic
Hailing	Street-hailing or calling	Mobile application	Mobile application

Taxi markets are going through changes globally, and has done so in the past. Basu (2019) describes that in India, taxi markets were unorganized till early 2000 when traditional radio-equipped, radio cabs, emerged with option to street-hail without reservation or making reservation beforehand. In the 2010s, major new players on the Indian taxi markets are Uber and Ola, which are competing with each other with service offerings, like Uber's pioneered cash payments, and with pricing (Basu, 2019). Taxis are most commonly used for relatively short private trips from specific origin to specific destination. Yang et al. (2010) mentioned in their article that in Hong Kong, there are average of 1.2 persons per trip and over 50% of urban are trips have travel distance less than four kilometers.

There are several factors that affects taxi market share compared to other transportation methods. Basu (2019) mentions that household income, availability of alternative transport modes, ease and cost of parking are factors that affect taxi market share. Jang, Farajallah, & So (2020) mentions that intrinsic cues (product reputation and seller reputation) and extrinsic cues (relative price and offer duration) are decisive in increasing demand, and their combined effects can be positive or negative.

2.1.1 Traditional taxi services

As Guo, Liu, et al. (2017) describe, traditional taxi service providers are one type of ride-on-demand service. As table 1 shows, traditional taxi service providers own and control their resources, meaning that traditional taxi service providers own the vehicles and drivers are working for them as labor. Traditional taxi service providers use pricing model that is built upon fixed fares. Such pricing model can consist of for example *basic fee* and *trip length fee* which do not change dynamically depending on current conditions. Customers can hail traditional taxis by calling or straight from street.

Even though traditional taxi service provider companies own their resources and can control those, many countries have some level of regulation applied to traditional taxis. Those regulations vary between countries, or even between operational areas in same country. However, many of those regulations have something in common. These include that these companies are required to obtain an occupational license to provide transportation services to customers, can only operate on specific area, have strict requirements for drivers who are allowed to operate vehicle, are required to follow work time regulations, have restrictions to fleet size and are required to follow defined fare structure (X. Wang, He, Yang, & Gao, 2016; H. Wang & Yang, 2019). These regulations might make it harder for new traditional taxi service provider companies to enter market but also harder for new drivers to start working.

The regulated pricing model might have negative effect for traditional taxi service providers' ability to compete in the transportation market. According to Yang, Fung, Wong, & Wong (2010) in Hong Kong, traditional taxi service providers' prices have room for reduction and that pricing model is currently not optimal. There traditional taxi service providers have issues to attract new travelers. When other transportation modes are offering different kinds of discounts and benefits, it is harder for traditional taxi service providers to attract travelers with their current "*linear*" pricing model which includes static basic fee and linear component calculating distance and stopping time (Yang et al., 2010).

Some authors have suggested ways to improve pricing strategy for traditional taxi service providers. X. Wang et al. (2016) suggests that optimal pricing strategy from public's perspective is to maximize social welfare. Jin, Ye, Liu, Wang, & Wang (2019) proposed dynamic pricing model for traditional taxi service providers that considered both balance of demand and supply, but also competitive relationship between ride-sharing services and traditional taxi services. Jin et al. (2019) tested their proposed pricing model against real-world data and results indicated that to improve traditional taxi's competitiveness against ride-sharing platforms, they need to decrease their prices until they have advantage over ride-sharing platforms. When traditional taxi have advantage over ride-sharing services or demand and supply is in balance in peak hours, prices should be increased to gain more benefits (Jin et al., 2019).

Emergence of ride-sharing services have led to situation where traditional taxi orders have decreased 35% or more (Jin et al., 2019). Brodeur & Nield (2018) also mentions that in New York City, traditional taxi service providers' income have decreased. According to Brown & LaValle (2020), travelers prioritizes affordability, reliability and accountability, and they suggest that ride-sharing platforms have implemented their technologies to successfully deliver those priorities whereas traditional taxi service providers have not capitalized new technologies, and needs to do more than lower their prices and adding more vehicles to network. Kusuma (2018) suggests that traditional taxi industry's problem compared to ride-sharing platforms is that anyone can easily join to ride-sharing platform which leads to bigger fleet and capability to answer demand. According to Kusuma (2018), one solution to this is to create collaboration between traditional taxi service provider companies by giving them possibility to provide their services in same digital platform, and continues to present three models for such traditional taxi collaboration platform. In first model, orders are allocated to vehicles that have the lowest travel cost and has the longest idle time whereas in second model, orders are allocated only to vehicles that have the lowest travel cost without prioritizing vehicles with longer idle times. In third model, orders are allocated to vehicles in such a way that it keeps pickup ratio in maximum level by taking into account travel cost, pickup distance, idle time and fleet size. However, such collaboration platform contains issues from business model standpoint such as differences on pricing models between taxi service providers and differences in fleet sizes (Kusuma, 2018).

However, the noncompetitive pricing and lack of technological solutions are not the only problems that taxi markets have. Basu (2019) mentions several factors that affect negatively on customers towards traditional taxi service providers in India market: blatant refusal of passengers for short distance and cherry-picking long distance ones, poorly maintained vehicles, rigged meters, overcharging, abusive bargaining, rude behavior and regular strikes over unreasonable demands.

2.1.2 Ride-sharing service providers

Ride-sharing services offer alternative ride-on-demand services to customers compared to traditional taxi services. In literature, alternative terms to describe these platforms, or services, are *app cab aggregator* (Basu, 2019), *car-hailing* (Hu, Zhang, & Cheng, 2019; Sun, Teunter, Babai, & Hua, 2019; J. Wang, Pan, & Li, 2018), *carpooling* (Li, Fei, Ruihan, Yu, & Dou, 2017), *ride-hailing* (Brown & LaValle, 2020; H. Chen et al., 2019; Jin et al., 2019; Mäntymäki, Baiyere, & Islam, 2019; Yan, Zhu, Korolko, & Woodard, 2019), *ride-sourcing* (Battifarano & Qian, 2019; Brown & LaValle, 2020; Chakraborty, Pandit, Xia, & Chan, 2019; Sun et al., 2019; H. Wang & Yang, 2019; Yang, Shao, Wang, & Ye, 2020; Zha, Yin, & Du, 2017; Zuniga-Garcia, Tec, Scott, Ruiz-Juri, & Machemehl, 2020), *shared mobility on demand* (SMoD) (Guan et al., 2019) and *transportation network company* (TNC) (Basu, 2019; Jiao, 2018; Ma, Xu, Meng, & Cheng, 2020).

When authors mention ride-sharing services in literature, they mean taxi services which are provided for customers by freelance drivers using digital platforms, and literature focuses mainly on those digital platforms. Those digital ride-sharing platforms create two-sided market which consists of demand and supply sides. On the demand side is customers, or riders, and on supply side, there are drivers who provide the service as a freelancer (H. Wang & Yang, 2019). Ride-sharing platforms offer their services using mobile application according to Guo, Liu, et al. (2017) and facilitates transactions between drivers and customers. By using that mobile application, customers can request a ride which creates demand, and those ride requests are then delivered to drivers who can decide whether they accept the ride request or not (Pandit, Mandar, Hanawal, & Moharir, 2019). Platform allocates the ride requests to drivers in real-time using matching algorithm, for example using first-dispatch protocol where platform matches order to the closest idle driver (Castillo, Knoepfle, & Weyl, 2017). Drivers, who participate on ride-sharing platform as freelancers, gets fixed percentage of the payment customer pays to platform from ride, and platform keeps rest of the payment as its commission for facilitating the transaction (Pandit et al., 2019). One of the most known such platform is Uber. Uber transformed traditional "*capital intensive*" industry to high-tech business by creating platform where drivers can register themselves which leads to independent pool of drivers (Bashir, Yousaf, & Verma, 2016). From every ride, 80% of payment goes to driver and 20% to Uber. Currently, Uber have presence on over 55 countries and has become one of the biggest taxi service providers, even though Uber's prior CEO, Travis Kalanick, have said that Uber is not taxi service provider (Bashir, Yousaf, & Verma, 2016). In addition to Uber, there are other platforms, such as Lyft and Ola.

Matching technology introduced by ride-sharing services is more efficient than traditional taxi industry's employed dispatch systems that spreads taxi's too thinly over city and forces drivers to unnecessarily chase customers (Castillo et al., 2017). According to Castillo et al. (2017), ride-sharing services can also enter to similar situation, failure mode, called wild goose chase when close to customer, there is no available idle driver and therefore travel distance to pick-up customer might increase unnecessarily. That leads to drivers waste time and reduce earnings. Castillo et al. (2017) suggests two ways to avoid such situation. One way to avoid such situation is to raise prices by keeping them unnecessarily high but that lowers total demand. Second way is to implement dynamic pricing to raise prices to keep demand under control but keeping normal, lower, prices when demand is normal.

Ride-sharing platforms itself do not own resources, in this case cars and drivers, themselves, so they can not directly control supply (Asghari & Shahabi, 2018). Their

supply depends on the fact that enough drivers register themselves to the platform (Bashir et al., 2016). In practice, to get enough supply to match demand, these platforms needs to attract drivers to participate their platform. According to Guo, Liu, et al. (2017), ride-sharing platforms attracts such drivers who wish to earn money using their own cars in their spare time without hassling with taxi licenses. Also, ride-sharing platforms enable supply providers (i.e. drivers) to schedule their own work time (Cachon, Daniels, & Lobel, 2017).

Ride-sharing services have several benefits. M. Chen, Shen, Tang, & Zuo (2019) mentions in their article that ride-sharing services have relieved traffic congestion problems. But more in general, any ride-on-demand services are beneficial for environment by increasing the utilization of cars and improving travel efficiency (Guo, Liu, et al., 2017). But according to Barnes, Guo & Borgo (2020), introduction of ride-sharing service in Chinese city that have underdeveloped market led to decrease on pollution initially but in long term, because of rapid increase of the number of trips, leads to overall increasing pollution. Földes & Csizár (2017) suggests that there is significant under utilization of vehicle capacities in urban mobility, and they showcase different possibilities for ride-sharing services that enables them to use their vehicles more efficiently by transporting both passengers and certain goods in same ride. That requires information systems and operations to be modeled in a way that dynamic prices coordinates demand and capacity in real-time (Földes & Csizár, 2017).

There are several reasons why ride-sharing services have been successful compared to traditional taxi services. The most visible aspect for customers is the result of successful digitalization in form of mobile applications targeted to customers. Basically ride-sharing services rely entirely on e-hailing and therefore these ride-sharing services can not be street-hailed like traditional taxi services (H. Wang & Yang, 2019). And as I have previously mentioned, ride-sharing service platforms have created complex dispatching systems to better match customers with drivers. These all combined leads to for example better vehicle utilization rates which allow Uber to drop prices significantly. Haucap et al. (2017) mentions that in Hamburg, taxi drivers spend 28% of their time with customer, whereas Uber drivers spends up to 60% of their time with customers. According to Asghari & Shahabi (2018), studies have shown that distances to pick up customers are shorter with ride-sharing platforms utilizing dynamic pricing which makes network more efficient, saves both drivers and customers time, and also drivers operational costs such as fuel.

One key thing about ride-sharing services is that it employs dynamic pricing as main pricing model (Guo, Liu, et al., 2017). I will describe dynamic pricing in chapter 2.3. With Uber, they also use fixed airport rates and standard fee which are lower than what competitors have. Bashir et al. (2016) mentions as an example that downtown Chicago to Midway costs $65 which is slightly less than two times cheaper than traditional taxi service providers. Brown & LaValle (2020) have done research on ride-sharing service quality compared to traditional taxi's in Los Angeles. Based on trip data collected in Los Angeles, Brown & LaValle (2020) present that ride-sharing service passengers will most likely get ride, pay 40% lower fares and wait 75% of the time less compared to traditional taxis with similar origin and destination pairs. Based on those findings, ride-sharing service providers pricing is competitive compared to traditional taxi service providers. As I mentioned earlier, drivers get fixed percentage of ride's payment and therefore, pricing needs to take into account both platform's and driver's operational costs and also their desired earnings (Bashir et al., 2016).

The other reason is current state of regulations in different areas towards taxi industry, and lack of regulations towards ride-sharing services providers. According to H. Wang & Yang (2019), in some areas, there are no need to hassle with licenses and certificates

as a ride-sharing service provider, and also there might be no limits on operational area, fleet sizes, pricing and working hours as traditional taxi service providers might have. But these ride-sharing service providers might also operate in legally gray areas because in some areas, usage of personally owned or leased vehicles for commercial purpose might be illegal (H. Wang & Yang, 2019). All of these aspects combined, they might create unfair advantage to ride-sharing service providers compared to traditional taxi service providers. To answer that issue, different areas are changing their legislation to address at least some of those issues (Basu, 2019; Yang et al., 2020). Basu (2019) mentions that, in India, many state governments are trying to regulate ride-sharing service markets by controlling maximum pricing and surge rates to prevent predatory pricing. Yang et al. (2020) mentions that in Singapore, there is surging cap in place and in Honolulu, there is cap on how much ride-sharing platforms can charge from customers.

There have been research done regarding on why customers choose to use ride-sharing services over traditional taxi services. According to Guo, Liu, et al. (2017), it attracts customers by its convenience, cleanness and sometimes low prices. H. Wang & Yang (2019) states that ride-sharing service users are sensitive to the price and quality of the service. In addition to reasons why customers choose ride-sharing services over traditional taxi services, there have been research related to ride-sharing platforms in general from user participation's perspective. Kooti et al., (2019) have analyzed data extracted from e-mail receipts sent by Uber to find out the role of demographics on user participation and based on that, they can accurately predict which customers or drivers will become active on Uber. Based on that, there are similarities in demographics between ride-sharing services customers.

One example of how ride-sharing services have emerged is described by Basu (2019). In Kolkata, India, technologically conversant urban people wanted alternative to the traditional taxi services and that happened while city’s social-economic profile and technological level evolved. According to Basu (2019), the majority of commuters were satisfied with ride-sharing services availability, reliability, cost-effectiveness, safety, cashless option, driver behavior, comfort and absence of bargaining, but there were issues regarding transparency and dynamic pricing. Similarly, drivers were satisfied with their improved earnings but there were issues regarding long hours and apprehensive incentive cuts.

2.2 Pricing in traditional taxi industry

In some areas, pricing in traditional taxi industry have been based on fixed fares and have been set to certain level by regulations. One such example is Finland before 1.7.2018, where local government determined taxi trip prices that were based on fixed fares. I will describe that pricing model in chapter 4.1. Problem with that approach is the way how government determines optimal prices. In situation where prices are too high, customers can not use those taxi services and if prices are too low, taxi service providers can not survive (Lin, Zhang, & Ge, 2011). Results from research done by Lin et al., (2011) related to optimal pricing model under government price regulation indicated that in case of Shenzhen, taxi trip price should have travel distance based charge, as traditionally have been implemented, but it should have different charge for different distance sections. That solution is fair for customers, and might help in Shenzhen in a situation where taxi drivers refuses for short trips to get longer distance customer to get more revenue. This model's idea is to make sure that revenue taxi driver gets stays same for every unit of time used for trip (Lin et al., 2011).

Another problem with traditional taxi pricing, which consists of used time and travel length which is same throughout the day, is that it do not take into account demand pattern changes. This leads to situation where taxi customers are paying too much when demand is low, and while demand is high, customers pay too less. Qian & Ukkusuri (2017) tested time-of-day pricing scheme for traditional taxi service providers to tackle this problem. Qian & Ukkusuri (2017) created estimated optimal prices for different times of day based on historical data, and that pricing model may increase daily market revenue up to 10%. However, Qian & Ukkusuri (2017) noted that this approach lacks possibility that demand and driving conditions varies spatially, so the problems remain same in some areas as it is currently with fixed fares.

Also, one issue according to Gan, An, Wang, Sun, & Shi (2013) is that drivers might choose not to work on peak hours because of congestion as at those times, taxi driver's income is lower, and therefore it is not beneficial for them to work at those times. To solve that problem, Gan et al., (2013) proposed a pricing scheme that makes it possible for drivers to get extra income from those peak hours, where they defined the minimum price for those peak hours that needs to be in effect to encourage drivers to work at those times. They defined different time periods and optimal prices for those time periods, but they set interval to be longer than what Qian & Ukkusuri (2017) had.

Even though examples above have focused on optimizing fixed fare based pricing, also other pricing models for traditional taxi services are both proposed and implemented. According to Egan et al. (2019), service providers, such as Liftago and GrabTaxi have implemented pricing mechanism that is based on auctioning. Basu (2019) suggested that taxi service providers could provide for example coupons as a mean of discount to promote their services and improve brand image and therefore use pricing as a tool to encourage customers to use their services.

There are several factors that affects to taxi service pricing. Yang et al. (2020) mentions that most operational costs comes from fuel and gas prices because busy drivers are en-route driving which consumes fuel. Yang et al. (2020) also mentions that especially with traditional taxi service providers, drivers also needs to seek passengers when street-hailing which also increases fuel consumption but that depends on driver's passenger seeking strategy. Some drivers prefer certain spots and some drivers might drive around seeking customers. But the operation costs itself can be assumed as constant for both occupied and vacant taxis, and for traditional taxi industry's perspective, operational costs are constant for fixed taxi fleet size (Yang et al., 2020; X. Wang et al., 2016). Also, depending on targeted customer group, it might be beneficial for traditional taxi service providers to optimize their operational costs to be able to better encourage customers to use their services. As an example of this, Basu (2019) mentions that because Indian customers are "*smart, very demanding and price-sensitive without brand loyalty*", there taxi service providers try to lower their operational costs as much as possible to lower their fares and that way maintaining and extending their customer base.

2.3 Dynamic pricing

Ride-sharing service providers use pricing as a tool to encourage drivers to participate on network so that network's demand can be matched, and to encourage customers to use their services. The ability to match demand is important because customers consider waiting time as important value when choosing whether to use taxi service (Yang et al., 2010). As Asghari & Shahabi (2018) mentions, "*finding the optimal price to balance the supply and demand has a crucial impact on the performance of the market*". To maximize ride-sharing platform's revenue and drivers income while keeping prices low,

dynamic pricing was implemented to define optimal pricing in real-time according to network's current conditions (He & Shin, 2019). Uber uses term *surge pricing* for their implementation of dynamic pricing, and that is also widely used term in literature. Similarly, Lyft has their own marketing term called *Prime Time*.

2.3.1 Reasons to implement dynamic pricing

There are several reasons why implementing dynamic pricing is good idea from ride-sharing service providers' perspective. The main idea behind dynamic pricing is to control network's supply and demand. Surge pricing, by increasing trip price at time of high demand, is there to balance demand and supply by encouraging drivers to participate and customers to postpone their trips until there is balance between demand and supply (Battifarano & Qian, 2019). Ride-sharing service providers also uses dynamic pricing to maximize platform's revenue, and that way they achieve near optimal profit compared to other possible pricing models (Asghari & Shahabi, 2018; Cachon et al., 2017). And in addition to those, Uber introduced *surge pricing* on their platform in 2012 to improve their completion rate, which is percentage of requests of rides that are fulfilled (Battifarano & Qian, 2019).

Compared to fixed fare pricing, prior research have shown that surge pricing helps to encourage drivers to participate on network and therefore help provide enough supply for demand because drivers operate in response to market profitability (Yang et al., 2010). For example in New York City, number of Uber and Lyft rides are 19% higher per hour when it rained, and at the same time, traditional taxi rides increased 5% per hour when it rained (Brodeur & Nield, 2018). According to results from Brodeur & Nield (2018), surge pricing encourages drivers to participate to network on rainy hours providing more supply, whereas traditional taxi drivers do not respond differently to increased demand caused by rain. Dynamic pricing also encourages drivers to drive more on the platform instead of ending their services (Asghari & Shahabi, 2018; Battifarano & Qian, 2019). It is shown in studies that from ride-sharing platform's revenue maximization perspective, dynamic pricing outperforms fixed fare pricing (Asghari & Shahabi, 2018).

According to Yang et al. (2020), there have been some criticism related to surge pricing because it encourages both drivers and customers to act strategically which in turn harm platforms long term success. And customers are confused and annoyed with non-transparent algorithm-based dynamic pricing compared to fixed fare pricing because surging might increase prices heavily at high demand times which also might be the worst time from customers perspective (Basu, 2019; Yang et al., 2020). That also covers extreme cases, such as what happened at times of terrorist attacks in London and Sydney, because at those times, surging increased heavily. Dynamic pricing can sometimes prevent customers from doing quick decisions because of uncertainty about prices (Guo et al., 2019).

Cachon et al. (2017) mentions concerns related to the welfare of drivers and customers, but surge pricing enables the possibility to better utilize drivers and therefore customers can benefit from lower prices when demand is lower while cost of labor is increasing. Similarly, Battifarano & Qian (2019) mentions that dynamic pricing can save customers money and time as time savings comes from more efficient resource usage which leads to better utilized vehicles on network. Asghari & Shahabi (2018) mentions that when surging is enabled on the area, which increases prices, it also decreases network's demand and therefore network's current supply can answer to demand more effectively.

Battifarano & Qian (2019) mentions that dynamic pricing can help to "*provide profitable insights to drivers*", which could potentially lead to better income for drivers, if they choose to use that information for their benefit. According to Asghari & Shahabi (2018), it is shown in recent studies that expected income impacts to participation on the platform which leads to situation that supply can be increased by promising more money to drivers if they participate when surging is enabled. Similarly, as customer's trip price depends on network's condition, same applies to drivers income (Cachon et al., 2017).

2.3.2 How dynamic pricing have been implemented

Ride-sharing platforms, such as Uber and Lyft, have implemented dynamic pricing. These platforms use real-time algorithm to determine current optimal pricing for current situation on the market. The exact variables controlling pricing are not published by these ride-sharing platforms but it is known that real-time algorithm uses real-time input data to determine currently optimal pricing in real-time at a trip's origin point without considering trip's destination (Asghari & Shahabi, 2018). The optimal pricing depends on supply and demand at current on the network and other road conditions because those can vary during the day, and for example in case of situation where there are less available drivers than customers, such as at the time of rush hour, the prices are increased to encourage more drivers participating on the platform, and at the time of less demand outside of rush hours, prices can be decreased (Asghari & Shahabi, 2018; Pandit et al., 2019). In addition to that, real-time algorithm tries to predict relation between demand and supply for next few minutes or hours (Battifarano & Qian, 2019).

Because ride-sharing platforms have not made their real-time algorithms public, it is impossible for third-parties to predict prices or predicting high demand times. According to Battifarano & Qian (2019, p. 1), prediction of surge prices for next few minutes to few hours seems to benefit all parties: "*(1) understand the foreseen results of evolution of service vehicles and demand for transportation managers; (2) help ride-sourcing companies navigate the changing transportation landscape for real-time operation; (3) provide profitable insights to drivers; and (4) save riders' money and time.*" But from publicly available information, surge multipliers and times of surging can be guessed because peaks are happening around same time every week and surging is likely to happen in same places (Battifarano & Qian, 2019).

According to Battifarano & Qian (2019), Uber is surging in major cities between 14% and 28% of the time and surging multipliers are bounded between 1.2 to regions maximum possible, depending on regulations and Uber's own definition of maximum multiplier, and that multiplier increases in steps of 0.1. Battifarano & Qian (2019) also mentions that in top six highest surging places, surges are around twice as high as average and also that Uber and Lyft are surging in urban areas between 2 and 3 times more than in sub-urban areas. Also, according to Battifarano & Qian (2019), surge multiplier is largely driven by customers waiting time which in turn is driven by the rate at which demand is out-pacing supply. According to Basu (2019), this happens by using technology, such as GPS, to coordinate drivers and customers in centralized platform to analyze current situation of demand and supply using big data analytic. That is then again used to determine pricing and making sure that drivers are in correct places in correct time, creating optimal taxi routing, minimizing pick-up times and minimizing waiting times (Basu, 2019).

L. Chen, Mislove, & Wilson (2015) mentions that Uber do not provide data about supply or demand, and dynamic pricing happens using opaque algorithm, which have led to concerns about if Uber manipulates prices or if dynamic prices are fair to

customers and drivers. Data collected from Uber using multiple Uber applications distributed to San Francisco and Manhattan helped to identify key implementation details of Uber's surge pricing algorithm which raises questions about the fairness and transparency of it (L. Chen et al., 2015).

2.3.3 Optimizing dynamic pricing

Dynamic pricing can be improved by optimizing certain values on how optimal pricing is calculated which could lead to improved platform's revenue, lower prices for customers and improved income for drivers. One such area that is researched is demand patterns. According to Asghari & Shahabi (2018), currently ride-sharing platforms consider only network's current supply and demand at a ride's origin to adjust price. By predicting networks future demand on trip's origin and destination when adjusting pricing, could lead in New York City up to 15% better revenue while reducing trip prices on average of 5% (Asghari & Shahabi, 2018). According to He & Sin (2019), existing dynamic pricing implementations only respond to short-term demand variations and spatial demand-supply balancing, which leads to mismatch of drivers and customers which reduces overall profit. He & Sin (2019) created pricing scheme that predicts demand and supply which was validated against real-world data, and they found that their pricing scheme can lead to 20% accuracy and 30% profit improvements over the current implementations.

Another area of potential improvement is prediction of future prices. According to Battifarano & Qian (2019), dynamic pricing is used to balance the needs of demand and supply real-time, and prediction of surge prices in short term encapsulates the evolution of service fleets and service demand. Therefore, correctly predicted prices could make network more efficient and reliable by helping to allocate vehicles more efficiently, by saving passengers time and money, and by providing profitable insights to drivers. Battifarano & Qian (2019) developed generic framework to predict surge pricing, and that can predict Uber's surge prices up to two hours in advance. Even though ride-on-demand services tries to provide service for customers that is convenient for customers, dynamic pricing creates headaches for customers when they are wondering if current price is low enough to accept or what they can do to get lower price (Guo, Chen, et al., 2017). Price prediction is one possible solution to relief those headaches as by predicting prices and providing such information for customers, they can see if prices are lower in neighbor locations or within short time, and they can use that information as part of their decision-making process. Results from research done by Guo, Chen, et al. (2017) indicates that different price prediction algorithms should be used in different areas of city, and the probability that customer could use that information to get lower price multipliers nearby is up to 89,4%.

Ride-sharing services have attracted customers, and platform's ability to match that demand is one major concern. According to Chakraborty et al. (2019), to attract more providers to provide supply to match that demand, dynamic pricing was implemented as a solution, which then again raises concerns towards congestion and emissions when drivers are encouraged to participate on platform during peak hours. To minimize drivers and customers waiting time, overall travel distance of drivers and to allocate vehicles more efficiently, simulation model was developed and validated using open-sourced historical data (Chakraborty et al., 2019).

Matching algorithm and dispatching strategies are also one area where improvements could be made. According to M. Chen et al. (2019), one of the key issues related to ride-sharing services is to create optimal pricing from platform's revenue perspective. By creating formulation where states are drivers distribution and decision variables are the

prices for each pair of locations, and that way optimal pricing can be calculated, which also creates optimal dispatching policy at the same time (M. Chen et al., 2019). M. Chen et al. (2019) shows that such way of pricing have advantages over fixed pricing schemes as well as several prevalent surge-pricing schemes. Because pricing and dispatching strategies are intrinsically interrelated, and because of that, both pricing and dispatching strategies should be improved together (H. Chen et al., 2019). Previously efficiency improvements are tried to get from optimizing either pricing or dispatching, but H. Chen et al. (2019) approach was to create learning framework that makes both pricing and dispatching inter-dependent. H. Chen et al. (2019) did comparison to real world data from Chinese cities which showed that usage of that framework significantly improved ride-sharing platform's efficiency. Guan et al. (2019) proposed dynamic pricing strategy, which was combined with dynamic routing algorithm.

2.4 Summary from the prior literature

Ride-on-demand services can be categorized to three different categories according to Guo, Liu, et al. (2017). These categories are *traditional taxi* services, *ride-sharing* services and *CFDP* services. This thesis focuses on first two of those categories. First one is *traditional taxi* service providers, which resources are owned by company, supply is fixed, pricing is based on fixed fares and ordering happens by street-hailing or calling. Second one is ride-sharing services, which resources are owned by driver, supply is dynamic, pricing is dynamic and ordering happens using mobile application. Also, from this thesis perspective, it is worth noting that literature focuses mainly on countries such as USA, China and India, which have different taxi markets compared to Finnish taxi markets as I mentioned in chapter 1.

Traditional taxi services have built their pricing models on fixed fares, which can consist of for example basic fee and trip length fee. Resources utilized by these companies are owned by company, and drivers are working for them as labor. In many countries, regulations are set to control traditional taxi service's supply, resource usage and pricing models. These regulations, especially pricing related ones, make it harder for traditional taxi service providers to compete against ride-sharing services after ride-sharing services emerged. That have led to decreased usage of traditional taxi services. Also, one problem is traditional taxi service's linear pricing model, because it is more expensive than ride-sharing services, is not attractive from drivers perspective and do not take into account demand pattern changes. In summary, the pricing model is not corresponding its operational area's optimal pricing.

In case of ride-sharing services, resources are owned by driver themselves, and the drivers work as a freelancer under ride-sharing platform and gets fixed percentage of the payment from ride. The ride-sharing platform allocates ride-requests with drivers in real-time using matching algorithm and drivers can decide themselves whether or not to accept it. The trip pricing is dynamic, which is calculated in real-time based on demand pattern at trip's origin point and traffic conditions. Currently, in several countries ride-sharing platforms do not have similar restrictions compared to traditional taxi service providers which means that they can operate more freely, including abilities to set pricing freely. Though, some countries have implemented some limitations on pricing as a form of for example surging limit. Main idea behind dynamic pricing is to maximize platforms revenue, improve drivers earnings, make trip's pricing cheaper when demand is low, attract more drivers to participate and customers to use services, and also encourage customers to postpone their trips while demand is high. Also, dynamic pricing is implemented to help balancing supply and demand, and also helping to better utilize vehicles. While dynamic pricing is effective, it is also mentioned to be

confusing and annoying for customers because pricing can spike to extremes and is also unpredictable.

3. Research approach

In this chapter, I will present research methods used for this research. Research methods employed in this research were qualitative. Research consisted from literature review, data about Finnish dispatch centers' pricing models retrieved from the internet, eight semi-structured interviews and data analysis. I archived all collected data including relevant literature, data collected from internet, interview recordings and transcriptions for possible later usage by saving documents to disk and inputting metadata related to those into spreadsheet.

I performed this research using multiple case as research strategy. Case study is research approach that answers to research questions "*how*" and "*why*" and it does not require control of behavioral events and focuses on contemporary events (Walsham, 1995; Yin, 2003). In Finland, the Act on Transport Services came into effect recently, specifically in 1.7.2018, and Finnish dispatch centers are still going through the process to change their business models to match current market situation. I specifically implemented this research as multiple case study because I collected data from 39 Finnish dispatch centers and I and this thesis's supervisor Karin Väyrynen conducted eight interviews with different Finnish dispatch centers to gain more insight about reasons for why pricing models were changed. It also made sense from research's results perspective as multiple cases makes results more compelling and study more robust but to accomplish that, cases needs to be carefully selected (Yin, 2003). And to reach that goal, I specifically selected interviewees that represented dispatch centers with different pricing models to get as broad understanding as possible about topic of this research and to cover reasons how different Finnish dispatch centers ended up to different pricing models.

3.1 Literature review

This research began with literature review. Literature review's main objective was to answer question that what dynamic pricing means, what effect it has and how it is implemented. In addition to that, I also searched literature about different business models and pricing models implemented in taxi industry. I started literature search process using Google Scholar and traditional Google to get list of relevant keywords and terms, and to understand context a little better. Search process used in this phase was using search string "*dynamic pricing*", and by going through the first few result pages on Google Scholar. I also looked through so-called Association for Information Systems Senior Scholars' Basket of Journals, but I did not find relevant literature from those sources.

I used knowledge developed from keyword search phase to create search string for Scopus containing all relevant terms found. I chose to use Scopus to find relevant literature because it contains list of references from major scientific publishers, and also those references are peer-reviewed. Also, I decided to limit my search to only literature published on year 2010 and later from my supervisor's suggestion, because Uber was launched in 2010, and relevant literature towards ride-sharing services and dynamic pricing is focused on that time period. This whole process led to following search string:

(TITLE-ABS-KEY (ride* OR hail* OR taxi OR cab OR taxicab OR "mobility as a service" OR maas OR "mobility on demand" OR "mobility service provider")) AND (TITLE-ABS-KEY ((("two-sided markets" OR "peer-to-peer economy" OR "sharing economy") AND pric*) OR "dynamic pric*" OR "surge pric*" OR "demand pric*" OR "time-based pric*" OR "nonlinear pric*" OR "pric* strategy" OR "trip pric*" OR "journey pric*")) AND (LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010))

In first part of this search string containing "*TITLE-ABS-KEY(ride* OR hail* OR taxi OR cab OR taxicab OR "mobility as a service" OR maas OR "mobility on demand" OR "mobility service provider")"*, my purpose was to tie generic taxi industry related terms to search string to avoid getting results from wrong industry. Here I specified that I wanted to find different *hailing*, *vehicle* and *taxi business model* related terms. But that was not enough because this literature reviews focus was also pricing models. Therefore, I created second part to this search string with desire to find *pricing* related results using string "*TITLE-ABS-KEY((("two-sided markets" OR "peer-to-peer economy" OR "sharing economy") AND pric*) OR "dynamic pric*" OR "surge pric*" OR "demand pric*" OR "time-based pric*" OR "nonlinear pric*" OR "pric* strategy" OR "trip pric*" OR "journey pric*")*". These contain *economy types* that are basis of ride-sharing platforms tied with generic pricing term to make sure that results do not contain irrelevant results including economy related articles or other irrelevant pricing related articles that did not contain information about taxi trip pricing specifically. Then I also listed more specific taxi industry related pricing terms that were relevant from trip pricing perspective. Finally, all results are limited to time published between 2010-2020.

That search string returned 160 results. I exported those results from Scopus including authors, topic and abstract for literature selection process. Then I created inclusion criteria for literature selection. If article's topic or abstract did not contain anything related to pricing models or trip pricing, then I did not include it to my study. After I went through all results by reading article's topic and abstract, I selected and archived 70 articles. From those 70 articles, 48 was used as part of this thesis' literature review because some of those articles were duplicates and not relevant from this research's perspective when inspecting closer.

In addition to search related to dynamic pricing, also I also conducted one general purpose search using Google Scholar to find additional articles about taxi industry's pricing in general. Used search string was "*taxi pricing"*, and by using that search string, idea was to look briefly into research done in the past related to taxi industry's pricing. I went through first five results pages and selected two additional relevant articles based on their title and abstract. That search also resulted other relevant articles, but those were already found using earlier search string.

3.2 Data collection from internet sources

I collected this study's data using publicly available sources from internet. For data collection, it is important to define plan to be followed when data is being collected. In this study's case, my data collection plan was heavily based on data archiving

methodology. That included the strategy to save data to disk, fill relevant metadata about that data to spreadsheet and date when data was published, or last edited, and when data was saved on disk. The amount and type of data is showcased in table 2. In addition to that, my plan for data collection was to go through list of Finnish dispatch centers websites and social media, and also other websites using Google search. Because this study's data collection phase was happening using publicly available sources on internet without actual field work, this research was by nature desk research.

Table 2. Type and amount of collected data from internet.

Type of data	Number of saved documents
Web pages	84
Facebook posts	36
Instagram posts	4
News articles	1
Twitter posts	1

For this data collection, I asked Taksiliitto for information about Finnish taxi dispatch centers to have a first starting point for doing internet research on the pricing models of Finnish dispatch centers. This list of 26 dispatch centers was complemented with 13 more dispatch centers I found through a search in Google. In the end, I had list of 39 Finnish dispatch centers. From those, 36 had data publicly available, and those 36 were included in this research. From this study's perspective, I qualified taxi company to be "*traditional dispatch center*" if they have some phone number to call for ordering taxi. There are other dispatchers, such as Uber and Yango, but those do not provide phone number to be used for taxi ordering, and therefore I do not consider those to be traditional dispatch centers.

3.3 Semi-structured interviews

To add more insights to collected data, I conducted in-depth interviews with eight taxi dispatch centers. For this study, semi-structured interviews was selected for interviewing method meaning that interview script is incomplete which lefts room for improvisation at the time of interview (Myers & Newman, 2007). This study is also part of bigger research project related to taxi industry in Finland, and because of that, this thesis's supervisor Karin Väyrynen participated also to these interviews as second interviewer.

From multiple-case design perspective, it was important to choose sufficient number of cases (Yin, 2003). To answer research questions as extensively as possible, I decided to choose one dispatch center to represent each pricing model. I derived pricing models from the data collected on the pricing models of 36 Finnish dispatch centers. The findings of this step are presented in chapter 4.2 and table 6. That made it possible to create more deep understanding of different reasons *how*, and *why*, these dispatch centers arrived to conclusion to implement specific pricing model. I approached selected dispatch centers via e-mail and asked their general manager or someone else "*who can tell about their pricing model and about changes in their pricing model from the last two years*". From those 11, eight responded and agreed to participate to interview, and in interview 1, two interviewees participated. Seven interviewees from nine total interviewees were positioned as chief executive officers (CEO), one was customer

relationship manager and one was chief financial officer (CFO). We conducted interviews remotely because interviewees were in different locations, and there were no specific need to conduct these interviews on site. The actual selection of technology used to conduct interviews was left for interviewees to make sure that actual participation is as smooth as possible for them. According to Myers & Newman (2007), it is important to minimize everything that can make interviewee uncomfortable. I recorded and transcribed interviews to make sure that I have actual proof about what was said because I used direct quotes from these interviews as part of this study. I also anonymized data gathered from interviews to make sure that interviewees can not be identified.

Interviews construct from four phases: opening, introduction, key questions and closing (Myers & Newman, 2007). On opening, we introduce ourselves for interviewee. Then we introduced this study's main purpose for interviewee, and we also asked permission to record interview. It is a good tactic to get interviewee to relax and feel confidence towards research when researchers do most talking for the first few minutes which can lead to more honest responses (Walsham, 2006). Then we performed the actual interview based on key questions we prepared earlier. In closing, we thanked interviewee for participating in this study as an interviewee.

For this study, interview questions were derived from collected data and from prior literature. After I had prepared the first version of the interview outline, and after discussion with my supervisor, I arrived at the interview questions. Finally, interview questions were divided into seven categories: *background information*, *current pricing model*, *dynamic pricing*, *old pricing model*, f*eedback from drivers and customers*, *e-hailing application* and *multi-homing*. Background information related questions were not used as part of this study's findings, because that data had to be anonymized, and it was not relevant from this study's perspective. Questions related to current pricing model, old pricing model and e-hailing application were formed based on the previously collected data about dispatch centers. Questions related to dynamic pricing was formed based on prior literature. Full interview structure used with these interviews are included as appendix A.

Table 3. Conducted interviews with information of interviewees status in company, interviewing method and interview duration.

Interview	Interviewee	Status in company	Interviewing method	Duration
Interview 1	Interviewee 1a	CEO	Video conference, Microsoft Teams	69:31
	Interviewee 1b	Customer relationship manager		
Interview 2	Interviewee 2	CEO	Video conference, Microsoft Teams	83:04
Interview 3	Interviewee 3	CEO	Video conference, Microsoft Teams	87:00
Interview 4	Interviewee 4	CEO	Video conference, Microsoft Teams	116:34
Interview 5	Interviewee 5	CEO	Phone call	52:56
Interview 6	Interviewee 6	CFO	Video conference, Microsoft Teams	78:28
Interview 7	Interviewee 7	CEO	Video conference, Microsoft Teams	46:47
Interview 8	Interviewee 8	CEO	Video conference, Microsoft Teams	79:45

Interview lengths varied between 46:47 and 116:34. Some interviews were shorter because I had some earlier data available for use, which allowed us to skip some parts of interviews. In addition to that, some interviewees talked more than others which also contributed to interview's length. I specified interviews to be "*maximum of 1-1,5 hours*" in interview invitation. Some interviewees agreed to participate for maximum of one hour and others had more time on their hand. Every interview was performed in Finnish, and I transcribed them in Finnish word-by-word. However, I translated selected quotes to English for this study's purpose. I also archived transcriptions and original recordings.

3.4 Data analysis

This study's data analysis consisted from three different phases. In first phase, I examined collected data and defined pricing models from the pricing data I collected on the internet. In second phase, I created list of every additional pricing method that were used in parallel with dispatch centers' main pricing model that came up from collected data. In third phase, I examined interview transcriptions and data collected from internet, divided those into different themes that I will discuss in this study.

I analyzed the pricing models of 36 dispatch centers that had information about their pricing scheme available by creating spreadsheet and putting collected current pricing information to there. For every different type of *fare*, I created new column and I put its price there. That was repeated for every dispatch center that had pricing information available. Then I identified different pricing model types using that data. However, that pricing model type identification was based on broader fare class division. Idea was to use these as pricing components to distinguish pricing models from each others. The identified pricing components were *basic fee*, *trip length fee*, *trip time fee* and *waiting fee*. That resulted 11 different pricing model types. Then I split these pricing model types into three distinctive categories based on how trip length fee, trip time fee and waiting fee was utilized. These identified pricing model types are shown in table 6.

For data collected from internet and interview data analysis, I performed thematic analysis. Thematic analysis in qualitative research is method for identifying, analyzing, organizing, describing, and reporting themes found from some data set, in this case interview transcriptions (Nowell, Norris, White, & Moules, 2017). To perform thematic analysis, I had to define themes for analysis. In this case, I already had defined broad themes in interview question definition phase, where I already specified main themes that I wanted to discuss with interviewees. Those interview questions are readable in appendix A. But because some of those themes from interview questions overlapped with each other, I decided to categorize data into three main themes: *currently employed pricing model*, *dynamic pricing*, *how technology affects pricing* and *e-hailing application*. First I categorized data collected from internet under those three themes. After that, I categorized each interview transcriptions contents into those same three themes. Then I proceeded to refine my theming based on that collected data as I became more familiar with it. These new themes contained pricing model related concepts including dynamic pricing, fixed pricing and reasons behind selection of interviewees' represented dispatch centers' currently employed pricing model, and technology related concepts including taximeter, dispatch systems and e-hailing applications. By performing thematic analysis, it helps to summarize key points from data, and to compare cases between each other to find similarities and differences between them (Nowell et. al., 2017). Therefore, I proceeded to compare findings with each other and reported findings which are presented in chapter 4.

3.5 Results validity and reliability

For any research, results validity and reliability needs to be ensured and I have taken steps to ensure that this research has been performed properly which also leads to reduced risk of making errors. First research methodology needs to be in line with research question. In this study, multiple case study was used as research strategy as I have explained earlier. It was also relevant choice because it allowed me to compare findings from multiple cases in perspective of research questions. I documented my main steps of this research, or collected data in a way that my steps were traceable. However, I should have done more in-depth documentation about this research process. That became visible in data collection part and data analysis part, where I did not keep detailed notes about my process and findings. That would have possibly saved some time for me but this also means that some findings might not end up being reported.

In this study, I collected data using two different data collection methods, and compared findings from both of those between each other, thus avoiding sampling bias. In desk research part, which I described in chapter 3.2, I collected everything that was relevant from pricing perspective. However, I started that phase with only that idea in mind, but to have more relevant data to be compared with interview data, I should have identified more themes for this part. For example, I left out technological parts, including e-hailing application, out of this data collection phase which ended up to be relevant theme in interviews. For interviews, which I have described in chapter 3.3, I performed eight interviews with eight different Finnish dispatch centers. Every interviewed dispatch center represented different pricing type, which revealed differences between each dispatch center from pricing model perspective. But for optimal results, I should have interviewed at least one dispatch center from each pricing type to understand completely why each pricing type was selected in use instead of other possible pricing types. In data analysis part, data triangulation made it possible to validate results of this study as I did not rely on only one source of data.

4. Findings

In this chapter, I will present findings from data analysis as documented in chapter 3.4. First I will present Finnish taxi market pricing model from before the Act on Transport Services came into effect as a background information, then I will present identified pricing models currently implemented, then I will present findings related to how technology affects taxi pricing, then I will present findings related to dynamic pricing, and lastly I will present how pricing models have evolved since the Act on Transport Services came into effect and what different aspects affects to taxi pricing in Finland.

4.1 Pricing model set by regulations before 1.7.2018

In Finland, before the Act on Transport Services came into effect 1.7.2018, taxi fares regulations specified maximum limit for taxi trip fares. And in addition to that, regulations also specified operational area where dispatch centers did have permission to operate. Because of that, fares were basically same for every taxi service provider and dispatch centers in Finland. These fares consisted from four main pricing components: *basic fee*, *trip length fee*, *waiting fee* and *other additional costs*. From these, basic fee was added to every trip cost. Then additional charges were added when needed. Then trip length fee and waiting fee was added to the trip cost, and that amount was dependent on length traveled and time used to drive slowly or alternatively standing still. But with trip length fee and waiting fee, noticeable thing is that both were not measured at the same time. Therefore, driving slowly do only add cost based on waiting fee but not cost based on length traveled, even thought taxi moves closer to the destination.

Basic fee is pricing component that is present at the start of every individual taxi trip. Before 1.7.2018, there was two different basic fees depending on time. Basically there was one price for daytime and for ordinary weekdays, including Saturdays and eves. The other price was in effect at nighttime or at public holidays. In table 4, the exact fees are shown together with the time when each of those two is in effect.

Table 4. Basic fee before 1.7.2018.

	Basic fee
Weekdays 06-20 Saturdays or eves 06-16	5,36€
Other times	8,18€

Second pricing component is *trip length fee*, which is being calculated when trip itself is happening. In practice, every time taxi moves, taximeter adds certain amount of money to total trip cost. That cost was presented as per kilometer cost, as shown in table 5. The amount of money per kilometer was dependent on how many passengers are onboard. In practice, these fees were split to four fare classes as shown in table 5.

Table 5. Trip length fee before 1.7.2018.

	Trip length fee
1 or 2 person(s)	1,45€/km
3 or 4 persons	1,74€/km
5 or 6 persons	1,88€/km
over 6 persons	2,03€/km

Third pricing component is *waiting fee*. This pricing component is measuring time used in taxi trip while driving slowly, or when standing still. In practice, it was in effect when taxi is standing, for example in traffic lights, or when moving slowly, for example because of congestion. This pricing component was presented as certain amount of money per hour but in practice, it added cost to total trip cost in smaller interval. Waiting fee's maximum limit was set to 42,76€ per hour before 1.7.2018.

Additional costs are last pricing component which includes things such as *pre-order fee*, *airport fee*, *aid fee* and *cargo fee*. This category is not relevant from this study's perspective so this will not be included in further analysis. This pricing component is also not possible to generalize between dispatch center, and also these are not fixed part of taxi trip's cost.

4.2 Identified pricing models

Pricing models in Finnish taxi markets are currently in constant consideration by dispatch centers, as interviewee 1a mentions in the interview: "*we do not think yet that our [pricing model] is final, or right one*". Reason for this statement is that because regulation change in Finland was big and recently happened, but most importantly opposed to the past, markets define pricing instead of regulations. Interviewee 4 summarizes the extent of the change as: "*compared to regulated world, pricing have changed to company-specific pricing […] previously it was nationwide pricing*".

Based on data gathered from Finnish dispatch centers, I was able to identify 11 different pricing models in use when writing this thesis. I will refer these pricing models as *pricing types*. Identified pricing types are shown in table 6, which also showcases differences between fare classes in those pricing types. I documented the process to identify those pricing types in chapter 3. I separated pricing types by *pricing component* differences that are employed on every ordinary taxi trip's cost. Those pricing components are active when regular passenger orders taxi trip by street-hailing, or using mobile application, calling or by text message. Identified pricing types include same main pricing components as the pricing model in effect before 1.7.2018 but there are also some new pricing components.

Most Finnish dispatch centers still employs *basic fee* in some form. In addition to basic fee, depending on time employed before 1.7.2018, basic fee's amount could be dependent on *amount of passengers onboard*, or it can be *fixed*. *Trip length fee* is added on top of basic fee and is dependent on *length traveled*. Before 1.7.2018, trip length fee's amount was dependent on *amount of passengers is onboard* in trip, and that is still employed, and interestingly it is still utilized in every pricing type that includes trip length fee. In addition to that, some dispatch centers employs trip length fee which is dependent on *time*. Last main pricing component is *waiting fee* which is calculated instead of trip length fee in case of when taxi is moving slowly or is standing still. Its calculation depends on time used for driving slowly, or alternatively when standing still,

so length traveled is not affecting to this pricing component. That was part of pricing model employed before 1.7.2018 and is currently replaced with *trip time fee* in some pricing types. The main difference between waiting fee and trip time fee is that trip time fee is calculated from whole trip without any special cases, such as driving slowly, and it can be calculated together with trip length fee. The amount of trip time fee could be dependent on *amount of passengers is onboard*, it can be dependent on *time*, or it can be *fixed*.

Pricing types can be further categorized to three main categories based on how taxi trip's total cost is calculated. In *category 1*, price's variable part is calculated using *trip length fee* and *waiting fee*, and holds types 1-4. In *category 2*, price's variable part is calculated using both trip length and time used for trip, and holds types 5-10. *Category 3* price's variable part is calculated only with trip time fee and type 11 is only pricing model that represents it.

Table 6. Different pricing models including variables that affect trip pricing (P = Persons; T = Time; F = Fixed).

Category	Type	Basic fee			Trip length fee		Trip time fee			Waiting fee
		P	T	F	P	T	P	T	F	
1	1		x		x					x
	2			x	x					x
	3	x			x					x
	4		x		x	x				x
2	5		x		x				x	
	6		x		x			x		
	7		x		x	x			x	
	8		x		x	x		x		
	9				x	x		x		
	10	x	x		x	x	x	x		
3	11			x			x			

Compared to pricing model employed before 1.7.2018, the *division based on passengers onboard* have changed a bit. The old way to have separate fare classes for 1-2, 3-4, 4-5 and over 6 passengers onboard, is still employed by few dispatch centers, mainly by those which are employing type 1 and type 4 pricing models. Many dispatch centers employing other pricing types have simplified their fare class divisions. One frequently used division is to divide fare classes only for 1-4 and 5 and more passengers onboard. Then there are two other special cases. One dispatch center have separate fare class for one passenger onboard and for 2-4 passengers onboard without possibility to have over four passengers onboard. Second special case is interviewee 6's represented dispatch center's case. Their vehicles used in taxi transportation can take up to six passengers onboard and therefore the price is same for 1-6 passengers. According to interviewee 6, that is possible because they have specific requirements for vehicles that are allowed to operate in their dispatch center. However, they still have separate prices for more than six persons onboard, but those vehicles are called as "*para transit vehicles*" according to interviewee 6.

4.2.1 Definition of category 1 pricing models

Category 1 contains pricing model types 1-4. These pricing model types calculates taxi trip price's variable part by using *trip length fee* and *waiting fee*. *Type 1* is identical to what Finnish taxi pricing was before the Act on Transport Services came into effect. It contains basic fee that is dependent on time, trip length fee that is dependent on number of passengers is onboard and waiting fee. *Type 2* is identical to type 1 with one exception: basic fee is fixed instead of being based on time when trip starts. This pricing model was mainly utilized as alternative pricing model for dispatch centers. One use case for this pricing model is for airport trip prices when customer hails taxi from airport's separate taxi lane, because those lanes have separate pricing models in result of tendering done by airport. Other use case was that one dispatch center used this pricing model in sparsely populated area. *Type 3* is identical to type 1 but instead of time based basic fee, it is based on number of passengers onboard. *Type 4* is identical to type 1 but trip length fee is also dependent on time. Therefore, trip length fee depends on both how many passengers are onboard and time.

Interview 1's interviewees' dispatch center uses type 1 pricing model. Interviewee 1a describes that to be "*in many was traditional pricing model*" which I also noticed when I identified pricing model types. As mentioned earlier, type 1 pricing model is similar to what pricing model was before 1.7.2018. Specific pricing component to this category is waiting fee, which according to interviewee 1a, do not "*play big role*".

Interviewee 1a mentions that they have received positive feedback about their pricing because customers feels that pricing is "*predictable"* and therefore customers can imagine that they are able to pay their taxi trip themselves. Interviewee 1a also mentions reasons to continue use that particular pricing model to be related to the times when media was writing about problems related to taxi markets, pricing and possible security problems from taxi customer's perspective. According to interviewee 1a, they also wanted to create image for customers that they do not react to regulation change by desiring maximizing profits but merely keep basic things as they were before regulation change, and that's why they decided to keep using the old pricing model.

> "*We created this brand, in which customer service, security, reliability and locality is highlighted, or we have been here long time, we are familiar with our environment, we are familiar with our customers and customers are familiar with us. Therefore, we wanted to create customer image about that not everything have changed.*"

4.2.2 Definition of category 2 pricing models

Pricing models under category 2 was referred as "*pan-European pricing model*" by several interviewees. Interviewee 3 claimed that this category of pricing models are "*widely employed pricing model in Europe*". Interviewee 5 mentioned that according to their monitoring, that category 2 pricing models are employed in "*quite many countries*". Interviewee 2 mentions specifically Sweden as one country where such pricing models are employed, and where industry was vacated in 90s similarly as in Finland in 1.7.2018.

Main difference between category 1 and category 2 is that instead of waiting fee, there is time based fee employed. *Type 5* employs time based basic fee, trip length fee is dependent on how many passengers is onboard and trip time fee is fixed. *Type 6* is identical to type 5 but trip time fee is dependent on time. *Type 7* is identical to type 5 but trip length fee is dependent on time. *Type 8* is identical to type 6 but trip length fee

is dependent on time. *Type 9* is identical to type 8 but without basic fee. According to interviewee 6, reason to drop basic fee was based on customer feedback because they had employed customer polls and there stood out that basic fee is something that "*highly irritates"* customers. After removing basic fee, interviewee 6 mentioned that they used basic fee removal as part of their marketing campaigns, and they also implemented minimum fee. *Type 10* is special case because this pricing model's prices depends on several factors. Basic fee, trip length fee and trip time fee depends on time when trip starts and how many passengers is onboard.

Several interviewees mentioned that category 2 type of pricing model have been employed by majority of dispatch centers in Finland. Usage of similar pricing model compared to competitors was one mentioned reason to implement category 2 type of pricing model. Interviewee 2 mentions that it would be easier for customers to compare taxi trip prices between different dispatch centers because "*different companies have so to speak similar way to express pricing*". However, based on data collected for this research, most Finnish dispatch centers are using pricing model from category 1. But several larger dispatch centers from southern Finland have implemented pricing model from category 2. Interviewee 7 mentioned also same thing, and added that they could have continued to use old pricing model before regulation change, but that would have been hard for customers to compare prices when other dispatch centers moved to category 2 type of pricing model:

> "*But then problems arise that if traditional model and time-length -pricing models are compared next to each other, price would not be as clear for customer. So it might be in some cases misleading in customer's opinion.*"

Main change from pricing model before regulation change to this category type of pricing model is the addition of continuous time based fee replacing waiting fee. Interviewee 7 mentioned reason to implement time based fee was to motivate drivers to be driving in challenging situations: "*we could not get drivers anymore to central congestion because drivers did not want to sign trips there*" and then continued the reason for that to be that "*it was so time-consuming*" to get there and out of there. Interviewee 6 mentioned specifically that "*drivers sees their work to be proportional to time*" and therefore for them, time based fee is important pricing component.

Interviewee 3 mentioned that in addition to time component, also trip length fee is important pricing component because "*it may be structured to be easier to understand that vehicle's usage costs and time usage costs*" and that is why they decided to implement specifically category 2 type of pricing model instead of category 3 type of pricing model.

There are also criticism towards trip time fee. Interviewee 1b stated that according to feedback from corporate and regular customers, "*transparency*" and "*computability*" are important aspects when talking about pricing, and then compares time based fee to be "*hidden pricing*". Interviewee 1b continues to mention that customers also mentioned that because "*taxi usage happens in a hurry, nobody wants to think if it's rush hour or not*" which leads to lack of confidence on ordering taxi because it would be hard to plan beforehand, what trip costs.

There was also several interesting mentions how this category of pricing models affects to taxi trip total costs compared to pricing model before the Act on Transport Services came into effect. Interviewee 3 mentioned that in their case "*shorter trips got quite a lot cheaper*". Interviewee 4 went a bit more specific by addressing specifically that "*on shorter trips, cost for customers have slightly lowered, on average trips costs have raised a bit and again on longer trips lowered*". Interviewee 4 continues that the idea

behind that is that "*on shorter trips, basic fee and trip length fee is not that steep*", and with longer trips basic fee do not "*cover in the distance*". Interviewee 5 mentions some possible criticism towards category 2 type of pricing models by mentioning that it could be experienced by customers as an "*eye-turning trick*" because "*unit prices will remain cheaper*". That could cause prices to look cheaper compared to pricing model employed before the Act on Transport Services came into effect.

Interviewees mentioned that they have received mainly positive feedback, but also some negative, from their customers and drivers about their currently employed pricing model. Interviewee 2 mentions negative feedback: "*whenever something is changed, there always comes negative [feedback]*". But interviewee 2 mentions that they have received surprisingly low amount of negative feedback, and they think that it is because in their operational area, several dispatch centers already have similar category 2 type of pricing model, and they have possibly experienced that it is easy to compare prices instantly between different service providers.

As I mentioned earlier about interviewee 3's case how their pricing model affected to trip costs on shorter trips, interviewee 3 mentioned that they had received feedback from customers that mentioned similar observation: "*others have said that [prices] have raised a bit but on the other hand got cheaper on shorter trips*". Interviewee 3 also mentions that customers have experienced their current pricing model to be more "*clear*" compared to old pricing model before regulation change in their operational area because "*in old model, customer could not really calculate beforehand how long time goes to traffic lights or other things*" and the reason for this issue is that "*hourly rate of slow drive [waiting fee] has not been clear*". Interviewee 4 mentions problems related to waiting fee that it is "*absurd notion*" for customers that what it means and provides example where one can travel same distance but when traffic lights comes on the way, it just keeps adding cost to taximeter. Because of that, interviewee 3 feels that their current pricing model is easier for customers to estimate trip price themselves by just input information for example to Google Maps where one can see trip length and time estimation when customer can calculate trip price estimation from that.

Feedback from drivers was several times mentioned to be related to that prices are too low in their opinion. Interviewee 7 also mentions one negative feedback to be that prices for some trips are too high. Interviewee 6 mentions that in their case, if trip to pick up location is too long, they decline large amount of rides that have cost of minimum fee. In interviewee 4's dispatch center's case, their drivers argued that "*day prices lowered a bit in short trips*". The management of interviewee 4's represented dispatch center have acknowledged that but their reason to keep such pricing model active is to encourage people that uses their "*own money*" because they do not have right for "*transport services in accordance with the Disability Services Act*" to use their services and that they do not want to lose those customers even though those trips tends to be shorter ones.

4.2.3 Definition of category 3 pricing models

Category 3 type of pricing models only contains *type 11* pricing model. It is completely different pricing model compared to other pricing models because it consists only from fixed basic fee and trip time fee which only depends on how many passengers is onboard.

Several reasons to implement category 3 type of pricing model raised from interviews. Interviewee 8 mentions main reason to implement only time-based pricing model to be that it is easier for customers to estimate trip price. According to interviewee 8, that

would be the case when customer knows estimation how long it takes to travel, for example 15 minutes, to destination but is not sure how long distance there needs to be traveled. That is also well-received from customers. Therefore, it is easier for customer to just calculate price using one component but it is also easier for drivers to give price estimation which interviewee 8 thinks not to be that clear in case of category 2 type of pricing models. Interviewee 8 also mentions that their pricing model matches closely to competitors pricing model's and also to pricing model before regulation change's cost level but might be "*slightly pricier compared to competitors if trip have a lot of waiting and short transitions*" but on the other hand interviewee 8 mentioned them to be more competitive if trip is straight route from origin to destination.

Operational costs, especially drivers paychecks, were one interesting aspect to point out when discussing benefits on category 3 type of pricing model. Interviewee 3 mentioned possibility to only pricing taxi trip based on time used to be "*justified*" if considering that taxi driver entrepreneur's turnover is "*50-70% wage bills*" and time creates working time. Interviewee 8 also mentions that drivers paychecks are time based. But interviewee 8 also adds that operational costs changes only marginally when car is moving or when is not. Therefore, every vehicle should have certain "*hourly return*" and that is also one reason why interviewee 8's represented dispatch center have implemented such pricing model.

Also, some criticism raised when discussing category 3 type of pricing model. Interviewee 6 mentioned that it could be "*pretty unfair*" from customer's perspective if vehicle gets stuck for example in traffic lights and prices raises to too high level even on shorter trips. Interviewee 6 mentions also another valid point more related to drivers behavior that this kind of pricing model might encourage drivers for "*unnecessary slowly driving*" and that was already visible when moving from purely trip based fee to interviewee 6's represented dispatch center's employed category 2 type of pricing model as taxi drivers "*speeding ended and taxis are slowing down over there*".

4.2.4 Fixed prices

Fixed prices was one pricing model mentioned to be employed in some manner by several dispatch centers. From collected data, it became clear that fixed prices have focused on the trips between city center and other transportation location, such as airports. But dispatch centers are offering fixed prices also for other routes even *permanently* or just as a *campaign* for certain time. Interviewee 6 mentioned that they are actively trying to identify "*main routes where people are traveling*" and offer always same price for those routes. Interviewee 2 mentions that their represented dispatch center offers fixed prices for similar routes because "*it is easy to set certain price to some certain, a lot of used routes*". Interviewee 4 mentions that in their case, fixed prices are targeted more to travelers in cooperation with local city government.

According to interviewees and collected data, there are three usual ways to offer fixed prices. One way is to *negotiate with driver* which came up with several interviewees. Second way is that dispatch centers *offer fixed prices for certain trips* via their website. Third way is to *offer fixed prices via application*. In addition to those, fourth way to *offer and order fixed priced trip is via calling* as interviewee 6 mentioned. Their dispatch center can offer fixed price for trip if customer provides origin and destination when ordering taxi by calling. In their case, there is one interesting technology related thing as their call center uses different map data compared to their application which might lead slightly different fixed price for customer ordering using application compared to ordering by calling.

Interviewee 6 mentioned *reason to implement* such fixed pricing is that they think it is important for consumer to know trip's price beforehand because otherwise it would be "*hard to make purchase decision without knowing what it costs*". Similarly, other interviewees raised same advantage for fixed pricing as it is beneficial for customer to know trip's total cost before accepting taxi trip from set origin to set destination. And that is, according to several interviewees, beneficial for customers that are not familiar with local taxi markets pricing, and area in general, and also do not know what kind of trip total cost to expect. When comparing fixed pricing to identified pricing models showcased in table 4, "*only that what we charge from customers as a basic fee and trip length fee, is not yet leading to certain outcome*" as interviewee 1a mentioned. Interviewee 8 mentions that fixed price is "*best of all methods"* and "*transparent"* pricing methods and that's why it should be used more often. Interviewee 2 also adds that by using fixed price, customer do not have to take a risk to get "*some other price"* when using taximeter to calculate trip's total cost. Interviewee 4 sums these nicely by speculating from customers perspective, what the benefit could be when using fixed prices:

> "*There is one euro per kilometer and one euro per minute, but how do I suppose to know how many minutes it takes to get there when I am for first time traveling there and how far that destination is. But if they say to me that it costs 20 euros. Would I use taxi more often? I think that I would. When taxi utilization needs to be raised, it needs to be brought to be as a form of support for public transportation. That would not be possible without telling to customer what it costs.*"

Interviewees also mentioned some *advantages* for drivers when using fixed price. Interviewee 2 mentioned that when price is fixed for certain route, and there are a lot of customers, it is also "*easier for drivers when price is always same*". But from drivers perspective, it is important that fixed prices are calculated correctly so that it is profitable for them. But at the same time, pricing needs to be competitive compared to competitors. Interviewee 1a mentions also that their target was to make fixed prices as close as their prices when driving with taximeter to avoid confusion and dispute.

Several reasons came up why dispatch centers *have not implemented*, or enabled, fixed pricing. One interesting *technology related* thing was that according to interviewee 1a, their represented dispatch center offers fixed prices via third party mobile application targeted to consumers that is not specific to certain brand. In that dispatch center's case, problem is that their own, branded, application do not make it possible for them to enable fixed prices because their application provider have not implemented that feature.

There are also *business reasons* why dispatch center *might not have implemented* fixed prices at all. Interviewee 3 mentions reason why they chose not to implement permanent fixed pricing was that they can not "*anticipate if someone else is going to that certain way or coming back from there*" which is dispatching related problem. Interviewee 4 mentioned that they were thinking about possibility to "*offer*" choice for customers to choose from fixed price or taximeter based pricing when they tell their trips origin and destination. However, interviewee 4 mentions problem here to be that from their experience, Finnish taxi customers do not want to tell their destination when ordering taxi, at least by calling. Interviewee 4 continues to suggest that if customers would tell their route, including both origin and destination, dispatch center could improve their dispatch systems to be more "*customer-oriented*" by making it possible to "*to chain trips*" to reduce costs from customers perspective. Interviewee 4 did not explain more in-depth why that certain issue matters so much. Fixed pricing might also be unfavorable for any party. Interviewee 2 mentions that it is "*risk*" that it might be more

expensive or cheaper for other party and also continues to mention that it could also be "*unprofitable*" for drivers to drive that certain trip. Interviewee 6 continues to mention that if there are traffic congestion "*of course it annoys the driver*".

Fixed pricing models have also some *potential problems* related to trip itself. One major problem is the changes to the trip on the go. Interviewee 1a mentions example where customer have paid for fixed price from origin to destination, but then decides that wants to visit for example at the pharmacy midway which creates problematic situation from pricing perspective. Interviewee 1a also adds that in their dispatch center's case, their drivers can adjust trip parameters in the middle of the trip and therefore whole thing is "*dependent on driver*" that changes to fixed prices trip are possible. Interviewee 3 also mentions similar things and adds that there are "*multiple parameters*" in taxi trip and changes to these parameters might lead to "*argument between driver and customer*". Interviewee 8 mentions same things as previous two but states that there needs to be concrete terms clearly stated for fixed price that it includes only traveling from origin to destination with certain waiting time, and that fixed prices terms can expire or there can be additional costs added if those terms are not followed. Interviewee 4 mentions one solution to be that if those terms expire, then "*new transportation*" is created. But to make fixed pricing work in practice, interviewee 4 mentions also that drivers need to understand "*what fixed pricing means*" and what are the correct actions if terms are broken.

Interviewees mentioned one certain way to calculate fixed price which is in many cases similar to how price estimation is calculated. More about price estimation calculation is described in chapter 4.3. Interviewee 8 mentioned that they offer fixed prices via more general purpose application which calculates fixed price based on customer's given origin and destination. Interviewee 8 continued to specify that the calculation itself is done in their systems using those parameters.

Some interviewees mentioned that they had received *feedback* from drivers related to fixed prices. Interviewee 1b mentioned that they received feedback that fixed prices can be lower than price using taximeter if they have needed to "*queuing at traffic lights*". In addition to that, interviewee 1b mentioned that they had received critical feedback from customers stating that trip could be "*overpriced*" fixed price when it is not understood that trip is shorter than assumed.

4.2.5 Other identified pricing methods

In addition to pricing models for regular trips, interviewees mentioned *campaign pricing* as one possible alternative. Several interviewees mentioned different *events* as one possible thing to offer certain campaign prices. Some dispatch centers mentioned that they have employed campaign prices *at certain days and events*. Pricing have been *fixed for certain route* from specific origin to specific destination. Or at some certain days, some group of people could have *traveled for free*. The idea to implement campaign pricing vary and interviewee 3 mentions that usually in their case, campaign pricing is created *in cooperation* with event organizer or with some other partner.

The reasons to implement campaign pricing vary. Interviewee 2 mentions that "*if customers experience that they get some advantage from using our services, that would be good thing*" because then they have reached their customer correctly which leads those customers to use their services again which then creates profit. Interviewee 6 mentions sole reason to implement campaign pricing to be making customer choose to use their services and therefore get new customers. Similarly, interviewee 8 mentioned that they did pricing at the beginning with mentality to offer their services "*a bit*

cheaper" than their competitors to help campaign their services, but they had to raise their prices to general level to make taxi trips profitable to drivers. Interviewee 7 also mentions that they have implemented many campaigns to raise demand and application downloads. Because of that, interviewee 7 mentioned that drivers have complained about these campaigns that those reduce prices too much. That's why it is their drivers decision if they want to drive with campaign prices or not.

Interviewee 3 mentions that they did not implement concrete fixed pricing but instead have implemented *campaign pricing with fixed prices* because in that case, there is "*higher chance get next trip where customer leaves taxi*", which they mentioned to be one reason why they have not implemented fixed pricing. They have had some campaigns in the past at the time of some larger event and reason for that is because many of those customers are out-of-town and therefore unfamiliar with local taxi markets and is not familiar with town. Therefore, it is beneficial to just offer fixed campaign price for certain route so those customers "*dare to use taxi*" and it is also easier to campaign certain price. Interviewee 2 mentions that customers have mentioned that campaign pricing is a good thing because it allows them to save money on trip costs.

Most dispatch centers across identified pricing model types uses *pre-order charge* when taxi has been ordered certain time before actual trip begins. This was part of old pricing model before regulation change but several dispatch centers have decided to drop pre-order charge altogether. Interviewee 3 mentioned that based on their gathered data about taxi trips and for what time pre-ordering is mainly targeted, they noticed that those would be mainly targeted at "*early hours*", for example airport trips. According to interviewee 1a, their represented dispatch center abandoned pre-order charge, because it is not "*this day*" and based on feedback they have gathered, it also added unnecessarily large amount to total trip cost just to get a taxi. Interviewee 3 mentions that customers would use pre-ordering "*willingly*" if it would not raise total cost of trip "*too much*". As mentioned earlier, interviewee 3 mentioned that their pre-orders are targeted at early hours in the morning, and therefore it would be beneficial for them to know about those trip beforehand, so they can "*organize*" trips more efficiently by "*chaining*" trips and make sure that driver will be there to pick up customer. Interviewee 3 also continues to mention that it is currently "*challenging*" to get driver to work at night and also drive shorter trips because after regulation change, they can not force drivers to do those trips. Interviewee 3 mentions lastly that by dropping pre-order charge, they want to encourage customers to pre-order taxi instead of trying to get taxi at early hours in "*fifteen minutes notice period*" and that is well-received by drivers because they also get information about trips earlier and can "*anticipate their actions better in taxi field*".

In case of interviewee 4's represented dispatch center, they initially removed pre-order charge from trips that were ordered via application because they wanted to encourage customers to use their app. So their reason to drop pre-order charge touched only specific portion of customers campaign-like. However, they decided to allow drivers to charge pre-order charge if they wanted because in some cases, where pick-up location is in remote location from their main operational area, they needed to "*ensure that they can get driver there*".

Based on data collection and interviews, some Finnish dispatch centers have also implemented *minimum fee*. Minimum fee means that customer pays every time at least certain amount for trip regardless of basic fee, trip length fee, trip time fee or waiting fee. Interviewees mentioned several reasons to implement minimum fee. Interviewee 2 mentions that "*it's easy for both driver and customer easy when we say that total cost of trip is always at least that*". Interviewee 6 mentions that they implemented minimum fee because when they abandoned basic fee, that led to situation where trip's total cost

would have been just few euros for short trips and that made drivers to complain. Interviewee 7 had similar thoughts about this issue, and they implemented minimum fee to make sure that drivers accepts even shorter trips. Minimum fee can also be used as part of marketing campaigns. Interviewee 6 mentioned that they used marketing campaign in form that with certain price, customer can ride taxi certain length in city centers.

According to interviewee 8, when they did not have basic fee, they were in situation where pricing was too low to be profitable: "*pricing can be so low that then drivers arrival and all other servicing would not have been possible with just few euros price*". But interviewee 8's represented dispatch center did not implement minimum fee, but they added basic fee instead because they felt that would be more "*fair*" for customers to have certain basic fee instead of minimum fee. Interviewee 5 was more critical towards minimum fee by implying that by removing pricing components, such as basic fee, and implementing instead minimum fee is basically "*eye-turning trick*" and in practice, that could be more expensive for customers for short trips and adds that it is "*cheating*" in their opinion.

Zone boundary pricing was mentioned by interviewee 2. According to interviewee 2, that pricing enabled drivers to turn on taximeter in another spot when driver needs to go outside specified zone boundary. Reason for this is that Finland is so sparsely populated in some areas, and dispatch centers operation area might be so large that drivers driving distances could be so long that they might have to drive very far to pick up customer. Therefore, they can charge customer from driving to pick up location from the length that is outside of zone boundary.

Then every Finnish dispatch center have *call service*, which customers can use to order taxi by calling or by texting. The phone calls are priced differently across dispatch centers, but basically every call has some kind of basic fee and then extra cost based on call length. Therefore, ordering taxi via phone costs extra compared to ordering via application or street hailing. Interviewee 4 and 7 mentions as an only interviewee that cost to be part of trip's total cost. Interviewee 4 also mentions another way to order taxi by calling and that service is called "suorataksitilaus". According to interviewee 4, that works by locating calling customer by operator, which adds unnecessary big cost to taxi trip's total cost. Interviewee 4 continues to mention that ordering taxi using call center only adds "*a bit over two euros*" to total cost of taxi trip. For interviewee 7's represented dispatch center's case, they mention ordering using phone to be one source of income and therefore ordering using applications reduces that. Interviewee 4 mentioned also that customers can get price estimation when calling by giving trip's origin and destination with other relevant parameters. Interviewee 4 also continues that only 10% of customers want to know price estimation so that is not "*ordinary*".

4.2.6 Possible pricing models to be used in Finland

When discussing other possible pricing models with interviewees, consensus was that pricing needs to be based on something that can be measured. In addition to trip length and time used, no other possible ideas were raised in interviews. Interviewee 3 answered to this question by stating that "*anyone can use whatever pricing model they want*" but no concrete ideas were raised. Interviewee 1a mentioned that "*best pricing model would be flexible which could be used in different situations, which is from customer's perspective transparent, believable, trustworthy and attractive*". Interviewee 7 just mentions that pricing models needs to be "*clear*". Interviewee 6 mentions that according to their customers, they "*only want to pay for length of the trip*" and it is one

problem to create pricing model that is only dependent on that, and what is "*transparent*" but then problems arise on longer trips.

Pricing based on *zones* inside operational area was one pricing model that came up in interviews. Interviewee 4 mentioned that such pricing could work in bigger cities but in their case, that would not work. Interviewee 4 continues to mention that "*trip costing 20 euros is 93% value of ride*" because their operation area is so small. That kind of pricing model came up as implemented when data collection was performed. In that case, it was clearly split into two separate zones in more sparsely populated area. That dispatch center operated with pricing model matching with type 4, which belongs to category 1, in one bigger city in their operation area and in the other operation areas, their pricing model is type 2, which belongs to category 1 as well. Interviewee 8 also throws idea about zone pricing but in a manner that customers buys tickets and taxi is comparable to public transportation but continues to mention that requires more "*volume*" to be profitable.

Interviewee 4 mentions different "*time -based flexibility so in a way different pricing models to different times in stages*" to be viable options for pricing models. That idea resembles some ideas from dynamic pricing, As an opposite idea, interviewee 6 mentioned that it would be possible to create pricing model that is as simple as possible, and also stays same regardless of time, for example "*basic fee would be 1e and minute 1e and 1e per kilometer*" and continues to add that would be easy for customers to understand and calculate price. Later interviewee 6 also mentions one pricing model that is not even implemented in Finland where there is only trip length fee without any other pricing components. According to interviewee 6, that could be "*clear and fair and easy for customers to estimate trip price*" but continues to mention that major disadvantage on that pricing model would be that it would not take into account "*traffic congestion*".

To sum every mentioned possible pricing model, interviewee 5 mentioned that pricing returns to starting position as "*how many kilometers it takes so operational costs and how much time it takes and how much fixed costs there needs to kill and working costs needs to kill or to target to transportation task*". Interviewee 5 continues that "*even though we considered many different pricing models, we always ended back up to this same length and time measuring*" and gives as an example cases of delivery services and fixed prices and mentions that their pricing is actually in the end about time and length traveled. To sum that up, interviewee 5 suggests that only viable pricing model in Finland could be based on time and length traveled, and after that there can be different methods such as "*shared costs, mixed transport pricing or ride chaining pricing*".

4.3 How technology affects pricing

Technological stack is key part of dispatch center operations. Interviewee 4 mentions that those systems have central role and contains multiple pieces to make one properly functioning system to control cars on the field because "*cars are not independent there and requires dispatch systems*". Also, worth noting that consumer applications are also integrated to those dispatch systems so those are not independent according to interviewees. The main question here is to understand that if, and how, technology affects taxi trip pricing. According to interviewee 8, in their case, technology do not currently affect to their taxi trip pricing at all, but others mentioned that technology is one big obstacle when doing updates to pricing.

4.3.1 The role of technology in dispatch centers

Several parameters affecting taxi trip pricing came up from interviews. Some are mandatory for current operations, some are mandatory to implement for example dynamic pricing and some parameters are just possibly useful. Interviewee 2 mentioned some parameters to be "*how many vehicles are free*" and "*on what areas those vehicles are at the moment*". Interviewee 2 mentioned Uber's ability to handle different parameters as part of their pricing as one example, and mentions situation where taxi prices raises because of some event.

Some *benefits using regular taximeter* came up in few interviews. Interviewee 4 mentioned that those are "*consumer interface*" and it is a good way to inform customer about pricing. Customer might ask fixed price and compare that given fixed price to actual price calculated by taximeter, and choose then which one they want to pay. Customers can also compare taximeters calculated price to pricing catalog in car, and to what dispatch center promises to be maximum price.

In part of interviewing, interviewees mentioned different alternative technologies that could be used as part of pricing, or to provide more flexibility to pricing. Interviewee 3 suggested that "*taximeter is not today any way required instrument because price can be provided for example verbally*" and continues to provide example: "*if price goes over 100 euros, then one needs to ask for permission or provide information before trip, but if side of vehicle reads that 10-kilometer trip is 99 euros, that is perfectly legal model to work and that do not have to be based on any taximeters calculations*". Interviewee 3 also mentioned that because regulations do not strictly define what kind of device can be used to calculate trip, the other device could be for example application which gives fixed price for customer such as Uber's application which "*only provides fixed prices wherever is the destination and it is not based on measured time or measured distance*" and that allows drivers to provide trips in any price they wish. Interviewee 3 also mention that because of standardized template to show taxi pricing, the taxi prices could be shown via electronic screen which enables drivers to have more flexibility to change pricing for example "*every 5 minutes*".

4.3.2 Challenges that technology brings in terms of pricing

Technology stack utilized by dispatch centers can affect taxi trip pricing different ways. Interviewee 2 mentions one restrictive reason to be if systems and technology is "*very old-fashioned*" because pricing models needs to be "*built inside the system*". In interviewee 4's represented dispatch center's case, their technology provider did not have the possibility to implement fixed prices to their older system. Interviewee 3 mentioned that they had some issues initially when they were implementing new pricing models into the system but after that, they have not had any issues with technology when working with pricing models. According to interviewee 3, the issue was about implementing continuous time based calculation instead of previous waiting time based calculation that occurred on set times when vehicle was moving maximum 28 km/h. Interviewee 3 also adds that "*technological expertise is required*" when implementing pricing model changes. Interviewee 3 also added that they needed to implement some changes to their system to be able to load new fares to their vehicles. Interviewee 4 mentioned issues regarding that their taximeter hardware and software, and also dispatch system was provided by different parties which led to "*lot of challenges*" when implementing new pricing models. Also, notable thing is what interviewee 4 mentioned that "*driver is not able to decide unit prices in the car themselves*".

In general, taxi dispatch center representatives feel that currently their technology stack providers are *restricting* possibilities to set prices for taxi trips. Interviewee 4 mentions "*vendor-lock*" to be big issue on technological development. Interviewee 4 mentions one example of such case: "*if you create own application and want there all your own features, you are however still at the mercy of dispatch systems interfaces*" and continues that it is possible to create completely own application if one have money but still all changes costs still and "*technology provider can set the prices to use interface as they wish*".

Interviewee 5 then mentioned that they *could not implement* new pricing model right after the Act on Transport Services came into effect because their technology provider "*was unable to implement the changes to their taximeters*" and continues to mention that they have wished their technology provider to implement some new features so that they could implement changes to their pricing model but those requests are still not fulfilled. According to interviewee 5, that particular feature would have been "*price cutter*" that would have been such that after certain distance, the taximeter would not calculate time component for total trip cost fully but only partly. Also, interviewee 5 mentioned that in their case, technology provider did not agree to develop any requested features for their specific hardware, because those were "*old*".

Interviewee 3 mentioned that currently they can implement "*not dynamically changing prices*". Interviewee 3 continues to mention several such pricing models: "*purely time based*", "*purely trip length based*", old pricing model before regulation change, their currently implemented pricing model, or any pricing model with or without basic fee. Instead, interviewee 7 mentioned that their decision to choose pricing model was limited by technology. And from more flexible pricing perspective, the main problem is traditional taximeters.

Few reasons came up from interviews why some dispatch centers *do not provide fixed prices* from application. In some cases, main problem is the technology in use. As interviewee 1a mentioned, their branded application can not use price estimation as a "*so-called contractual price*". On the other hand, others have decided just not to offer fixed prices via their application.

Also waiting fee adds technological challenges. Interviewee 6 mentioned that it was hard to "*simulate*" slow driving in their application, which led to situation where their application provided significantly different price for trip compared to pricing determined by taximeter.

4.3.3 Dispatch centers' provided e-hailing application for customers

Most dispatch centers offer tools for customers to calculate estimated price for their trip via dispatch center's website or via their mobile application targeted for consumers. Interviewee 4 mentioned that people out-of-town uses price estimation calculators to estimate price they are required to pay for trip when customer is not familiar with place where one is heading or to check following day's trip's cost. Some mobile applications offer also ability to use fixed price calculated from input parameters. Mainly these input parameters are origin and destination, but several dispatch centers allow entering multiple additional parameters, such as time of trip to calculate with correct fare if it's based on time, number of persons would be onboard, possible additional stops in the middle of trip and several additional parameters to calculate additional costs, such as pre-order charge and if there will be extra cargo.

These *price estimation calculations are based on map data* to calculate estimated route from origin point to destination, including all extra parameters. There are various different map data providers in use. Some mentioned map data providers were Google Maps, TomTom and Mapbox. Some of those map data providers require users to pay license fees to use, such as Google Maps, and some are free, such as Mapbox. According to interviewee 4, because of low price calculator usage, they feel that it is not necessary for them to pay different license fees to get "*real time statistics*" about traffic. Interviewees mentioned that they use only one map data provider with their systems and some have choice to select which one is preferred for them. But with interviewee 6's represented dispatch center's case, they use different map data in call centers and in their application which might lead different fixed price for same trip. Several interviewees mentioned that their pricing estimation, and other prices also, are fetched from their own dispatch system.

Price estimates are according to interviewees pretty accurate, but in some cases there are issues. In one dispatch center's case, their mobile application's price calculator do not take into account different taxes for different times of day. Interesting mention here is that at the same time, they use application from third-party provider which supports these pricing parameters fully and therefore is capable of providing more accurate pricing estimation than their own application. There are several other variables that can affect to price estimate. Interviewee 2 mentioned that amount of traffic congestion and "*amount of traffic lights and their position depending on if there is red or green line*". Reason for that is simply according to interviewee 2 that system can not know what the conditions are for trip in real-time and that is why final price forms from the real distance and time used to travel.

Interviewee 3 mentions that their pricing estimation from map data provider might not be 100% accurate because of possibility to use other routes if customer or driver knows more cost effective one from customer's perspective, but not worse one. Interviewee 3 also mentions that their price estimation is usually correct, or a bit higher than actual price, but they have not heard about situation where price estimation was lower than final price. Interviewee 4 mentions that their current pricing estimation are close to reality based on customer feedback, and they have "*iterated it a lot*".

Interviewees mention that their mobile application for customers *lack some features* that are relevant for them. In these cases, they are mainly using application that is same with other dispatch centers. One lacking feature mentioned was lack of zone boundary pricing, and therefore pricing might not be accurate when ordering taxi from that application. Interviewee 2 mentions that because application is "also *used in other areas*" and therefore that application can not be specifically customized to one's need without making it harder to distribute application in application stores and for customers to choose correct version of application for certain area. Second feature lacking mentioned was ability to show correct price via application when campaign pricing is active, and interviewee 3 mentioned that but added that the actual payment happened with the information from taximeter instead of what application shows and therefore ordering campaign priced trip via application with correct pricing is possible. Interviewee 3 also clarifies that campaign prices are implemented as "*contract price*" which driver needs to input manually to the system. Interviewee 6 mentions that their application only supports to order taxi with fixed price. According to interviewee 6, the reason for that is "*some kind of technical challenges*" but customers can separately request to ride with taximeter instead of fixed price. However, interviewee 6 mentions that this lack of feature is not problem from their perspective, and they think that "*customers want even more to know the correct price before trip and it helps them to make final purchase decision*".

Not every dispatch center relies only on one specific application but can also be part of other third-party, more general purpose, *taxi hailing platforms*. In Finland, there are two nationwide applications available to customers which can be used almost every municipality. These general purpose applications enables customers to be able to compare dispatch centers pricing between each other easy way. Interviewee 2 also mentions that one application also informs customer and allows comparison of how "*fast taxi arrives from order*".

On the other hand, other third-party applications might not have same features than others. Interviewee 3 mentions that with other application, compared to their own "official" application, it lacks price estimation, which is required feature today. According to interviewee 3, that is result of lack of development from third-party application provider, and lack of any possibility to customize that application to suit individual dispatch center's needs and that is also one of the reasons why they have adopted their current "official" application: "*if application do not fulfill those standard where for example price estimation needs to be offered to customer, then we need to have another product that can deliver those features*".

4.4 How dynamic pricing is received and understood

Definition of dynamic pricing from dispatch centers' representatives varied a bit but mainly their view was that it means pricing model similar to what Uber currently uses. But some interviewees mentioned right from the beginning that exact definition of dynamic pricing is unclear for them. That was shown as interviewee 2 tried to guess its definition as follows: "*so does dynamic pricing mean that price changes according to the times of day?*" and interviewee 2 states afterwards about dynamic pricing that "*in my opinion it is a bit opaque that whole dynamic pricing on what it means and I think that nobody really knows what it actually means*". Interviewee 4 also mentions similar issue: "*dynamic pricing is a bit such a thing that when this is talked about, many people understand it different ways*".

Interviewee 2 is along the same lines as they think that dynamic pricing is about different pricing at different times of day and adds that then it is required to understand how pricing model acts if it changes during the day, or if thinking that it changes based on season when "*trend would be longer term*". Interviewee 2 mentions that their thoughts related to dynamic pricing are more related to "*long term pricing*". Interviewee 2 also adds that in other hand, markets deciding pricing is also "*dynamic pricing*".

In addition to those, interviewee 3 mentioned that in practice, dynamic pricing focuses to rush hour times, or times with less demand. Interviewee 3 mentions specifically Uber and that they brought "*development*" to taxi markets by implementing dynamic pricing where price changes based on demand and supply. Interviewee 4 describes dynamic pricing similarly to be what Uber uses for pricing in which when cars are on the duty, then prices are "*put down*" and when supply is low and demand is high, then prices are increased. Interviewee 4 continues by defining further their understanding of dynamic pricing that it creates "*price flexibility*" and that can be implemented using technology.

Interviewee 6 described dynamic pricing a bit differently as they just mentioned pricing to be dependent on current demand without mentioning supply. Interviewee 8 mentions only that with dynamic pricing, it is dependent on "*demand spikes*". Interviewee 1a mentioned that in their opinion, dynamic pricing requires "*some sort of continuous demand*" and from their perspective, it is about that price changes according to times of day or certain events or related to demand. Also, interviewee 5 was mentioning similar things.

Part of this research was to understand if interviewees thought that their current pricing model, or possibilities to implement pricing model, would be more dynamic. In general, interviewees did not consider their current pricing models to be more dynamic. Others considered them to be "*some ways*" more dynamic. Interviewee 2 mentioned that their current pricing model gives "*more accurate price*" and that it is "*more correct to certain transportation*", especially when trip is happening in "*urban condition*" instead of when driving on the highway where that does not matter. Interviewee 6 do not consider their current pricing model to be completely dynamic but think that it have some elements from dynamic pricing as their pricing model have different fares for different times. Interviewee 6 stated that it is "*poor dynamic pricing*" as it assumes demand to vary similarly "*day-to-day and week-to-week*". But interviewee 6 also mentioned that their current possibilities to change pricing models are more dynamic because now they can adjust application's pricing "*very flexible*".

Interviewee 7 mentioned that their current pricing model is created based on demand by analyzing historical data. According to interviewee 7, they analyzed "*occupancy rate*", how pricing was implemented in "*elsewhere in the world*" and "*other similar comparisons*". Based on that information, they had few options to go with, and they chose implementation that at times "*with less demand, price is lower*" and at times that "*have more demand, price is higher*". Interviewee 7 clarified that they do not consider that to be "*real*" dynamic pricing because they set their fares "poorly" beforehand based on "*estimations*". Interviewee 7 also argued that pricing based on demand and supply, specifically "*Uber -alike*", will be more popular in the future.

4.4.1 How technology affects to implementation of dynamic pricing

Dynamic pricing is something that is not possible for several interviewed dispatch center's case. Interviewee 3 mentioned that they would need to build more technology to support dynamic pricing based on demand and supply. Interviewee 8 thinks that one issue to be solved related to implement dynamic pricing is about "*how current price can be offered to customers*" and what system have "*enough capacity*" to implement those features. Then interviewee 8 continues to mention that at least their systems do not make it possible to implement dynamic pricing currently.

Interviewee 1a mentioned that from their point of view, issue with implementing dynamic pricing within "*traditional dispatch centers*" is that technology providers have created their products to the "*old, closed system*" where were only a few variables to be processed, and also these systems are built in a way that makes it impossible to "*change one component without affecting to several others*". According to interviewee 1a, that means from implementing dynamic pricing perspective that even technology provider or service provider needs to be changed or technology provider needs to create new system which is based on "*microservices*" that makes it possible to "*personalize*" on a customer-on-customer basis.

Interviewee 6 mentions that they are currently considering implementing dynamic pricing in their application "*right when technology makes it possible*" which implies that their current technology stack do not make it possible. Interviewee 6 mentions main problem to be that their application contains so many integrations to different dispatch systems which makes it complex as a whole. Interviewee 6 continues to mention that their long term target is move to use only one dispatch system which makes those kinds of "*efforts*" move forward faster.

Dynamic pricing requires specific features to be implemented to technological stack to make it possible to implement dynamic pricing. Interviewee 2 mentions that system

needs to have ability to generate the current price during the day automatically, which is based on some "*trend*" generated from "*tracking data*" that determines how price should be adjusted on different events, and then that price needs to be sent to taximeters inside vehicles. Interviewee 5 adds that they would also need pricing system in to the vehicles that can be adjusted in real-time as a requirement to implement dynamic pricing. According to interviewee 7, they are going to implement real-time dynamic pricing at some time frame. Interviewee 7 mentions that biggest limitation they have with their current technological stack is that they are unable to set fares real-time but instead they "*must*" set fares beforehand to their taximeters. Interviewee 7 continues to suggest that solution for this problem would be "*software taximeters*" but the regulation towards them are currently unclear and therefore prevents them to use those.

In case of interviewee 4's represented dispatch center, their technology provider have notified them that dynamic pricing "*is possible to bring to their system*" but it is not currently "*enabled*". Interviewee 4 continues that according to their technology provider, it is more about "*if some operator wishes to start using it*". Interviewee 2 claims that their currently utilized technological stack makes it possible to implement dynamic pricing.

4.4.2 What possibilities dynamic pricing offers

Dynamic pricing can also be possibility if it is done right as interviewee 1a mentions their own opinion about that by following: "*I personally would take dynamic pricing to direction that it would motivate taxi users to use that service when they do not have anything else and also on the other hand to motivate drivers to that when there are no demand […] driver could perform differently priced trip*". Interviewee 5 mentioned conditions when dynamic pricing could be potential choice. According to them, dynamic pricing could be used to encourage drivers to work on uncomfortable times such as public holidays by "*modifying pricing as by raising prices and creating difference compared to normal weekdays*". Interviewee 5 also mentioned that this kind of adjustments they will make.

Interviewee 1a also lists good thing about dynamic pricing to be that at the times of low demand, one can offer ride "*a bit cheaper*" and "*create demand*" that way which leads to situation that vehicle is actively moving instead of being inactive. Interviewee 3 acknowledges possibilities but with certain limiting factors: "*we could offer at times with less demand cheaper rides but with those rides, we need to get proper profit*".

Interviewee 5 also mentions possibility to change pricing model on the go based on areas where taxi is currently driving by using technologies such as GPS to match more area specific pricing.

4.4.3 What are considered to be problems in dynamic pricing

Interviewee 5 mentioned that "*all kinds of weather effects affects to pricing*" and therefore dynamic pricing is about changing of "*occasionally occurring variables that can not be predicted*" which is also the reason they are not going to implement dynamic pricing. Interviewee 1a mentioned that possible problem would be that if pricing moves to direction which "*customers might not necessarily understand taking into account*".

Dynamic pricing raises doubts within dispatch centers. Interviewee 1a mentioned that "*dynamic pricing have not raised any positive thoughts*" at their dispatch center's board. The common issue is that because it might make pricing to spike from too cheap to too

expensive. Interviewee 2 thinks that their company do not see it "*right now topical*". Interviewee 4 mentioned that they do not consider dynamic pricing to be suitable for Finnish taxi markets: "*Finnish taxi users are very old-fashioned in a sense that they like to know that there would be no surprises*". According to interviewee 7, dynamic pricing could be implemented as fixed pricing or as a taximeter based. One based on fixed pricing would currently be possible but in their case, dispatch center owners are hesitant to implement it: "*we could implement it but our ownership, taxi entrepreneurs, are not ready to completely move to that*".

Several interviewees raised potential problems related to dynamic pricing' actual pricing and how customers would see it when using taxi. Interviewee 2 mentioned possibility that if pricing changes "*quite a lot*", that might put customers to certain situation where they are required to follow themselves what it costs at times and therefore dynamic pricing might be unclear for customers. Interviewee 2 compares dynamic pricing to "*gas station -type of pricing*" where price of gas differs between gas stations and then regular drivers are aware of gasoline prices and might go to refuel their vehicle if price is lower than usual. Interviewee 2 then states that such pricing model "*do not fit to every service*" because then pricing changes too rapidly, but instead interviewee 2 mentions possibility to "*implement some kind of discount or -raise*" as a measure to adjust pricing. Interviewee 3 mentioned things about problems related to rapid pricing changes but adds that customers can see exact pricing from application. Then interviewee 3 continues to mention following example: "*let's imagine that I would travel from here to for example every day at four o'clock to city, the trip might be priced differently tomorrow than today*" and concludes that example by mentioning that it would not be beneficial for "*regular user*". Interviewee 8 also thinks that there is risk related to dynamic pricing and how customers might think about it as after certain threshold related to pricing changes, customers might stop using service because they are not aware of current prices. According to interviewee 8, customers value more that pricing is in certain line that there are not that big changes frequently.

Interviewee 3 points out that to be "*traditional dispatch center*", they can not implement dynamic pricing. According to interviewee 3, "*traditional dispatch center*" differs from Uber by making it possible to order taxi by calling and that customers can be sure that pricing stays at the same level. Another reasons to not implement dynamic pricing for interviewee 3's represented dispatch center is that they have decided to keep their pricing "*clear*" for customers and also their management have not seen it to be "*beneficial*" because operational costs do not vary that much regardless of demand.

Interviewee 4 raises some criticism towards Uber's dynamic pricing as the drivers can not see the prices and customer just pay "*some*" amount of money.

4.5 Reasons why dispatch centers have made changes to their pricing

Pricing models have evolved to different directions after the Act on Transport Services came into effect. Some dispatch centers have made changes right after that regulation change but some have at later time. One reason to delay pricing changes was that regulation change was "*drastic and radical*", as interviewee 2 mentioned, and therefore they wanted to "*stabilize*" the situation. According to interviewee 2, the problem was that nobody was not sure on how to act, and they felt that they did not receive any instructions related to that which led them to do decisions at later time. Multiple dispatch centers have adjusted their pricing multiple times whereas some have only between from zero and few times. These changes have consisted from small pricing adjustments to total pricing model changes.

Almost every dispatch center in Finland have mentioned in their websites or in other sources that their pricing is "*maximum*" what drivers can charge from customers driving under dispatch centers brand. Several of those have implemented that right at 1.7.2018, whereas others at later time because of uncertainty towards regulation related things. Interviewee 2 mentioned one reason to be that it is for "*customer's safety*". Interviewee 3 mentioned that they think that maximum fees makes it clearer for customers to know "*what trip with taxi ordered from them costs at highest*". Interviewee 4 mentions maximum fees to be "*brand warranty*" which states for customers that maximum fees can not be exceeded and dispatch center also "*refunds*" to customer if that happens. Notable things here are that drivers can set price freely if that would be lower than dispatch center's maximum fees are.

Interviewee 4 also mentioned that *markets are now in control* of taxi trip pricing compared to past: "*actually we can not alone to determine anything, but competition determines market price, and we need to look for our place in relation to vehicle availability, quality and such things*". According to interviewee 6, taxi pricing is "*balancing with market*" where "*drivers think that prices are still too low and according to customers, too high*". Interviewee 5 mentioned that one thing affecting their decision towards new pricing model was to increase their "*competitiveness, or attractiveness*" and at the same time ensuring that business would be profitable. Interviewee 6 criticizes current taxi market players that "*not all have understood that market has changed*" and have tried to act like before when they could act as a monopoly. Interviewee 6 continues that "*it is natural that profits drop when new players arrive at the field and that needs to be accepted*" and also mentioned that "*bringing prices down is not sustainable solution*".

Also *brand related* reasons raised when looking into reasons for pricing changes. Interviewee 4 mentioned that when they changed pricing, they explicitly tried to "*dodge*" that idea in customers eyes that "*something costs more*" after changes. Interviewee 6 mentioned that when taxi market prices raised in general, they wanted to show to customers that their prices "*do not raise*" by dropping basic fee. Interviewee 6 mentioned that there might be things related to specific brand that affects pricing. Interviewee 6 mentioned as an example case, where taxi drives under other dispatch center which then again forces them to comply with their pricing. Interviewee 6 also mentioned that customer using certain brand's taxi's tend to have specific ways to use that dispatch center's services, such as for longer trips or airport trips. That sort of specific needs affect to pricing decisions. Interviewee 6 mentioned possible pricing model in that case to be having only trip based fee and higher basic fee which makes pricing to have smaller changes but then cheap trips drops altogether.

Customer base might also affect to trip pricing. Interviewee 6 mentioned, that one of their used application gives different price than their other applications, which are more brand specific, because those application services different purposes based on customer group utilizing it. In their case, interviewee 6 mentioned that one of the applications is targeted to "*local*" customers, who are familiar with brands and pricing, whereas other one is for customers "*from abroad*", who cares more about vehicle availability and is not familiar with local taxi markets.

Interviewee 4 added to reasons to adjust pricing to be that they want to keep their quality of service high. Interviewee 4 mentioned that "*biggest reason why one would use some company's services is the availability of vehicles, not that if it is one euro cheaper or one euro more expensive*" and to ensure that, it was their main priority when performing pricing changes. So for customers, the main thing would be that "*taxi arrived in correct time and took you to correct place, and the price matched that without exceeding maximum price*". Interviewee 8 have similar views regarding this:

"*in general I think that taxi customers do not look into pricing quite much until arriving destination*" and continues to mention that main thing would be that pricing matched to what they are used to. Interviewee 6 do not agree with that, and continues to mention that according to their researched, "*50-60% of those who seeks so-called normal taxi, are not willing to pay more and for them, price is important*".

4.5.1 How dispatch centers have adjusted their fares

One common change to pricing models after 1.7.2018 was to drop fare classes from old four to current two in trip length based fee. According to interviewee 1a, their represented dispatch center were one which implemented such change and reason for that was "*simplifying pricing*" which makes it "*clearer and more understandable*" which leads to "*less speculation*" and that brings "*more value*" for customers. Interviewee 1a however criticizes that current "*price tag*" set by regulations is "*too schematic*" and "*not that readable*".

One notable thing about dividing fares by number of passengers onboard is that it might not be thought as number of passengers onboard but as a size of a vehicle used for taxi trip. Interviewee 4 describes their fare division to be: "*our trips are split in a way that 1-4 [passengers onboard] have own price and 5-8 [passengers onboard] have own price, as small- and big vehicle*", and interviewee 5 have similar thoughts: "*small vehicles pricing and big vehicles pricing*". In those cases it came apparent that interviewees are actually referring those fare divisions to be based on "*vehicle's size*" instead of number of passengers onboard. That stood out when interviewee 4 mentioned specifically that their pricing model has been split into two categories based on time: "*there is daytime price and then there is nighttime and also weekend price*". Interviewee 4 mentions that their reason to utilize such pricing is because they need to encourage drivers to participate driving at nights when demand spikes because "*if price is the cheapest then, then we would not get drivers to work there*".

It became clear from data collected that pricing changes were in many cases minor as just being adjustments on fare amounts. Interviewee 1a mentioned that in one of their pricing changes they did that kind of adjustments when dropping "*small cents*" from fares to get more "*round*" prices which made it easier for customers to calculate quickly the price of trip. And after that, their changes have been moderate and have been more about small pricing adjustments based on current market situation.

Operational costs are one mentioned reason to adjust pricing. Interviewee 1a mentioned their pricing changes that they have mainly trying to "*catch up*" costs that were increased and therefore provide a way for their drivers to practice their profession. Interviewee 4 lists such operational costs to be related to "*driving in general, insurance, vehicle, brokerage fees and others*", adding also salaries to that list. To cover those costs, driver needs to get enough income. In interviewee 3's represented dispatch center, they have done some small raises and checks in relation to "*taxi price index*". Interviewee 4 mentions also similar things and adds that maximum fee definition needs to be based on "*the cost structure of the entrepreneur*" in a way that they can live with the income after pricing changes because they do not want to have "*50% staff turnover*". Interviewee 5 mentioned also that their current pricing is based on their estimation of their typical operational costs, including "*fixed costs*", "*variable costs*" and "*labor costs*".

Interviewee 3 mentions that in their operational area, they have a lot of "*driving to*" when picking up customer and compares their situation to be a lot different from in more densely populated areas in which there are a lot smaller risk for such driving.

Interviewee 3 mentioned that their current pricing model is based on that information so it takes into account empty drivings additional costs and adds that in principle, "*the more users, the more it would be possible that trip costs would be cheaper*".

4.5.2 Old pricing model's problems

One notable aspect about reasons for pricing changes from interviews was that most interviewees could not specify anything to be wrong in old pricing model which was in effect before 1.7.2018. Interviewee 2 just mentioned that "*I am not sure if there were nothing wrong in old one*".

Interviewee 3 mentioned that "*old pricing model was experienced as a bit old-fashioned in many ways*" but then clarifies that "*basic fees was experienced to be harsher*", more specifically "nighttime*'s*" basic fee. Interviewee 3 mentioned also that compared to their current pricing mode, old pricing model was not that "*customer friendly*" and mentioned that price of short trips became cheaper in their case.

Interviewee 4 mentioned main problem in old pricing model was linearity where "*first and last kilometer cost same*", which led to situation where price just kept raising to unreasonable high amounts on longer trips which did not match to real operational costs. According to interviewee 4, their current pricing model have been implemented based on real-world data collected from trips, so they could determine the effects to different trips.

5. Discussion

In this chapter, I will discuss empirical findings and compare them to prior literature. First, I will present summary of empirical findings. Then I will discuss about current state of Finnish dispatch centers' digitalization. I will also provide answers to following research questions:

1. Are pricing models implemented by dispatch centers more dynamic?
2. What is needed to make dynamic pricing possible in Finland?

Currently, pricing models implemented by Finnish dispatch centers are more dynamic than before the Act on Transport Services came into effect when comparing to definition of dynamic pricing, and especially reasons to implement dynamic pricing based on prior literature. I will discuss more about this in chapter 5.3. But to accomplish dynamic pricing where pricing is adjusted in real-time, there are several obstacles that Finnish dispatch centers needs to overcome. I will discuss what is needed to make dynamic pricing possible in traditional Finnish dispatch centers in chapter 5.4.

5.1 Summary of findings

Collected data and interviews gave broad overview how pricing models have evolved in Finland after the Act on Transport Services came into effect. Most of Finnish dispatch centers have moved away from old pricing model and developed new one, or at least have altered old pricing model slightly by dropping for example fare classes or simplified prices. Currently, Finnish dispatch centers pricing models can be categorized to three different categories as showcased in table 6 found in chapter 4. *Category 1* is most closely related one to old pricing model consisting from basic fee, trip length fee and waiting fee. *Category 2* is what most dispatch centers have moved to when they have changed pricing model, and in that category waiting fee is replaced with trip time fee. *Category 3's* only pricing model type is based on basic fee and trip time fee. According to findings, most Finnish dispatch centers are currently employing category 1 types of pricing models and category 2 types of pricing models is clearly second in popularity. And only one dispatch center was found utilizing category 3 type of pricing model. In addition to those categories, also fixed pricing, campaign pricing, zone-boundary pricing and minimum fee -based pricing have been utilized. In summary, pricing changes have been made to balance on drivers needs to get maximum profit, customers needs to get as cheap as possible and dispatch centers need to get as much possible revenue while ensuring that their quality level stays on acceptable level.

Based on interviews, it became clear that pricing changes have been made customers in mind. One common argument heard from every category's representatives was that their selection of pricing model is predictable, easy to calculate trip total cost, easy for customers to understand and is transparent. It seems that this depends on particular persons personal views and different operational areas different requirements. For example waiting fee used in category 1 was criticized to be opaque by other category's representatives, but category 1's representative mentioned that in their area, it does not affect to trip's cost that much. Interestingly, category 2 representatives mentioned their reason to implement such pricing model to be that from their perspective, the majority of Finnish dispatch centers have implemented such pricing model. That was explained

in a way that it should be easier for customers to compare prices between dispatch centers when dispatch centers have similar pricing models. When interviewees was asked about possible benefits in fixed pricing, interviewees answered to that from customers perspective. One thing they mentioned was that fixed prices are easy for customers because they know what trip costs, but on the other hand, fixed pricing might create issues when unscheduled changes to trip happens. Interviewees also mentioned that pricing has been used as a tool to encourage customers to use their services by lowering offering cheaper rides than competitors, and also having campaigns that offered discount. In combined, dispatch centers have tried actively to bring good quality service for customers that matches pricing, and they also try to avoid confusing them with their pricing changes. And that while maintaining their current customer base and when trying to get new ones. It was also mentioned in interviews that not every customer is interested in pricing, but more about availability so that they can be sure that they get the car.

Also, drivers and their profits have been under consideration when dispatch centers have implemented their pricing changes. It became apparent that drivers might easily discard trips that they feel to be unprofitable or if trip is uncomfortable for them. That kind of situation is for example driving in congestion which is time-consuming. One example mentioned was introduction of time based fee in one case, which was partly implemented to encourage drivers to drive in congestion. Actually there was interesting remarks on how much pricing model changes affects to drivers behavior. The fact that moving from trip length based fee to trip time based fee reduced taxi drivers speeding, but on the other hand made them driving unnecessarily slow at times.

5.2 Finnish dispatch centers' digitalization

In addition to pricing model changes, also Finnish dispatch center's have performed some digitalization processes in their business. That is also one major difference between Finnish taxi markets and traditional taxi markets in other countries which were more focused in prior literature. One specific thing that have changed is that currently almost every Finnish dispatch center offers their services through some mobile application. Therefore, as Guo, Liu, et al. (2017) have mentioned, traditional taxi service providers offer their services only via calling or street-hailing. Based on that, it is clear that Finnish dispatch centers do not match completely to traditional taxi's definition because Finnish dispatch centers offer their customers possibility to order taxi using mobile application just like ride-sharing services and CFDP does. But Finnish dispatch centers still can not be categorized as ride-sharing service because resources are owned by company, supply is fixed, pricing is based on fixed fares and Finnish dispatch centers still offer possibility to order taxi by calling or street-hailing. And in addition to that, Finnish dispatch centers can not be categorized to be CFDP either because pricing is based on fixed fares and Finnish dispatch centers offer traditional hailing options in addition to mobile application. Though, Finnish dispatch centers' pricing models can be considered to be more dynamic and I will discuss more about that in chapter 5.3, but they are still based on fixed fares without possibility to adjust pricing in real-time which is required for dynamic pricing.

Table 7. Key differences between traditional taxi, ride-sharing, CFDP and Finnish dispatch centers using categorization created by Guo, Liu, et al. (2017).

	Finnish dispatch centers	Traditional taxi	Ride-sharing	CFDP
Resource owner	Company	Company	Driver	Company
Supply control	Fixed	Fixed	Dynamic	Fixed
Pricing	Fixed fares	Fixed fares	Dynamic	Dynamic
Hailing	Street-hailing, calling or mobile application	Street-hailing or calling	Mobile application	Mobile application

As mentioned in literature, traditional taxi service providers needs to do more than just lower their prices. Currently, Finnish dispatch centers have taken small step in digitalization. They have enabled possibility for their customers to hail taxi using their mobile phone. In addition to that, those mobile applications makes it possible for customers also to estimate trip's total cost using price estimate calculator. However, same functionality can be found most of Finnish dispatch centers websites. Also, some mobile applications provide possibility for customers to select fixed price for their trip if they order taxi and tell their specific origin and destination whereas others have had issues related to pricing in mobile applications.

Another interesting thing related to addition of mobile applications as one of the hailing methods is that based on interviews, Finnish dispatch centers profits also comes from separate order cost from calling. In Finland, traditional dispatch centers have call centers that have certain cost if customer calls there. According to data collected and interviews, that adds few euros extra cost to total trip's costs. That same source of income is not there when customers order taxi using mobile application, because that is free for customers. Therefore, that might lead to situations where Finnish dispatch centers needs to find new source of income to replace call centers provided income if taxi orders focuses more on applications. But is that real problem for dispatch centers? It seems not to be that big because dispatch centers have even promoted their mobile applications and had campaigns to boost application downloads which indicates that they are ready to pursue that direction.

In literature, it was mentioned, that ride-sharing services have upper hand in competition compared to traditional taxi service providers because ride-sharing platforms can offer bigger fleet than traditional taxi service providers. That is because everyone can join ride-sharing platforms freely and that way platforms supply grows whereas traditional taxi service providers operates as smaller company with smaller fleet and can not offer as big fleet themselves. One solution mentioned by Kusuma (2018) is to create collaboration platform for traditional taxi service providers, where traditional taxi service providers can offer their services under one bigger platform like ride-sharing platforms do. However, that contains problems related to pricing model differences and fleet sizes. In Finland, there are few such collaboration platforms where Finnish dispatch centers can join and provide their services that way. The problems related to differences in pricing is avoided by giving selection of taxi service provider to customer, instead of that platform automatically matches customer to free vehicle. Similarly, problems related to fleet sizes are also eliminated as platform do not perform automatic matching from pool of idle vehicles. Based on interviews, additional problems related to such collaboration platform was mentioned. One was that same collaboration platform makes it impossible for dispatch center to customize application towards their needs, as added complexity and dispatch center specific features makes it

harder to distribute that application, but also harder for customers to select and use correct one. Also, such platform might have issue as some needed and requested features might not become available, or that whole platform's development stops and whole platform dies. That is also one reason mentioned in interviews that having own application works also as a backup if bigger platform dies or development stops. They can also implement their needed features to that application as they are only service providers in that application.

5.3 Are pricing models implemented by dispatch centers more dynamic?

Empirical results suggest that currently pricing models are more dynamic compared to old pricing model in effect before the Act on Transport Services came into effect. As table 6 shows, pricing models take into account time of day or day of the week, therefore pricing has been split to more refined classes based on those variables. When comparing empirical results to literature reviews definitions of dynamic pricing, and reasoning behind it, we can see similarities on both of them. It became clear from interviews that dispatch centers do not consider their pricing models to be dynamic currently even though they mention utilizing some elements from dynamic pricing.

Before this can be answered thoroughly, it is important to understand at first how Finnish dispatch centers understand dynamic pricing. It became apparent that they could not describe it with confidence and also some admitted that they do not understand its definition and added that so different entity talks about different things with same term. Especially when talking about KKV's definition of dynamic pricing, no one seemed to understand what they mean with that term. But consensus was that dynamic pricing is what Uber uses where pricing changes dynamically in real-time based on demand and supply, as it is described in literature.

In addition to that, also ideas about that dynamic pricing could be adjusted based on longer time frame, instead of adjusting it in real-time. Therefore, pricing would not change continuously but for example depending on current season. Alternative pricing model to dynamic pricing was mentioned to be smaller price raises or decreases. That eliminates rapid changes in prices but allows dispatch centers to adjust prices related to current situation in network if needed. Also, pricing determined by markets can be considered to be as somewhat dynamic pricing. In literature, X. Wang et al. (2016) described a bit similar case, where price should be changed according to competition on markets. Then market situation would be used as a one extra variable controlling pricing.

Interestingly, few interviewees mentioned that Uber's applications provided pricing is not based on traveled distance or used time. When asked about alternative pricing methods, dispatch centers representatives were unable to come up any other pricing method that was not based on length traveled or time. Actually few interviewees said straight away that every taxi related service is priced based on traveled distance or time, and that there are no any alternatives to that. At the same time it is logical to match pricing to provided service and it's duration. On the other hand, is that necessarily needed? From operational costs perspective, they stay at somewhat same level even if vehicle and driver is idling or utilized regardless of driven distance or time used.

The pricing models employed in Finland can be considered to be more dynamic because reasons behind pricing models are comparable to dynamic pricing. One comparison to idea behind surging is that according to Asghari & Shahabi (2018), surging helps to encourage drivers to participant on platform. Similarly, interviewee 4 as an example

mentioned that they did changes to pricing to encourage drivers to drive at unpleasant times. According to interviewees, in free markets, dispatch centers can not force drivers to work by predetermined schedule, and therefore they need to use pricing as a tool to make sure that drivers work at those times also, similarly how surging is used as a tool by Uber to encourage drivers to participant their platform. Similarly, pricing is also used as a tool to encourage customers to use services. At the times of low demand, some Finnish dispatch centers have lower prices enabled compared to peak hours.

And that distinction between demand patterns are second comparable thing to dynamic pricing. Dynamic pricing is at its heart price optimization to encourage drivers to drive and customers to use, but also to get maximum profit from rides. Even though Finnish dispatch centers do not consider their pricing models to be dynamic, they have optimized their pricing models to maximize revenue, and to encourage both drivers and customers. That optimization is based on historical data, and therefore pricing is planned and set beforehand, which is biggest difference to dynamic pricing where pricing adjustments happens in real-time. But according to Battifarano & Qian (2019), surging can be seen to be happening in same places at same times, and therefore surging can be guessed. Therefore, it would be possible to adjust surging roughly to match areas demand and supply situation beforehand as dispatch centers are currently doing in Finland.

When comparing empirical findings to the part of literature where new solutions were suggested to optimize traditional taxi service providers pricing models, we can see that time-of-day pricing is relatively close to what Finnish dispatch centers have done. Qian & Ukkusuri (2017) created estimated optimal prices for different times of day based on historical data, and that pricing model may increase daily market revenue up to 10%. In interviews, it became clear that also Finnish dispatch centers have implemented their pricing models based on historical data. That way pricing can take into account changes in demand patterns, but still lacks accuracy spatially as different areas have different demand patterns, but also other smaller peaks in demand, such as holiday seasons.

5.4 What is needed to make dynamic pricing possible?

There are currently many obstacles that Finnish traditional dispatch centers needs to resolve before they can employ dynamic pricing. Figure 1. shows the path to implement dynamic pricing in Finnish dispatch center. In first step, dispatch center needs to think that are they even willing to implement dynamic pricing and what that would mean from businesses standpoint. If there is will, and it seems right solution from businesses standpoint, then there are technological implementation. Currently, Finnish dispatch centers are not able to implement dynamic pricing technologically mainly because their systems are not capable of doing that. That includes issues related to taximeter, mobile application and dispatch systems in general. Other possible obstacles might currently be applied legislation in Finland related to technological solutions of how trip's total cost should be calculated but also how information about pricing should be delivered to customers. But some Finnish dispatch centers are planning to implement dynamic pricing as soon as their technology makes it possible.

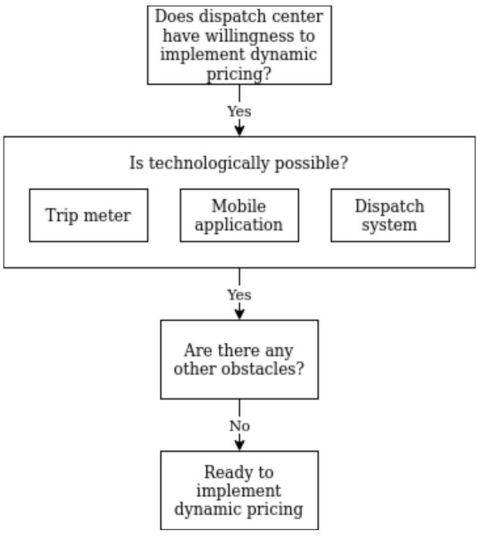

Figure 1. Path to implement dynamic pricing.

The first issue related to implementation of dynamic pricing in Finnish dispatch centers is the willingness to do so. In many cases, dispatch centers are hesitant to implement dynamic pricing because they have negative thought towards it and that it would not make sense from business standpoint. They also think that implementing dynamic pricing is not important right now and also that traditional dispatch center can not implement dynamic pricing because ensuring price to stay same for customers who ordered taxi by calling, is not possible. Also, it was mentioned in interviews that dynamic pricing is not suitable for every service type, referring in this case to taxi industry. Also related to operational costs, there would be no need to implement dynamic pricing to cover costs more optimally as operational costs do not change *that much* based on network's demand.

One reason that stood out was interviewees thoughts on how their customers would receive it when implemented, and how that would affect customers trust to dispatch center's service offerings. Interviewees mentioned that Finnish taxi customers do not like surprises, and therefore continuously changing pricing might upset several customers. Interviewees also mentioned that changing price is also not good thing for regular users. These issues were also raised from literature as there was mentions about how customers felt dynamic pricing to be confusing as pricing changed constantly without understanding the reason behind it. Interviewees mentioned similarly that dynamic pricing depends on variables that are not visible, and that customers might not even realize that at all. Therefore, pricing would be unclear for customers. And as I mentioned earlier, customers are one key thing that dispatch center personnel consider when implementing changes to pricing models.

One common fear was related to price spiking as price could jump unnecessarily high level in case of some event and that is common criticism that came up also in literature. Interviewees also mentioned that price spiking might lead to too cheap ride from drivers perspective, because even from cheap trips, they need to get proper profit. Same thing was mentioned in case of fixed prices as they also should not be too cheap, and therefore unprofitable for driver. That then might lead to situation where drivers might be unmotivated to work at times of low demand and therefore reject uncomfortable and unprofitable rides.

Also, it became apparent that technology utilized by Finnish dispatch centers do not make it possible to implement real-time based pricing adjustments. Current systems

have built for "*old world"* needs where processed data was minimal, and to change that, technology providers needs to expand their current systems or create new one. Or dispatch centers need to change technology provider to get those features. According to Basu (2019), technology should be able to analyze current market situation of demand and supply, and also monitor where drivers and customers are at different times. Based on interviews, it became clear that currently majority of dispatch systems are not capable of that. One interviewee mentioned that current systems do not have enough capacity, and similarly another went more into details mentioning that their system do not have ability to generate pricing automatically based on "*tracking data*". Similarly, price estimate calculators can not give accurate estimation of trip's price because those can not use real-time data from, for example, current traffic conditions. Apparently at least some dispatch centers could use some real-time data provided by map data provider, but currently dispatch centers do not need those features. What that suggests is that the data could be available and it would be usable in case of automatic price calculation based on traffic conditions. Also, currently those price estimations comes from dispatch center's systems so at least on some level, those systems have capability to provide some price based on given attributes. Based on interviews, they seem to have ability to collect and utilize at least some historical data as several interviewees mentioned their usage of historical data when determining optimal pricing. In summary, some of those systems seems to have some capability to collect and use data, which seems to be expected as several interviewees mentioned their possibility to get dynamic pricing implemented in their systems if they wish.

Then taximeters were mentioned especially to be one major restricting technological issue. That same issue was also present when asked about problems related to their new pricing models implementation as it was hard for dispatch centers to get new pricing models installed to taximeters. The biggest issue with taximeters according to interviewees are that they can not fetch current pricing automatically from centralized system. Therefore, unit prices needs to be set beforehand. Also, with current taximeters, drivers can not change unit prices by themselves, but they can change contract price. That indicates, that current taximeters can also be suitable for dynamic pricing, if dynamic price is fixed based on given origin and destination, and then inputted to taximeter as contract price, similarly as dispatch centers are currently handling their campaign pricing as well. Then there is no need to automatically update unit prices dynamically.

In addition to dispatch systems and taximeters, also consumer applications have limitations in same cases even though it has been considered to add flexibility to set prices and making easier to to make pricing more dynamic. Based on interviews, there are issues related to get price estimates to be shown correctly, inability to get campaign prices shown in application and issues related to getting different pricing methods, namely fixed pricing, to work. Therefore, if dispatch centers can not update their more static pricing to mobile applications, it seems to be also almost impossible to implement dynamic pricing to applications as that requires ability to update pricing in smaller intervals. It was mentioned that part of the problems are related to available interfaces in dispatch systems which limits the possibilities to integrate mobile applications, or any other new technological solution, to communicate with dispatch system. Specifically vendor lock-in was mentioned in this context. Also, some vendors have not implemented requested features, and they have also made limitations on devices that they agree to develop on so old functioning devices might not get any updates or new features from vendors. And because those devices are proprietary, vendor locked systems and devices, their user can not implement features themselves. And in one case it was mentioned that one dispatch center is moving towards one dispatch system solution to make it more flexible from their perspective to implement new features.

Similarly, interviewees mentioned that problems also raise when different parts of the systems are provided by different vendors.

One suggested solution to problems related to traditional taximeters would be software based taximeters that have more abilities than "*traditional*" taximeters. But in that case, interviewees felt that regulations towards replacing those "*traditional*" taximeters with software based ones are unclear. That seemed to be confusing topic as some interviewees mentioned that traditional taximeters were mandatory and that software taximeters are not enough, and others disagreed with that. At the same time, this solution is also one problem related to current regulations. Another problem related to regulations are that what is the correct way to inform customer about pricing. It was mentioned that traditionally taximeters are used as consumer front-end to provide information about taxi trip's price. That is challenging to do if there is no way to update unit prices to taximeters. At the same time, price catalog needs to be updated if pricing is based on unit prices calculated. That could be possible using some kind of digital screen to show current prices in place of current, standardized, pricing catalog. Another option would be to provide dynamic prices using application as fixed price, where trip's price is calculated before trip begins and customers agrees to it.

But are all of those issues possible to solve? It depends. Confusion towards dynamic pricing can be relieved as one interviewee mentioned that the exact pricing can be seen from mobile application. And if dynamic price will be given as fixed price, as one interviewee suggested, then price would not change after trip is started. Second possible solution to relieve customers uncertainty towards dynamic pricing would be making real-time pricing algorithm publicly available for inspection, and provide price predictions to customers so they can see how price might evolve in near future and if they can affect themselves somehow to trip's price.

One solution for issue of too cheap rides is implementation of minimum fee, or adjusting basic fee to the level that trip prices are at minimum profitable. That have already been done in Finland. The question that arises from here is that are those solutions possible in case of dynamic pricing? If dynamic pricing is based on unit prices, then base fare could be implemented. But minimum fee instead could work in every case. But problem with minimum fee can be that some customers might consider it to be trick to look cheap while being more expensive than competitors.

6. Conclusions

In this study, I investigated how pricing models implemented by traditional Finnish dispatch centers have evolved and whether they are more dynamic. In addition to that, I investigated what is needed to make dynamic pricing possible in Finland. This study also reveals how pricing models have evolved after 1.7.2018 when the Act on Transport Services came into effect, how technology affects to Finnish dispatch center's abilities to implement pricing and how dynamic pricing have been understood by traditional Finnish dispatch centers. To answer all those questions mentioned, I performed literature review about taxi industry, pricing models in general and dynamic pricing, then I collected data on internet about Finnish dispatch centers' pricing models and I conducted eight semi-structured interviews to add more insights to collected data.

Finnish dispatch centers pricing models have evolved from pricing model set by regulations to have more diverse pricing models between dispatch centers. This study identified 11 different pricing models employed by Finnish dispatch centers and reasons behind those changes. It is clear that not any of those Finnish dispatch centers have implemented similar dynamic pricing model as Uber have, and pricing models are still based on fixed fares. However, those fixed fare classes have been split into more specific classes, and now fares can depend on time and how many persons are onboard, or they can be fixed. Many interviewees mentioned that decisions to create pricing models and fare classes was based on historical data. Similar ideas was also presented in prior literature for traditional taxi service providers, such as time-of-day pricing pricing scheme introduced by Qian & Ukkusuri (2017). Also, as part of pricing model development, dispatch centers have considered how pricing affects to drivers willingness to continue driving uncomfortable times and customers willingness to use those services while maximizing dispatch centers profit. These reasons are similar to what was mentioned in prior literature about definition of dynamic pricing, as with dynamic pricing, ride-sharing service platforms want to encourage drivers to participate on platform (Yang et al., 2010), encourage customers to use services (Asghari & Shahabi, 2018) and to maximize platforms profit (Cachon et al., 2017). But compared to dynamic pricing, none of the interviewees mentioned that their reasons behind pricing model changes was targeted to encourage customers to postpone their trips when demand is high as is with dynamic pricing (Battifarano & Qian, 2019).

Finnish dispatch centers have also done digitalization with various success. Some dispatch centers have adopted new technologies, specifically new e-hailing applications for customers, successfully, whereas others still have issues with their applications. That new option to hail taxi is also different to what traditional taxi industry have traditionally offered based on prior literature, and also there are collaboration platforms available for Finnish dispatch centers to use in addition to their own, branded, applications. Also, dispatch systems and especially taximeters have caused issues for dispatch centers to implement new pricing models, but according to interviewees, they have mostly solved their biggest issues. However, it became clear that their current technological capabilities are not enough to implement similar dynamic pricing as Uber have, but in addition to that, also they mostly do not have willingness to do so and there are other obstacles, mainly related to current legislation about how pricing needs to be presented to customer and what is required to calculate trip's total cost.

As a result, this thesis provides table 6 to showcase 11 identified pricing models currently employed by Finnish dispatch centers, and also figure 1 to showcase, what needs to be considered when starting to implement dynamic pricing. Figure 1 can also be used to identify and discuss obstacles that Finnish dispatch centers needs to solve, and what aspects from regulations needs to be clarified in the future to make dynamic pricing possible to implement without hesitation of its legality. This study contributes to previous research by providing information about how the Act on Transport Services have affected to Finnish dispatch centers pricing in general. This has not been researched previously in Finland and therefore this study can help dispatch centers and law makers to understand its effects on Finnish taxi markets. But for law makers specifically, this study also reveals insights about how dynamic pricing have been received in Finnish dispatch centers and what are the main obstacles on implementing it, because Finnish government have specifically mentioned ability to implement dynamic pricing to be one of the main reasons behind regulation changes. And for technology providers, this study can help to understand combined needs and problems related to technology utilized in Finnish taxi markets.

As to the limitations of this study, I left out other contract based trips, such as business to business and public sector trips, from this research because those trip's pricing are not always public information and are more specific, therefore not possible generalize. Also, no comparison between old pricing model from before 1.7.2018 to current ones have performed. And also no analyzing was done to see if current pricing models are in practice more dynamic compared to both old pricing model or to definition of dynamic pricing, i.e. does it match networks current supply and demand more effectively. One limitation related to this study's trustworthiness is that I did not have solid prior knowledge about Finnish taxi markets and regulations that affects it. Therefore, findings and discussion might contain errors that are caused by misunderstanding. This could have been avoided by putting more effort into studying Finnish taxi markets in general more and by performing more comprehensive literature review especially from traditional taxi service providers perspective.

To follow-up with the biggest obstacles why dynamic pricing is not currently possible to implement in Finland, next area of research would be regulations towards taximeters and what kind of solution would fulfill requirements set by regulations, and requirements set by taxi service providers wishing to implement dynamic pricing. Another interesting research topic would be how dispatch centers business models have evolved when the Act on Transport Services came into effect to today, and how that have affected to dispatch center's abilities to do business.

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Appendix A. Interview structure

Interviewee's and represented dispatch center's background:

- Can you tell something about yourself?
- When your represented dispatch center have been formed, and how many rides you dispatch in a year?
- How many vehicles are driving under your dispatch center?
- What dispatch technology you have in use?
- Do your dispatched vehicles have traditional taximeters?

Current pricing model:

- Can you describe more in-depth your currently employed taxi trip's pricing model?
- How did you end up to your currently employed pricing model?
- Did you consider any other pricing models?
- How your currently employed pricing model differs from pricing model that was employed before regulation change?
- Have your pricing model changed in past two years, after regulation change?
- Have your currently employed pricing model caused any problems?
- What is your view about what kind of pricing models would be possible on Finnish taxi markets?
- Do you offer fixed priced trips? And if so, since when?

Dynamic pricing:

- When can we talk about "*dynamic pricing*" in your opinion? How would you define it?
- Would you consider your currently employed pricing model to be somehow dynamic?
- How your currently used technology in dispatch centers and vehicles affects to your abilities to form pricing?

Old pricing model (before regulation change):

- What were the benefits and drawbacks in old pricing model, which was employed before regulation change, compared to your currently employed pricing model OR to other revised pricing models (if there were multiple revisions after regulation change)?
- What did you consider problematic or useful in old pricing model?

Drivers and customers opinion about currently employed pricing model:

- How your drivers have received your currently employed pricing model OR other new revisions (if there were multiple revisions after regulation change)?
- How your customers have received your currently employed pricing model OR other new revisions (if there were multiple revisions after regulation change)?

- How your drivers and customers have received your more dynamic pricing model (if you would consider your currently employed pricing model to be mode dynamic)?

E-hailing application:

- Do you have some application or applications in use which customers can use to order taxi?
- Through which received or took the application into use? (For example, is that applications developed by yourself, is it provided by your dispatch technology provider, is it ordered from software developer company, is it offered by some other dispatch center etc.)
- Since when have you had that application in use? Have you had any other applications in use?
- How application works?
- Do your pricing differ between trips ordered using application and trip ordered using another method?

Multi-homing:

- How do you feel about that drivers uses multiple applications and drives for several dispatch centers or platforms?
- Are your drivers allowed to drive for other dispatch centers or platforms? Has this changed during last two years?