ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

CAN HYPERLOOP TECHNOLOGY TAKE TURKISH LOGISTICS INDUSTRY TO A NEXT LEVEL?: A PRELIMINARY ANALYSIS.

M.Sc. THESIS

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HYPERLOOP TEKNOLOJİSİ TÜRKİYE LOJİSTİK SEKTÖRÜNÜ BİR SONRAKİ SEVİYEYE TAŞIYABİLİR Mİ?: ÖN ANALİZ.

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Görkem KEREM, a M.Sc. student of İTU Graduate School student ID 507171017, successfully defended the thesis entitled “Can Hyperloop Technology Take Turkish Logistics Industry To A Next Level?: A Preliminary Analysis”, which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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Date of Submission : 31 December 2021
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To my parents and loved ones,

FOREWORD

In “Can Hyperloop Technology Take Turkish Logistics Industry To A Next Level?: A Preliminary Analysis” named thesis, it has been studied as adaptation of a new technology in Turkey, which has been considered a developing sector.

For all their support and contributions, I would like to thank my thesis advisor Prof. Dr. Dilay ÇELEBİ GONIDIS.

I would also like to thank Managing Director of ATC Group International Transportation, Ayşem ULUSOY, for all of her supports and contributions to allow me to contact many important people in the sector. I’d like to thank UTIKAD Association for creating Hyperloop working group to contribute my thesis. Finally and perhaps the most importantly, I would like to thank Hardt Global for allowing me research on this topic by providing required information, and I also would like to thank Anna DABROWSKA and Constantine DEMETRIOU from Hardt Global for all their support.

Lastly, I owe my parents a debt of gratitude for all their support through my master’s degree and my thesis.

December 2021

Görkem KEREM
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ABBREVIATIONS

App **:** Appendix
GDP **:** Gross Domestic Products
LI **:** Logistics Industry
LPI **:** Logistics Performance Index
SSI **:** Semi-Structured Interviews
UAE **:** United Arab Emirates

SYMBOLS

i, j	**:** Set Of Regions
k, m	**:** Set Of Sectors/Subsectors
$\mathbf{X_{ijk}}$	**:** Trade Flow Between Regions i And j For Sector k
$\boldsymbol{\varepsilon_{ijk}}$	**:** Deviation From Total Share Of Sector k In Origin Region i And Destination Region j
$\boldsymbol{\delta_{jm}}$	**:** Deviation From Total Expected Input To Sector m In Destination Region j
$\mathbf{T_{ij}}$	**:** Total Trade Flow From Region i To Region j
$\mathbf{B_{ik}}$	**:** Share Of Sector k In Region i
$\mathbf{\Gamma_k}$	**:** Final Demand Rate In Sector k
$\mathbf{L_{mj}}$	**:** Share Of Region j In Sector m
$\mathbf{G_m}$	**:** Total GDP In Sector m
$\mathbf{a_{km}}$	**:** Number Of Units Used From Sector k For Producing 1 Unit From Sector m (Input-Output Matrix Of Coefficients)

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CAN HYPERLOOP TECHNOLOGY TAKE TURKISH LOGISTICS INDUSTRY TO A NEXT LEVEL?: A PRELIMINARY ANALYSIS.

SUMMARY

Our goal in this thesis is to get a deeper knowledge and understanding about Turkish Logistics Industry, see the trends towards the new technologies such as Hyperloop, which we discussed in this thesis, and searched for most appropriate way to implement such technologies within the industry.

Elon Musk come up with the idea of Hyperloop in 2013, which can be explained as a mixture of railway and airway, travel across within tubes that specifically made for Hyperloop. From that day, it has been started to discuss about many different ways. Musk's idea was considering human transportation via Hyperloop, but as time progressed, cargo transportation started to be considered via Hyperloop.

With all these development, many companies have shown interest in cargo transportation via Hyeprloop. Huge investments happened in countries such as UAE, India, Germany etc. In our thesis, we aimed to show whether such investment in Turkey is possible, if so what are the main challenges would be and how we can overcome of these challenges? In addition these, we also tried to determine cargo types that can be carried via Hyperloop, and possible routes accordingly, since Hardt Global, a Netherlands based Hyperloop company, has interest in investment in Turkey.

Firstly, we conducted a literature review about new trends in LI and the major factors affecting the modal choice in LI. Due to Hyperloop being a new technology, we learned the details from Hardt Global. With respect to literature we also expand our research wih market and gathered some data to take the next step.

Our idea was collecting data of economical indicators and logistics within Turkey, compare it to the knowledge we gained through literature review and set up a Semi-Structured Interview (SSI) accordingly. Hence, our methodology in this thesis was SSI we conducted with market drivers and prospects in Turkish LI. With SSI, we aimed to get more deep knowledge of the industry, learn some of the major problems that the industry faces, as well as introduce Hyperloop to get ideas about correct way of implementation in Turkey. Due to its fragile and cost-effective competition, Turkish LI seems to be quite challenging to implement such technologies. Our questionnaire has formed according to the results of both our literature and data analysis that we conducted.

In our SSI, we had 3 sections, which are; introduction of the interviewee, important product group of their company, and as the final section we had some open-ended questions after introducing Hyperloop to our interviewees. Second and third sections are the most crucial to us, in order to conlcude our thesis. Due to Covid-19 restrictions most interviews happened online via meeting app Zoom, on phone or written form of questionnaire (see App. B) and answers.

All in all, we get to conclusion that, such technologies like Hyperloop might be a great next step for countries that want to be a centre of logistics Worldwide. To do that, first

we need strong infrastructure of Hyperloop within Turkey. The most strong advise/suggestion is to focusing on the strong suit of Hyperloop rather than trying to convince the whole sector about its costs. As conclusion, implementation of Hyperloop is not impossible, but we (as Turkey) need to be very cautious while doing so. Failure on such investment might cause some devastating results.

For further steps, a feasibility work should be conducted. Though, this was a preliminary work, we touched on the subject to some extent by deciding best possible product groups that can be carried via Hyperloop, and possible hubs/routes accordingly. As a next step this could be extended with respect to cost analysis to justify such investment in Turkey.

HYPERLOOP TEKNOLOJİSİ TÜRKİYE LOJİSTİK SEKTÖRÜNÜ BİR SONRAKİ ADIMA TAŞIYABİLİR Mİ?: ÖN ANALİZ.

ÖZET

Türkiye, gelişmekte olan ülkeler arasında olup, son yıllarda bazı sektörler bazında oldukça ön plana çıkmaktadır. Bu sektörler (inşaat, turizm vb. gibi), her ne kadar pastanın büyük dilimlerini alsalar da, gelişmeye ve ilerlemeye elverişli değillerdir. Bir anlamda doyum noktasına ulaşan bu sektörler, ülkenin kalkınmasında çok büyük etkileri olmayacaktır veya tek başlarına yetersiz seviyede kalacaklardır. Ülke gelişimi açısından, daha çok gelişime açık, ve gelişmiş ülkelerin de önem derecesinde ön sıraya koydukları sektörlere yönelmek, büyük avantaj sağlayacaktır. Özellikle, Dünya'da belli bir sektörde kritik noktalardan/merkezlerden biri haline gelmek, Türkiye'yi bir ileri seviyeye taşıma konusunda önemli bir faktör olacaktır. Gerek coğrafi konumu, gerekse geçmişten gelen bilgi ve birikim sebebiyle (bkz. İpek Yolu), ürün taşınması yani günümüzdeki ismiyle lojistik sektörü Türkiye'nin gelecekte yıldızlaşabileceği, Dünya'nın birkaç merkezinden biri olabileceği bir sektör olarak gözümüze çarpmaktadır. Biz de tezimizde, Türkiye'nin lojistik sektöründeki etkinliğini artırmak, bir sonraki seviyeye çıkarmak ve Dünya'nın bu alanda sayılı merkezlerinden biri haline gelebilmesi için yeni teknolojilere "erken benimsyenler" yani İngilizce'si ile "early adopters" sınıfında bulunmasının etkilerini araştırdık. Söz konusu teknoloji, Hyperloop olacaktır.

Hyperloop, Tesla Motors CEO'su Elon Musk tarafından 2013 yılında ortaya atılan bir fikir olarak hayatlarımızda ilk yerini almıştır. Musk'ın ortaya attığı fikir en basit tabirle, karadan giden uçak olarak tanımlanabilir. Teoride uçak hızlarına çıkması ön görülen bu sistemin en temel özelliği bunu karada yapabiliyor olmasıdır. Karada gidiyor olarak lanse edilse de, teoride bu hızlara ulaşabiliyor olmasının sebebi, özel inşa edilmiş tüplerin içinde, hava basıncı değişimi yaratılabilecek olmasıdır. Hyperloop sistemini yüksek hızlı trenlerden ayıran en temel olgu, sistemin çalışma yöntemiydi. Uçak hızlarına, hatta daha da fazlasına ancak bu methodla çıkabiliyordu. Her ne kadar, teoride 1200 km/sa gibi hızlar konuşulsa da önemli olan bu değerlerin pratikte ne kadar uygulanabileceğiydi. Bu fikir ortaya atıldığında hedefin yolcu taşımacılığı olduğu da göz ardı edilmemelidir.

Elon Musk'ın da popularitesiyle bu fikir çok kısa bir sürede yankı uyandırmayı başardı. Tabi tum bunlar, beraberinde çokça tartışmayı da getirdi. Olumsuz yönde olduğu gibi, olumlu olarak tartışmalarda söz konusu olmayı başardı. Bu tartışmalardan birisi de sadece insan taşımacılığında değil, aynı zamanda kargo taşımacılığında da böyle bir teknolojinin kullanılıp kullanılamayacağıydı. Fikrin ilk olarak Elon Musk tarafından ortaya atılmasından birkaç yıl sonra başlayan bu tartışmalar zamanla gerçekliğe doğru evrildi. Başta Arap Yarımadası olmak üzere, Hindistan, Almanya, Avusturalya, Amerika gibi pek çok ülkede bu alanda çalışmalar yapılmaya başlandı. Günümüzde ise bazı test denemelerinin (gerek insan gerekse kargo taşımacılığı veya bir başka deyişle lojistik alanlarında bazı kısa mesafeli testlerin) gerçekleştirilmiş olması, bu teknolojinin gelecek vadettiğinin en büyük kanıtlarından birisidir. Bu tez çalışmasının amacı, yük taşımacılığı için Türkiye'de böyle bir teknolojinin kullanılıp kullanılamayacağı, bunun ne şekilde adapte edilebileceği hakkında bir ön çalışma yapmaktır.

Tez çalışmamızdaki en temel hedef, Türkiye lojistik sektörünün böylesine yeni bir teknolojiye ne kadar uyum sağlayabileceği, bu sürecin nasıl yönetilebileceği, bu tarz bir değişikliğin sadece endüstri/sektör bazında değil, aynı zamanda ülke bazında da ne gibi yararlar sağlayabileceğini araştırdığımız bir ön çalışmayı tamamlamaktı. Tabi, böylesine yeni bir teknoloji haliyle litertürde büyük boşlukların olduğu anlamına gelmektedir. Bu sebepten ötürü literatür araştırmamızda Hyperloop teknolojisinden ziyade, lojistik sektöründe gerçekleşen son yıllardaki trendler, bu sektördeki en önemli kararlardan biri olan uygun taşıma yönteminin seçilmesi gibi alanlarda yürüttük. Bunların yanı sıra lojistik sektörünün Türkiye'deki konumunu, sektörün yapısını, dört farklı ulaşım metodunun son yıllardaki durumunu da bu çalışmamız kapsamında inceledik. Literatürde Hyperloop ile alakalı büyük boşluklar bulunması, özellikle kargo taşımacılığında bulunan bu boşluklar sebebiyle literatür araştırmamız yalnızca literatürle sınırlı kalmayıp aynı zamanda market araştırması ile desteklenmiştir.

Market araştırması kapsamında iki tür veri toplamaya çalıştık. İlk tür, literatür araştırmasında gerçekleştirdiğimiz, lojistik sektöründe taşıma yöntemlerinin belirlenmesini etkileyen temel faktörlere bağlı olarak gerçekleştirdiğimiz, Türkiye'deki dört farklı taşıma metodunun -kara, demir, deniz ve hava yolu- son yıllardaki etkinliğini incelemeye yönelik bir çalışma yürüttük. Bunun yanı sıra, belli başlı ekonomik göstergeler aracılığıyla, ekonomik anlamda Türkiye'nin ve sektörün genel yapısını ortaya koymaya çalıştık. Sonuç olarak buradaki amacımız, Türkiye'de böyle bir teknolojinin -Hyperloop- böyle bir sektördeki -lojistik/taşımacılık- uygunluğunu hem sektörel hem de ekonomik bazda inceleyerek, böyle bir uygulumanın gerçekliştirilmesinin önündeki engelleri ortaya koyarak, en uygun adaptasyon için atılabilecek adımları öğrenmektir. Bu alanda literatürde daha evvel bizim incelediğimiz kadarıyla herhangi bir çalışma olmadığından, amacımız bu boşluğu kapatarak literatüre katkıda bulunmaktır.

Yaptığımız araştırmalarda, en temel hedefimiz Türkiye'nin gerek genel anlamda, gerekse sektörel bazda bir haritasını çıkartmaktır. Bu harita doğrultusunda, Hyperloop teknolojisini en sağlam temeller atılarak entegre edilebilmesi açısından ilk adımı atmayı hedefledik. Bu kapsamda incelediğimiz bazı ekonomik göstergeler ile Türkiye'deki farklı taşıma modlarının kullanımları ve bunların merkezleri, bu yolda attığımız ilk adımdı. Ekonomik göstergeleri seçerken en çok dikkat ettiğimiz husulardan bazıları, sektörle etkileşimde olabilecek veya genel olarak Türkiye'deki ekonominin durumunu gözler önüne serebilecek olmalarıydı. Bu göstergeleri seçerken sadece bir yıl ile sınırlı kalmayıp, hem eğilimi görmek, hem de daha doğru bir fikir yürütebilmek adına genel olarak şehirler bazında (NUTS3) ve beş yıllık özetler halinde bu verileri topladık. Üretim, tarım vb. verilerin yanı sıra gayrisafi yurtiçi hasıla (GDP), yaş gibi etkenleri de dikkate alarak şehirlerin farklı açılardan gelişmişlik seviyelerini incelemeyi amaçladık. Buna ek olarak, Türkiye'de Hyperloop teknolojisi ile taşınabilecek kargo türlerini ve bunların hangi rotalarda Hyperloop teknolojisine uygun olduğunu ortaya koymak da bir diğer amacımızdı. Bu kapsamda tez çalışmamızda gerçek hayattan bir olay ile desteklemeye de çalıştık. Türkiye'de faaliyet gösteren bir üçüncü parti lojistik firmasından 2019 yılına (araştırmamız esnasında Covid-19 sebebiyle 2020 verilerinin sağlıklı olmayacağını düşündüğümüzden 2019 yılına ait veriler ile ilerlemeyi uygun gördük.) ait aldığımız veriler ile daha önceden araştırmış ve incelemiş olduğumuz verileri kıyaslamaya çalıştık. Aslında tüm bu veriler doğrultusunda elde ettiğimiz sonuçlar bizi tezimizde kullandığımız metodoloji olan yarı yapılandırılmış görüşme (SSI) için hazırlanmamızı sağlayan temel yapı taşlarını oluşturdular.

Yarı yapılandırılmış görüşme (semi-sturctured interviews) sıkça başvurulan yöntemlerden biri olup, diğer tür görüşmelerden ayıran en temel özelliği belli bir formatta olmasına rağmen, görüşmecinin fikir ve göüşlerini rahat bir şekilde bildirebileceği ucu açık sorulardan oluşturulabiliyor olmasıdır. Bizimde tez kapsamında hedeflediğimiz sonuçlara ulaşmamızı sağlayabilecek en uygun metodun, bu sebeplerden ötürü yarı yapılandırılmış görüşmeler olduğuna kanaat getirdik. Bu kapsamda hazırlamış olduğumuz format (bkz. Ek. B) toplamda üç kısımdan oluşmaktadır. İlk kısımda görüşmeyi yaptığımız kişiyi tanımaya yönelik sorular sorarken, ikinci kısımda bulunduğu firmaya ait belli başlı ürün gamları ile alaklı daha çok neden-sonuç ilişkili sorulardan oluşturduk. Üçüncü ve son kısım ise önce Hyperloop'un tanıtıldığı, ardından daha evvel yapmış olduğumuz araştırma ve elde ettiğimiz veri analizi sonuçlarına bağlı olarak oluşturduğumuz ucu açık sorulardan oluşan bir kısım olup, elde edeceğimiz bilgilerin tezimizi sonuçlandırmamızda en temel katkıyı sağlayabileceğine inandığımız kısımdır. Tez çalışmamız esnasında Dünya'da yaşanan pandemiden ötürü bu görüşmeleri ne yazık ki yüz yüze gerçekleştirme imkanı bulamadık. Ancak, gerek online toplantı uygulaması olan Zoom üzerinden, gerek telefonda gerekse de yazılı formda görüşmelerin sonuçlarını aldık. Bu metodoloji de en önemli husus örneklem seçimi idi. Biz bu görüşmeler için örneklem seçimini belirlerken, veri analizi ve literatür/market araştırmalarından elde ettiğimiz sonuçlara bağlı kalarak, belirli ürün gamlarında hizmet veren firmalar ile, üçüncü parti lojistik firmaları, gönderici (shipping) firmaları ve sektörde hizmet veren dernek ve kuruluşları belirledik. Bu kapsamda hedefimiz her alanda birkaç firma ile iletişime geçerek uygun sayıda örneklem elde edebilmektir. Ancak pandemi şartları sebebiyle bu örneklem sayısı istediğimiz seviyeye ulaşmamış olsa da toplam yirmi kişilik bir örneklem sayısına ulaştık. Bu yirmi kişilik grup içerisinde onüç farklı gönderici, üçüncü parti lojistik firmaları ile belirlediğimiz ürün gruplarında üretim yapan firmalar bulunmaktadır. Bunların haricinde iki tane de dernek ile görüşme gerçekleştirdik. Bazı firmalarda ve bir dernekte (UTİKAD) birden fazla kişiyle görüşme yaptık. Sonuç olarak bu ilk aşamada yirmi örneklem ile tez çalışmamızı gerçekleştirdik.

Bu çalışma ile elde ettiğimiz sonuçları iki kategori altında toplayabiliriz: ilki topladığımız verilerin analizi sonucu ulaştığımız bulgular, ikincisi de gerçekleştirdiğimiz yarı yapılandırılmış görüşmeler sonucu elde etmiş olduğumuz bilgiler. İlk kategoride toplamış olduğumuz ekonomik veriler ile literatürden elde etmiş olduğumuz bilgileri harmanlayarak, Hyperloop için öncelikle uygun ürün gruplarını ve buna bağlı olarak Hyperloop için kurulabilecek merkezlerin ve merkezler arası rotaların belirlenmesine yönelik yapmış olduğumuz çalışmalardan elde edilen sonuçlar bulunmaktadır. Burada en öne çıkan konu Hyperloop'un kapsül yapısı sebebiyle sınırlı kapasitesinin olması (uçak veya gemide olduğu gibi yüksek tonajlı yük taşınması Hyperloop ile mümkün değildir.) ve her tip kargo taşımasına mümkün olmaması sebebiyle, ağırlıklı olarak paletleme yöntemi kullanılacak ve kapasitesini zorlamayacak ürün gruplarının tercih edilmesi olmuştur ki bu da yaptığımız görüşmelerde, görüşmeciler tarafından en çok desteklenen konulardan birisi olmuştur. Bu ürün grupları ağırlıklı olarak pahada yüksek ancak ağırlık olarak düşük olan elektronik, otomobil yedek parçaları ile, hızlı ulaşım gerektiren taze meyve-sebze (ya da genel anlamda taze yiyecekler), ilaç vb. grupları kapsamaktadır. Bu ürün gruplarını baz aldığımızda, ekonomik etkenleride göz önünde bulundurarak, belli merkezler ve rotalar ortaya çıkardık. En çok dikkat çeken husus Türkiye'nin batısı ile doğusu arasındaki büyük uçurum oldu. Ağrılıklı olarak batı şehirleri ön plana çıkmakta. Başta kosmopolit yapısı sebebiyle İstanbul ve üretimin belki de ana merkezi olan Kocaeli

birçok listede ilk iki sırayı almıştır. Bunların haricinde Tekirdağ, Bursa, İzmir, Antalya ve Ankara öne çıkan diğer şehirler olmuştur. Bu bulguları gerçek bir vaka ile göstermeye de çalıştık ki burada elde edilen sonuçlarda daha evvelkileri destekler nitelikteydi. İkinci kategori olarak bahsettiğimiz görüşmelerden elde edilen sonuçlarda ise bunlara ilaveten, Hyperloop teknolojisi ile e-ticaretin boyut atlayabileceği sonucuna ulaştık. Bunun en temel sebebinin, Hyperloop'un en temel özelliğinin hızı olması, ve e-ticarette en çok üreticiler ve göndericiler için en çok ihtiyaç duyulan özelliğin hız olması, tüm bunlar göz önüne alındığında Hyperloop'un e-ticarete çok uygun olabileceği kansına vardık. Aynı zamanda Türkiye'de alışılmıştan vazgeçmenin, özellikle lojistik sektörü bazında, hiç de kolay olmadığını, uygun maliyetli ulaşımın rekabetteki en kritik nokta olduğuda dikkatimizi çeken noktalardan biridir. Bu açıdan Hyperloop teknolojisinin uygulanabilmesi için dikkatli ve temkinli adımlar atılmasının, maliyet konusunda ikna etmek yerine, tezimizde de ayrıntılı olarak belirteceğimiz belli başlı sorunlara çözüm olacağının anlatılmasının en doğru yaklaşım olacağı sonucuna ulaştık.

Sonuç olarak, Hyperloop her ne kadar yeni bir teknoloji olsa da yakın gelecekte hayatlarımızdaki yerini almaya başlayacaktır. Sadece insan taşımacılığında değil aynı zamanda kargo/yük taşımacılığında da kullanılabilecek olması, önemini artırmaktadır. Bu tarz bir teknolojiye, özellikle de sektörel bazda düşünüldüğünde erken adapte olmanın, hem ülke hem de sektörel bazda çok büyük katkıları olacaktır. Bu kapsamda yapmış olduğumuz ön çalışma sonucunda Türkiye için bu fırsatın kaçırılmaması gerektiği, ancak başarısız olmaması adına sağlam bir temel oluşturulup, atılacak tüm adımların dikkatli bir şekilde atılması gerektiği sonucuna ulaştık. Sonraki aşamalarda, fizibilite çalışmaları yapılarak, bunların devlet kaynaklarına sunulması ön görülebilir.

1. INTRODUCTION

Today's global World is changing and evolving rapidly. One of the main factors is the technology. As it has unlimited usage in many different areas, any new technology is significantly affect the development. Even more, it can be a total game changer for an entire sector[1]. We will be examining if this is the case for logistics industry within Turkey. The said technology will be Hyperloop. First we will be giving a background which will be followed by the purpose of this thesis and a brief summary of the hypothesis.

1.1 Background

21st century, also known as the information age, is the age in which the environment constantly changing and developing. Whether if it is a new technology, or just a know-how, business environments change nonstop and rapidly. A new technology might substitute another relatively new technology. Therefore expectations, demands and even supplies change rapidly. In order to keep up with the pace, with respect to rapidly changing environment, businesses must come up with new solutions and they must come up with those new solutions as fast as possible. Otherwise, it would be impossible to keeping their businesses afloat, let alone competing with their competitors. Having a competitive edge is the most important factor to gain control in the market. Globalization is an important aspect that businesses should consider it carefully. Although it can be seen as a result of the information age, -since we can reach any information, there is no solid borders anymore, or to be more precise borders only there to separate countries geographically- globalization can be reviewed separately. To achieve globalization, more markets should be considered as a business. Consequently, more market means more competition. On the other hand, safety is another noteworthy subject, considering any information can be reached within seconds, with almost no effort. For that reason, safety measures should be taken

[1] Smart phones overtaking the regular old cell phones could be a great example for this.

carefully. Apart from these, there is many other aspects in today's World. These factors can be applied to any businesses in any sector, logistics are no exceptions. In the grand scheme of this, competition is inevitable, hence businesses must find solutions to be one step ahead against their competitors.

It is expected that, a great many sectors will grow in the upcoming years. The increasing importance of transportation, the popularity and widespread usage of the internet will accelerate the development of some markets. Logistics is the biggest candidate to be one of those markets, especially express delivery market due to widespread of internet (Vakulenko et. al., 2019). Covid-19 emphasized the importance of the logistics and express delivery market or e-commerce. E-commerce, which has been growing with the increasing number of virtual applications and websites, became one of the most important topics during Covid-19, has been growing rapidly during Coivd-19 (Bhatti et. al., 2020). Due to many precautions that has been taken by the government such as the restrictions (curfew, lockdown etc.), less physical contacts, providing better internet directed people to use e-commerce more. In addition to that demand for short delivery times doubling the importance of delivery market. Logistics sector does not just consist of delivery market, B2C and e-commerce, there is also B2B side. Taking into account all of these, logistics will continue growing, however it will be highly competitive. Solving a common problem whether if it is just a simple precaution or adapting a new technology will be an important aspect in logistics.

The most common problems in logistics (especially in e-commerce and express delivery market) were caused by few aspects such as time limit (Archetti & Bertazzi, 2020), capacity shortages (Bi et. al., 2019), driver shortages (especially applicable for the road freight) (Mittal et. al., 2018). One aspect is not the source of the major problems that happens in logistics. Usually, combination of multiple factors will cause the problems. Hence, overcoming these problems might be difficult. A solution might resolve one aspect but bring another aspect into the mix. For instance, hiring more drivers, if there is a driver shortage, might be a solution, but it will increase the expenses. Out of all possible factors that causes problems in logistics, speed related problems are the most important problems. Any transportation, any delivery, any freight is expected to be completed as quick as possible. The most important example to this could be the Covid vaccines. There are many variants of the vaccine which produced in different countries from all over the World, yet it needs to be transported

everywhere. Some variants required to have 2 dosages of them within a month. As it can be understood, there is a time limit and it had to be delivered before the due date. Otherwise, the first vaccine would be useless and will have no effects on the person. Just as the speed, it also transported carefully under certain circumstances. As is seen from the vaccine situation, speed measurements are the most crucial aspects of transportation. In addition to that safety might be considered as another important aspect in Turkey, due to certain reasons (illegal activities such as smuggling). These aspects will give the competitive edge, if it has done better than the competitors. While focusing on fast and safe deliveries, costs should never be ignored. Lowering the costs of the business is the main goal of the board and the management. Each business expects the maximum possible profit. In this regard, lower costs are essential to achieve the maximum profit. Nonetheless, they should hold to speed and safety, while minimizing their costs. In theory this is the best scenario for any logistics company. Looking at the bigger picture, this is also the best scenario for the whole industry. With that being said, achieving this seems to be more difficult than it is on theory. Applying any solution to the current problems in logistics, especially sector-wide problems, might be costly, such as adapting to new technologies, improving business and the process.

Solving major problems within the industry sometimes requires adaptation/implementation of a new technology. Technologies that resolve the problems in long terms, rather than makeshift solution. Nonetheless, investing into a new technology is a costly solution. Especially investing into new technologies that can reshape the whole industry. According to Globelink Unimar, technologies such as GPS integration in vehicles, RFID, M2M (Machine to Machine) can be used in existent transportation methods. Also, with the new technologies such as AI and AI controlled vehicles/devices, drones will bring new ways of transportations and these types of technologies can resolve any type of congestion, which is a major issue in Turkey's logistics sector. AI driven cargo bikes or drone transportation in cities, autonomous freights especially trucking might be a game changer in many aspects. In addition to those, technologies like Hyperloop might reshape the whole industry for good. In the objectives section we will explain the aim of this thesis with brief information about Hyperloop and its implantation in Turkey.

1.2 Purpose of This Thesis

The main objective of this thesis is to get a deeper knowledge and understanding about Turkish Logistics Industry, including market structure and competition level, see the trends towards the new technologies such as Hyperloop, which we discussed in this thesis, and searched for most appropriate way to implement such technologies within the industry, and its possible effects onto the Turkish LI. Hyperloop, also can be called Hyperloop, is relatively a new technology to complete transportation between two points with the change of air pressure in custom made tubes. In theory, Hyperloop is estimated to reach near plane speeds (around 1200 km/h), due to the low friction within the custom tubes. Although the tubes can be built under the ground, similar to underground rail system, it can also be built on ground-level. The original concept was developed for human transportation, but Hyperloop can be even more applicable in freight sector to start with. As of writing this thesis there is couple examples of Hyperloop all over the World. We will be mentioning these projects in the next section in details. Likewise, this thesis will be synchronized with a real-life project that contains possible investment of Hyperloop in Turkey.

This thesis consists of three tasks, which are;

- Task 1: Literature review, state of Turkish LI and basic market research,
- Task 2: Economical data collection,
- Task 3: Pre-Analysis: Product group selection, and routes identification,
- Task 4: Getting an insight knowledge from market drivers and prospects via SSI.

The first task, we will be investiagating literature about logistics industry, rather than Hyperloop technology itself, since it is a new technology and there is not many studies have been done to the best of our knowledge. Hence, we will be focusing on LI, and we will be researching what are some of the key factors that affect modal choices in LI, the state of Turkish LI with some market research about different modal choices with respect to the literature. This task is one of the two steps -with task number 2- for preparation for our SSI questionnaire and findings.

In the second task, we would be collecting some datasets, to give us an insight of Turkey's economic circumstances. Our aim with this task is to understand the

economical conditions of Turkish provinces and with results of the analysis -third task- guide us to prepare an SSI questionnaire respectively. The economical datasets will be collected based on the provinces, and consist of last 5 years if it is available. As economical indicators, we selected age, employment rate, number of vendors, GDP, as well as three main sectors -agriculture, production and services- and their datas in Turkey to analyse. We will be conducting an analysis in the upcoming task with respect to the knowledge we gained throughout the first two tasks.

Third task is the first part of the findings, which will include the results from the information and data that we collected during the first two task and determining our questionnaire for our forth and final task. In addition to that we will be analysing a real life case to reach more in-depth results about Turkish LI, especailly for identifying routes, selecting fitting product groups for Hyperloop.

Forth and the final task will be our interview with the market drivers and prospects/associations, where we dive deeper into the sector and learn more than what we can see from the surface. In a national and regional context, identifying the characteristic of the industry, and understand the major and minor problems that the industry face, whilst introducing Hyperloop to them to get their opinion on such technology. We will be using Semi-Structured Interview (SSI) as our methodology in this thesis. The details of the SSI, such as the selection of sample, the form of interview, timeline for the interview etc. will be explained during the methodology section.

The thesis is structured as follows. Section 2 gives a literature review about recent trends in freight sector, both globally and within Turkey's boundaries, some of the key factors that affect the modal choices in LI, as well as some brief information about Hyperloop provided by Hardt Global. Section 3 explains the methodology used in this thesis, dataset and their characteristics. Section 4 presents the results of the analysis for both datasets/market research via literature and the findings of SSI. Section 5 shows the conclusions with respect to findings that explained in the section 4 and some recommendations for further studies.

1.3 Hypothesis

Our hypothesis, briefly, is to find out whether technologies such as Hyperloop can be implemented in Turkey, especially in logistics sector, which has very high competition (cost-effective), and if so, how difficult would it be to do such implementation, how should we approach, learning some of the limitations/obstacles and try to overcome those.

2. TRENDS AND DEVELOPMENT

2.1 Trends In The Freight Transportation Sector

One of the major issues in the World is the increasing population. Although developed countries have low birth/death ratio, some of the developing countries and most of the non-developed countries have high ratio (Wikipedia). Hence the World's population doubled in 50 years according to World Bank's World Population data[2]. The rapid increase in population brought many problems with it. Resources have become an issue over the last few years, such as food, water and even shelter. Naturally, people are shifted more towards to urban areas, and therefore, populations in the cities/urban areas have increased rapidly over the years. When it all comes together, consumption rate has increased accordingly. This brought increased demand on certain sectors/industries. One of the sectors/industries is the transportation/logistics. With technological developments, demand towards consumer products have increased rapidly. Introduction of e-commerce played a vital role in that regard. The environmental factors, such as Covid-19, have led to an increase in freight volume swiftly. Herewith, logistics sector encountered many problems over the years, such as congestion and traffic, international freight operations become more popular with globalization, and more competitive environment has emerged. In addition to that, environmental issues must have been considered during operations in freight sector. Creating more eco-friendly, and sustainable environment within and between companies considered to be a must. Hence, this gives extra challenge to everyone, not only business level, but also individual level. Taking into account all of these, many researchers have an interest on how to solve major problems in logistics/freight sector. Although this has been studied for a long time, with the new topics such as e-commerce has created more research opportunities. According to Lagorio et. al. (2016) although this is gaining attention of many researchers, this subject is still "fragmented" and due to that, it is difficult to identify and fill the gaps.

[2] Total World population was 3 billion in 1960, and reached over 7.5 billion in 2020.

The rapid growth of technology creates new opportunities to fill out those gaps. Not only that, but it can also find new solutions to existing problems such as congestion and pollution (mostly air and noise pollution). Electrical vehicles are on the rise to eliminate air pollution. With the spread of the internet, the environmental awareness has also increased. When all these come together, new trends emerge in freight industry, just like in other industries.

One of the most discussed topics in logistics industry lately is e-commerce. By virtue of increased usage of internet, e-commerce has become a hot topic in logistics, especially in urban logistics. According to Statista's (2021) research on e-commerce, there is 6% annual growth has expected (CAGR) in next few years (globally), whilst Turkey was expected to be the number one with almost 15% growth rate. In addition to that they stated the sales in 2019 was 3.53 trillion USD and envisioned to be almost doubled in 2022 (over 6.5 trillion USD). According to DHL ecommerce drastically increase the importance of the last mile logistics. Last mile logistics can be defined as the last part of the process and usually the most difficult part of the whole process. After our interview with some of the market drivers and prospects we learned that sometimes it would be longer to transport goods from the airport/port to the destination than the rest of the process. We will be also discussing the details on this topic in the further sections.

E-commerce is not the only topic that has been discussed. One of the most important issues that acknowledged by many researchers and market drivers is the environmental problems caused by logistics. Due to most popular modal choice being the road transportation (this is especially crucial, because of last mile logistics, which cannot be done otherwise), many have raised the environmental awareness. As we mentioned before, air and noise pollution are the pollutants that most affected by the freight industry. Hence, more green solutions have been discussed/mentioned while not affecting the industry deeply. Naturally, sustainability became a factor that each and every market driver and prospects have to consider as much as cost, safety and other important factors for their business. To the best of our knowledge, emission is the most studied subject over the last few years, especially CO_2 emission. The freight sector accounts for a large portion of CO_2 emissions due to high utilizations of trucks. Decreasing the CO_2 levels that caused by trucks and other means became a number one priority. In that regard Ranieri et. al. (2018) suggest some solutions such as electric

vehicles, especially trucks, usage of drones or bikes and other options for more clean and sustainable transportation during the last mile logistics. In addition to emission, fuel consumption levels are rising due to increasing number of vehicles and its negative effect to the environment. One salient solution might be the truck platooning, which is using two or more trucks and use aerodynamic effects to save fuel[Hata! Yer işareti tanımlanmamış.].

Lastly, technological advances and their effects on logistics can be mentioned. Although it seems that logistics will not be affected as much as the other sectors, there is still plenty of room to improve in logistics with the contributions of technology. The most recent trends show that AI would be a great candidate. Autonomous or self-driven vehicles, especially trucks, is one of the most discussed subjects in literature over the past 5-10 years. Besides this, importance of data (especially big data) and advancement in electronics will allow more digitized logistics options such as digitized trucking, RFID and barcode systems, GPS tracking etc. In addition to all of this, technologies such as drones would be a great alternative method in last mile logistics. Apart from these, Hyperloop would be a great alternative to existing modal choices such as road or airway and might even be a main modal choice in the future. Last couple of years, researchers and academicians are focusing adaptation of these technologies in logistics/freight sector. The major difference between other technologies Hyperloop's main focus was human transportation rather than cargo transportation. Virgin Hyperloop One's deal with DP World managed to draw attention in cargo transportation via Hyperloop. However, Hyperloop and cargo transportation/freight are the two terminologies that are not mentioned together as much as the other technological developments. Naturally, there is a huge gap in the literature, especially in cargo transportation. We aim to fill the gap of Hyperloop's integration in Turkish logistics sector. All the details will be shared in the further sections.

2.2 Freight Transport in Turkey

Logistics or freight sector is one of the sectors which is on the rise around the World. With the introduction of e-commerce and the pandemic raise the importance of freight, especially the urban logistics. Turkey plays a vital role in global logistics, due to its geographical location. Being the bridge between Europe and Asia and controlling the

Black Sea cannot be underestimated. In that regard, logistics might be the most important industries in Turkey. Statistica's (2021) study seems to be supporting this opinion; Turkey expected to have a 15% growth rate (almost) on ecommerce sales (CAGR), which makes Turkey number one on that study. Although KPMG's 2020 report on logistics in Turkey does not seem to be positive[3], 2020 was expected to be a positive year and freight sector expected to have a great potential in the future (Yavuz Öner, 2020). This point of view is also supported by World Bank's global LPI and aggregated LPI reports. According to LPI report by World Bank (2018), Turkey was 47th with the global LPI (logistics Performance Index) of 3.15. On the other hand, the aggregated LPI of 2012, 2014, 2016 and 2018 shows that Turkey was 37th with 3.29 LPI score (World Bank, 2018). Aggregated LPI help us understand the "bigger picture" in logistics. According to these reports, customs seem to be the main issue, which has the lowest score for Turkey out of all six categories in both global and aggregated LPI. All in all, it is clear that the freight sector in Turkey has potential to improve, and with technologies and investments such as Hyperloop might help Turkey to take the next step forward in that direction.

The steps to be taken by the government will be of great importance for this development. In that context, Turkish government's Ministry of Development announced MTP 2018-2020 (Medium Term Programme). Logistic services are one of the industries that the government focused on improving in this programme. Here are some of the topics from this programme (Ministry of Development, 2017):

- Logistics centers; improving the old ones and building new ones with better management and operations,
- Reduce the costs,
- Railway investments to improve the overall quality,
- Improvement of connection of different modal options (port-highway or port-railway etc.)

[3]Worldwide trading seems to be shrinking. Hence this reflects onto Turkish Logistics Industry in a bad way. National problems might add onto those already existing problems, which is why the report by Yavuz Öner seems to be negative for Turkey.

- Improving the speed and the quality, such as tracking mechanism, border control, customs check etc. will be improved.

In addition to these topics that have been discussed in MTP report, there was a section about transportation improvements regardless of logistics, which is called public investments. Under this topic it has been emphasized that infrastructure investments will be the priority and one of the subsections were transportation. These improvements can be seen in Table 2.1 below. All the data collected by the directorates or ministries accordingly.

Table 2.1 : Transportation Infrastructure in Turkey over the years.

Transportation Infrastructure	2016	2017	2018	2019
Road Network				
Highways	2 542	2 657	2 842	3 060
State Road	31 106	31 066	31 021	31 006
Divided	19 790	20 237	20 475	20 723
Other	11 316	10 829	10 546	10 283
Provincial Road	33 513	32 896	34 153	34 165
Divided	1 499	1 613	1 796	1 922
Other	32 014	32 283	32 357	32 243
Amount of Load - Tonnes-km (Million)	253 139	267 730	266 502	267 579
Railway Network (km)				
Conventional	8 182	7 948	7 273	7 050
Electrical	4 350	4 660	5 467	5 753
High-Speed Train	1 213	1 213	1 213	1 213
Train kilometres (Freight Train)	18 767	21 435	24 177	24 295
Amount of Load - Tonnes (Thousands)	25 886	28 469	31 673	33 536
Domestic	22 716	26 473	29 353	30 738
International	1 831	1 815	2 070	2 548
Amount of Load - Tonnes-km (Million)	11 661	12 794	14 481	14 707
Port Handling				
Export	94 805 120	113 692 068	110 424 635	131 676 578
Import	215 132 519	233 656 024	218 544 820	221 404 812
Transit	66 963 307	63 429 725	71 628 260	74 974 298
Air Cargo				
Domestic Flight (tonnes)	857 335	884 811	886 025	833 768
International Flight (tonnes)	2 219 579	2 596 400	2 969 206	3 256 399

Hyperloop's integration in Turkey might not be as simple as the developed countries. Due to its traditional structure and the heavy usage of road transportation model might be a difficult obstacle to overcome. According to foreign ministry's report by Keçeci (2006) at the end of 2004, 76,1% of the transportation had been made via road. Although more up to date sources do not include a percentage, most of the sources we have been reviewed mentions that the road transport is the most preferred modal choice

in Turkey. In addition to that there is thousands of active transport companies partake in Turkish freight industry. In that regard, we mostly focused on the road freight to understand Turkish freight industry. We have collected the data of the number of trucks in Turkey since 2015, and the quantity of each cargo type which transported via trucks in 2019. As it can be seen in Figure 2.1, food products, drink and tobacco are in lead with over 50 million tonnes-km in 2019. This was followed by non-metallic minerals, metal ores and other minerals and agriculture, hunting and forestry. These four categories cover almost 60% of the road freight in 2019. Other noticeable statistics would be the "not defined" or empty carriage. Over 10 million tonnes-km was empty carriage, which might mean there is an efficiency problem in Turkish road freight.

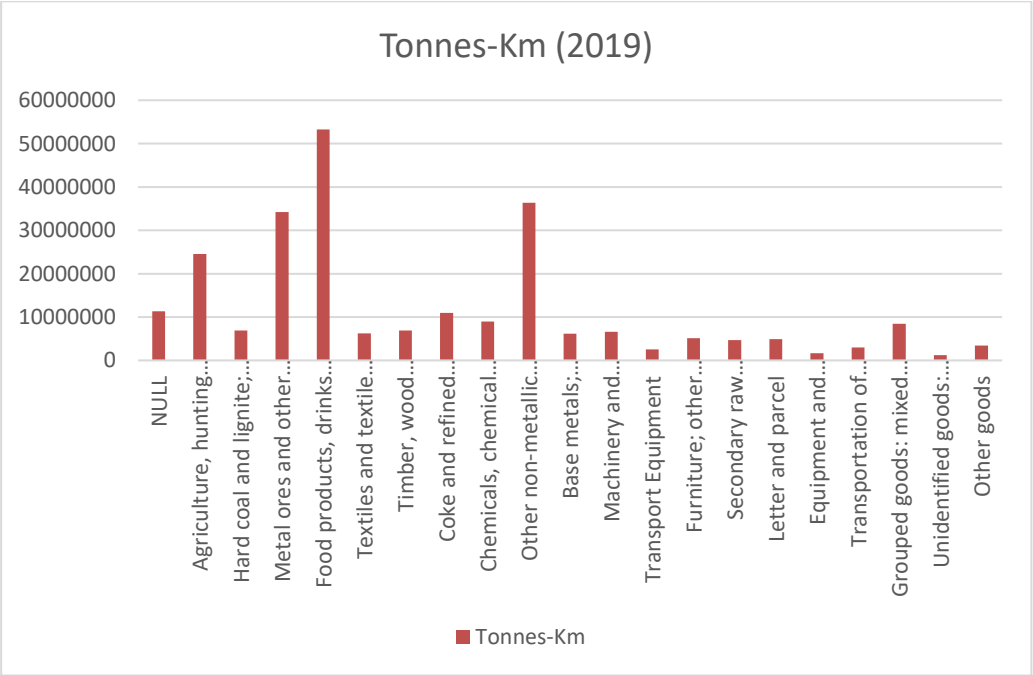

Figure 2.1 : Turkish Road Freight by Cargo Types (2019, tonnes-km) (Source: General Directorate of Highways).

Figure 2.2 below illustrates the registered number of trucks in Turkey. In 2020 the registered number of trucks almost reached 860 thousand (859 thousand). In five years, there is over 7 percent increase in registered trucks which supports the Foreign Ministry's Report in 2006, in which they predicted an increase in road freight on top of 76%. Majority of the registered trucks are on western cities. Marmara region contains over 30% of those, due to İstanbul (TURKSTAT, 2020).

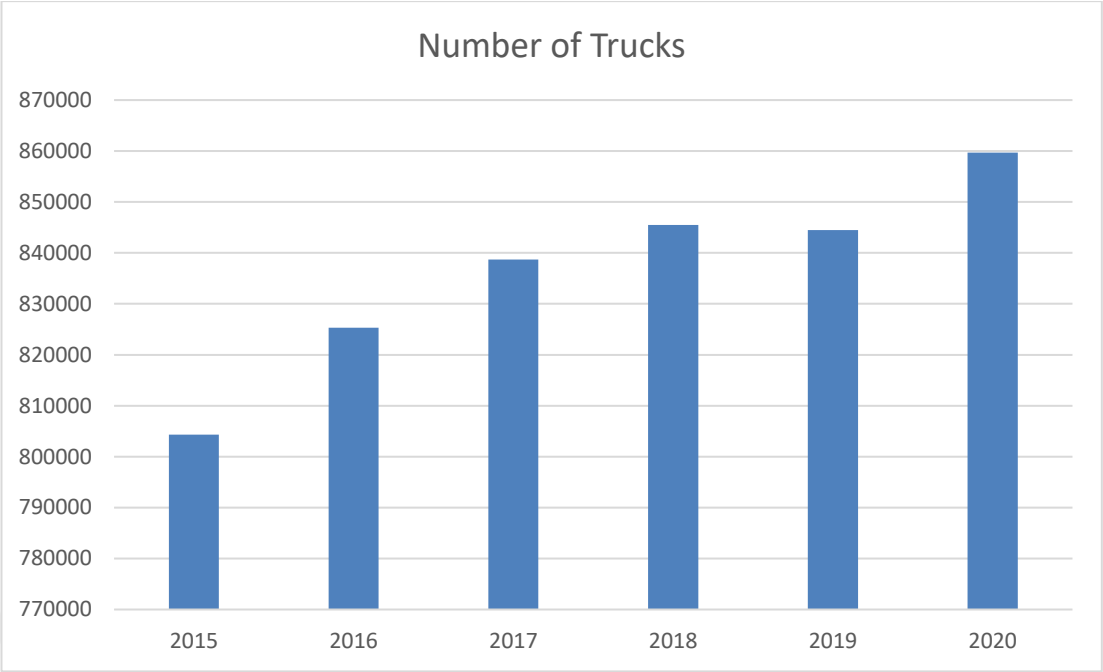

Figure 2.2 : Number of Trucks in Turkey (Source: TÜİK)

In addition to that we collected the dataset that show the truck traffic in Turkey. Majority of these are between western cities, especially within Marmara region (İstanbul, Kocaeli, Bursa) and between metropolitans such as İstanbul, Ankara, İzmir. On the south side Mersin, Adana, Gaziantep and İskenderun (Hatay) seem to have a heavy traffic compared to neighbourhood cities and the eastern side of Turkey. This figure might help us locate Hyperloop hubs, if it will be a competitor to road freight in Turkey.

Figure 2.3 : Turkey Truck Road Traffic Map (Source: General Directorate of Highways).

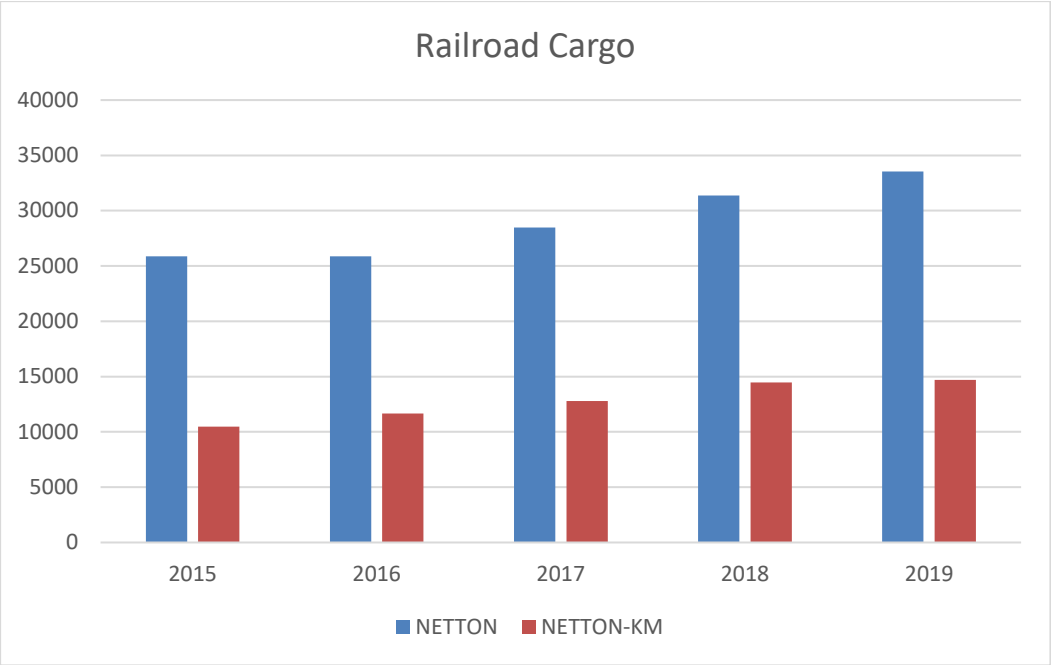

Figure 2.4 : Turkish Railroad Netton and Netton-Km (Source: TCDD 2019 Railroad Report).

Although railroad seems to be the least popular modal choice in Turkey -and in generally all around the World- we included some statistics to position Hyperloop in the right place. According to UTİKAD's 2020 report by Güler (2020), railroad length has been increased by 17% between 2003 and 2020, and the capacity -in tonnes- has increased by 41%. Mostly ore and mining products are being carried by railroad according to TCDD's 2019 report. As it can be seen in Figure 2.5, iron ore has almost 30% of the tonnes-km in 2018.

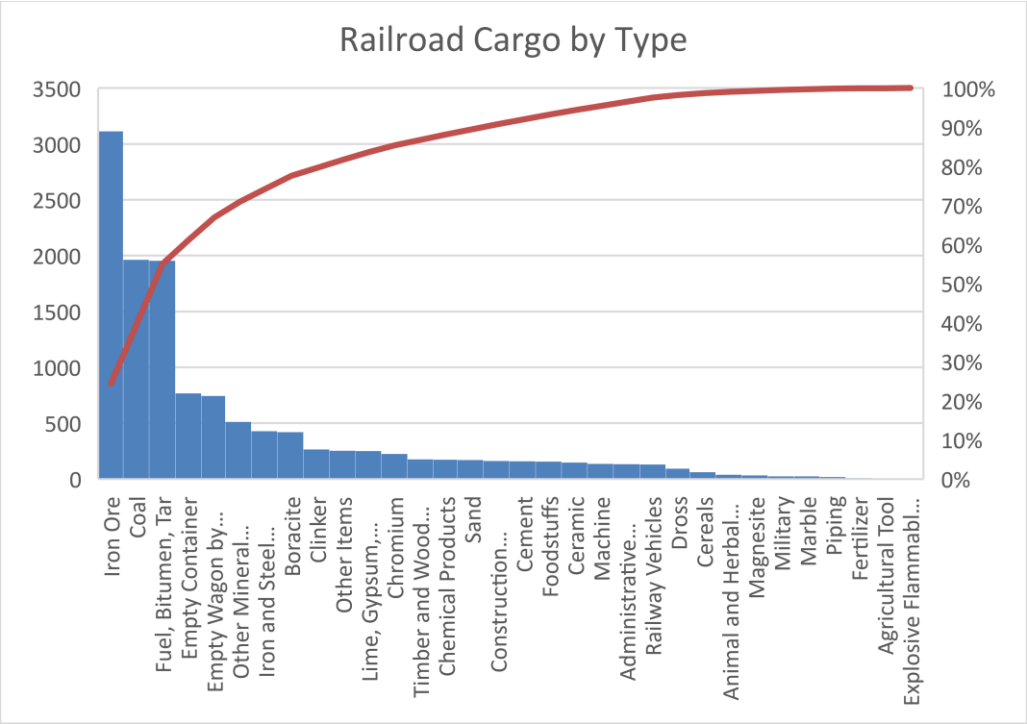

Figure 2.5 : Railroad Cargo by Type (Tonnes-Km) (Source: TCDD 2019 Railroad Report).

Road freight takes the number one spot in domestic freight, whilst seaway is the main choice for import and export according to KPMG's report, which shows that seaway has over 40% of the freights during import/export (Yavuz Öner, 2019). Although it seems that airline freight is continuously developing, seaway does not lose its significance, contrarily it increases its popularity over the years. Another important point is the increased popularity in Ro-Ro transportation. Ro-Ro transportation in Turkey, showed continuous development in the last 30 years -which can be seen in Figure 6- and has been preferred as a transport type, both in terms of its geographical features and from legal and political instabilities in the country according to the relative geography, and accordingly the negative effects on the road transportation. Forecasts regarding Ro-Ro freight demands and shipments for the upcoming years are that the freight demands of Ro-Ro will increase.

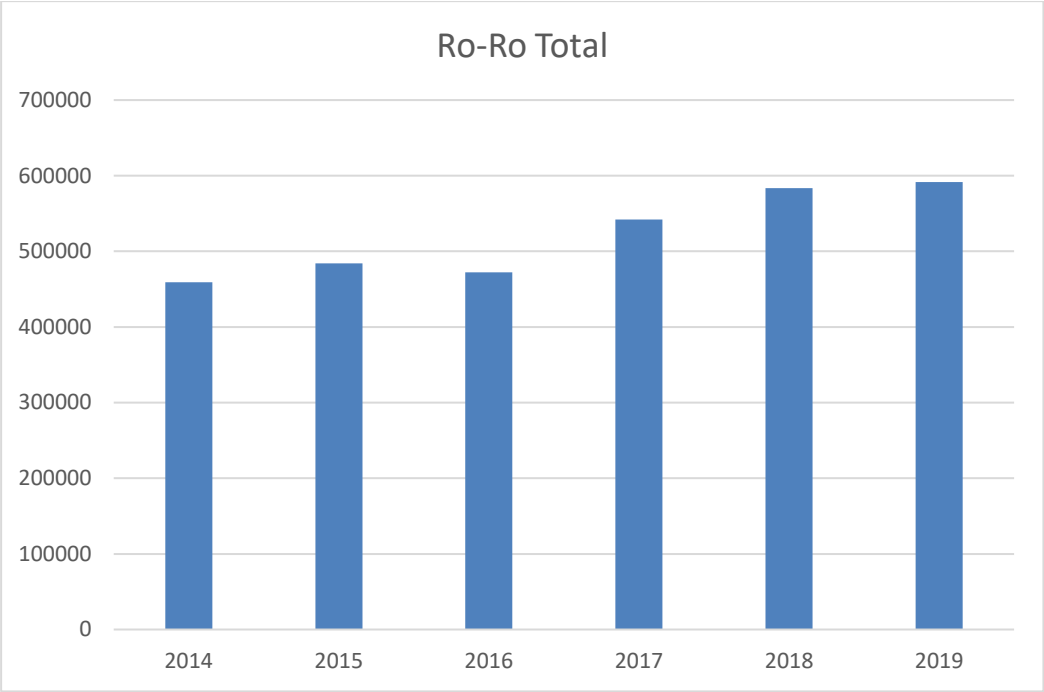

Figure 2.6 : Ro-Ro in Turkey over the years (Source Ministry of Communication).

In addition to Ro-Ro, we believed that finding the busiest ports in terms of cargo and container handling. Due to seaway being the most important and most used modal choice for overseas logistics all around the World, increases the importance of the ports for Hyperloop solution. Because one of our initial thoughts would be connecting ports and airports (which we will be explaining later in this section) to other hubs might be another solution that Hyperloop might bring to the table. In terms of this, we collected raw data from governmental sources, which is also available to public. In Figure 2.7 and 2.8 below, it can be seen that few ports outshine the others. Ports, such as Kocaeli, Ambarlı, Tekirdağ, Aliağa, İskenderun might play an important role for deciding the Hyperloop routes.

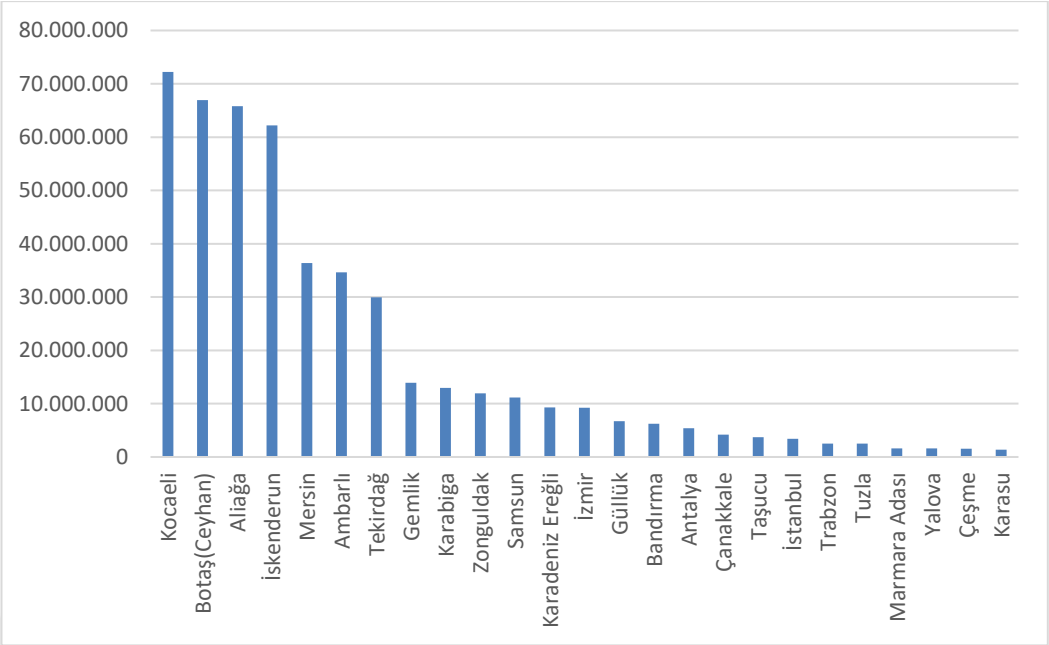

Figure 2.7 : 2019 Cargo Handling by Ports (in Tonnes) (Source: General of Maritime).

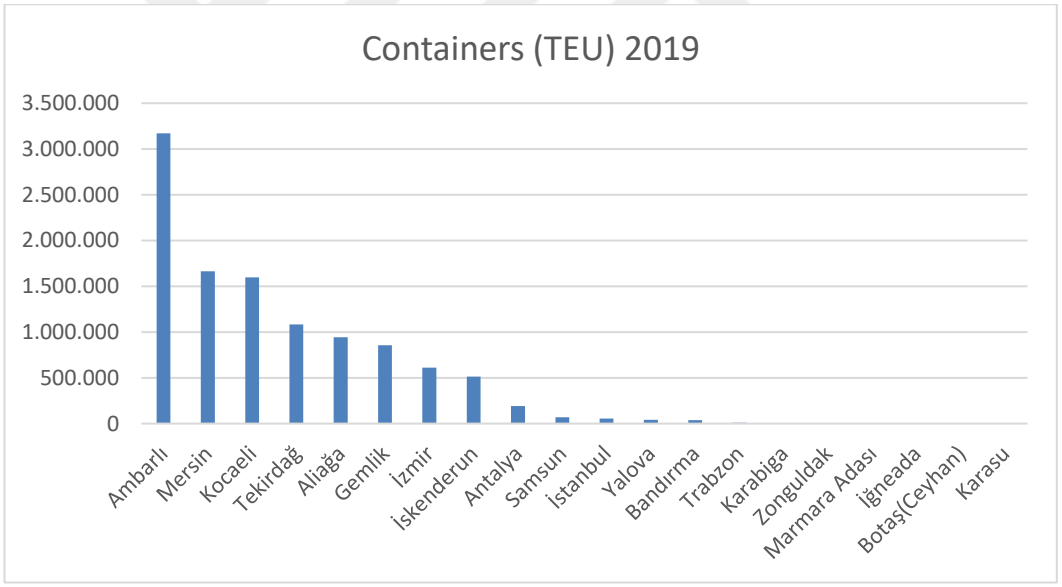

Figure 2.8 : 2019 Containers (TEU) by Ports (Source: General of Maritime).

Last modal choice is the air cargo. Shorter times on longer distances made air cargo more popular in recent years all over the world. Although it is usually more expensive than seaway cargo, short delivery times ensures that this effect is ignored, especially when there is a time constraint. Likewise, air cargo has increased its importance over the years in Turkey. Figure 2.9 illustrates both domestic and international air cargo traffic since 2015. It is very clearly to seen that; air cargo has increased over 65% in 5 years (2015 to 2019). Despite the fact that, in 2020 air cargo in Turkey decreased a

little due to Covid-19, 2020 was not a regular year to make comparisons with. Another noticeable point in that illustration is the rapid increase in international cargo, and the slowly declining domestic cargo traffic. As we mentioned before, in domestic cargo transportation, road (trucks) is the preferred option. Our comment on this occasion would be, air cargo is becoming the preferred modal choice for a cargo, over medium to long distances with a time restraint.

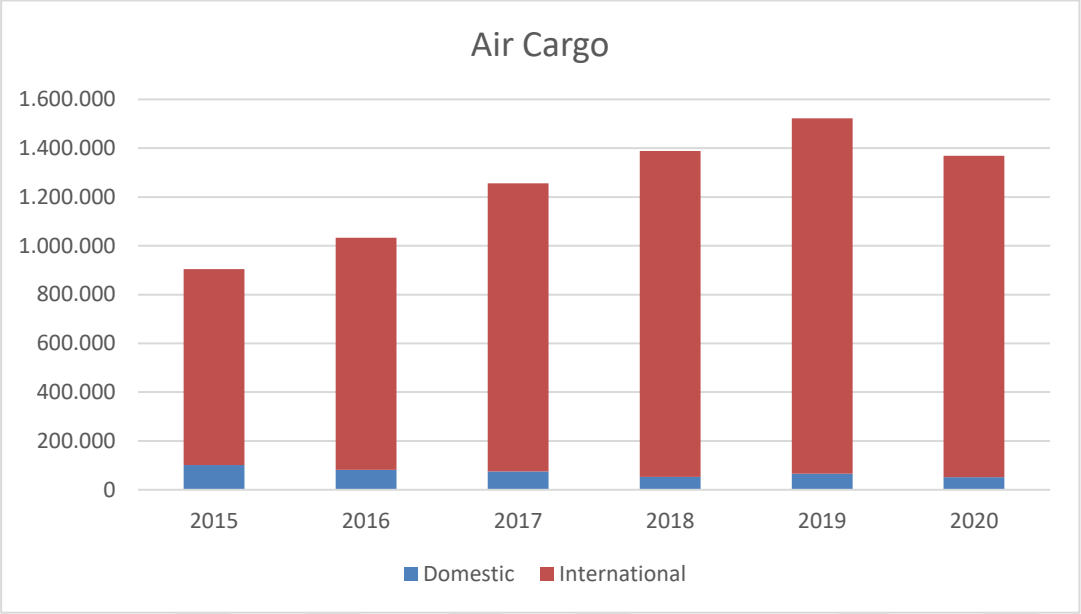

Figure 2.9 : Air Cargo over the years (in tonnes) (Source: DHMİ).

During the Covid-19 measurements, e-commerce became more important, especially in 2020. Ministry of Commerce prepared a report showing the Turkish e-commerce. Figure 2.10, 2.11 and 2.12 illustrates Turkish e-commerce. In sectoral distribution, airline industry takes the biggest share, which supports rapid increase in air cargo over the years. In addition to that, MoC also showed the major cities in e-commerce. According to this İstanbul has over one third of the shares, which followed by other metropolitan cities such as Ankara, İzmir, Bursa, Antalya and Kocaeli. Lastly the comparison between 2019 and 2020 (first half) shows that there is 64% increase in e-commerce due to Covid-19.

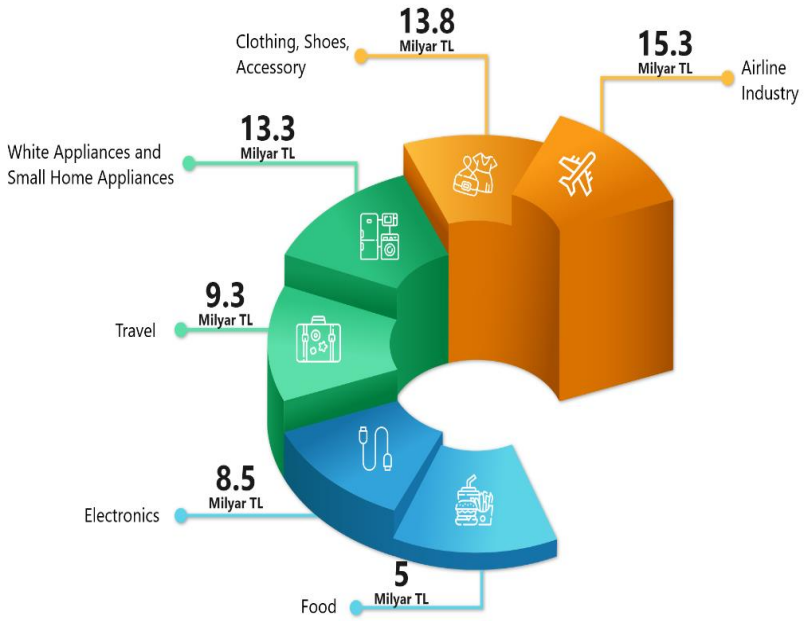

Figure 2.10 : Sectoral Distribution in e-commerce (Source: Ministry of Commerce).

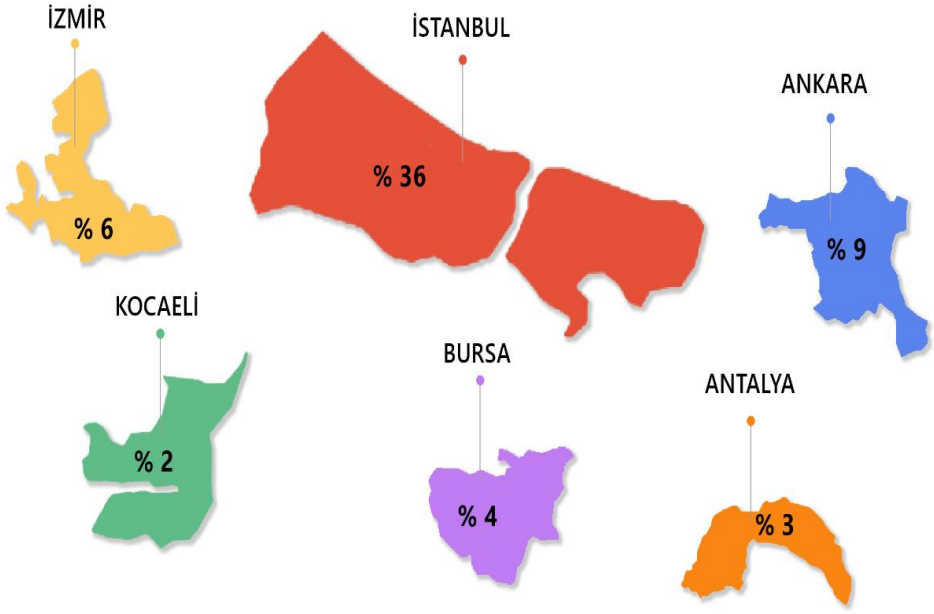

Figure 2.11 : Top cities in Turkey e-commerce (Source: Ministry of Commerce).

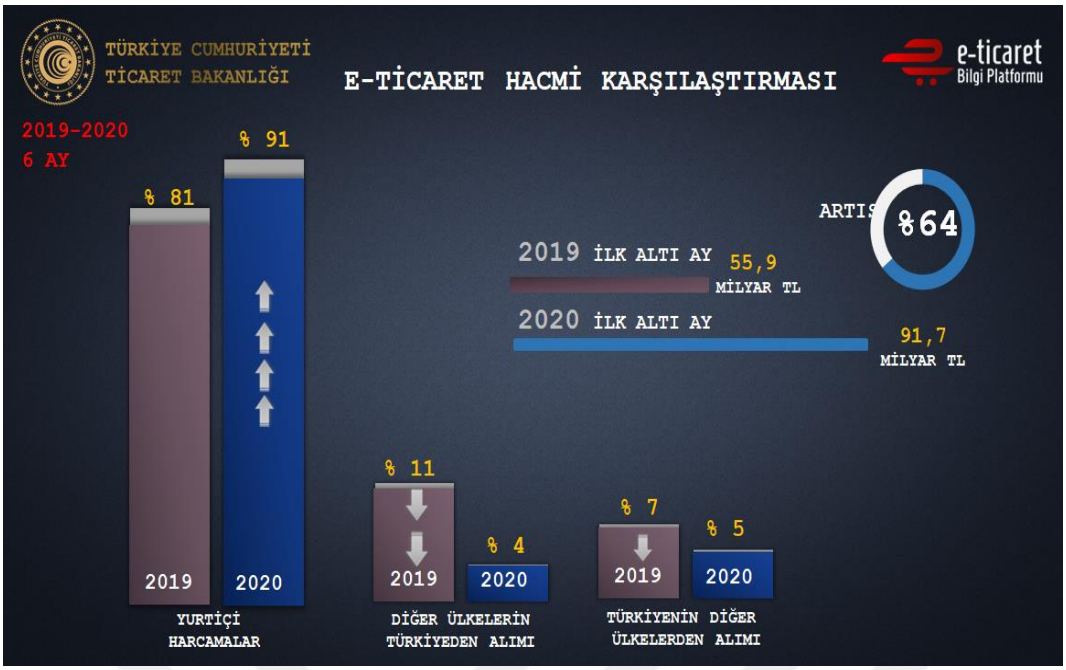

Figure 2.12 : E-commerce comparison between 2019 and 2020 (Source: Ministry of Commerce).

In final words, freight sector in Turkey has a huge potential to grow. Due to its geographical location, with the e-commerce, Turkey might become one of the arbiter countries in the future. Connecting Europe and Asia, and especially with technologies like Hyperloop, might become easier. The most important problem to overcome would be deciding Hyperloop's position in Turkish freight sector. Defining and positioning Hyperloop will be very crucial during the integration. In the next section, we will be reviewing the literature in that regard to understand which factors affect the modal choice and how can we define Hyperloop accordingly.

2.3 Factors Affecting Modal Choice in Freight Transport

One of the most important decisions in freight transport is selecting the transportation method. Selecting the correct modal choice in regard to which factor shippers' needs is crucial and this will allow shippers to gain the competitive advantage in a highly competitive market. In order for Hyperloop to be the main modal choice for many shippers, we need to first understand these factors which affect shippers' modal choice. In the literature, cost was highlighted by many researchers, but it is not the only factor that affects the modal choice. Flodén et. al. (2017) found out that many factors, both qualitative and quantitative, internal, or external criteria affects the modal choice.

Authors also found out that, four factors are the most crucial, with cost being the most important, which followed by quality, transport time and reliability (Flodén et. al., 2017). Many other researchers point out these four factors: Cost (Lammgård and Andersson, 2014; Bergantino et. al., 2013; Danielis & Marcucci, 2007; Zeybek 2019), Quality (Punakivi & Hinkka, 2006; Flodén et. al., 2017), Reliability (Arencibia et. al., 2015; Bergantino et. al., 2013) and Transport Time (Punakivi & Hinkka, 2006; Danielis & Marcucci, 2007; Arencibia et. al., 2015).

Although those four factors underlined by many researchers, those are not the only factors mentioned in the literature. Other factors such as safety/security (Danielis et. al., 2005), flexibility (Danielis & Marcucci, 2007), infrastructure (Blauwens et. al., 2006), regulations (Dalla Chiara et. al., 2008), and some other factors which has been given medium to low rate of importance by some researchers such as frequency (Bergantino et. al., 2013; Flodén et. al., 2017), environment (Arencibia et. al., 2015; Lammgård and Andersson, 2014), IT (Lammgård and Andersson, 2014). In addition to safety and security some researchers also mentioned the damage to the goods (Danielis & Marcucci, 2007; Arencibia et. al., 2015).

As is mentioned before, many researchers pointed out cost as the most vital factor in regard to modal choice in freight industry. In his study Beuthe et. al. (2001) found out that, minimum transport cost is the main actor for market drivers in freight industry to take actions. Likewise, many other researchers noted the importance of the cost (Kreutzberger 2008; Lammgård & Andersson, 2014; Vannieuwenhuyse et. al., 2003). Especially Kreutzberger (2008) mentioned that the actors of freight transportation believes that cost is number one priority when it comes to the intermodal freight transportation. In that regard, García-Menéndez et. al. (2004) came to the conclusion of cost elasticity is higher on sea transportation than road transportation with respect to intermodal transportation, thus road transportation is less sensitive. In addition to that, Arnold et. al. (2004) reached the finding of intermodal transportation cost - between rail and road- mostly depends on “relative cost of rail”. Authors also underlined that 500 km should be the minimum distance to achieve this (Arnold et. al., 2004). This also mentioned by Janic (2008), in which he claimed costs of intermodal freight will be lower compared to road transportation after 1100 km if Conventional Intermodal Freight Trains are used, and 600-700 km if Long Intermodal Freight Trains are used as a modal choice. Until that distance road transportation seemed to be most

dominant modal choice (García-Menéndez et. al., 2004; Arnold et. al., 2004; Janic, 2008, Blauwens et. al., 2006). Thus, road freight generally the most used transportation modal around Europe. Hence, it is expected to be taking some measurements to shift it to the other modal choice. One of the discussed methods was road tolling and its effects on road freight (Gibson et. al., 2014). In addition to that, Gomez and Vassalo (2018) found out that, the effect of tolling is so minimum and insignificant, it almost does not shift the modal choice from road to the other modal options. Taking different precautions such as "increasing the cost of road transportation", "better lead-time performance of combined transportation" would be the key measurements in order to shifting from road to other modal choices (Blauwens et. al., 2006).

Although cost is the most important factor, it is not the only factor that has been discussed in literature. Flodén et. al. (2017) considered transport quality as one of the four major factor that affects the modal choice, whilst Punakivi and Hinkka (2006) found out that in Finland quality is the most important criteria in one of the four sectors that they focused on during their research. Quality differs from researchers to researchers, on the other hand reliability is usually considered to be one of the factors that follows cost in that regard. Matear and Fray (1993) put reliability -indirectly- above low cost for shippers. In addition to that, during their research, the result of their model showed that reliability is more important than cost and transport time (Truschkin and Elbert, 2013). Transport time is also considered as one of the most important factors, Arencibia et. al. (2015) also brought up frequency, damage to the goods and punctuality in addition to transport times. Elbert and Seikowsky (2017) mentioned that shippers in certain industries prioritize frequency more than cost or reliability. Rich et. al. (2009) mentioned shipment size in that regard, whilst Bouchery and Fransoo (2015) believes that shipment size is important, especially for intermodal transportation, due to the reason of lowering the cost of transportation -bigger shipment sizes is a better fit for intermodal transportation-. Lastly Cullinane and Toy (2000) brought the impact of shipment characteristics' importance determining the decision of the modal choice.

All in all, the factors mentioned above, affect the modal choices in freight transport. Although cost seems to be the most important factor, which is usually followed by transit time and reliability etc. in the literature, it totally depends on what shippers are looking for, what is the requirements of the industry are the crucial information to

deciding the modal choice by the shippers. Most researchers agreed on that, shippers play a key role in determination of modal choice. Some of them emphasized the importance of modal shifting towards an intermodal transportation (Bouchery and Fransoo, 2015; Arencibia et. al., 2015; Lammgård and Andersson, 2014; Bergantino et. al., 2013; Danielis & Marcucci, 2007). In Turkey, shippers are the one that selects the transportation modal in most cases (Çelebi et. al., 2018). In the same research Çelebi et. al. (2018) conducted a survey about the importance factors in logistics within Turkey. The results of that survey shown in Figure 13.

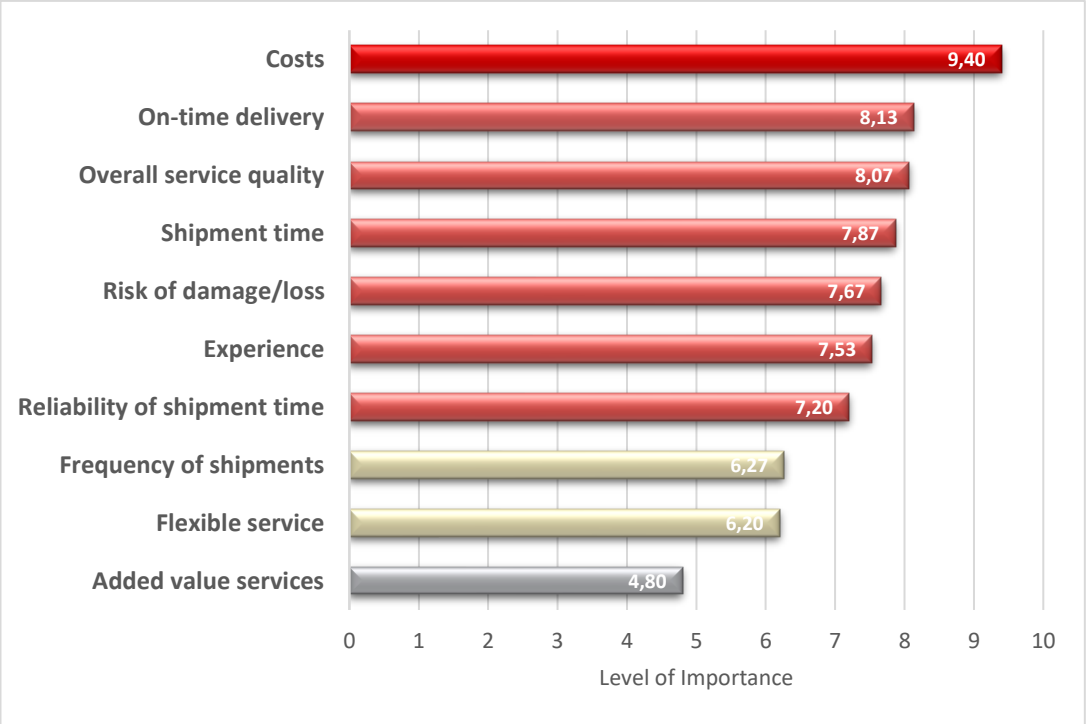

Figure 2.13 : Importance factors of shipments in Turkey (Çelebi et. al., 2018)

As it has been discussed by many researchers, factors affecting the modal choice is no different in Turkey. Figure 2.13 shows that costs are the most crucial, whilst delivery time (on-time delivery), service quality, shipment time, risk of damage/loss follow, experience and reliability follow costs. These factors have over 7.0 rating, which indicates them somewhat being important. Out of all 7 factors, only experience has not been discussed as much as the other factors in literature. Also, in the same study by Çelebi et. al. (2018), they showed the difference between shippers and logistic service providers which can be seen in Figure 2.14. Mostly, these two sides of logistics agree on factors affecting the modal choice, there is few aspects such as quality, shipment time, experience and reliability seem to be different from one another.

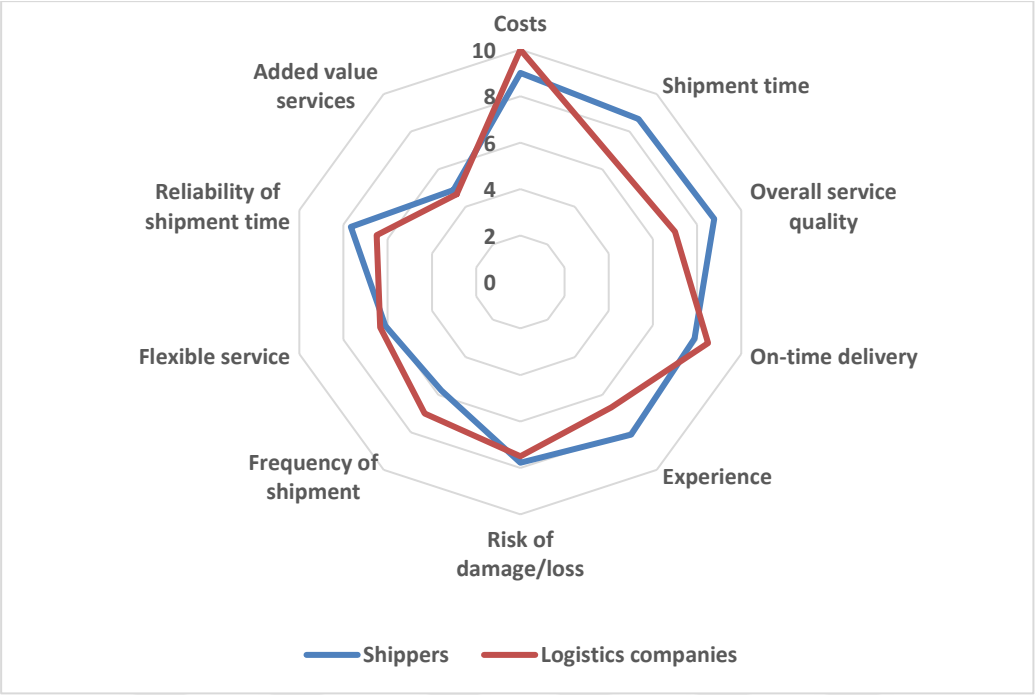

Figure 2.14 : Difference between shippers and logistic service providers in Turkey (Çelebi et. al., 2018)

2.4 Technical Specifications and Current Applications

Hyperloop is relatively a new technology, which seems to be a game changer in transportation operations in the future. Hyperloop was first brought forward by Elon Musk, the founder of Space X and the CEO of Tesla Motors, in 2013. It appears to be the 5th way of transportation for both human and cargo (pipelines can be used to transport liquid or gas but it is not as common as the other modal choices), alongside with road, railway, seaway, and airway. As a new modal option, Hyperloop must be understood well, and applied correctly, since it is a quite expensive investment. The most important question about the Hyperloop (or Hyperloop cargo) operation is to decide the route and the goods that can be carried via Hyperloop. Due to its limited capacity, some goods are not suitable for Hyperloop. In order to apply Hyperloop, first we need to understand the technical specifications.

The first concept to Hyperloop was the “Alpha Version” which was created by Elon Musk and Tesla Motors. According to the Alpha Version, Hyperloop is a transportation method which has the same operation logic as the pneumatic tubes that used to send items such as mail, paper, and paperwork. In that concept work (Hyperloop Alpha), they described Hyperloop as the “enlarged version of the old

pneumatic tubes"[4]. Using the air pressure distribution, Hyperloop can reach to top speed of 700 mph (~1200 km/h), which is close to an airplane speed. This concept was tested between Los Angeles and San Francisco, which is 350 miles. With the top speed, it is estimated that Hyperloop can travel between these two cities in 35 minutes, which takes almost 6 hours on road. Hyperloop Alpha was mainly focus on human transportation. In Hyperloop Alpha it is possible to carry 28 passengers with 2 rows of 14 seats (Tesla Motors Inc., 2016)[4]. Although this was the first concept for Hyperloop, this concept brought new perspective to transportation. According to Dudnikov (2017), with this concept, there will be 9 major advantages, which are;

- Human and Cargo will be transported in high speeds,
- Eliminates the speed limit problem,
- Possible under sea transportation,
- High capacity,
- Low cost,
- Low operating expenses,
- It is independent from weather conditions, and it is quieter than the current technologies,
- Clean technology,
- Safety.

Although Dudnikov mentions that Hyperloop has a low-cost advantage, it is not as cheap as perceived. The Alpha Version Passenger Hyperloop is estimated to cost 6 billion $[5]. Although it is expected to reduce the traveling times significantly, the initial cost is rather expensive. The concept only covers 350 miles. If the distance increases, initial cost will increase accordingly. Cargo, or passenger and cargo, which is another possible combination with Hyperloop, will have different pods from passenger version of Hyperloop. This might also increase the cost, especially an Hyperloop system for both human and cargo.

[4] Tesla's Hyperloop Alpha Version page 3
[5] Tesla's Hyperloop Alpha Version page 6. This estimation has made for two one-way tube which can carry "7.4 million people per tube" according to Hyperloop Alpha report.

According to Wikipedia, there is 8 companies that are making investments in Hyperloop technology, which are Virgin Hyperloop One, Hyperloop Transportation Technologies, TransPod, DGWHyperloop, Arrivo, Hardt Global Mobility, Zeleros and Novemo (previously known as Hyper Poland). Hardt Global Mobility, which formed the basics of this thesis, wants to make an investment in Turkey with Hyperloop, a Hyperloop system solely focus on freight transportation.

Cargo transportation is one of the possible outcomes with Hyperloop technology. This technology might be an optimal solution for cargo transportation, especially among the places that are affected by heavy traffic. High speed transportation allows Hyperloop to be competitive against other methods of transportation. According to Nick Eerle -senior vice president- Hyperloop will be 100% competitive against airway, 22% competitive against road and 13% competitive against seaway (Arabian Business, 2017) . One more advantage that Hyperloop will bring would be the quick delivery times. With the high speed and no traffic problems, Hyperloop technology would be the ideal solution for certain product types, mostly the time sensitive product types.

Virgin plays the major role with Hyperloop One, especially in Arabian Peninsula, India, and USA. Their 500-meter test tube, which was held in Nevada (Virgin Hyperloop), was a success, and they expect to have an operational system by 2022. As of writing this thesis, Virgin Hyperloop One have a partnership with United Arabian Emirates port operator DP World, called Cargospeed, and in one of the interviews Josh Giegel -Virgin Hyperloop One's technical officer- described their Hyperloop, more specifically the Cargospeed, as "moving of the flight at a cost of trucking". Also, Rob Lloyd, CEO of Virgin Hyperloop One, mentioned that according to McKinsey this system reduces finished goods inventory and warehouse space by 25% (Supply Chain Digital, 2020).

Cargospeed is not the only work in progress for the Hyperloop technology. Currently HyperloopTT is working on a cargo solution for Hamburg Port, Germany, via Hyperloop. Similar to Hyerploop One, HyperloopTT is working with Hamburger Hafen und Logistik Aktiengesellschaft (HyperloopTT Projects Web Source). CNBC's (2019) interview with Kamal Nash, chief minister of Madyha Pradesh, he discussed the possibility of an Hyperloop Cargo systems between Indore-Bhopal-Jabalpur. Also, Zeleros (2020) has raised 7 million € for Hyperloop development in Europe. In

addition to this Umman, some states of the USA and many other countries are considering the possibility of Hyperloop cargo transportation.

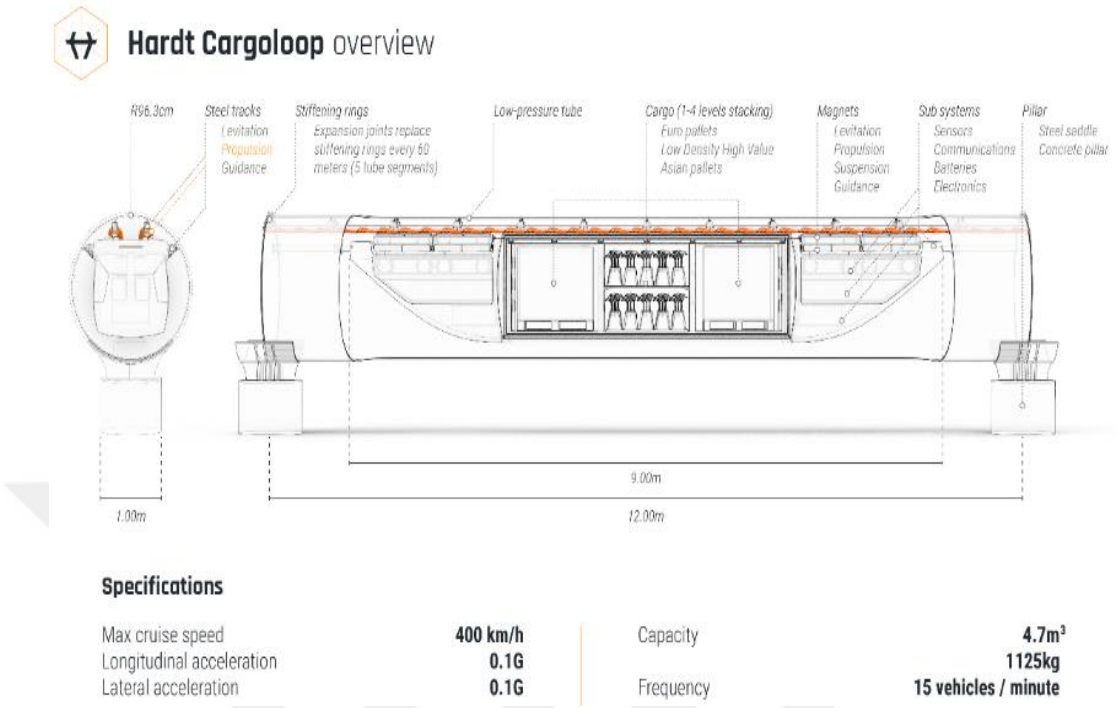

Figure 2.15 : Hardt's Casrgoloop Scheme

Hardt Global provided us basic information about their Hyperloop design and concept work. Their description of Hyperloop is as following: "The Hyperloop Cargo (Hyperloop) is a fast mode of freight transportation, which is currently in test stage, but expected to be realized in various locations over the World by 2023"[6]. Hyperloop is a sealed system of tubes with low air pressure through which a pod may travel substantially free of air resistance or friction. The initial assumption for speed is 300 (with the maximum speed of 400 km/h) km/h, which may be increased up to 1000 km/h. Each vehicle may carry up to 3 cargo units, approximately 1.56 m^3 each. Theoretical weight capacity is around 375 kg/cargo-unit (total capacity is 1125 kg since the concept has 3 cargo units). They expected that their Hyperloop concept will have 50% higher costs than trucking with almost 80% reduction in delivery times." Although they anticipated 80% delivery time reduction, extra cost might be an impediment to Hyperloop's competitiveness. Hence, implementation of Hyperloop should be done carefully, which is the aim of this thesis.

[6] This is the description we retrieved from Hardt Global during our interview with Anna Dabrowska and Constantine Dimitriou from Hardt Global.

Table 2.2 : Comparison of different transport methods (Hardt Global, 2020).

	Air Transport	Road Transport	Hyperloop
Speed performance *(km/h)*	600-900	80-100	150-400
Frequency of vehicle departure *(vehicle/hr)*	12	12	500+
Operational hours	17 *(due to night restrictions)*	9 *(due to driver restriction)*	22 *(2 hours for maintenance)*
Competition with passenger transport	Medium	High	None
Capital investment (CAPEX) *(€M per km)*	Not available per km *(expected higher than road)*	€10,00 - €50,00	€ 8,00 - €12,50
Operational costs (OPEX) (€/100 km) transporting 1 m^3 *(costs excl. financing costs, inc. maintenance etc)*	€ 5,60	€ 1,92	€ 1,69
Energy source	Fossil	Fossil	Electric
CO_2 (g/km) per 1 m^3 cargo	158	35	0
Air/noise pollution	High	Medium	Low
Distance between destinations	200+ km	0 – 1,500 km	10 – 2,500 km

In addition to the technical specification that provided by Hardt Global, they also prepared a comparison table for different modal choices which can be seen above. First and foremost, this table can be applied to European countries, especially the first World countries such as Germany, France, Netherlands, Belgium, Switzerland etc. Although Turkish standards might be different from this table's contents, it still can provide a significant insight to the logistic modalities and their competitiveness, especially around Europe. Connecting to Europe and Asia is a possible outcome for Turkey after such investment. In that regard, this table might become the standards for Turkey, especially the costs. Second of all, Hyperloop seems to compete with all different modal choices, according to this table. Longer operational hours, both short and long distances and the possibility of underground (naturally under sea tunnels) tunnels, it can cover seas as well as land. As previously mentioned, and according to the Hardt's study, Hyperloop might be a great alternative to both airway and road. Given the fact that, Hyperloop will be able to cover distances such as 10 kilometres and 2500 kilometres, Hyperloop might be the most used transportation method in the future. Lastly, it is environment friendly. Werner (2016) found out that, implementation of Hyperloop not only reduces costs, but also reduces pollutions.

Hyperloop, a cargo transportation operation via Hyperloop, has not being discussed much by researchers. Hyperloop was mainly focused on human transportation in research field. There are only few researchers have been focusing the potential of cargo transportation. In addition to that, there is only few master level theses in this area, but most of them are focusing on human transportation. In Marcha Pijnenburg's thesis (TUDelft University-2019), the aim was to complete a feasibility study of Hyperloop in Europe using Cost Benefit Analysis. Best to our knowledge, there has not been any study or thesis has been done regarding cargo transportation in Turkey via Hyperloop. In this thesis we aim to fill that gap, by completing a basic analysis of the Turkish logistics industry, understanding the positive and negative sides of it, and how can Hyperloop be the correct solution to those negative sides in logistics. Eventually, we conduct a semi structured interviews according to our data analysis to get the idea of potential Hyperloop solution. In the next section we will be explaining those in detail.

3. DATA & METHODOLOGY

3.1 Data

This thesis is only a preliminary study and deeper research will be done in the following stages. Hence, the main concern is to understand the core of the logistics in Turkey, acknowledge the major problems, and detecting whether Hyperloop will be the solution to these problems. If so, what would be the best way to implement Hyperloop, deciding which cities would be the best to have hubs on them, and in the future how to connect Turkey with Europe and Asia via Hyperloop were the major questions we faced throughout the process. Unlike many solutions that applied before -not only in logistics, but in any given industry in Turkey- we want to make sure that Hyperloop is not just a solution to save the day. We rather try to create better opportunities in the future with Hyperloop.

As we mentioned in the introduction, we create four main tasks to understand different sides of Turkish logistics industry. These tasks are:

- Task 1: Literature review, state of Turkish LI and basic market research,
- Task 2: Economical data collection,
- Task 3: Pre-Analysis: Product group selection, and routes identification,
- Task 4: Getting an insight knowledge from market drivers and prospects via SSI.

Task 1 and 2 are the first steps towards the understanding of Turkish logistics industry. In the further sections we will be explaining how to select and collect the related data (task 2), and which methodology we used to analyse this data in the further parts of this section.

3.1.1 Data Collection

First, this thesis carried out by investigating the current conditions of logistics in Turkey and estimate the future of the industry by analysing the market. To be able to

conduct such analysis, we first identified three main dataset topics for potential Hyperloop solution:

- Economic indicators,
- Infrastructure network data,
- Approximation of freight traffic data.

First of all, we discussed which economic indicators might help us understand Turkish economy and also allow us to make progress in our project. We believed that a few indicators such as agricultural production, employment and unemployment rates, GDP, number of ventures and population by age and region would be beneficial and assist us to decide the potential routes of Hyperloop. We collected all the said datasets from Turkish Statistical Institute (TUİK), which are publicly available, covering the last 5 years (2015-2019) with NUTS3 province level, if available.

Second category is collecting information about infrastructure in Turkey for different freight modals. Primary goal to achieve with these datasets is to understand the main hubs and locations for different freight modals and detect the main corridors of Turkish freight within the country borders. These datasets are collected from the related directorate or administrations. Although we collected data for different freight modals, our main focus was road and railway, because our initial estimates were Hyperloop to compete with these transport modals within Turkey. Naturally, we collected the characteristic of Turkish road and railway corridors to support this idea.

Last category of datasets is to understand the core of the Turkish freight industry, by collecting raw data for all modal choices, determine the major corridors, product categories (including density, delivery times etc.) to be able to estimate the correct corridors for Hyperloop with the correct product type. In this context we focused on four subcategories, which are;

- Trade Flows,
- Sectoral and Regional Distributions,
- Road Traffic Data,
- Freight Flow Data by Origin-Destination

With these four subcategories our aim is to cover different aspects of Turkish freight industry, to be able to reach the core of it. These datasets are collected from related/selected sectors, Ministry of Industry and Technology – Entrepreneurial Information System, Directorate of Highways and ETA Logistics.

In the next sections we will be explaining our analysis of this data and the methodology that we select regarding to that analysis.

3.1.2 Data Analysis

In our data analysis, separated under three categories, we examined the datasets both within and among themselves. Our main concern was to see if there is any significant correlation with those datasets. Since our aim for this thesis is to find the potential routes for Hyperloop with the correct product group, our analysis consists of finding that correlation not only for cities, or product groups, and between those two.

We mostly used categorization for the economic indicators. Whether it is logarithmic or numerical categorization, we try to understand economic development and some indicators in Turkish cities via categorization.

We preferred charting method to analyse and obtain basic results for the network infrastructure of the Turkish logistics industry. With the 5-year datasets we compare the increase or decrease -mostly increase, because Turkish logistics industry is developing over the years, and it is expected to keep that growth in the future- and if there is any significance within the modal choices. In addition to that we examined if there is correlation between some of the logistics hubs/locations and economic indicators.

Final and the main part of the datasets were the freight traffic data that we obtained from different sources. Although our main goal is to decide the potential hubs for Hyperloop, understanding of the trade flows within Turkey plays a vital role, to select a hub. Without trade flow datasets, big cities such as İstanbul, Ankara, İzmir would be the obvious choice. But the main concern was, if Hyperloop hubs in those locations would be the correct solutions that logistics industry is facing right now. We used GIS to analyse the data and find the most congested routes for different product groups (Çelebi & Kerem, 2021). In addition to that, understanding which corridors are the most congested with different product group is also important. As volume being a constraint for Hyperloop, selecting correct product group to transport will impact as

much as selecting the correct hubs. As a matter of fact, selecting the correct product group will help us significantly towards our goal. Herewith, we also collect and analyse trade flows and volumes of some of the product groups of different sectors in Turkey such as agriculture, automotive etc. All in all, our aim was to understand the corridors within Turkey, identify the congestions and other problems, and present a solution via Hyperloop on those corridors. For that regard, we analysed the dataset that we obtained from ETA Logistics that has over 500.000 FTL orders from different companies in different sectors. Main contribution of this dataset was the origin-destinations, which gave us general information about production sites for each sector, end customers' locations with the volume that they order. In the dataset, there is every type of cargo, and there is total of 381986 different freights during 2019. When we eliminate the cargo types that we believe will not be a good idea for Hyperloop at the beginning, we see that there was 21280 freight transport, which is more than 5% of the annual freight transportation. On the other hand, this list does not include and pharmaceutical products. The noticeable point is the departure of those product types, especially electronics, machinery, and other valuable items. Most of those cargo types have the departure points of İstanbul, Kocaeli, İzmir, Tekirdağ, Bolu and Adana. Although arrivals usually differ by each freight, this information would help us decide the correct routing of Hyperloop. Hence, finding a common corridor(s) within each sectoral transportation. This analysis gave us general idea of how to process further in our study.

All this analysis, that has been explained above in this section, was the preliminary analysis for our thesis. Our main goal with this analysis is to decide which methodology would be the best fitting with respect to the datasets we obtained. According to our data analysis, we conducted a semi structure interview, with the results that we got. We will be sharing the results of the data analysis and the findings of that semi structured interviews in details in the upcoming sections.

3.2 Methodology

Our preliminary analysis of the datasets that we obtained directed us towards the semi-structured interviews. Our aim is to gain an insight knowledge of the logistics sector in Turkey and to compare the data we had, to see if there is any significance between raw data and expert comments, their thoughts on current problems and discussion of

possible solution to those problems. As a part of our interview, we will be giving brief information about Hyperloop to the participants and see their initial reaction to possible Hyperloop solution in Turkish logistics industry. In this context we prepared an interview questionnaire (see Appendix), with respect to our results that we found from our data analysis. In addition to that, this interview will also help us to understand some of the problems in logistics that we cannot acquire from datasets as we mentioned before. First, we will be explaining why we selected semi-structured interview with respect to the literature. Later in this section, we will be giving all the information about our interview process.

Semi-structured interviews are one of the methods that is used in the literature to gain information about certain topic via questionnaire -which is qualitative and included open ended questions- and usually have definite format via set questions/questionnaire (Wikipedia). This type of interviews mostly preferred, when an interviewer wants interviewee, whether it is an expert on that subject/topic or just a sample from a population, to give his/her ideas or thoughts about to subject. Hence, semi-structured interviews have usually open-ended questions, unlike the structured interviews, which is stricter compared to semi-structured interviews. As we mentioned before, it has been used as a methodology in the literature for decades. Naturally, it has been discussed in the literature as a separate topic. In 1946 Robert Merton and Patricia Kendall's research considered to be the premise of the semi-structured interviews (McIntosh & Morse, 2015). Richards & Morse (2007) believes semi-structured interviews allow researchers to gain subjective information. McIntosh & Morse (2015) think semi-structured interviews popularity comes from the freedom it gives to the respondents with open ended questions while following a structure at the same time. Barriball and While (1994) mentioned that semi-structured interviews have selected in the literature because of the input that respondent can put. In addition to those semi-structured interviews allow both sides -interviewee and interviewer- to be able to contribute (Galletta, 2012), interviewer to come up with follow-up questions (Hardon et. al., 2004, Rubin & Rubin 2005, Polit & Beck 2010). Although, this characteristic of semi-structured interviews seems to be making it preferable, but Williamson (1981) underlines the non-respondents may disrupt the research. Hence, selecting the correct interviewers who can respond and give enough information/responses to reach a significant conclusion is the key for researchers who uses semi-structured interviews

for their topics of research. Kallio et. al. (2016) correlates semi-structured interviews popularity to "versatility and flexibility" it brings. Bryman (2006) believes that semi-structured interviews are being one of the most popular qualitative methods in research fields, but it can still be quantitative due to its structure and collectable samples.

As it has been explained briefly, semi-structured interviews would be the best way of getting the results for our thesis. Our aim with SSI is to gain some information about Turkish logistics industry, introduce Hyperloop to the experts and get their comment on Hyperloop via some open-ended questions. We have conducted this SSI under three sections. First section is brief information about the respondent (such as name/contact number etc.) and his/her company/institution (private or public, warehouse information etc.). This section has few questions like we mentioned, and it was expected to be completed in five minutes. In the second section, we asked respondents about most important product type(s) (up to three) and their detailed shipment information such as volumes, origin-destination, modal choice, delivery times and other key factors that affect the importance of that product group. Our goal in this section is to find the best product types for Hyperloop. Expected time for this section was ten minutes. The final section is the brief introduction of Hyperloop with some open-ended questions about general issues in Turkish logistics industry to the future and Hyperloop's possible effects on Turkish logistics industry. Although we have a structure for this part, we would like to expand if it is necessary, depending on the answers and comments we will get from our interviewees/respondents. Our expected time on this section was 25-30 minutes, which brings us to total of 45 minutes for each interview. As previously mentioned, due to last section we put +15 minutes on top of that time, in case of any discussion with extra question related to the answers we obtained from the open-ended questions.

This brings us to the next step in the process. Sample selection and deciding the interview environment. First step after the interview structure was to select the sample size and respondents. Our initial target for sample size was between twenty to thirty, which could be extended depending on the responses we get. Our selected samples will be consisting of the expert of Turkish logistics industry such as third-party logistics service providers, board members of logistics associations, and shippers. In the further steps we would like to expand our samples with some ministerial interviews. Our next step was to decide the environment. Unfortunately, Covid's

existence during our research in this subject restricted our options for that. First, we tried to conduct a possible list including third-party logistics service providers, shippers, institution boards and some companies for the product group(s) we thought would be the best for Hyperloop. Due to Covid-19 and their busy schedule, we could not be able to reach any companies, but we reached total of twenty experts including third-party logistics service providers, shippers, and market drivers such as associations via e-mail and/or phone calls. We first explained our research topic and invited them to our interview which we aimed to finish in 45 minutes. We reached some of them via phone first, and then send an invitation mail to them, and for the rest of the respondents we directly reached them via e-mail. We attached the questionnaire with the invitations. Some of the respondent filled the questionnaire in written form and sent it back to us with the information needed, although it could have been better to do the interview online but due to different conditions we receive and analyse their responses in written form. For the rest of the respondents, we conducted an online interview, with respect to Covid-19 measurements, via online meeting software Zoom or phone interviews. We will be sharing the results and important notes/factors we obtained during our interviews in the upcoming sections.

4. FINDINGS

4.1 Determination of Product Types

First and foremost, we believed we should decide the best possible cargo types for Hyperloop. Our data analysis and literature review/market research shaped around identifying the most ideal cargo types. Herewith, we found out that the most suitable cargo types are time sensitive and/or high value cargos since speed is the strongest suit of Hyperloop. Our findings show that fresh and perishable foods, pharmaceuticals, electronics, automotive and especially spare parts for automotive are some of the product groups that we can consider for Hyperloop. In that regard, Hyperloop has some similarities with Air Cargo. Tzimourtos (2015) came up with a table of value density for Air Cargo, which might be very useful to Hyperloop (Table 4.1).

Although we considered Air Cargo as the most similar to Hyperloop, there is a major difference in between, which is the capacity/weight handling. Due to its working schematic, Hyperloop can only contain two small capsules, which can only handle certain type of cargos. Because of its structure, capsules can only be loaded by small sized pallets, which means any cargo for Hyperloop must be packed in a suitable unit for this structure. Tzimourtos (2015) found the average density for each product types in Air Cargo, which can be seen in Figure 4.1. This diagram might be a good fundamental for Hyperloop, due to its similarities. In this Figure, the black line expresses the density of Hyperloop. This density explains the ideal cargo types for Hyperloop, which can be calculated via the weight capacity of Hyperloop divided by the volume of the capsules. According to Hardt (Table 2.2), the weight capacity is 375 kgs, and the volume is 1.57 m^3 (1.1x1.1x1.3). Consequently, the average density of Hyperloop can be found as 238.85 kg/m^3, which can be considered as the ideal cargo type for Hyperloop. Any product group that has way above or below this threshold, then there will be either excess volume or shortage in volume. For example, Metal Product which has 451 kg/m^3 density is way above the Hyperloop's ideal line. So, the pallet must be loaded half to compensate. On the other hand, Live Animals have 101

kg/m^3, so this will be very light for Hyperloop. Therefore, according to Tzimourtos (2015), best product groups would be Tobacco products, Jewellery, Cosmetics, Perishables, Plastic products, Machine Parts, and Processed food, with respect to the Hyperloop's ideal density. Selecting these goods for Hyperloop transportation will allow carrier to carry full load pallets and utilize maximum efficiency from Hyperloop.

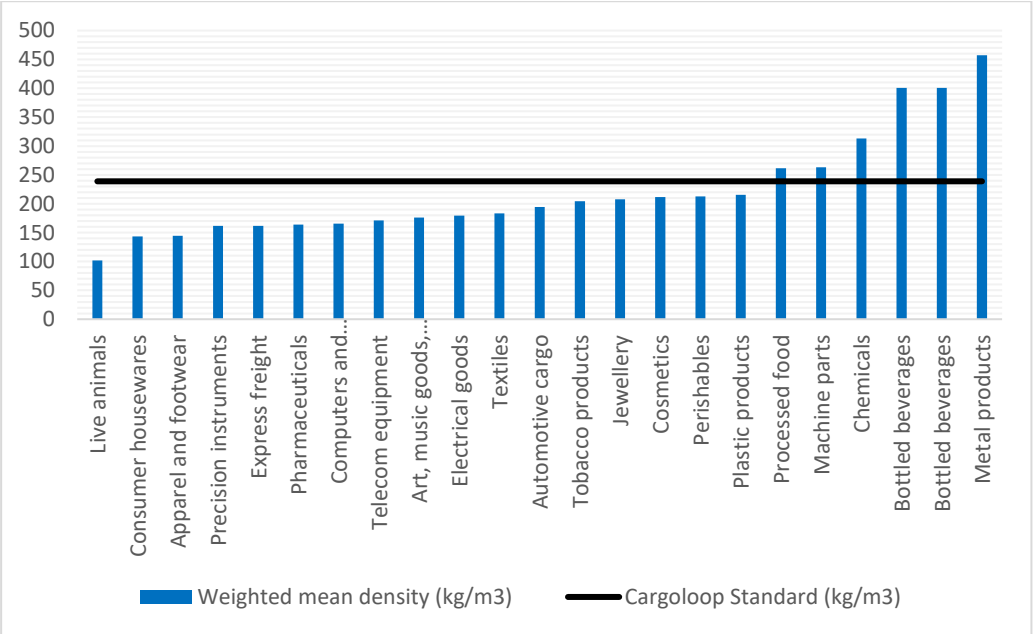

Figure 4.1 : Average weight density of different product groups (compared to Cargoloop's density) (Tzimourtos, G., 2015).

In our data analysis and literature review/market research, we keep those results in mind, while obtain findings from our data analysis. In the upcoming section we will be sharing our results of the analysis with details.

Table 4.1 : Average value density of different product groups in Air Cargo (Tzimourtos, G., 2015).

Commodities	**Value Density (US$/kg)**
Beverages and tobacco	11,91
Crude materials, inedible, except fuels	52,91
Mineral fuels, lubricants and related materials	33,21
Animal and vegetable oils, fats and waxes	7,92
Chemicals and related products	29,49
Manufactured goods classified chiefly by material	15,47
Machinery and transport equipment	20,97
Miscellaneous manufactured articles	20,73

4.2 Preliminary Data Analysis

Our data analysis consists of economic indicators, cargo quantity (in tonnes) from different modal options. First of all, we examined GDP, because it is an important economic indicator to show the potential of the province. Figure 4.2 and 4.3 shows GDP per capita distribution by provinces for 2018.

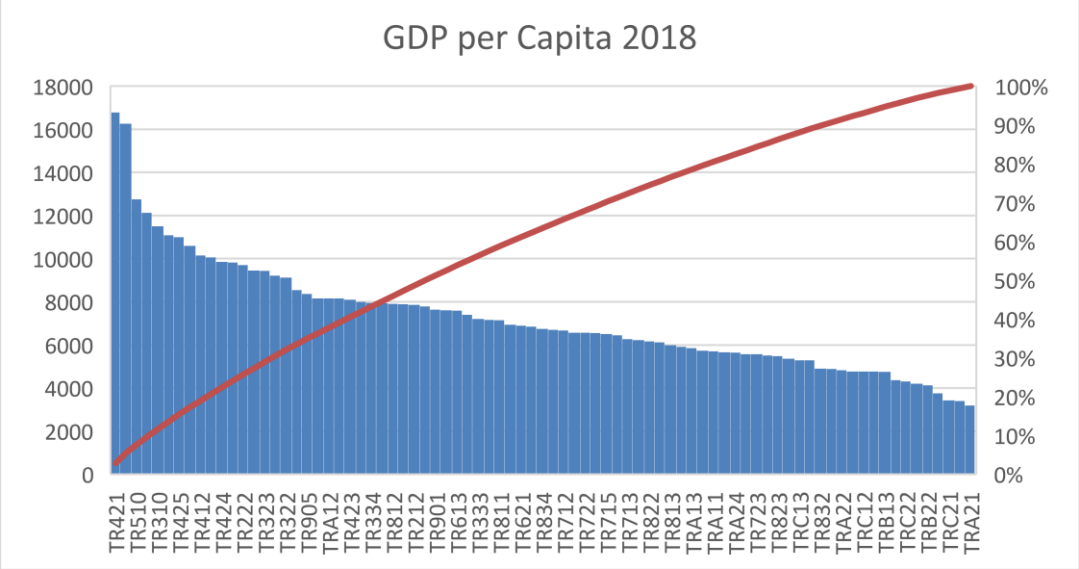

Figure 4.2 : GDP per Capita of Turkish Provinces (NUTS3) in US Dollars.

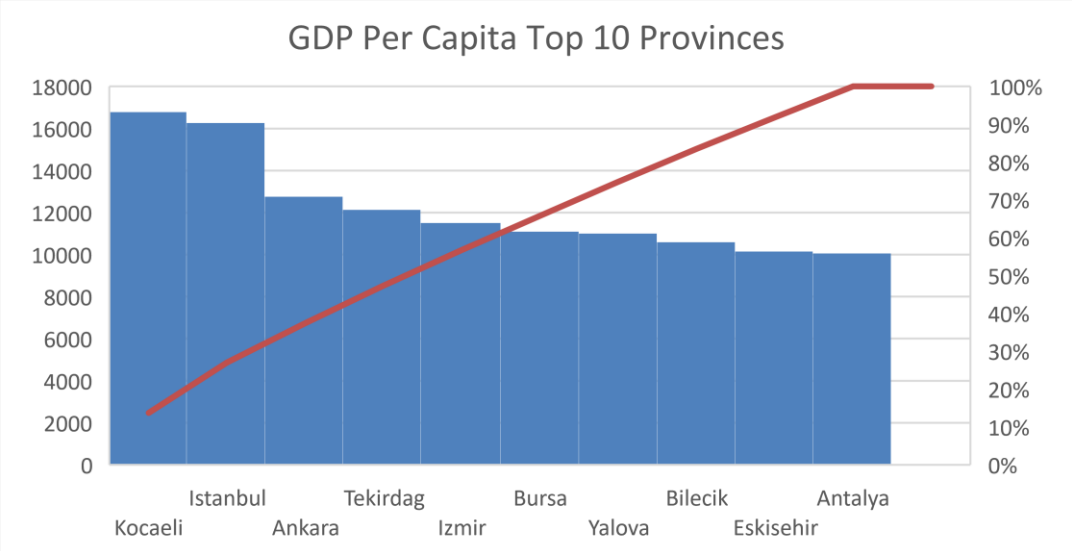

Figure 4.3 : GDP per Capita of Turkish Provinces (NUTS3) in US Dollars (Top 10 provinces).

As it can be observed Kocaeli (TR421) has the highest GDP per Capita in 2018 with 16.791$. Kocaeli is one of the ten provinces that has over 10.000$ GDP per Capita which is the 50% threshold. Those other 10 provinces are (in order) İstanbul (TR100), Ankara (TR510), Tekirdağ (TR211), İzmir (TR310), Bursa (TR411), Yalova (TR425), Bilecik (TR413), Eskişehir (TR412) and Antalya (TR611). Most common ground for these provinces is being the western cities (which can be seen in the map, western side of Turkey illustrated with darker colours, whilst east side illustrated with lighter colour, meaning that GDP per capita decreases towards the eastern side of Turkey), and have multiple different modal options (Figure 4.4). Some of the biggest ports, airports are in those cities. İstanbul -considered to be the most important city in Turkey- is right behind Kocaeli with slightly over 16.000$ GDP per Capita. Third richest city Ankara, the capital of Turkey, has only over 12.000$ GDP per Capita. This difference shows that Kocaeli and İstanbul are by far the most remarkable cities. Hyperloop hubs in İstanbul or Kocaeli might be a good choice. In addition to this, a hub in Tekirdağ would also be a good choice, which might be the connection to other European countries via Hyperloop.

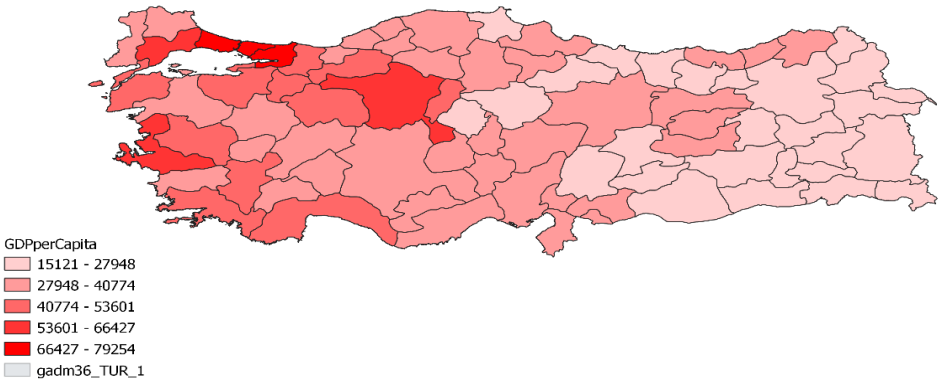

Figure 4.4 : Turkey's GDP Per Capita Map.

Second economic indicator that we analysed was the population and the employment rates by provinces. This is one of the important factors of understanding the economic state of the city and the country itself. Although population itself might not mean

anything, combination with the employment rate will give us an insight about states of the provinces. The total population and the employment rates can be seen below in Figure 4.5, 4.6 and 4.7.

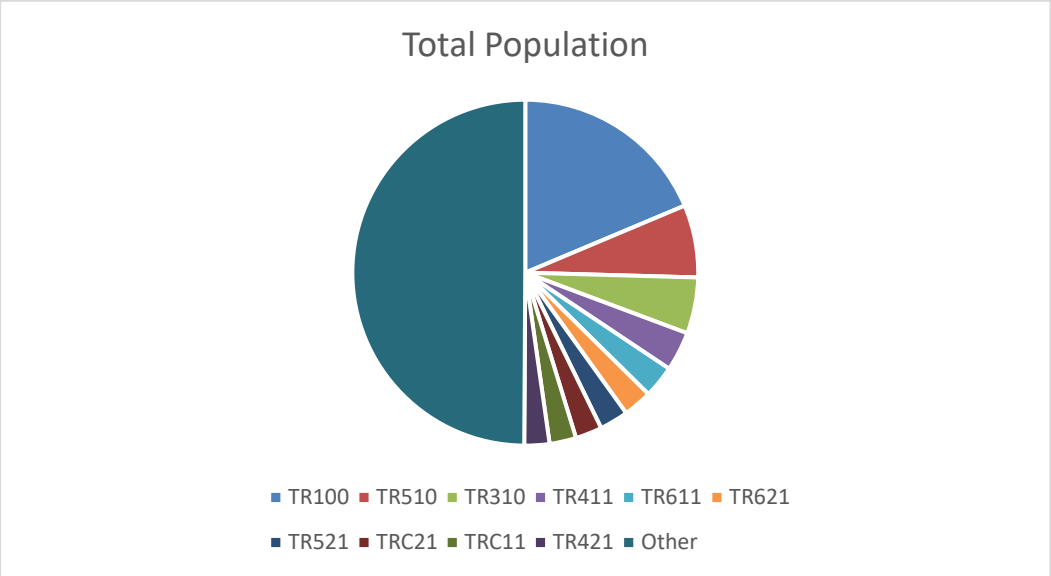

Figure 4.5 : Total Population by Provinces.

Figure 4.6 : Turkey's Population Map by Province (Logarithmic Scale).

In the illustrations above (Figure 4.5 and 4.6) we can see the total population by provinces in Turkey. Figure 4.5 shows that, approximately half of the Turkish citizens live in ten different cities, which are (in order) İstanbul, Ankara, İzmir, Bursa, Antalya, Adana, Konya, Şanlıurfa, Gaziantep and Kocaeli. The most striking points of these

cities are they are mostly the top cities in GDP Per Capita. Another important information might be the number of cities that have over 1 million population. To get this data we tried to illustrate the population by provinces in logarithmic scale in Figure 4.6. Analysing this data with the employment/unemployment rates allow us to see the bigger picture.

According to the employment and unemployment chart there is only two areas that have over 20% unemployment rate (important note that employment and unemployment rates are based on NUTS2 codes instead of NUTS3), which are TRB2 and TRC3. The provinces in those areas are Van, Muş, Bitlis, Hakkâri, Mardin, Batman, Şırnak and Siirt. Most common ground of these provinces are being the eastern cities and have relatively lower GDPs. This might mean freight to these cities could be more difficult than anywhere else in Turkey. This needs to be analysed carefully in the further steps whether a Hyperloop hub in those provinces are good choice or bad choice. Employment/unemployment rates seem to be positive on northern cities. Western cities also have acceptable rates.

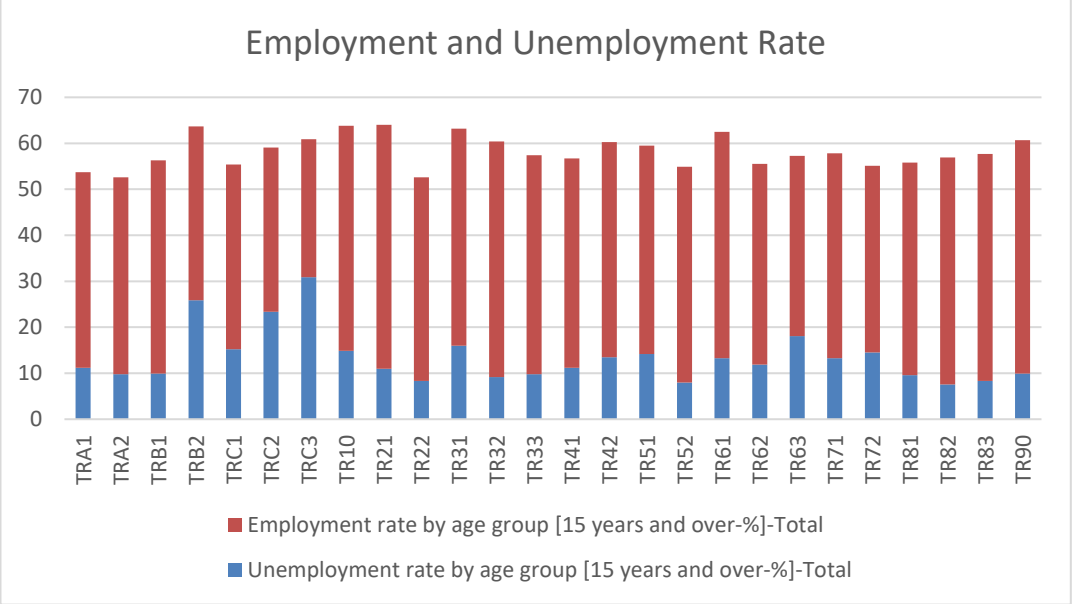

Figure 4.7 : Employment and Unemployment Rate by Age Group.

Another economic indicator that we investigated was the agricultural production. Due to Turkey is being one of the countries that have an agricultural background, this indicator is an important one to understand Turkey's economical state. As it can be seen by the graph and the illustration above southern part of Turkey is the main contributors to the agricultural products. Antalya (TR611) is the only country that has

over 1.6 million tonnes agricultural products (almost 4 million tonnes). Cities like Mersin, Burdur and Adana follow Antalya, but even three of these cities just surpass Antalya's 2019 production. This is similar in the previous years too. Same cities usually produce more than 95% of the annual agricultural products.

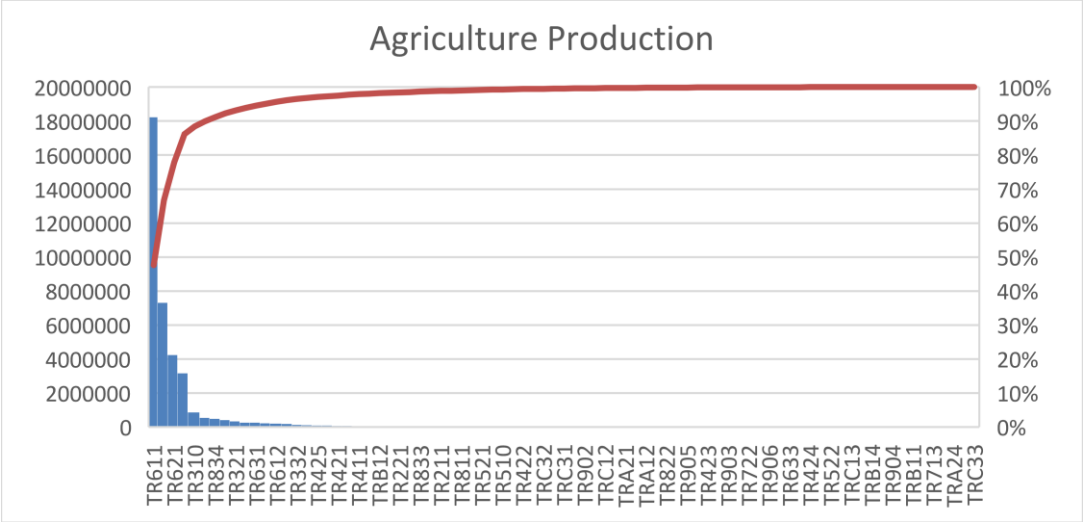

Figure 4.8 : Agriculture Production by Province (Tonnes).

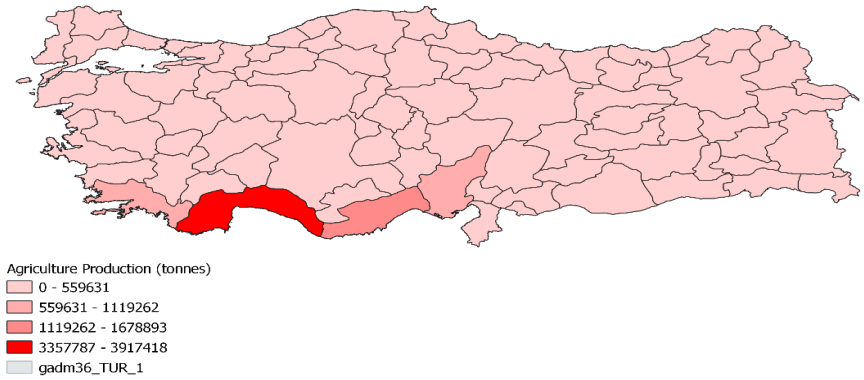

Figure 4.9 : Agriculture Production by Province Map (Tonnes).

Last indicator was the number of ventures by provinces. İstanbul is overwhelmingly predominant against any other provinces with almost 900.000 ventures in total. Ankara, İzmir, Antalya and Bursa are following İstanbul, but none of these cities have

ventures over 20% threshold. Just by the percentages, İstanbul covers one quarter of the total amount. Number of ventures can be seen in Figure 4.10 and 4.11 below.

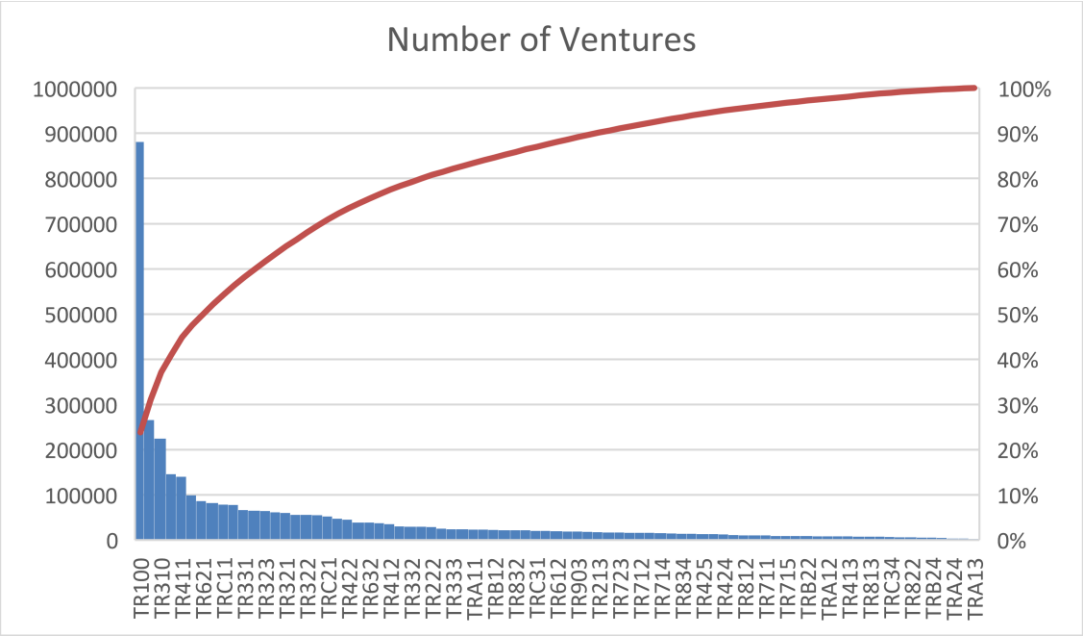

Figure 4.10 : Number of Ventures by Province.

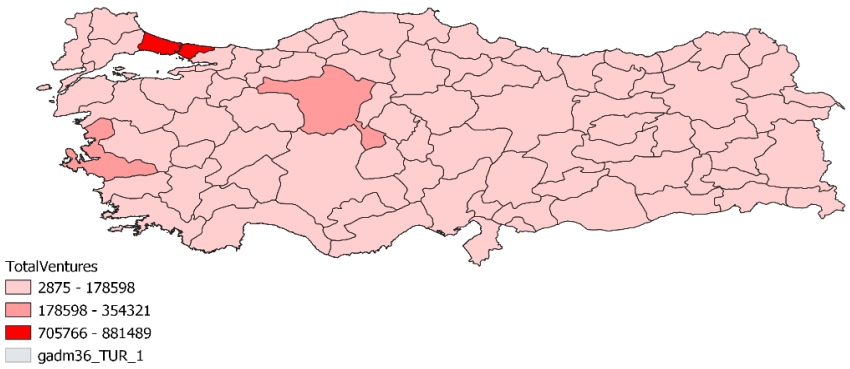

Figure 4.11 : Number of Ventures by Province Map.

4.3 Demand Assessment and Route Identification (Case)

One of the major datasets that lead us into our interviews was the dataset we obtained from Borusan Logistics' subsidy ETA Logistics' origin-destination dataset of the years 2019 and 2020. ETA Logistics can be considered as third-party e-transportation company for both truck owners and load owners (manufacturers). They provide us both years' datasets of all the orders and freight transports they had in terms of origin-destination by product groups. The transportation model in those datasets were road (trucks) in which the load type was FTL (Full Truck Load). There was total of 542642 orders and 381987 transportations in 2019. Due to Covid 19 and pandemic, 2020 dataset was not enough to compare and understand an annual performance of the company, so we mostly focused on 2019.

Figure 4.12 : ETA Logistics' Order Origin-Destination Map.

First thing to note is that the dataset was prepared only for FTL (Full Truck Load) and any LTL (Less Than Truckload) did not take into account. In Figure 4.12 the top origin-destination map can be seen. It is clear that, Marmara region is quite supereminent compared to rest of Turkey. Which also shows resemblance to the other datasets we analysed so far, especially the economic indicators. As it can be observed İstanbul, Tekirdağ, Kocaeli, Bursa, Manisa, Eskişehir and İzmir have most of the shipments between each other. One thing to note is Adana. According to the results, Adana seemed to have its own distribution network for southeast side of Turkey.

Before we continue with more in-depth analysis, we first checked the transportation times. As transportation times, we considered order date, and reaching the destination date. Majority of the orders have zero delay, despite that there is certain percentage of the orders that have delays. Most noticeable ones are the delays that more than one year. Out of 542642 orders there was 1490 orders have a delay over a year, which means that 0,2% of the orders which made in 2019, arrived in 2020. Although 0,2% seems small portion of the actual orders, over a year delay between the order and creating it must investigate further. There are only 8 sectors have this delay, and most of those sector does not have time limits (there is few exceptions such as non-alcoholic beverages and nourishment/food) such as cosmetic products (toilet paper etc.), glass, porcelain, ceramic, electrical products, construction products, paper and packing, rubber etc. On the other hand, when we analyse the non-delayed orders, we found out that 534148 orders have no delay between receiving the order and creating the order. That is 98,5% of the orders that received in 2019. In that category we mostly see product categories that are time sensitive such as e-commerce, food, and beverages, FMCG and some of the product categories that we considered for Hyperloop (high value density) such as automotive and spare parts, electronics. The rest of the 1,3% have a delay of less than a year, which makes total of 1,5% delayed orders. Nonetheless this dataset does not tell us the reason of these delays and as we mentioned before it can be investigated in the further steps of this project. Although we said that as delayed order, but this does not include the transport times after the truck loaded at the origin.

Another analyse we did was on origins, and if there are any patterns between origin and product group(s) (which can be seen by the illustration above). According to ETA Logistics' 2019 order dataset, there is 43 different origins for over 1000 order. The most noticeable origins are (in alphabetical order) Bornova (19533 orders), Çayırova (10879 orders), Çorlu (30096 orders), Dilovası (11063 orders), Gebze (55588 orders), Gemlik (107013 orders), Karadenizereğli (10859 orders), Lüleburgaz (10595 orders), Mudanya (27328 orders), Odunpazarı (12124 orders), Tarsus (12041 orders), Torbalı (26582 orders) and Yunusemre (12345 orders). Those origins mentioned above covers more than half of the orders starts from those locations (346046 out of 542642 orders which means 63,77% of the orders). Here is the full list of the origin locations that has over 1000 orders:

Adapazarı-2135, Arifiye-1845, Avcılar- 1325, Bornova-19533, Beylikdüzü-1542, Bolu-1522, Çerkezköy-4352, Çayırova-10879, Çorlu-30096, Dilovası- 11063, Ereğli-3011, Eyyübiye-2709, Ergene-4765, Gemlik-107013, Gölcük-6798, Gebze-55588, İstanbul-1929, İzmit-1150, İnönü-1679, İncesu-4902, Karadenizereğli-10859, Küçükçekmece-5397, Körfez-2737, Kemalpaşa-2224, Kadıköy-3649, Lüleburgaz-10595, Mudanya-27328, Nilüfer-7343, Odunpazarı-12124, Osmangazi-3717, Orhaneli-4406, Polatlı-6231, Sapanca-8844, Sarıçam-3790, Seyhan-3139, Selçuklu-7972, Silivri-1928, Şehitkamil-8474, Torbalı-26582, Tarsus-12041, Tuzla-5982, Yenişehir-5856, Yunusemre-12345.

Figure 4.13 and 4.14 illustrates the top 25 origin-destination locations (separately).

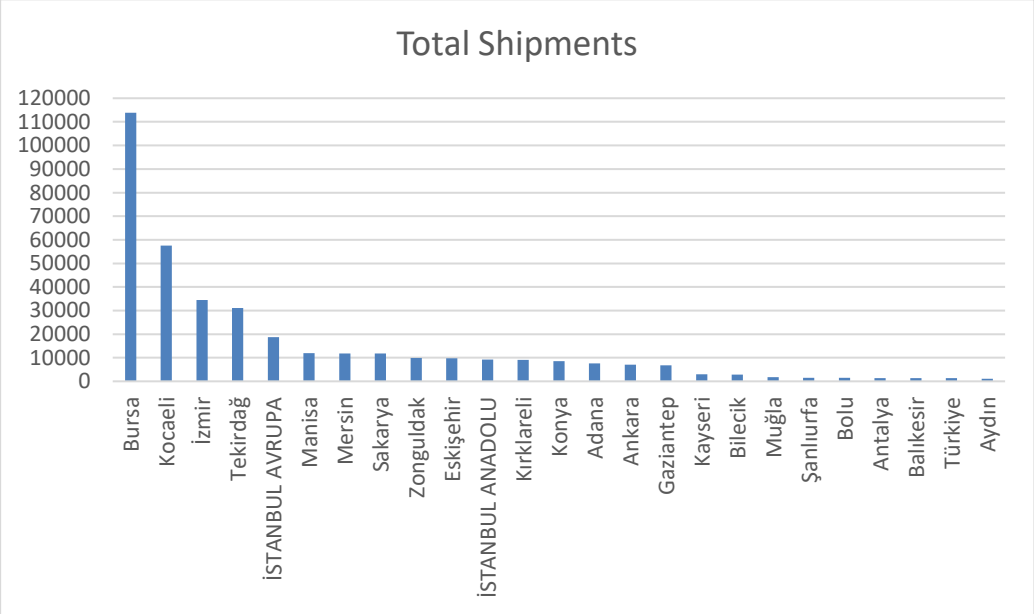

Figure 4.13 : Top 25 Origin Cities in Shipments (Source: ETA Logistics 2019).

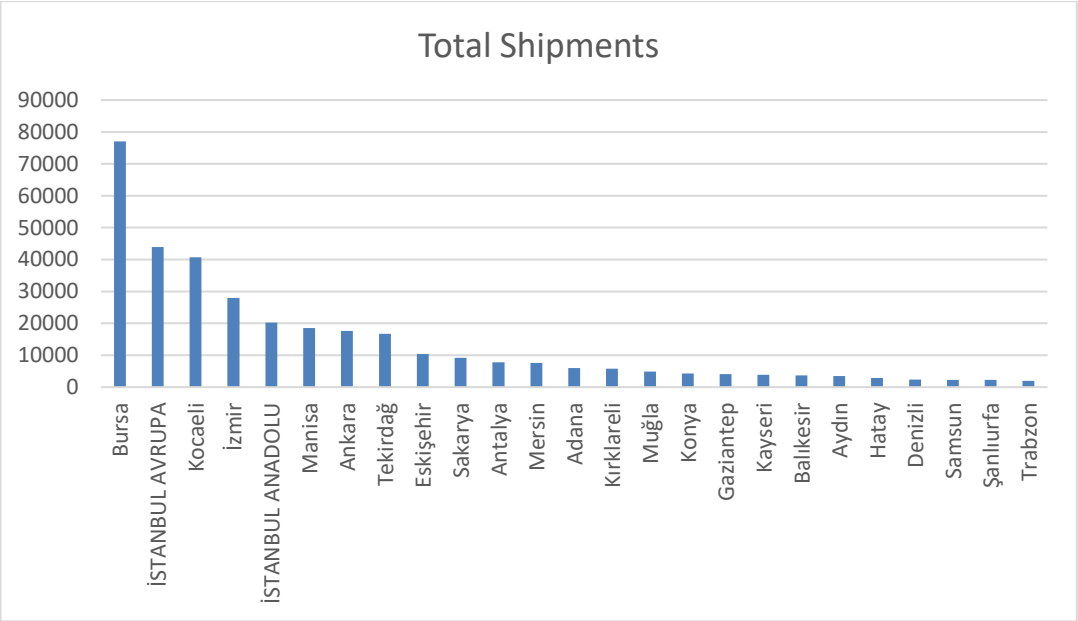

Figure 4.14 : Top 25 Destination Cities in Shipments (Source: ETA Logistics 2019).

The most noticable difference between ETA Logistics' origin-destination dataset and previous datasets is the province/city orders in terms of transportation. Our findings from other datasets usually show that Kocaeli, İstanbul as the top cities with huge gap compare to others. Unlike other datasets, ETA Logistics shows that Bursa is the top city followed by İstanbul, another point is ETA Logistics separated İstanbul into 2 which are Avrupa and Anadolu, and Kocaeli. This gap stands out especially on origin cities (Figure 28). Then we tried to understand where this gap comes from. Once we eliminate the data that does not have origin city as Bursa, we have realised that this comes from due to certain product group that we did not consider before. That product group was Base Metal. The map of base metal distribution can be seen in Figure 4.15.

Figure 4.15 : ETA Logistics' Base Metal Origin-Destination Map.

Gemlik, Bursa is the only origin location that had over 100000 orders. When we analysed the product groups, huge portion of those orders, 97555 to be exact, were industrial products such as base metal. This corresponds to 91,1% of orders which have originated at Gemlik. That is the main reason why Gemlik looks like an outlier. Later, we eliminated all the product categories, except the product groups like food, electronics, automotive and spare parts, to figure out possible origin points that Hyperloop hubs can be infrastructure. Origin points, such as Ereğli, Odunpazarı etc. stand out with that analyse. Even though this is a huge dataset and can give so much information about freight transport, it still belongs to one company, and more datasets from different companies should be investigated in the further steps. In addition to that the dataset only contains FTL orders and this is not a realistic scenario, and any orders with LTL should be included to get more correct results.

Although base metal seems to cover decent portion of the orders, ETA Logistics have variety of product groups. In Figure 4.16-4.20, it can be seen different product groups and their respective shipments.

Figure 4.16 : Non-Alcoholic Drinks Origin-Destination Map (Source: ETA Logistics).

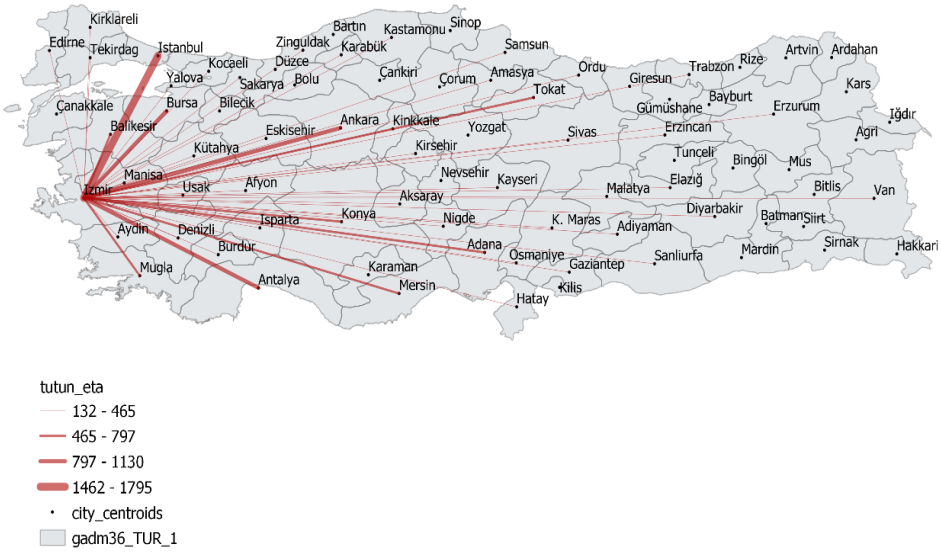

Figure 4.17 : Tobacco Origin-Destination Map (Source: ETA Logistics).

Figure 4.18 : Food and Beverages Origin-Destination Map (Source: ETA Logistics).

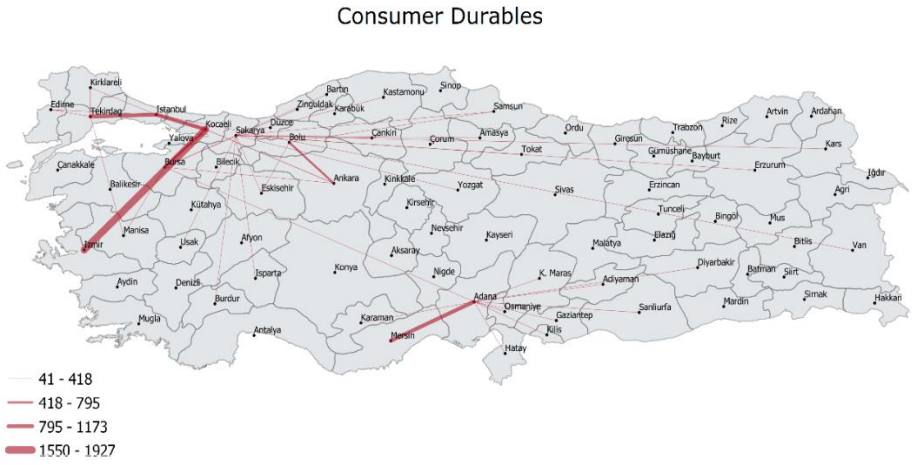

Figure 4.19 : Consumer Durables Origin-Destination Map (Source: ETA Logistics).

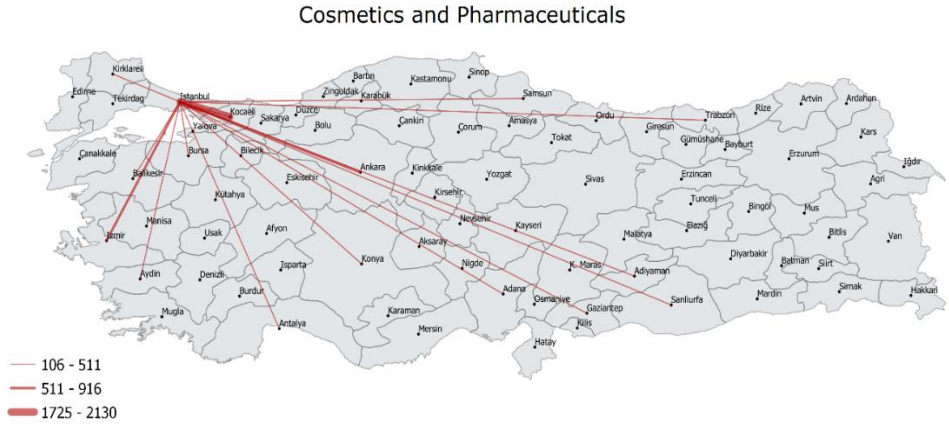

Figure 4.20 : Cosmetic and Pharmaceutical Origin-Destination Map (Source: ETA Logistics).

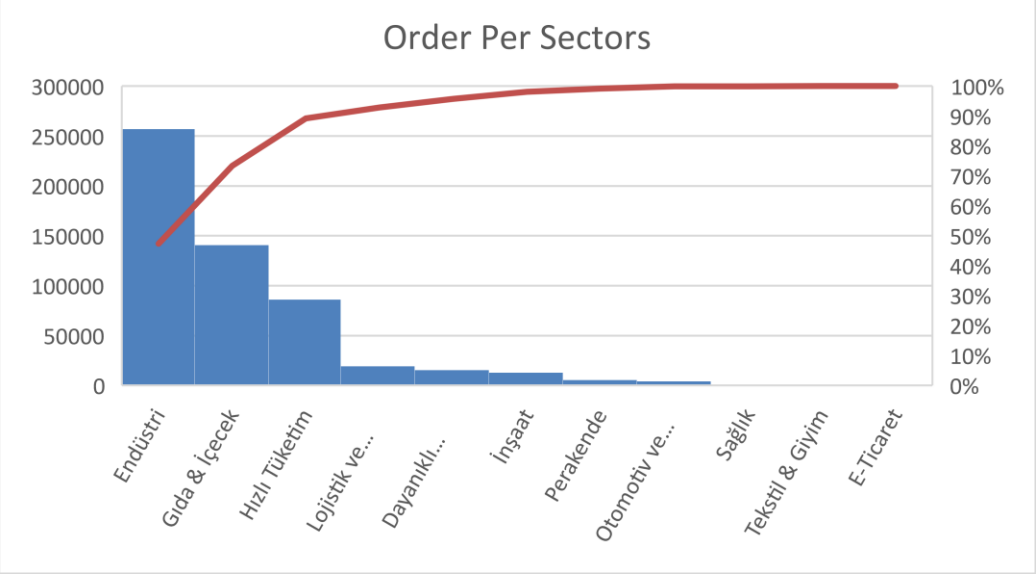

Figure 4.21 : Order Per Sectors (Source: ETA Logistics).

Figure 4.21 illustrates the total orders in 2019 by sectors. Industrial products (such as base metal) almost cover half of the orders within a year. Industrial products have been followed by food and beverages and fast-moving consumer goods which corresponds over 90% of the orders.

Ministry of Technology and Industry has released a report concerning the socio-economical network between provinces in 2020. Figure 4.22 and 4.23 illustrates both trade and cargo flow between regions.

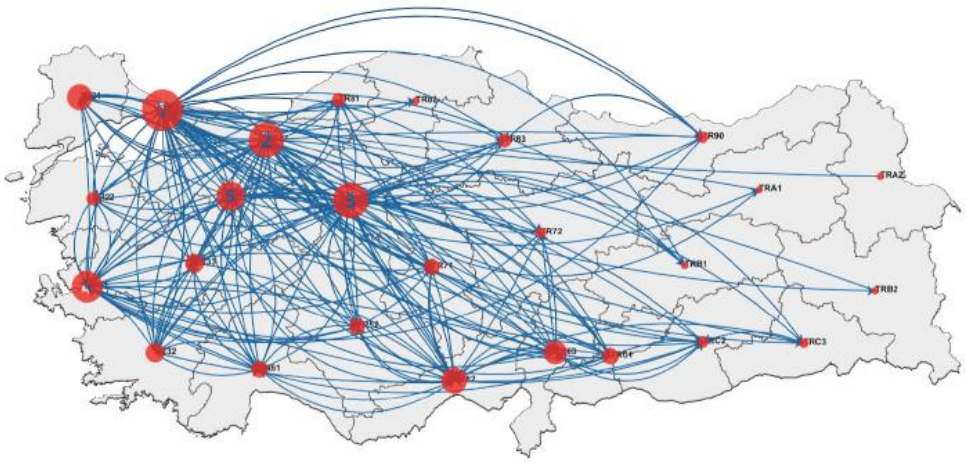

Figure 4.22 : Trade Flows between Regions (Source: Ministry of Technology and Industry).

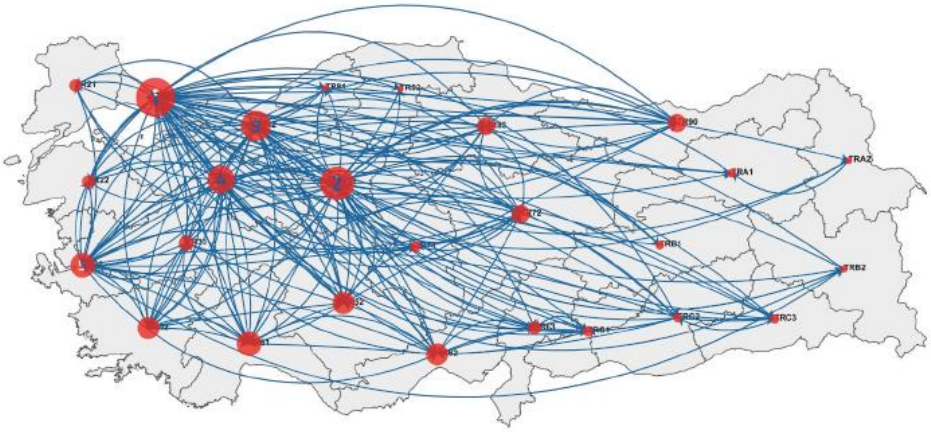

Figure 4.23 : Cargo Flows between Regions (Source: Ministry of Technology and Industry).

Lastly, we investigated the model which developed by Çelebi and Kerem (2021), to estimate the multiregional economic input-output relationship between provinces in 2017, which is also provided by Ministry of Technology and Industry. They mentioned in their report that this is just to estimate the trade flows between regions considering the total trade values between regions on different sectors. Their mathematical model as follows:

$$\text{Minimize } Z = \sum_i \sum_j \sum_k \varepsilon_{ijk} + \sum_j \sum_m \delta_{jm} \quad (1)$$

$$\sum_k x_{ijk} = T_{ij} \quad (2)$$

$$\left| x_{ijk} - T_{ij} B_{ik} \right| \leq \varepsilon_{ijk} \quad (3)$$

$$\left| \sum_i x_{ijm}(1 - \Gamma_m) - \sum_k a_{km} L_{mj} G_m \right| \leq \delta_{jm} \quad (4)$$

$$x_{ijk} \geq 0 \quad (5)$$[7]

Three major sectors (agriculture, manufacturing, and services) according to the model can be seen in Figure 4.24-4.267.

[7] Mathematical Model by Çelebi and Kerem (2021).

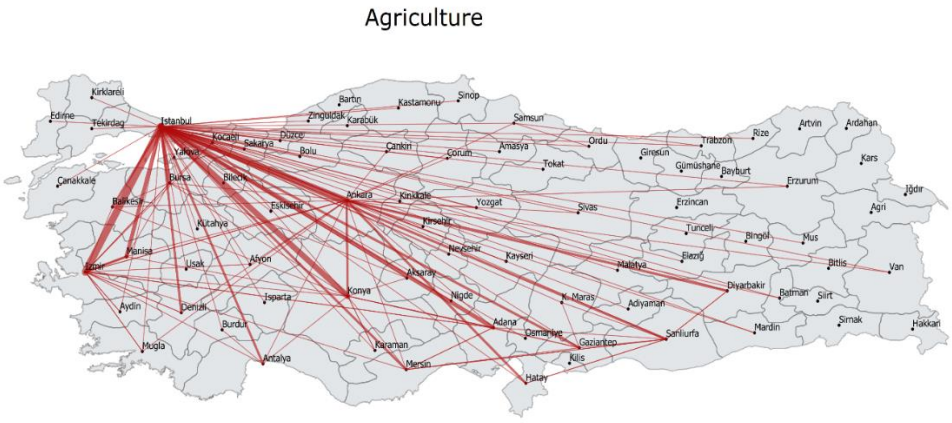

Figure 4.24 : Agriculture Trade Flow Map.

Figure 4.25 : Manufacturing Trade Flow Map.

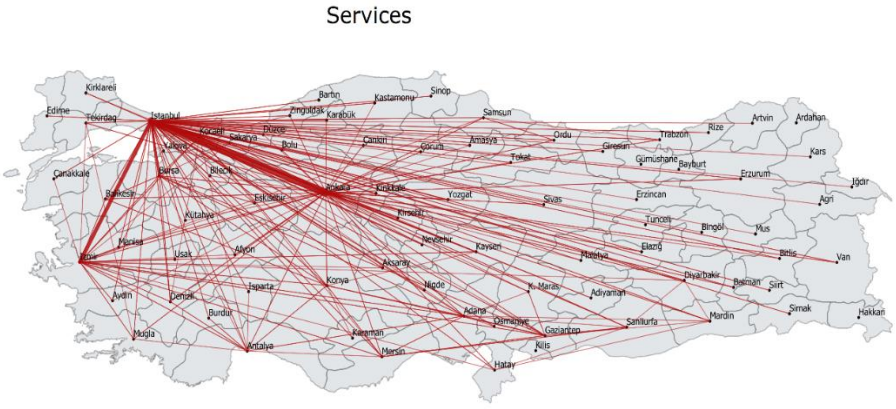

Figure 4.26 : Services Trade Flow Map.

In addition to those major sectors, authors[8] also applied the same model onto the subsectors such as food, beverages, computer, and electronics etc. which can be seen between Figure 4.27-4.34.

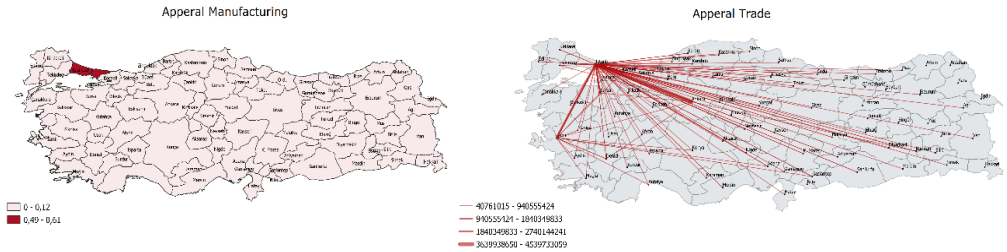

Figure 4.27 : Apparel Manufacturing and Trade Flow Map.

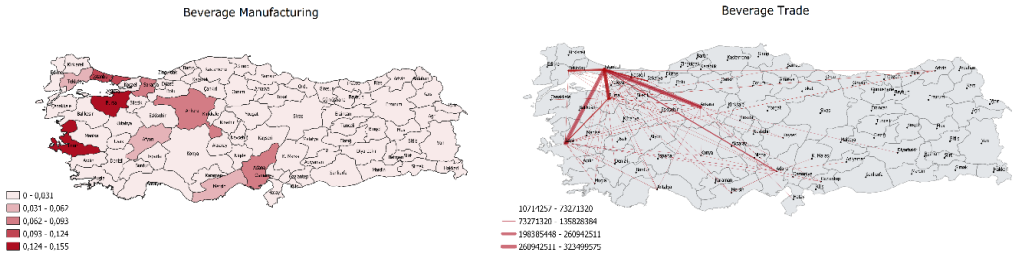

Figure 4.28 : Beverage Manufacturing and Trade Flow Map.

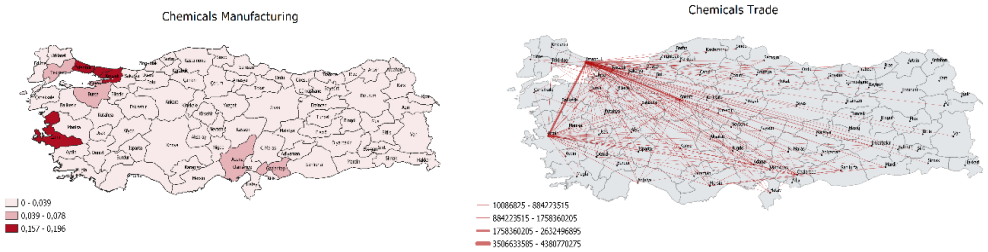

Figure 4.29 : Chemicals Manufacturing and Trade Flow Map.

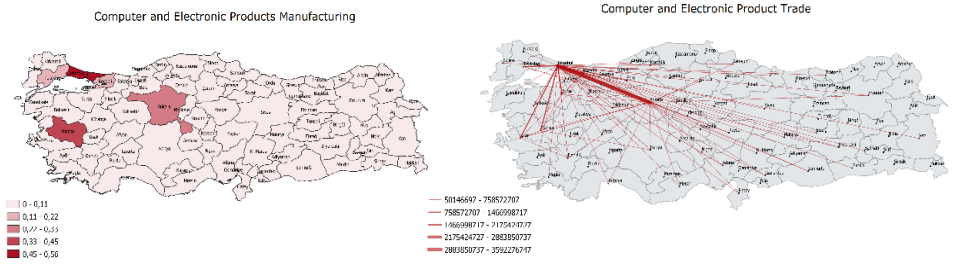

Figure 4.30 : Computer and Electronics Manufacturing and Trade Flow Map.

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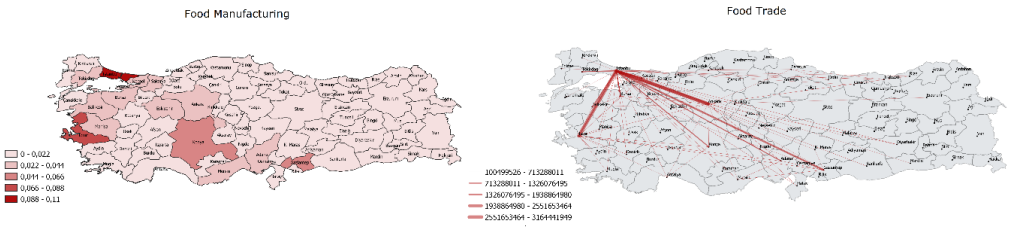

Figure 4.31 : Food Manufacturing and Trade Flow Map.

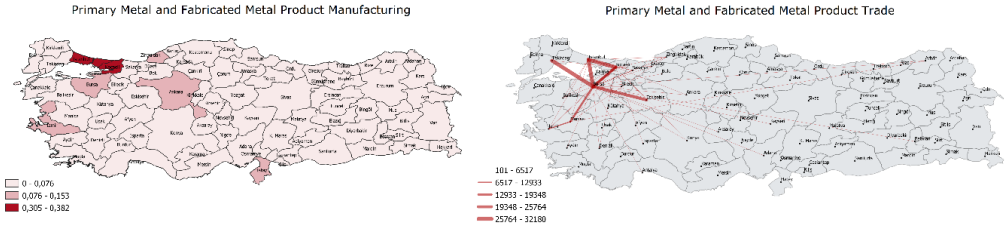

Figure 4.32 : Metal (Primary and Fabricated) Manufacturing and Trade Flow Map.

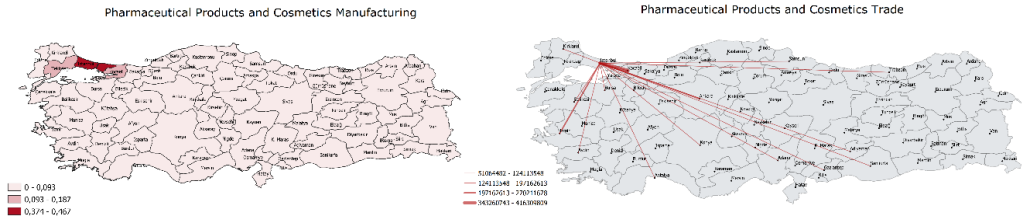

Figure 4.33 : Pharmaceutical Manufacturing and Trade Flow Map.

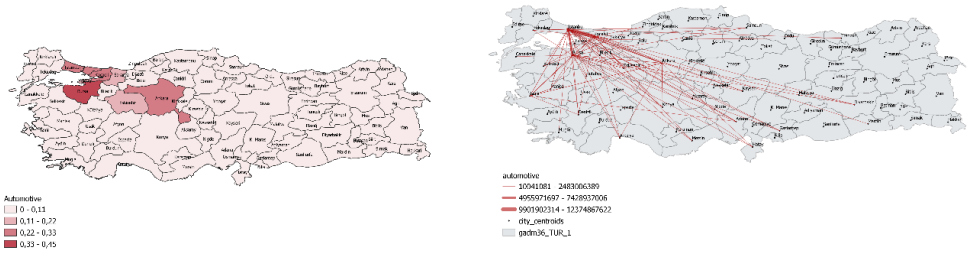

Figure 4.34 : Automotive and Spare Parts Manufacturing and Trade Flow Map.

Considering all these results, we conclude that few cities become more prominent in Turkish logistics sector in terms of both production and transportation. With İstanbul being the centre of this, Kocaeli, Bursa, Tekirdağ, Ankara and İzmir seem to be the provinces where the industry is concentrated. In addition to that, many product groups

have high network flow between aforementioned provinces. These results also match up with our market analysis, which pointed out the same cities generally.

When distances taking into consideration, we believe that İstanbul, Kocaeli, Bursa triangle might be a good starting point for Hyperloop. Due to its high investment costs and the traditional state of Turkey, implementing Hyperloop to many cities might be disastrous. Later, if the system works as intended, Hyperloop hub web can be extended to Tekirdağ, where is also might be our connection to Europe in the upcoming years, Ankara, where is connect Hyperloop to the rest of Turkey, and İzmir.

Finally, we believe that whether these hub locations are possible or not, Hyperloop might solve some of the major problems that Turkish logistics industry faces. Selecting the correct hub locations would be helpful, but this won't be enough to change the game. Hence, we carried on with our semi-structure interviews, not only to find possible hub locations, but also understand some of the major issues many shippers/market drivers face. In the next section we will be sharing our results that we obtained during the interviews.

4.4 Interview Results

Our findings of market analysis directed us into semi-structured analysis for our thesis. Our selected samples were consisting of market drivers and prospects with authorized people in logistics sector in Turkey, mainly the logistic companies (third party etc.), shippers and associations such as UND (International Carriers Association-Uluslararası Nakliyeciler Derneği) and UTİKAD (International Transport and Logistics Service Providers Association-Uluslararası Taşımacılık ve Lojistik Hizmet Üretenleri Derneği). In this section we will be sharing the results and information we got during our interviews with market drivers and prospects. In the next section we will be explaining what could be done next, in terms of Hyperloop's integration in Turkish logistics industry with respects to results we got from our study.

Our interviews are mainly focused on understanding the current issues in Turkish logistics sector and get a different point of view for Hyperloop technology and its implementation. As we explained in the methodology section, due to Covid-19 measurements we conducted those interviews using either online interview service Zoom, or received as written in questionnaire form, if we cannot conduct an online

interview with the interviewee. Our semi-structured interview consists of 3 sections, with first two being more informational about the interviewee and the company, whilst the third section, which is the most important section to us since it consists of open-ended questions which we could profit by our interviewees experience and their knowledge of the sector. In addition to that, third section is where we explained the details about Hyperloop, so our interviewees can comment on accordingly. Although each company has different product types that are crucial to them, due to their customers, the most initial reaction was usually the same among most interviewees. The most remarkable feedback was Hyperloop's speed, considering it is supposed to be on or under the ground. Hence, most of them believed that this could be a game changer for certain product groups, if they can be carried via Hyperloop within Turkey. Product groups such as time sensitive products and high value, but lighter products (electronics etc.). Besides that, the most noticeable comment we got was possible implementation of e-commerce. Speed is the most important element in e-commerce and Hyperloop's existence might be a great solution to major problems that Turkish e-commerce industry has been facing over the years. Therefore, in the further steps of this study we should focus on these product groups. Nevertheless, most of our interviewees agreed that without proper explanation, and bringing any solutions to the current problems that Turkish logistics industry is facing, Hyperloop's implementation would be difficult. Switching from one mode to other (such as from road transportation to Hyperloop) might be too costly if it doesn't solve the major issues. We will be explaining some of the major problems we learned during those interviews.

Each interview, we learned more about the logistics sector and its problems in Turkey. Although each interview was unique and had different points of view, there are few topics that stand out. Here is some of the most important topics that have been discussed during our interviews:

- The first topic would be the safety and security. Safety and security are not specific to Turkey, for instance damage on goods during transportation is a worldwide issue. Nonetheless, safety and security become critical in Turkey. During one of our interviews with UTİKAD, we learned that any modal choice has a huge risk of damaging the goods. For instance, loose shunting (from 10-15 km/h) on railway would create enough G-force to damage all the goods inside. In addition to this, other modal choices have their own risks such as

vibrations created by waves on seaway, lifting and landing on airways and uncertainties/huge accident possibilities on road demonstrates that this is a major issue in logistics. Generally speaking, Turkey has the issue of painstaking working. This reflects on certain sectors/industries affected more than the others, and logistics is one of them, due to being a bridge between manufacturers and customer (whether it is end customer or middle customer such as businesses). Our interview with Miltzer&Münch they gave 10 importance factor (out of 10) to safety and security which shows how important this topic for any type of prospects whether it is a company or association. Furthermore, they have been suggested that with Hyperloop from point A to point B without any other stations/hubs might be a great solution and this might even make market drivers to ignore the extra costs -which is another important topic that we will discuss later on- in order to grant higher safety and security measures. This also will prevent possible thievery and smuggling, which are another security flaws in Turkey. Due to its geographical location, Turkey has higher potential of smuggling/illicit trades. According to WHO, Middle East has the second highest illicit trade of tobacco, which is one of the product groups we considered for Hyperloop, with over 10% of the tobacco trades in that region[9]. If the Hyperloop technology can prevent all these security flaws and grants high safety measures, it might be the number one modal choice in Turkey, despite the possibility of high costs compare to other modes.

- The second topic was the costs. Although it seems that it is self-explanatory, costs are more exhaustive than it is. Every company in every sector wants to have minimum costs and always tries to lower their current costs for maximum profit. For Hyperloop to compete with other transportation modes, costs should be considered the most. The reason for this is because Hyperloop's initial costs are quite expensive. With that being said, most companies in logistics sector are not keen to switch their established system. This means extra costs to all companies, whether it is an opportunity cost, or an actual cost, switching to a new system from established system would be costly. Especially to a system that is quite unknown, and a dark horse in terms of performance. The most

[9] Smuggling and illicit trades https://illicittrade.org/smuggling-of-goods

important feature of the Hyperloop is speed, but if this does not satisfy the expectations, the cost will be much higher than the initial adaptation costs of the system. Hence, Hyperloop should be carefully explained to the market prospects. In our interviews this was emphasized multiple times by many of the interviewees. In addition to that, all the logistics companies we managed to interview gave either 9 or 10 importance factor (out of 10) to the costs, which shows the importance of the costs. Also, some interviewees mentioned the investment for Hyperloop being too costly (million, maybe even billion dollars to set up Hyperloop), which might create negative perception and only way to break this perception is by compensating this negative side with more positive attributes of Hyperloop. Most of our interviewees have agreed that speed factor should be underlined, but even then, this might not be enough to implement Hyperloop in Turkey. In order to compensate the costs, it needs to cover more flaws of logistics sector in Turkey. Such flaws like safety and security as we mentioned before, and some other points we will be pointing out later on instead of convincing about costs might be a better strategy to implement Hyperloop to Turkey. Otherwise, Hyperloop will be a failure that people will be remember in the future.

- Another topic that discussed during our interviews was the speed of the Hyperloop and the importance of this feature of Hyperloop. One of the major struggles of logistics sector -not just in Turkey only, but also in the World- is the time limit of freights, especially with the development of e-commerce. Day by day, with the increased amount of volume in terms of good transportation causes congestions. Naturally, this increases the problem exponentially. We learned that that this congestion problem is beyond imaginable, solving this might require non-practical methods sometimes. During our interviews with UTİKAD, Serkan EREN mentioned that sometimes it takes less time for a cargo to arrive in Turkey from manufacturing country, than distributing the cargo within Turkey. He also added that as MNG they are having one of the shortest flights in the World (from İstanbul Atatürk Airport to Sabiha Gökçen Airport-15 minutes) to keep up with speed and meet the cut-off costs. Hence the most important comment we got was if the speed of Hyperloop is practical or not? Because high speed -on or under the ground- feature might allow

Hyperloop to compete with other modal options and help with this congestion problem that Turkish logistics industry faces especially around organized industrial zone (also known as OSB-Organize Sanayi Bölgesi). One Hyperloop rather than many trucks means that less traffic. He also suggested that with the speed of Hyperloop it might be a better solution to connect airports, which bring us to another topic: connection of different transport modes. According to our observations during our interviews, regulations, customs, transferring goods from point A to point B seem to be an issue in Turkey. Starting with customs and regulations, a lot of logistics companies face certain problems of delivering goods to somewhere else first when it is necessary, especially for export goods. Usually, most companies and customs positioned in airports, especially in bigger cities such as İstanbul, Ankara etc. Due to that, exporting might become an issue from time to time. Cargo might send to another airport before the export, even though it has produced in different city. This will also add to already existing congestion problem in logistics. Nonetheless, with Hyperloop's speed this could be a great solution if the airports -and different modal options- connected to each other via Hyperloop. Also, some of the interviewees talked about dry ports, which only created to connect ports to railroad or road. In addition to that some of the interviews that we received written, put an emphasize on intermodal transportation. In that case Hyperloop might be considered as a complementary rather than competitive transport modal. This might need to be considered in the further steps of Turkish Hyperloop.

- Last topic that mentioned by some of our interviewees is the sustainability and environmentally friendly side of Hyperloop. Main powering source is solar panels for Hyperloop, with that it can use clean energy. As a result, it will prevent any air pollution since the system does not release harmful gases such as CO_2. Hyperloop is also foreseen to be preventing other types of pollutions such as noise, thermal pollution etc.

In addition to these factors, it has been discussed that whether Hyperloop can make Turkey, a logistic centre between Europe and Asia. With a system like that, while speed is the most striking feature, without any congestion problems, it can easily connect Europe to Asia through Middle East. Some of the interviewees mention that

modern ‘Silk Road’ can be created via Hyperloop. The most important recommendation we got was the introduction of Hyperloop to the industry, which should be organic and solution-oriented rather than problem-oriented.

All in all, what we learned that Turkish logistics industry has certain problems that needs to be solved. A lot of the actions are taken to save the day, rather than solving the problem completely. In that case, Hyperloop might present solutions to certain problems many prospects and market players face in Turkey. With that being said, it needs to be carefully evolved and making sure of it does not bring more problems than the number of problems it solves.

In the next, and the final section of this thesis, we will be summarizing the thesis, give our opinions and what could be done in the future research related to this subject.

5. CONCLUSIONS AND RECOMMENDATIONS

Our aim with this study is to understand the Hyperloop technology, its adaptability and implementation into Turkish logistics industry. Hyperloop is relatively new technology, which has many question marks on practical use for either side of transportation, human and cargo. Although few practical tests have been completed/getting done as of writing this thesis, those tests are usually for short distances. Naturally, some uncertainties are still presence. On the contrary, the features Hyperloop offers seem to cover these uncertainties, and a new way of transportation in our lives will be around the corner. Nevertheless, the news around the World, the development of Hyperloop technology and our research shows that this is quite possible and maybe it will be a new method of transportation sooner than expected.

5.1 Practical Application of This Study

First of all, we started our thesis with literature review on both Hyperloop/Hyperloop and Turkish logistics industry. On one side, literature has quite the gap, due to Hyperloop's introduction has made less than ten years ago. During our research, we found out that main focus on Hyperloop was human transportation, rather than cargo transportation in the literature. With that being said, there is decent number of researchers have focused on cargo transportation via Hyperloop. Although most of them have more technical side as their main concern, there is still few researchers that we reviewed. Due to the gap on that side, we tried to understand the factors that affect modal choices in logistics industry with respect to trends, rather than reviewing the technical side of Hyperloop. We found out that the industry is evolving into e-commerce, and pandemic has increased the speed of this evolvement. Hence, speed became one of the key factors, which is the main feature Hyperloop offers. Nevertheless, costs cannot be ignored while improving the speed of the cargo transportation. Unambiguously the initial cost of Hyperloop seems to be rather high. Although Hyperloop can pay off itself quite rapidly, the initial costs shouldn't be ignored. In addition to that, strategy between Hyperloop and other modes should

selected carefully. Otherwise, Hyperloop investment would be a burden to not only the prospects of the industry, also towards the industry as well. Main reason behind this problem that we figured was its implementation requires radical changes in freight sector. Analysing the market and finding the optimal solutions for the current problems of freight sector, seemingly the best way of implementing Hyperloop in Turkey. Although Turkey is a developing country, logistics is one of the up-and-coming sectors in Turkey, and such investments like Hyperloop might make Turkey a logistics centre. This brings us to the second part of our literature review, Turkish logistics industry. This part is more data collection to understand the numbers behind the industry, which we believed will give us the best insight about the industry. As we mentioned our main concern on this part was to understand the stance of Turkish logistics industry and gather more information about the industry itself. We investigated each of the cargo transportation modals and their performance especially within Turkey. Anyhow, we did not ignore the position of Turkey globally due to its geographical location and the performance of these modal options in global logistics industry. Turkish logistics industry seems to be following the global trends in the industry, but the most noticeable trend in Turkey was the shift towards the e-commerce according to our findings. This is something we concerned for the rest of our research as well as other trends in Turkish logistics industry. In addition to that we gathered some technical information about Hyperloop from Hardt. During our research on Hyperloop cargo transportation, we saw a huge gap in the literature. Our goal was to fill the gap as the implementation of Hyperloop technology in Turkish logistics industry, since there was no similar work has been done in the literature that we have found, as of writing this thesis.

Secondly, we started collecting related datasets with respect to the literature. We can divide this part into two, likewise the literature review. First part was collecting data about each modal choices and their performances in Turkey from different sources. In addition to understanding the Turkish logistics industry, this data collection also helped us compare it to our findings from literature review, as well as shaping our thesis. Our second part of data collection was consisting of economic indicators such as GDP, employment rate, ventures etc. and real case from a third-party logistics company in Turkey. As we dug deep into the literature, and progress with our industry research evenly, we believed that transportation of certain product categories with

Hyperloop would be a better solution, as Hyperloop has a capacity limit. All this information has brought us to our SSI (semi-structured interview).

Next step in our thesis after data collection was preparing a semi-structured interview. The SSI was the methodology that we used in our thesis. Although our initial goal was having a statistical analysis of possible Hyperloop hubs and routes, as we progressed, we believed that strong fundamentals on this subject would be crucial. Hence, we prepared a semi-structured interview to gain insight knowledge of the industry more and present our findings from our research. We selected our samples from Turkish logistics market drivers and prospects such as third-party logistics companies, shippers and even associations. With SSI, we had two goals; gain more insight about the industry and introduce Hyperloop to our interviewees. Due to pandemic conditions, we could not be able to do the SSIs face-to-face. Our method of interviewing was either get it in written form or do the interviews on online meeting app Zoom or phone calls, but mainly on Zoom.

Our aim with this preliminary study was to collect as much information/data as we can and analyse it for the further steps. With collected data from ministry, TÜİK, and market drivers/prospects, we completed a basic preliminary analysis to identify product categories, possible routes (most common routes for given product categories, origins etc.) for Hyperloop. Main concern that we had during our thesis is to position Hyperloop into the industry. In that case, our SSIs helped us understand and overcome that problem. With that being said, our findings during our interviews can be summarized as follow:

- Hyperloop should be considered and introduced as a complementary mode, instead of competitive mode against other modes,
- Current problems that the market drivers and prospects have should be carefully investigated, and Hyperloop should be presented to show how it can overcome the problems that industry have,
- Initial costs of Hyperloop might scare of the market drivers of using the technology. Hyperloop's other features such as speed, safety and security should be put on display, rather than convincing market drivers to invest into Hyperloop via mentioning costs and how Hyperloop can amortize it quickly to prevent negative perception before the investment,

- In addition to the previous one, price strategy should be carefully developed, to affect the demand for Hyperloop in a positive manner,
- Multiple different options can be achieved via Hyperloop. While it can be a main modal choice, it can be complementary as well as connection between two or more of the same or different modal choices. Especially with the recent growth in air cargo in Turkey, this can be achieved rather easily,
- Hub locations will play a crucial role, especially in Turkey where the distribution becomes problematic way too often. Hubs close to other modal options, or near customs might be the most feasible solutions. However, this is a topic that we would suggest for future study/work,
- As we mentioned before, Hyperloop's features might solve some issues other than the problems within industry such as congestion, smuggling etc.,
- Throughout the study, we encountered speed as the key feature of Hyperloop. For Hyperloop, this should be complemented with loading/unloading times. Because it seems that, this is the main time waster for Hyperloop. Hence, it must be carefully handled,
- The gap of knowledge cannot be ignored at this early stage of Hyperloop technology. Being transparent might help overcome this problem,
- Due to its limits and challenges, cargo types should be selected carefully to utilize Hyperloop to its fullest potential,
- E-commerce seems to be one of the best choices for Hyperloop, considering the recent growth of e-commerce in Turkey,
- Similar to hubs, routes should be selected carefully. This also affects possible connection to Europe and Asia via Hyperloop. Although we figured some possible routes with our preliminary study, this should be analysed and worked on in future studies with more details.

All in all, Hyperloop seem to be a great addition for any country that want to be a logistics centre. With the recent developments in Turkish logistics industry, such opportunity should not be ignored. On the contrary, introduction of this technology plays a crucial role, maybe more than investment and adaptation of itself. This is a preliminary study and more should be done before the investment itself. In the further

steps, a feasibility analysis to determine whether the routes are eligible for Hyperloop should be done. In the meantime, the technology should be introduced to more market drivers and prospects and associations within the industry. In addition to that governmental side should be included more during this introduction. Not only just to introduce it to government, but also get the legal permissions. Before we finish this study, we believe that Hyperloop would be possible in Turkish logistics industry, and we believe that it might change the industry and Turkey in logistics in a positive way. Careful planning and strategizing would play a crucial role on this. With Hyperloop Turkey can also become one of the logistics hubs in the World, which help the development of the country itself.

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APPENDICES

APPENDIX A: Data Dictionary
APPENDIX B: Semi-Structured Interview Questionnaire
APPENDIX C: List of Respondents

APPENDIX A

Table A.1 : Data Dictionary.

Field Name	Description	Type	Specifications
Area Code/ID	The code given to specific province or area	Character	5-digit alpha-numeric characters
Name	Name of the province	String	Name of the province in NUTS2 or NUTS3
GDP	Gross Domestic Product per Capita	Numeric	In currency (Turkish Liras or US Dollars)
Agricultural Production	The amount of production made in a year by provinces	Numeric	In tonnes
Labour Force	Labour force by different conditions such as education etc.	Numeric	In 1000 people
Employment/Unemployment Rate	The ratio of employment and unemployment in provinces	Numeric	Percentage
Ventures	The total number of ventures in provinces	Numeric	Up to 7-digit numerical number
Population	The total population of the province	Numeric	Up to 8-digit numerical number
Port Bulk	The total amount of handling made in ports	Numeric	In tonnes (Up to 8-digit numerical number)
Airport Cargo	The total amount of cargo transportation made in airports	Numeric	In tonnes (Up to 7-digit numerical number)
Product Types	Type of products used in different type of modal choice	String	Name of the product type

APPENDIX B

1.GENERAL INFORMATION

Q1	**Name:** **Job title:** **Company:** **Contact information:** **Company structure:** Private sector share (%): Public share (%): Foreign investment (%): **Number of staff:** Blue collar: White collar: **Number and location of manufacturing facilities:** Domestic: International: **Number and location of storing/warehousing facilities:** Domestic: International:
Q2	**Please provide a brief description of your role, including the extent to which you are responsible for making transport decisions on behalf of your company**

Figure B.1.a : Semi-Structured Interview Questionnaire (First Page).

Q3[1] **What industry/industries would you describe your company as being in? (Please mark all that apply)**

☐ Agricultural products	☐ Basic metals, metallic products
☐ Metal ores and other mining	☐ Machinery and equipment
☐ Wood products	☐ Electronic and other electrical equipment
☐ Coal, crude oil, and natural gas	☐ Waste and scrap
☐ Construction	☐ Fabric and textile products
☐ Chemicals and chemical products	☐ Pharmaceutical products
☐ General manufacturing	☐ Food products and beverages
☐ Automotive – vehicles	☐ Retail - food
☐ Automotive – parts	☐ Retail - other
	☐ Other (Please indicate):

Q4 **When choosing a transportation mode, how important are each of the following factors? Please give an importance score between 1 and 10 for each of these factors (where 10 means extremely important, and 1 means extremely unimportant)**

	Importance of factors
Costs	
Shipment time	
Overall service quality	
On-time delivery	
Risk of damage/loss	
Frequency of shipment	
Flexibility[2]	
Reliability of shipment time	
Added value services (e.g. tracking & tracing)	
Availability and accessibility	
Environmental factors	
Number of transshipments	
Other (please specify)	

[1] *Only applicable to shippers*
[2] *Ability to respond to last minute changes*

Figure B.1.b : Semi-Structured Interview Questionnaire (Second Page).

2.FREIGHT[1]

Which type of products would you consider as time sensitive e.g. require guaranteed delivery or urgent transportation or valuable e.g. have a high retail value or profit margin (and/or require secure carriage)?

For each type of product mentioned above please indicate the following:

Product Type	Product Characteristics	Shipment Characteristics	Most Common Routes
	Value Density ☐Low ☐Medium ☐High **Time Sensitivity** ☐Low ☐Medium ☐High **Transport Time Restrictions/Requirements (if any):**	**Type of transport** ☐General cargo ☐Container/ İntermodal unit ☐Dry bulk ☐Liquid bulk ☐Dangerous goods ☐Temperature controlled goods ☐Automotive ☐Post/Courier ☐Other (_____) **Average Shipment Size (kg/shipment unit)** (_____)	Origin | Destination | Transport Mode | Annual Volume (tons) | Transport Time | Avg. Cost (per ton-km) | Transport Frequency
	Value Density ☐Low ☐Medium ☐High **Time Sensitivity** ☐Low ☐Medium ☐High **Transport Time Restrictions/Requirements (if any):**	**Type of transport** ☐General cargo ☐Container/ İntermodal unit ☐Dry bulk ☐Liquid bulk ☐Dangerous goods ☐Temperature controlled goods ☐Automotive ☐Post/Courier ☐Other (_____) **Average Shipment Size (kg/shipment unit)** (_____)	Origin | Destination | Transport Mode | Annual Volume (tons) | Transport Time | Avg. Cost (per ton-km) | Transport Frequency

[1] *Please answer for the most frequent or the most important shipments.*

Figure B.1.c : Semi-Structured Interview Questionnaire (Third Page).

	Value Density ☐Low ☐Medium ☐High **Time Sensitivity** ☐Low ☐Medium ☐High **Transport Time Restrictions/Requirements (if any):**	**Type of transport** ☐General cargo ☐Container/ İntermodal unit ☐Dry bulk ☐Liquid bulk ☐Dangerous goods ☐Temperature controlled goods ☐Automotive ☐Post/Courier ☐Other (_____) **Average Shipment Size (kg/shipment unit)** (_____)	Origin | Destination | Transport Mode | Annual Volume (tons) | Transport Time | Avg. Cost (per ton-km) | Transport Frequency

Figure B.1.d : Semi-Structured Interview Questionnaire (Fourth Page).

3.CARGOLOOP

A brief information about Cargoloop

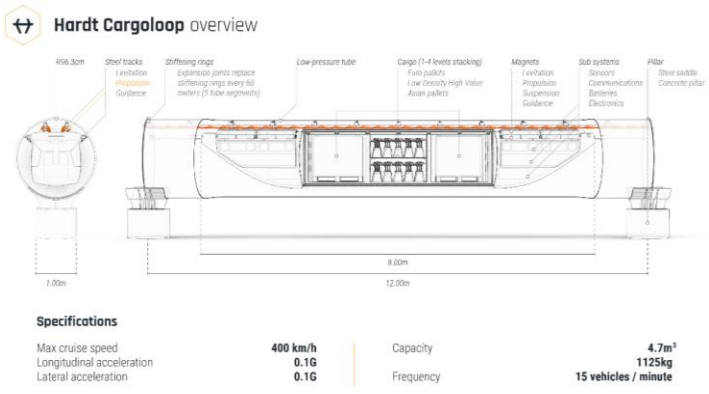

Figure 1 - A concept illustration of a Cargoloop pod (Source: Hardt Hyperloop)

The **Hyperloop Cargo** (Cargoloop) is a fast mode of freight transportation, which is currently in test stage, but expected to be realized in various locations over the World by 2023. Hyperloop is a sealed system of tubes with low air pressure through which a pod may travel substantially free of air resistance or friction. The initial assumption for speed is 300 km/hr, which may be increased up to 1000 km/h. Each vehicle may carry up to 3 cargo units, approximately 1.53 m3 each. Theoretical weight capacity is around 375 kgs/cargo-unit. The system is expected to have 50% higher costs than trucking with almost 80% reduction in delivery times.

Figure B.1.e : Semi-Structured Interview Questionnaire (Fifth Page).

Figure 2: Comparison Cargoloop vs. other modalities (Source hardt Hyperloop)

	Air transport	Road Transport	Cargoloop
Speed performance *(km/h)*	600-900	80-100	150-400
Frequency of vehicle departure *(vehicle/hr)*	12	12	500+
Operational hours	17 *(due to night restrictions)*	9 *(due to driver restriction)*	22 *(2 hours for maintenance)*
Competition with passenger transport	Medium	High	None
Capital investment (CAPEX) *(€M per km)*	Not available per km *(expected higher than road)*	€10,00 - €50,00	€ 8,00 - €12,50
Operational costs (OPEX) (€/100 km) transporting 1 m^3 *(costs excl. financing costs, inc. maintenance etc)*	€ 5,60	€ 1,92	€ 1,69
Energy source	Fossil	Fossil	Electric
CO_2 (g/km) per 1 m^3 cargo	158	35	0
Air/noise pollution	High	Medium	Low
Distance between destinations	**200+ km**	**0 – 1,500 km**	**10 – 2,500 km**

Q1	**Based on your expertise in logistics systems in Turkey, for which routes and type of products you believe that Cargoloop may be competitive with other modes of transport? Please explain your reasoning.**
Q2	**What are the problems and difficulties you expect to face in the future with regard to freight transport?**
Q3	**What trends do you expect to observe in the future with regard to freight transport?**

Figure B.1.f : Semi-Structured Interview Questionnaire (Sixth Page).

Q4	**Which of the following transport scenarios would you choose?** • **Current way of transport with the current price you pay** • **New way of transport reducing your transit time by 50% with transport price increase of 20%** • **New way of transport reducing transit delays by 90% with transport price increase of 20%**
Q5	**Which routes do you expect to be more heavily used in the future for high value and time sensitive goods?**
Q6	**What improvements in transport services you use would you like to see in the next 5 years? How would they benefit your business?**
Q7	**Any other general comments:**

Thank you for taking the time to participate in the study

Figure B.1.g : Semi-Structured Interview Questionnaire (Seventh Page).

APPENDIX C

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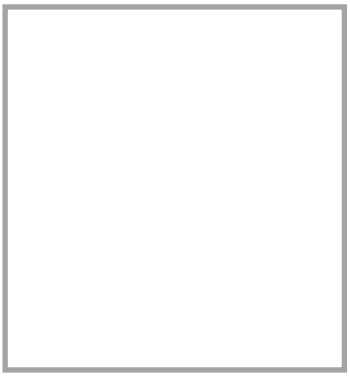
CURRICULUM VITAE



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