Customer satisfaction within district heating networks with different organizational designs

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Bewoners proeftuin Lariks Assen lopen nog niet warm voor warmtenet!

RTV Drenthe – Remy Posthumus & Esmeé Söllner – Donderdag 24 december 2021, 15:02.

Bewoners van de gasloze proeftuin Lariks-West in Assen zijn nog niet overtuigd om over te stappen op een warmtenet. Dat staat in een tussenrapport van de gemeente, waarin is gekeken naar haalbaarheid van de gasloze woonwijk en belangstelling onder bewoners. Hieruit blijkt dat het plan financieel en technisch haalbaar is, maar bewoners zijn afwachtend en kritisch.

An multiple case study on customer satisfaction within district heating networks with different organizational designs.

A Master's thesis submitted for the degree of Environment and Society Studies with the specialization of Corporate Sustainability

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Preface

This thesis was written in order to conclude my Master's degree of Environment and Society Studies at the Radboud University of Nijmegen. Throughout its speciality program 'Corporate Sustainability', one of the most common themes was improving collaborations between public and private sectors, in terms of the sustainable business environment. This not only prompted my interest in the subjects of this thesis but also ensured a lasting curiosity in sustainable business concepts, especially in energy infrastructures.

The sustainable transformation of the current Dutch energy sector has always been the main motivation behind my study efforts. I have therefore always regarded it as a series of great opportunities, however, disguised as unsolvable problems. When I was walking through the city of Nijmegen, I stumbled upon the ARN's waste incineration plant, which is considered the main source of district heating in Nijmegen. This sparked my initial interest in the subject. After conducting some literature research, I found out that heating networks are considered durable and profitable, however, are also subject to criticism, especially from heat consumers. These conflicting revelations ultimately guided me towards this research design.

This study has given me the opportunity to delve deeper into the matter and look at it from all different angles. Ultimately, however, it turned out that evaluating sustainable transformations within the heating sector is an extremely complicated problem with numerous interferences across different sectors. In the end, it was also a major challenge to understand the involved complexities of the district heating systems and the quantitative study took more time than I had originally anticipated. Finally, I started the writing process late, because my specialization (Corporate Sustainability) lasted a full study period longer than most of my fellow students. Nevertheless, I truly believe that the outcomes of this study has resulted in relevant and thought-provoking results, not only from an academic, but also from a societal perspective.

Furthermore, I would like to thank certain key people who helped me enormously throughout my writing process and also contributed in shaping my current academic knowledge. First, I would like to thank the inspiring teachers and my fellow students at the Radboud University who helped me to build the required knowledge and confidence in tackling such a comprehensive study report. In addition, I would also like to thank the participants who contributed in getting the appropriate data-sets that were necessary in order to answer the main research question. To conclude, I want to thank, and give my ultimate appreciation, to my thesis supervisor 'Sietske Veenman'. Without her time consuming efforts and guidance, this report would not have the same quality. Moreover, when it was needed the most, she provided me with critical feedback, she always trusted me in my own writing process and gave up a lot of her time by helping me.

With the completion of this research report, my life as a student has come to an end. Now I am ready to put the knowledge, that I have acquired throughout the years, into practise. I hope you enjoy reading it!

Abstract

The Dutch government aims to eliminate its dependency of natural gas production and consumption due to earthquakes located in the gas-producing province of Groningen and decreased geopolitical interests. Therefore, one of the main objectives of the Dutch heat transition is a sustainable transformation of the entire building stock, with an intermediate target to connect 750.000 houses to district heating networks by 2030. This requires a collective infrastructure, in which (sustainable) heat is produced at one location. In order to support municipalities in realizing these intended increases, new organizational designs were introduced for district heating networks, which led to new principles of ownership, which describes the ways in which certain networks could be publicly or privately owned, and new market structures, where networks could be centralized (closed) or decentralized (open) to third party access for producers and/or suppliers. The main objectives of decentralization and privatization were to promote market competition in which supply and demand ensure cost efficiencies, transparency and flexibilities for heat consumers. However, there are increasingly more complaints within Dutch residential regions about these structures as the consequences for consumers were neglected, which impedes them for opting new heat solutions.

Therefore, the main objective of this study was to identify, not only overall customer satisfaction levels, but also evaluate similarities and differences across multiple organizational design types. Thereby, using a multiple- and holistic case study design in which the following cases have been selected in accordance with their ownership and market structure: private-centralized networks, private-decentralized networks, public-centralized networks and public-decentralized networks. Subsequently, a comprehensive survey was conducted into customer satisfaction levels and the most important determinants that influence these outcomes using the highly acclaimed ACSI-model. In addition, the second phase is based on a literature study that evaluates potential market problems and solutions that could improve these satisfaction levels.

The results show that when all data-sets, and thus organizational design types, are combined, consumers are overall reasonably satisfied. The main determinants that have an important influence on an increased customer satisfaction are related to the level of comfort, consumer protection and the additional services. However, these values are almost near the neutral range of indifference. Therefore, although most heat consumers are reasonably satisfied, these satisfaction levels are still divided in most heating networks. However, when the data-sets are evaluated separately, and are thus based on their organizational design, it could be stated that decentralization does relate to higher perceived customer satisfaction levels, since the overall satisfaction levels are the highest within private- and public decentralized networks. One of the main determinants could be that within decentralized networks, heat consumers have indicated that the level of flexibility is perceived to be higher than in centralized networks. Moreover, heat consumers have indicated to be overall more satisfied within publicly owned networks than within privately owned networks. One of the main determinants could be that within publicly owned networks, heat consumers have indicated to be more satisfied with the price and the level of sustainability. However, implementing

public ownerships-and-decentralized market structures in district heating networks comes with its costs. Heat consumers within publicly owned networks have indicated that the level of consumer protection is perceived lower than in privately owned networks, and in decentralized district heating networks, heat consumers have indicated that the level of transparency is perceived to be lower than within centralized district heating networks. In terms of the advantages that theories on competitive markets assume, these are contradictory results and could thus be incentives to keep some form of municipal oversight. In the end, municipal and private actors have to make trade-offs between the appropriate organizational design and their own resource connections and capabilities. The resulting market problems and/or solutions need to be considered, not from a national, but from a local scale, as there is no 'one size fits all' solution.

However, it should be noted that these results do not represent generalizable representations. They serve as general observations that consumers conceive to be true, within purposively selected district heating networks. Therefore, although an observable relationship was identified within these specific data-sets, more research is needed in order to make accurate and concluding statements about the relationship of customer satisfaction levels and district heating networks with different organizational design structures. Here, customer satisfaction levels should be measured in other regions with district heating networks in the Netherlands. The results could be used in the formulation of the new heat law of 2023, in which the customer's needs and interests are currently still heavily underestimated, neglected and unrepresented.

Wordcount: 29.100

Keywords: District heating networks, customer satisfaction, organizational design, customer expectations, perceived quality, perceived value, customer complaints, customer loyalty.

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1 Introduction

1.1 Background

In recent years, the United Nations (UN) has mandated that if rapid and global progress is not made on the myriad of sustainability, new generations could face a future steeped in inequity and environmental disasters (Cook et al., 2013). In order to link pressing issues of economic development, while protecting the environments planetary boundaries, the Dutch government grounded and provided a framework of the climate agreement on June 28 of 2019. It comprised an integrated vision of the Dutch future energy supply in order to ensure access to affordable, sustainable and reliable energy for everyone. Its dynamics were rooted in complex adaptive systems in which systems remain stable as long as disturbances remain within a certain range, bounded by some critical thresholds (Rotmans, 1994). Currently, these thresholds are being crossed as there is an ongoing shift from a system dominated by finite (fossil-based) production and consumption towards an efficient system of renewable and sustainable energy sources (Klip, 2017).

In the Netherlands, the initiatives are based on transforming four energy principles: 1) space heating; 2) industrial process heat; 3) transport; 4) power and light (Ministery of Economic Affairs/Climate Policy, 2016). Here, the transition from natural gas to sustainable heating sources for residential urban areas is one of the most urgent transition initiatives within the Dutch energy transition, as the Netherlands relies more on natural gas than any other country in the EU (Loorbach et al., 2008). In addition, prospects for unbated natural gas have changed dramatically due to the induced earthquakes in the gas-producing province of Groningen and decreased geopolitical interests for gas (Mulder & Perey, 2018). Therefore, the Dutch government aims to eliminate its dependency of natural gas production and/or consumption. This entails a sustainable transformation of the entire building stock of 7.7 million houses by the year 2050 with an intermediate target of 1.5 million households by the year 2030 (Beckman & Beukel, 2019).

Various studies have concluded that district heating networks are the best replacement for conventional gas-fired boilers (Kirch et al., 2020; Loorbach et al., 2011). Therefore, the Dutch climate agreement aims to connect 750.000 households to district heating networks by 2030 (Mulder & Perey, 2018). This requires a large-scale roll-out of networks in which sustainable (residual) sources are supplied through collective networks Here, the municipalities have a coordinating role in making district-oriented plans regarding the decarbonisation of the build environment (Klip, 2017). In order to support municipalities in realizing this intended increase district heating networks, a new market organization was introduced. Traditionally, district heating in the Netherlands had been organized mainly as municipal utilities. Here, one public party was often responsible for both the realization and exploitation of heat to the end users. However, the heating sector was liberalized in 1995, making it possible for numerous private actors to enter the market (Spaans & Resink, 2019). An important condition for these actors is that a new market organization is put into effect that assumes classic economic theory of free markets (Spaans & Resink, 2019). Therefore, a shift was proposed from centralized heat markets, where tariffs are regulated by one (public) authority, to decentralized markets where competition leads to price formation. This led to the possibility of opening up the tasks in district heating. Whereas traditionally the tasks and responsibilities of the entire heat chain was subdivided under one authority (closed networks), production, transportation and supply of heat can now be outsourced to many private parties through competition (open networks).

1.2 Research problem

The main objective of decentralized heat markets was to promote market competition in district heating and thereby ensuring cost efficiency, market transparency, knowledge sharing and consumer protection (Spaans & Resink, 2019). The theory describes competitive markets in which supply and demand creates competition, ensuring that the best goods and services are delivered to consumers at the lowest price. It should also offer more freedom for consumers when choosing their suppliers of heat (Aberg et al., 2016). In turn, this should create confidence in the market and increase the support and willingness to invest in district heating infrastructure. However, although there is broad support among public and private actors for the promising potential of district heating, little consideration is given to the needs of the consumer.

There are increasingly more complaints in Dutch urban residential areas about district heating networks in terms of high prices (Jeude & Midden, 2014). Heat consumers also complain about little freedom of choice in terms of choosing heat providers and alternatives for district heating (Janssen, 2015). Most municipalities in the Netherlands obligate residents to take a connection, whereby the end users therefore take on the contractual risks and responsibilities for at least twenty years. Switching to heat alternatives is possible, but only under expensive and strict conditions. Furthermore, other complaints originate from a still continued use of (non-sustainable) fossil fuels within the district heating systems and from a lack of transparency and also openness in the development of district heating networks (Jeude & Midden, 2014). These practices could impede other heat consumers for opting for new district heating solutions.

One of the main challenges is therefore to map out how the district heating networks should be designed from an organizational standpoint, in order to safeguard the consumers energy interests and needs. When describing the organizational design, a distinction can be made between the ownership and the market structure in which the heating systems operate. In the case of ownership, a choice could be made between a public or a private model. For the market structure, a heating network could be centralized (closed) or decentralized (open). In an centralized (closed) network, there is one actor that completely fills in the heat chain, from the production to the delivery of heat. Here, monopolistic tariff regulation leads to price formation. In an decentralized (open) network, several heat producers and/or suppliers compete within the same network (Dekker et al., 2020). Here, competition leads to price formation and service provision. Therefore, the customer complaints are project-specific, as the district heating networks take on different organizational designs in the Netherlands. Ultimately, this choice for an organizational design ends up with the municipalities who are in charge of the heat transition within residential areas. However, after the introduction of decentralized and private markets, and thus new organizational designs, it is unclear how this has effected the customer satisfaction levels in district heating networks. In addition, it is also unclear how the potential problems could be solved in order to safeguard the heat consumers needs best.

1.3 Research questions

This report examines the relationship between the organizational design of district heating networks and customer satisfaction levels. Therefore, this report aims to address the following main research question: *Is there an observable relationship between customer satisfaction levels and the organizational design of district heating networks in the Netherlands, and how could these satisfaction levels be improved?*

From the main question, the following sub questions are derived and will be addressed in this research:

1) *Which organizational design types can be identified when it comes to district heating networks in the Netherlands?*
2) *How could the overall customer satisfaction be measured within district heating networks with different organizational designs?*
3) *What is the overall satisfaction level among heat consumers within the district heating networks, and what are the main determinants of these outcomes?*
4) *What satisfaction differences and similarities can be observed across district heating networks with different organizational designs, and what are the main determinants of these outcomes?*
5) *Based on the literature, what potential market failures and solutions could be identified in order to improve the satisfaction levels among district heat consumers in the Netherlands?*

1.4 Research Aim

The summation of the research questions results in the following main research aim and six objectives: *Providing insights into the relationship between customer satisfaction and the organizational design of district heating networks and identify solutions that could potentially improve these satisfaction levels.*

- 1) Describe the technological characteristics of district heating networks (literature study).
- 2) Identify the organizational design types in which district heating networks in the Netherlands operate (literature study)
- 3) Operationalize the term ‘consumers satisfaction’ and identify the variables that could measure and influence these satisfaction levels in district heating networks (literature study).
- 4) Test the variables by measuring the customer satisfaction levels of heat consumers within the designated district heating networks across different organizational designs (survey).
- 5) Identify and the main determinants and the observed satisfaction differences and similarities among district heat consumers within different organizational design types (analysis).

- 6) Identify potential market failures and solutions that could improve the customer satisfaction levels within the designated and purposively selected district heating networks (literature study).

1.5 Societal and scientific relevance

Over the last couple of years, both policymakers and market practitioners are considering how district heating networks could be utilized and contribute to the policy plans of major cities and the acceleration of the Dutch energy transition. However, as mentioned before, after the introduction of decentralized and private markets, and thus new organizational designs, it is unclear how this has effected the customer satisfaction levels in district heating networks. This could be described as a general phenomenon as most studies focus on the economic and political policy outcomes in which customer satisfaction is neglected. Because this research report concerns a case study, no generalizable conclusions will be sought. The main objective is to map out the overall customer satisfaction differences across multiple cases and also how this could be improved. This compliments the current theory and prompts more studies in the future.

According to Geurts (1999), scientific relevance concerns the importance and the additional properties of research outcomes for academic purposes. Thereby, many studies have already been conducted into the determinants that predict successful outcomes on the design of district heating networks (Amovic et al., 2020). However, there is still limited knowledge and data available on overall customer satisfaction of heat consumers within these district heating networks. Moreover, no studies have yet been conducted in which these satisfaction levels have been divided and compared within different organizational design types of district heating networks. Therefore, this research paper aims to further elaborate on the existing academic knowledge of district heating network design principles and also to gain new insights into how these structures should be orchestrated, in order to support the needs of heat consumers most effectively.

The societal relevance relates to the importance and consequences of the research outcomes for the client and possibly also for the society (Geurts, 1999, p. 1333). However, this study is not carried out on behalf of a municipality or particular organization. Therefore, no specific research problems or questions need to be addressed, nevertheless, the research outcomes could be detrimental for policy makers and market practitioners in order to gain insights into the consequences of their efforts. With the research outcomes, municipalities and heat producers/suppliers are better equipped to serve heat consumers from different regions and also to provide customized solutions for each municipality. This is an necessary step for the acceleration of the energy transition, as heat consumers are ultimately dependent on the chosen strategy for a long period of time, bear the additional costs and are responsible for the overall strategy acceptance. Ultimately, the results of this study could be used as an tool in order to establish the satisfaction levels of heat consumers in other regions, drive customer loyalty and increase the attractiveness of new district heating solutions in the Netherlands. These are desperately needed in order to eliminate its dependencies of natural gas production and consumption and also reach the climate goals that have been set for 2030.

2 Technological characteristics

Before a thorough inquiry can be conducted, it is important to first provide insights into the functioning and technological characteristics of district heating networks. The first section provides insights into the energy supply chain; the second section elaborates on heat chain characteristics; in the third section, the actor characteristics will be examined; the fourth section elaborates on the distribution characteristics.

2.1 Energy supply characteristics

A district heating network is a network of pipes that transports hot water and common resources through a collective infrastructure from a central location to individual buildings and end-users (van Leeuwen et al., 2019). In contrast to local heating, centralized heating systems could be utilized by all apartments in one apartment building, all households in one street or even all houses in a neighbourhood or an entire city district. In addition, district heating plants can provide higher efficiencies and better pollution and climate control than localized boilers (Klip, 2017). This is because the water can be heated from a central point within a city district with more sustainable alternatives than gas, such as geothermal, solar, biomass and industrial residual heat (Sarma et al., 2019). Figure 1 shows the district heating infrastructure and supply chain (denoted by the red line), where potential heat sources are transported to the end consumers.

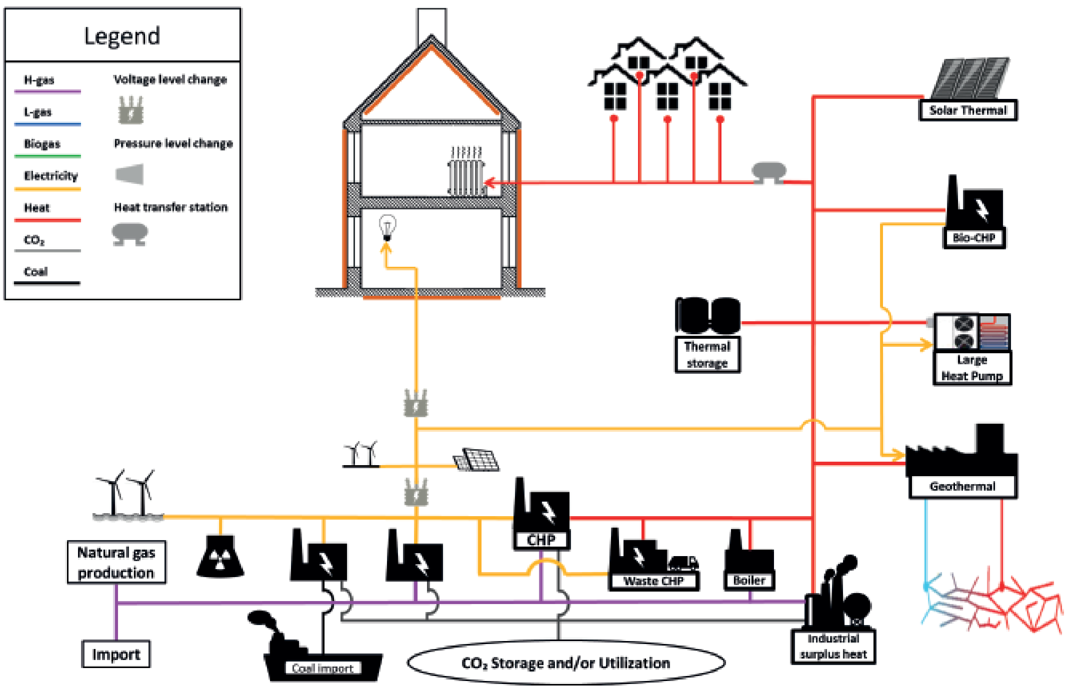

Figure 1: The district heating infrastructure and energy supply chain (Klip, 2017).

As shown in figure 1, the district heating infrastructure is interwoven with the current electricity system. While some technologies produce both electricity and heat (such as biomass), others consume electricity to produce heat (such as geothermal technologies). The implications for this neutral infrastructure is that the production of heat can consist of multiple heat production technologies, allowing for fuel switching according to the cost of heat and potentially the CO2 intensity of heat production (Leeuwen et al., 2019). Although, most district heating networks are still supplied by gas-fired and waste incineration combined heat and power (CHP) plants, numerous initiatives have been applied that make use of low-carbon heat sources. Here, large-scale heat pumps supply relatively low-carbon heat to the system during periods of high intermittent heat production, e.g. from wind, solar, biomass and/or residual heat (Kirch et al., 2020). Therefore, Klip (2017) argued that: "one of the major advantages of district heating is that the networks can be connected to sustainable alternatives that have not yet been feasible or have not yet been invented.

2.2 Heat chain characteristics

The heat chain (figure 2) is the connection of parts within district heating networks which runs from the production of the heat source to the actual consumers and it includes all functionalities that are involved within this process. In the district heat supply, several infrastructural characteristics can be distinguished. Table 1 elaborates on these technological characteristics within district heating networks in more detail.

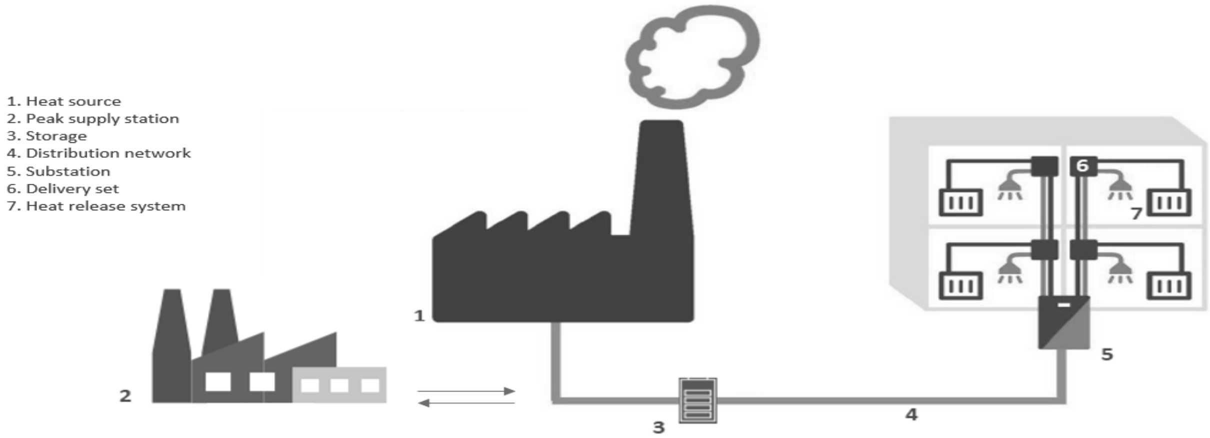

Figure 2: The heat chain within district heating networks (Schilling et al., 2020).

Infrastructure	Function
1. Heat source	Various heat sources that are not available on location, such as fossil, sustainable and residual (industrial) sources, are produced from a central combustion plant.
2. Peak supply station	To cope with peak consumption, fossil fuels are often used, which are burned in auxiliary combustion plants. But, sustainable sources are increasingly being used.
3. Storage	Short-and-long-term energy storage is increasingly being used. Simultaneous supply and demand of energy is thereby combined/coordinated to save energy and costs.
4. Distribution network	The distribution part of the heating network consists of pipes (supply and return) that transfer heat from a central heat station to the heat users.
5. Substation	Pressures and temperatures are adjusted to the consumption patterns of end users through heat exchangers. These heat exchangers are located in the substations.
6. Delivery set	The consumer's indoor installation is connected to the network through a delivery set. It delivers water in homes and measures and regulates the heat consumption.
7. Heat release system	The heat release system is a separate pipe which returns water, with most of the energy removed, to the production plant and for reprocessing.

Table 1: The heat chain and its functional characteristics (Leeuwen et al., 2019).

2.3 Actor characteristics

Many actors can be defined in an institutional network of heat. Here, some actors play an active role and others a more passive and supporting role. The passive roles include financiers, legislators, shareholders and the constructers. Furthermore, the literature also describes six active actors .These active participants influence the ways that heat is provisioned in heating networks on a daily basis (Dervis & Nierop, 2015).

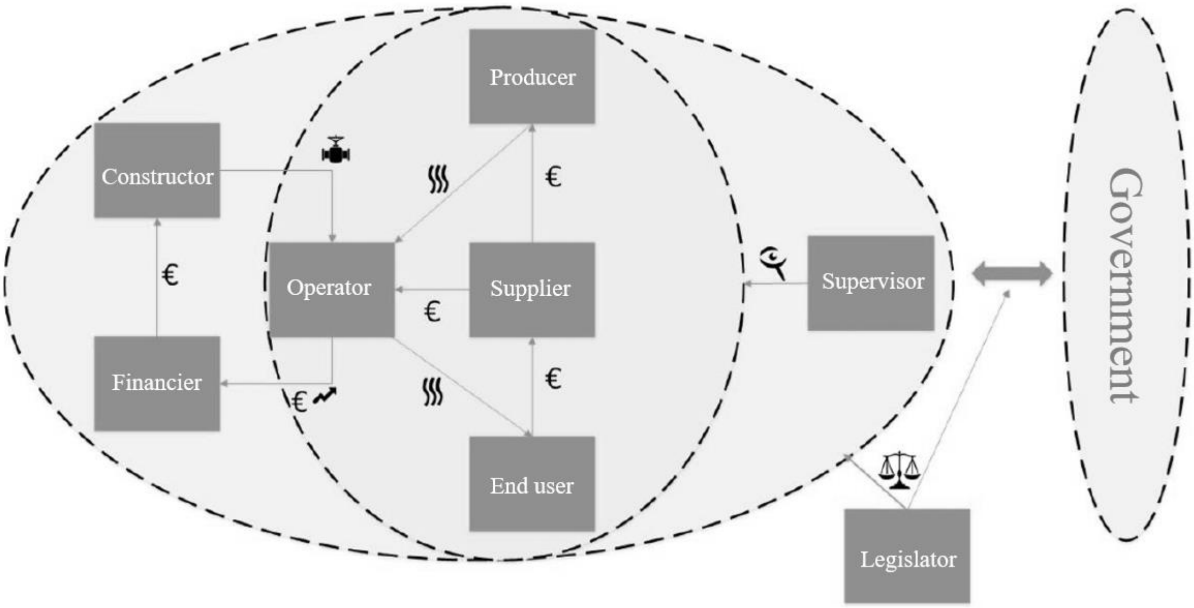

Figure 3: Actor composition and roles in district heating networks (Dekker et al., 2020; Hoogervorst, 2017).

1) Heat producer

According to Tieben & Benthem (2018): "the heat producer generates heat and feeds this into the district heating grid to be transported to a consumer with a certain demand" (p. 5). The role of the heat producer is therefore essential to the functioning of a district heating network since it is considered the first activity within the 'Heat chain'. The role of a heat producer can be fulfilled by a wide variety of different actors. Persson (2015) distinguishes in his study three different types of heat producers: regular producers, auto-producers and prosumers. Here, regular producers produce heat and/or electricity directly to the central combustion plant (CHP). Auto-consumers produce residual heat, which is heat that is released during an industrial production process that can no longer be used economically. Prosumers are the end-users that both use and supply energy through solar-thermal installations and cooling systems (Ecofys, 2015).

2) Grid operator

The grid operator is responsible for the transport of heat through pipes of the distribution network to a certain assigned area. Here, heat is transferred through the substation, which consists of heat exchangers, where pressures and temperatures are adjusted to the consumption patterns of end users. A separate pipe, which is also connected to the distribution network returns this heat to the 'Central Combustion Plant' for reprocessing purposes (Leeuwen et al., 2019). Söderholm & Warell (2011) describe in their report that most grid operators within hating networks function as monopoly enterprises. Here, grid operators are granted exclusive rights to transfer heat to a designed district in order to be consumed by end users.

3) Heat supplier

The heat supplier is ultimately responsible for the supply of heat to the customer. The supplier receives financial compensation for the supply. Part of which must be paid to the grid operator for the use of its pipes and part of it must be paid to the heat producer for the purchase of the heat (Leeuwen et al., 2019). Tieben & Benthem (2018) describe that the heat supplier is also responsible to create heating contracts with the end users, where both parties agree on prices and regulation. This process involves weighing up fixed and variable costs, which is calculated on the maximum capacity of sufficient heat production.

4) End Users

The role of end users is to consume heat. In principle, the role of the consumer can be fulfilled by anyone. End users appear in different types and sizes like: individual homeowners, companies, property owners and housing corporations. End users assign their energy contracts according to the temperatures that are needed, the connection capacity of the heat suppliers, the degree of insulation within their property, the quality of their delivery sets and the volume of (sustainable) heat that is required (Hoogervorst, 2017). Whereas residential consumers base their energy preferences on the criteria of, reliability, price, safety and services, industrial end users base their preferences depending on the production needs (Klip, 2017).

5) Heat Supervisor

The supervisory role is within the Dutch district heating market predominantly fulfilled by two parties: the ‘Autoriteit Consument & Markt’ (ACM) and also the ‘Staatstoezicht op de Mijnen’ (SODM). ACM supervises the contracts between the supplier and the consumer. The supervision of tariffs that suppliers are allowed to use is also their responsibility. In addition, the supply licenses must also be obtained and submitted by the ACM. These licenses are necessary in order to be able to supply heat (Ministery of Economic Affairs and Climate Policy, 2016). The SODM supervises for the safety of the used resources.

6) Government

The active participants within the government differ widely around the globe, which is based on their constitutional and organisational structure. In the Netherlands, the national government is considered as the main legislator and regulator whereas the regional government (municipalities) function more at the operational level. Therefore, the implementation strategies of heat planning is the responsibility of the municipalities, which in turn influences the development of district heating directly. Most municipalities outsourced these practises in the past, however some policymakers in the Netherlands are increasingly in favour of more involvement by the public sector in realizing district heating (Hoogervorst, 2017).

2.4 Distribution characteristics

The distribution part of the heating network consists of pipes (supply and return) that transfer heat from a central heat station (CHS) to the heat users. This can be a power plant, a waste incineration plant or a combined heat and power plant (Schepers & Valkengoed, 2009). Most distribution networks also have auxiliary combustion plants (ACP) which absorb peak consumptions during peak demands and serve as backup systems. Distribution networks (figure 4) generally consist of a 'Primary Heat Transfer Station' (PHTS) and a 'Secondary Heat Transfer Station'(SHTS), which doses and transports water to end users.

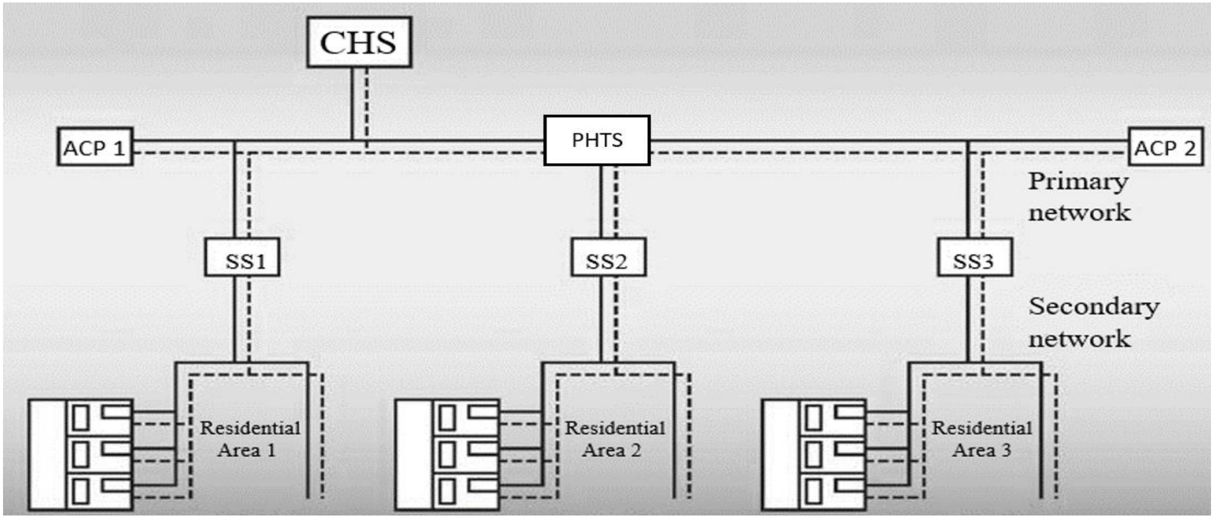

Figure 4: Distribution networks within district heating networks (Leeuwen et al., 2019).

When the water enters the secondary network, more heat exchangers are used at house level. These heat exchangers are located in the substations (SS), where the temperatures and pressures are adjusted to the consumption patterns of the end-user. By doing so, cheaper equipment can be used and it also provides more safety for end-users (Rekenkamer, 2018). These substations are placed as close as possible to the end users and can function both at a district- and house level. Ultimately, cold water flows back to the transfer stations, after the heated water is used, which will then be reheated again (Leeuwen et al., 2019).

3 Theoretical foundation

The main objective of this study is to map out the overall customer satisfaction of heat consumers within district heating networks with different organizational design types. Therefore, in order to gain the right insights, the theoretical foundation on which the conceptual model is built upon will first be elaborated. In order to do so, the notion of the organizational design and customer satisfaction will first be evaluated.

3.1 Organisational design

When looking at the existing literature, it has proven difficult to define the term 'organizational design' in energy infrastructure. This is because it originated from classic economic theory and has been utilized in many contexts. Galbraith & Kates (2007) describe it as "the deliberate process of configuring people practices, structures, processes, reward systems and technologies to create an effective organization of achieving the business strategy". Foster (2018) argued that "it is a systematic appraisal and composition that is required to achieve the organization's purpose and encompasses the unseen as well as the seen in regard to the architecture of the organization (p. 2). In this study, the organizational design is thus more focussed on the palette of organizational aspects that are organized to choose the appropriate design for district heating networks. It should therefore not be confused with the organizational structure, which is described as the formal and lines of authority like management, shareholders, employees and customers.

Classic economic theory assumes that the organizational designs that are most effective are based on the notion of contingency theory. Foster (2018) argued that: "The fundamental idea of contingency theory is that there is no one single best way that can be prescribed when it comes to an organizational design; Whatever environmental conditions are present will require different organizational design responses, which are contingent on what is happening (p. 23). This is especially relevant within district heating networks, as the design is dependent on the internal strategy and external forces such as the availability of skilled partners, the current state of the infrastructure and the availability of heat sources (Klip, 2017).

3.1.1 Organisational designs in district heating networks

Foster (2018) also stated that: "Designs are iterative and fluid. They must be flexible enough to respond appropriately to external forces while strong enough to provide the internal structure needed to keep the organization functioning. However, in energy infrastructure, most organizational designs are static as it requires long-term agreement contracts, high investment costs, high barriers of entry/exit, predetermined heat plots for producers and reliable heat sources for end users (Magnussen, 2016). Therefore, it could be argued that, in energy infrastructures, it is not sensible to fit contingencies constantly based on today's external reality. The organizational design should not be created on the merit of flexible circumstances, instead, there needs to be an thorough examination beforehand of the organizational design that fits the contingencies best to the operating external reality and the desired internal strategy from the beginning.

Therefore, according to Dekker et al (2020), the organizational design in district heating network could be operationalized from an compositional perspective. They describe two design parameters which are: the ways in which the distribution network is operated by certain actors (ownership) and how energy is supplied to the network (market structure). Both design components have not yet been studied in the Netherlands so far, and could have a major impact on the customer satisfaction levels of consumers, as there is often only one actor that owns the network, accumulates considerable market power and, also, the ways in which heat sources are exploited could differ greatly. Therefore, in this study, the notion of the organizational design concerns the numerous ways in which the development, management and exploitation of district heating systems are designed, in order to fit the contingencies of the organization from the beginning. Both concepts 'ownership' and market structures' will be further elaborated below.

3.2 Ownership

According to the literature, one of the main components of the organizational design that could influence the customers satisfaction levels in district heating is the concept of 'ownership'. According Scott (1979) ownership has a dual character, as both a legal relation and a social one. He argues that ownership is comprised of an owner's all-embracing legal power, but also consists of the feeling that something is yours. Therefore, Yan (2000) reported in his study that "Ownership is a combination of legal rights and responsibilities with respect to a specific asset" (p. 11). Hence, in this study, the notion of ownership is referred to the set of legal imperatives that are applicable to owning the distribution networks for heat.

Traditionally, district heating in the Netherlands had been organized mainly as municipal utilities. The district heating sector was, however, liberalized in 1995, making it possible for other actors to enter the market. This has led to the entry of private and cooperative actors who took ownership of the networks:

Actor	**Ownership**
Public	In this organizational form, the distribution network is owned by one or more public parties (usually municipalities). If the municipality owns a heat source and the municipal organization has sufficient expertise, the municipality can choose to design, construct and exploit a heating system by itself. A municipality can also choose to outsource the heat production to third (private) parties.
Private	In this organizational form, the distribution network is owned by one or more commercial market parties. The municipality is completely relieved by these private parties and only needs to give up limited capacity within the municipal organization to contribute to the development and management of a district heating system.
Cooperative	This organizational form consists of formal and informally owned district heating systems in which (citizen-led) energy cooperatives propose collaborative solutions to facilitate, operate and manage distribution networks locally. In this study, however, energy cooperatives will be excluded from the conducted research as there are almost no heating networks with this ownership structure in the Netherlands.

Table 2: Multi-actor ownership in distribution networks (Bauwens & Holstenkamp, 2016); (Dekker et al., 2020).

3.2.1 Ownership in the Netherlands

As mentioned before, the distribution part of the district heating network (figure 4) consists of the supply and return pipes that transfer heat from a central heat station to the heat users. The owners are the actors who are mainly responsible for the initial investments, and thus the construction, of the infrastructure of the distribution network. Thus, ownership relates to owning the infrastructure, where parties are granted the exclusive and legal right to construct, manage and operate the district heating networks (Tieben & Bentham, 2019). This entails that the exploitation (production and supply of heat) can still be outsourced to commercial third parties. This study only takes full ownership into account, as most heating networks are still owned by one actor in the Netherlands (Spaans & Resink, 2019). Therefore, although some form of collaborations take place, public-privately owned distribution networks are excluded from the study.

Most distribution networks in district heating systems are currently in the Netherlands privately owned. These distribution networks are mostly acquired through mergers, acquisitions and regulations during the liberalisation of the energy market. However, due to increasing risks of market manipulation, unfair energy prices and private uncertainties, some policymakers are increasingly more in favour for publicly owned distribution networks (Hoogervorst, 2017). In the Netherlands, this debate about the ownership and its consequences on the operational performance, and thus on customer satisfaction, is still ongoing.

3.3 Market structures

As mentioned before, the organizational design is conceptualized into two different design components. The first design component is conceptualized in the notion of ‘ownership’, which describes the way the distribution network is owned and operated. The other design component of the organizational design describes the way that heat is supplied and/or exploited within the distribution network, which is also known as the ‘market structure’. The latter will be further explained and conceptualized in this chapter.

3.3.1 Centralization versus decentralization

In both public and private development of a district heating network, there is the option of developing and operating the heat chain integrally (closed) or split (open). In this case, both of these exploitation roles therefore determine the market structure that is proposed within the development of district heating network. Based on this concept, a spectrum can be plotted from full monopoly, in which regulation leads to price formation and energy provision, to a completely open market where competition leads to price formation and energy provision. Although several (hybrid) variants could in theory be applied, only two market structures with a clear distinction from each other will be discussed. Firstly, there is a centralized approach, where one party is responsible for the entire system (integral heat chain). It is also possible to opt for the decentralized approach (open heat chain) in which the chain is split so that several producers or suppliers of heat are free to use the network and compete with each other within these certain roles. Both types are visualized in figure 5, which outlines the centralized and decentralized market structures.

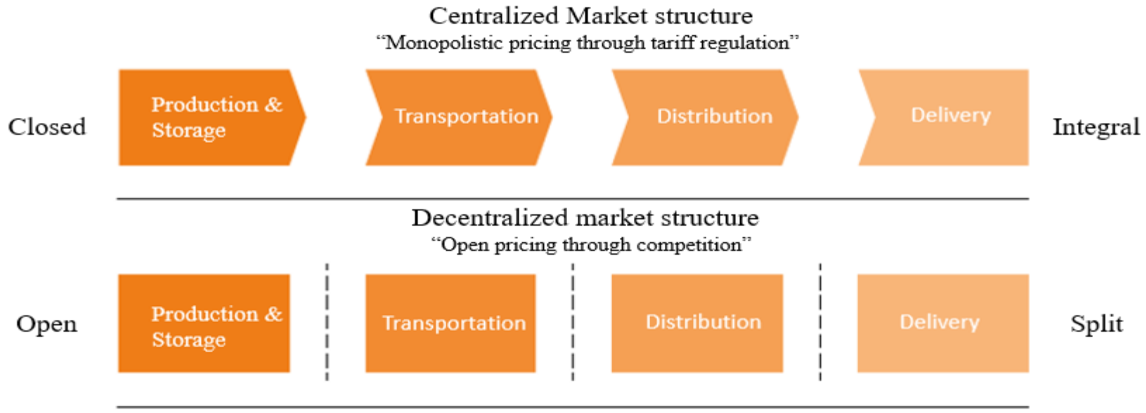

Figure 5: Different market structures within district heating networks (Dekker et al., 2020).

3.3.2 Centralized (closed) market structures

Within this market structure (figure 6), there is one public or private party that completely fills in the heat chain and is responsible for the entire heat process (from production to delivery). The heat chain is thereby integrated, and thus therefore closed. So if the municipality owns a heat source and the municipal organization has sufficient knowledge, the municipality can choose to design, install and operate a heat network itself. It is also possible to outsource the heat process to market parties within the integrated model. The municipality selects a market party to jointly, or fully, manage the entity within which the district heating network is being developed (Dekker et al., 2020). In theory, the various roles within the network go hand in hand, because one party can optimize the entire chain according to its own output.

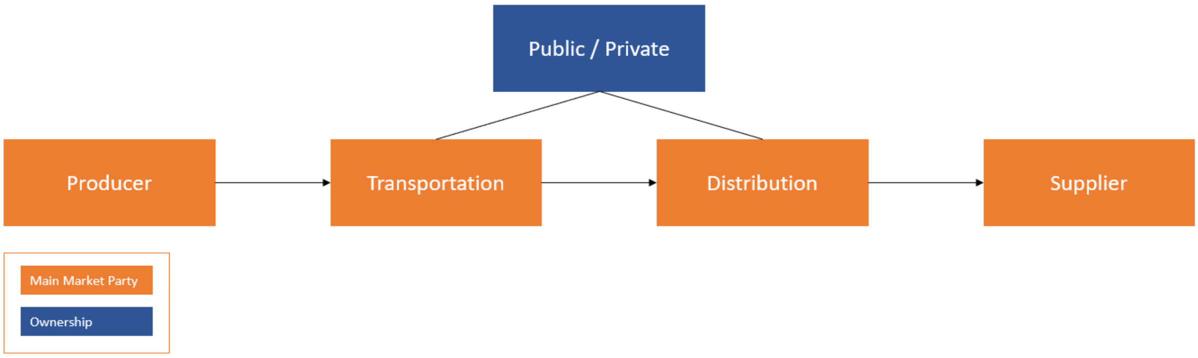

Figure 6: Centralized (closed) district heating network with no third party access.

Due to the physical properties of district heating, heat is expensive to transport over long distances due to the large efficiency losses. The consequence of this is that a heat network is dependent on heat sources that are available on a local or regional scale, which means that it has a monopolistic character and has relatively little competition (PWC, 2015). Because of this natural monopolistic position, heat lends itself perfectly to centralization, in which tariff regulation leads to price formation. Public utility parties in a monopolistic position are mostly expected to charge as a non-profit. For private parties, with private shareholders, making a profit is one of the primary goals. That is why strict regulation is necessary for private parties in order to protect customers. In Denmark, 60% of households are connected to a heating network where the heat is supplied via a central structure in closed networks (Johansen & Werner, 2022).

A potentially important advantage of this market structure is that the responsible party has (full) control and can (partly) determine the pace of realization and, later on, can set (favourable) rates. Ecofys (2015) also describes that splitting the roles by external parties can lead to 20% extra system costs. However, a possible disadvantage of this market structure lies in the risk that the responsible party assumes. Another point off attention is whether the responsible party has the right (permanent) capacity, expertise and support within its own organization to develop and operate a district heating network. It is not yet clear to what extent this market structure influences customers satisfaction levels in the Dutch energy market.

When there is an increase in the number of district heating networks in a region, potential economies of scale can arise, especially within centralized grids with one active party. Economies of scale can arise through expertise, labour and material (Dekker et al., 2020). It is therefore easy to imagine that if three nearby municipalities or communities all invest in their own equipment and employees, they could possibly end up with higher costs than if one party is responsible for all the three networks (PWC, 2015). Material required for maintenance and personnel will then not always have to be deployed. Better use of materials and manpower could therefore also mean less fixed costs and thus cheaper energy provision.

3.3.3 Decentralized (open) market structures

Within this market structure (figure 7), the heat chain is split into several roles, where the public and/or private parties are open to use the network and compete with each other within a certain role (Dekker et al., 2020). Here, open pricing and tariff regulation is used through competition. The implementation of this market approach, and thus the split to an open network, can in theory be done at various roles in the heat chain. Firstly, opening is possible on the production side. Here, several producers can be connected. Second, on the delivery side. In this way several heat providers can offer the heat. As a third alternative, a complete split between the network operator and also the production supply is possible (Ecofys, 2015).

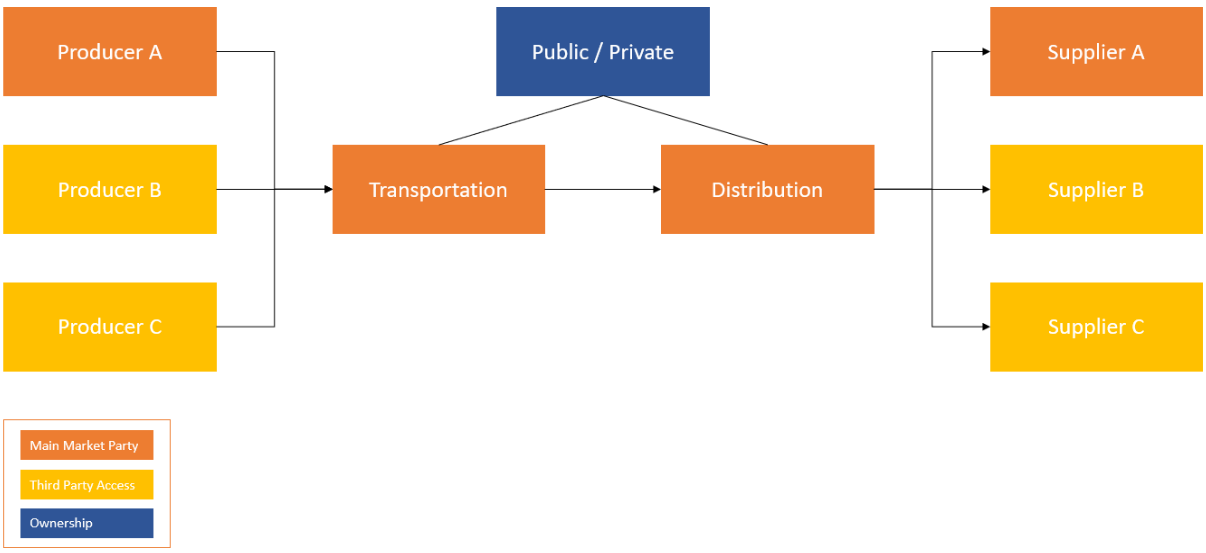

Figure 7: Decentralized (open) district heating network with third party access.

However, an complete split between the network operator and also on the production and delivery side (option three) does not yet exist in the Netherlands. Therefore, in order to conduct a thorough case study, research will only be carried out into open heating networks in which the heat chain is split from the production or delivery side. This is an open heating network in which several heat sources are produced and supplied by multiple suppliers to the same system. In the context of production, the main objective in an open network is to connect as many potential producers and suppliers as possible (Ecofys, 2015).

As mentioned before, in an open district heating network with a decentralized functioning, multiple heat producers and suppliers compete for price-setting and thus the provision of heat. In this market structure, both the production and delivery of heat can be supplied by both public and private parties. The operator, and therefore the owner of the network, is usually responsible for the transportation and distribution of the heat sources (see figure 7). In addition, the owners are also deemed and responsible for maintenance, management and to balance the supply of heat sources with demand from end users (Dekker et al., 2020).

With different heat suppliers and multiple heat sources, a competitive price can be created through the market forces. It is important that the district heating network operators, which are in most cases the owners, use a transparent cost allocation model so that parties can assess the reasonableness of the rates that are charged. Heat consumers are connected (and bound) to a local or regional network with a limited number of sources that feed the network. It is therefore not self-evident that natural market forces and competitive prices are feasible if there are multiple heat producers in the network (Dekker et al., 2020).

The trend to develop open district heating networks is mainly due to the desire to give consumers more freedom of choice. Consumers generally want to have, or experience, the freedom to choose between different (sustainable) heat sources and producers. However, this remains a subject of discussion as heat is a 'natural monopoly'. An open heating system also makes it possible to link more heat sources if there are more connections required and thus the heat demand increases (Dekker et al., 2020). Ecofys (2015) also indicates in their study that there are now companies that would like to sell their heat, but are unable or unwilling to offer long-term security of supply. The presence of more suppliers on the energy market means that long-term obligations for the supply of heat may become redundant. Parties that do not want to invest under the conditions of supply securities may then have an incentive to enter the energy market. This could lead to more competition, which in turn could lead to lower heat prices for heat consumers.

Opening networks with multiple producers or suppliers is possible through ‘Third Party Access’ (TPA). It is a regulatory framework to ensure effective competition, non-discriminatory access and security of supply within the natural monopolies that are generally characterized in decentralized heating networks. Whereas some authors are proponents of third party access through negotiation, other authors propose the notion of regulation. Wissner (2014) concluded in his report that heating networks are considered as natural monopolies with extreme barriers of entry and/or exit, which requires some regulation in order to increase fair competition. He substantiates this statement by studying Sweden's energy market, where excluding feasible third parties in TPA leads to cherry picking and thus high energy prices for end users. This debate about obligatory TPA and the need for regulation is in the Netherland and EU still ongoing.

3.4 Organizational design types

To conclude, district heating networks can both be publicly or privately owned and the market structure can both be centralized or decentralized oriented. This results in four different design types that will be evaluated by means of a case study (see figure 8). The results could provide insights into the relationship between the organizational design and customer satisfaction. Ultimately, four designs are distinguished:

- *Private-Central:* Within this organisational design, the distribution network is privately owned and there is one private party that completely fills in the responsibilities of the heat chain.
- *Private-Decentral:* Within this organizational design, distribution network is privately owned, but the heat chain is split on the production and/or delivery side. This means that several heat producers and heat suppliers can be connected to the grid, who compete for energy provision.
- *Public-Central:* Within this organisational design, the distribution network is publicly owned and there is one public party that completely fills in the responsibilities of the heat chain.
- *Public-Decentral:* Within this organizational design, the distribution network is publicly owned, but the heat chain is split on the production and/or delivery side. This means that several heat producers and heat suppliers can be connected to the grid, who compete for energy provision

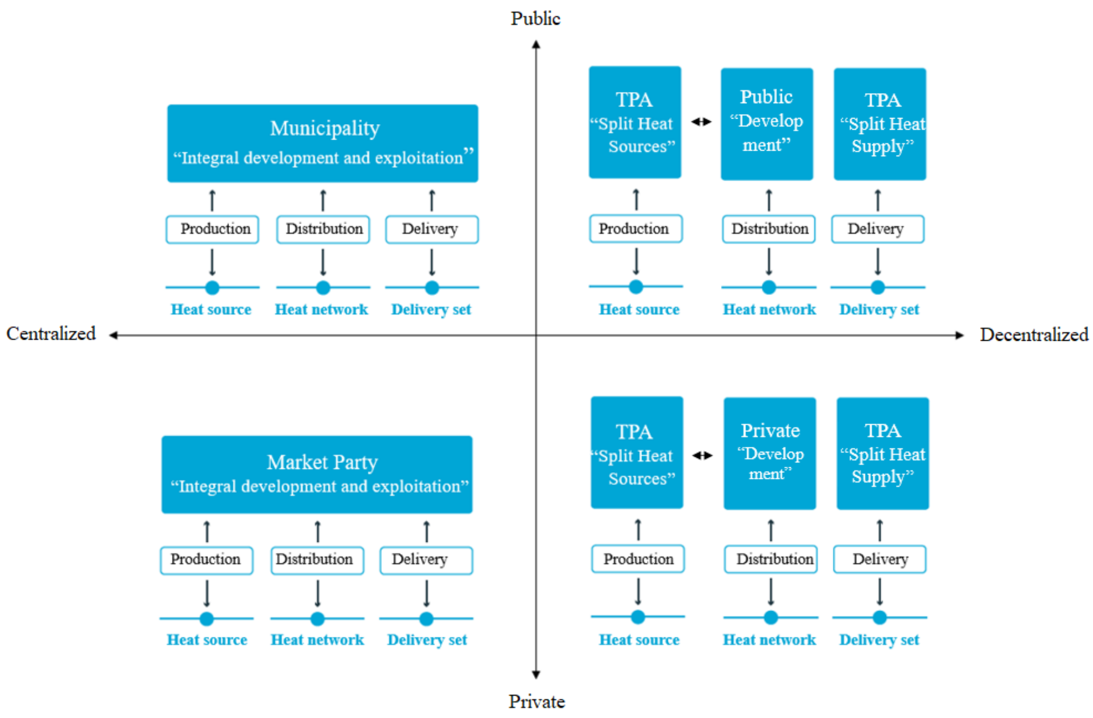

Figure 8: Conceptualized organizational design types in district heating networks.

3.5 Customer Satisfaction in district heating networks

The study of measuring customer satisfaction levels has been one of most important indicators that could influence the possibilities of future economic endeavours and competitive forces in the energy sector. It is considered a proven motivating factor to improve attractiveness and maintain the consumers loyalty.

3.5.1 The ACSI model

The ACSI model is a measurement system developed for evaluating the performance and satisfactions of companies, industries, economic sectors and national economies. The model is designed to be able to perform benchmark studies and can therefore also be used as a model to measure customer satisfaction. The ACSI model, also known as the 'American Customer Satisfaction Index', was developed in 1994 and builds upon traditional customer satisfaction models, in which customer expectations are neglected.

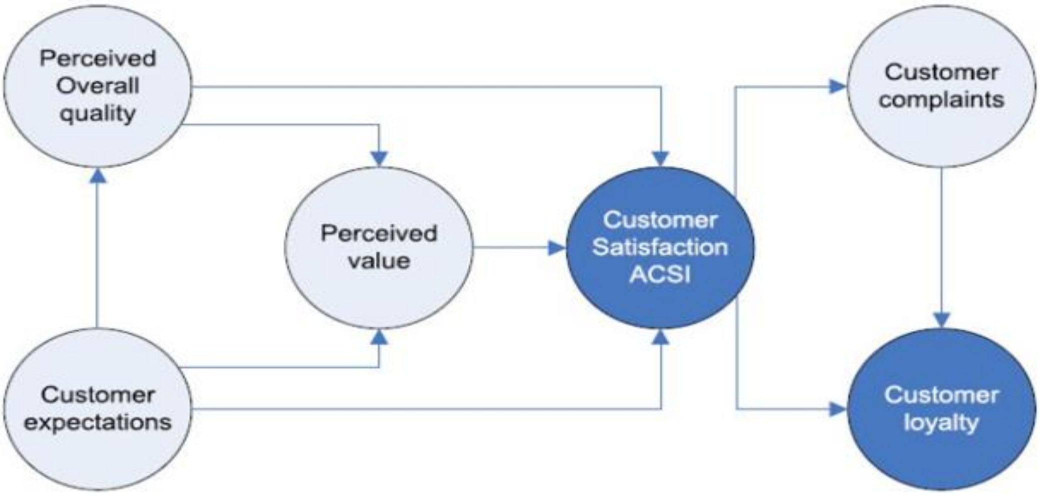

Figure 9: The American Customer Satisfaction Index (Theoretical model).

According to (Fornell, 1996): "the ACSI model is a cause-and-effect model with indexes for drivers of satisfaction on the left side (customer expectations, perceived quality, and perceived value), satisfaction (ACSI) in the centre, and outcomes of satisfaction on the right side (customer complaints and customer loyalty, including customer retention and price tolerance)". The model is used as a self-weighting model that evaluates the parts that need to be improved order to maximize the customer satisfaction and loyalty. In this report, the ACSI model, shown in figure 9 above, will therefore be used as the theoretical model.

1) Customer expectations (CE)

The customer expectations can be described as: "a measure of the customer's anticipation of the quality of a company's products or services" (Fornell, 1996). It includes both prior consumption experiences, and the expectation to provide adequate products and services in the future. Knowing the expectations of the customers is crucial in order to anticipate the customers loyalty and thus willingness to participate in new district heating solutions. Therefore, the customer expectations are positively and directly related to the customer satisfaction levels. A broadly used model that can be analysed in order to map out the role of these customer expectations, in terms of customer satisfaction, is the Kano-model. The main aim is to gain insights in expectations of customers and adjust strategies accordingly (Zeithaml et al., 2000).

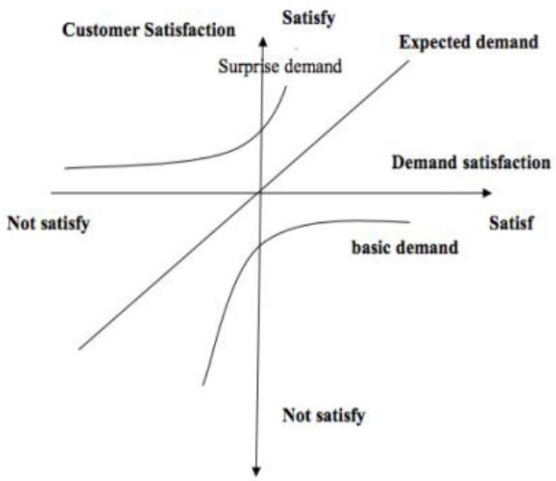

Figure 10: The Kano-model (Zeithaml, 2000).

The x-axis of the model indicates the quality of the product or service and the y-axis indicates the degree of customer satisfaction. In addition, the top half of the graph indicates positive satisfaction levels and the bottom indicates dissatisfaction levels (Sauerwein et al., 1996). Furthermore, three different product and service expectations are described within the model with a direct impact on customer satisfaction:

- *Basic demand:* These are the basic expectations of the customer that must be met. If these needs are not met, customers will be extremely dissatisfied with the provided products and/or services.
- *Expected demand:* These are the performers that are not only expected but will also induce high satisfaction levels if there are more of them noticeable in the product and/or service experience.
- *Surprise demand:* These are the added extras that are not spoken or expected by the customers. These are the factors that are not missed, but can have a positive influence when they are present.

In the end, the Kano-model describes that if high expectations are met, customers are generally satisfied. Therefore, as these consumers are positively related to the service and/or products from the upset, overall customer satisfaction is easier to achieve. However, the Kano-model also describes that if the consumers have low prior expectations and demands, overall customer satisfaction is generally difficult to achieve.

2) Perceived quality (PQ)

The perceived quality is the reflection of current consumption experiences that measures the quality of a firm's products or services. It is mostly measured with the degree in which a product or service meets the customer's individual needs and the frequency it goes wrong (Fornell, 1996). Heat provision in the

Netherlands is mostly considered a service, despite the fact that actual products are provided. Therefore, a broadly used model that conveys the perceived quality of consumers is the three components model.

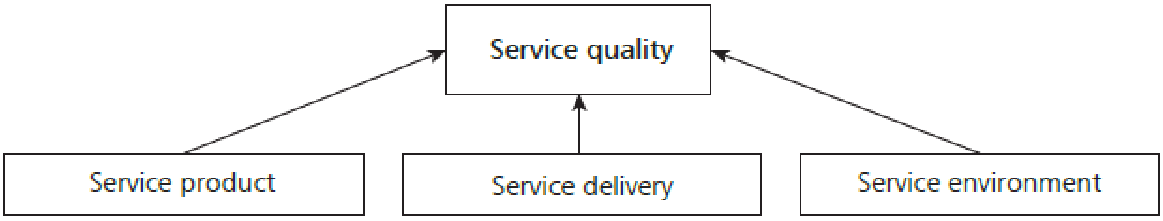

Figure 11: Three component model (Polyakova & Mirza, 2015).

This model is grounded on the work by Grönroos (1982) and describes the perceived quality in terms of service quality, which is highly relevant in energy provisions. Three distinct components are described:

- *Service product:* This consists of "what consumers get as a result of service (i.e., outcome) and also of the consumer's perception of the service" (Polyakova & Mirza, 2015, p. 68).
- *Service delivery:* This component stands for "the consumption process with any relevant events that occur during the service act" (Polyakova & Mirza, 2015, p. 68).
- *Service environment:* This component represents "the internal and external atmosphere in which a service takes place" (Polyakova & Mirza, 2015, p. 68).

In order to measure the perceived quality in district heating networks, customer satisfaction indicators are needed. These indicators provide the groundwork for the perceived quality and reveal the values of consumers that are considered important in order to be satisfied with their supply. The chosen indicators are based on a collection of literature, which provide the additional context into the following indicators:

PQ	**Indicators**	**Items**	**Sources**
Service product	Energy quality	Customers expect adequate, safe and reliable energy provision.	*(Drosos et al., 2020)*
	Additional services	Customers expect adequate maintenance services, but also additional services such as: monitoring, internet and keys-in-the-hand services.	*(Ahvenniemi & Klobut, 2014)*
Service delivery	Price	Customers expect adequate prices and the appropriate price-quality ratio.	*(Jeude & Midden, 2014)*
	Transparency	Customers expect adequate transparency in pricing, standardized bills with a full breakdown of costs and reliable heat price comparator mechanisms.	*(Jeude & Midden, 2014)*
	Flexibility	Customers expect adequate influence on costs and possibilities to opt for new producers and/or suppliers that offer the best deal or profit from regular client discounts.	*(Drosos et al., 2020)*
Service environment	Comfort	Customers expect adequate temperature control, low maintenance, radiator capacities and easiness within the installation process.	*(Ahvenniemi & Klobut, 2014)*
	Sustainability	Customers expect adequate levels of sustainable (non-fossil) heat provision within new district heating solutions.	*(Drosos et al.,, 2020)*
	Consumer protection	Customers expect adequate customer service-and-complaint handling procedures within the provision of heat.	*(Which?, 2015)*

Table 3: The conceptualized perceived quality variables.

3) Perceived value (PV)

Ciavolino & Dahlgaard (2007) describe in their study that the Perceived Value is: “the perceived level of product quality relative to the price paid or the ‘value for money’ aspect of the customer experience; Value is defined as the ratio of the perceived quality relative to price” (p. 546). It could be stated that as the impact of value increases in relation to the product and service quality, price is one of the determinant factors. In addition, the PV is an important factor in establishing and maintaining the customer’s loyalty. The perceived value is in principle self-explanatory and does not require a model to study its influence.

4) Customer satisfaction (CS)

Throughout the years, many research attempts have been performed in order to define, quantify and also measure the impact of customer satisfaction within the organizational context. These conducted studies have all provided different attributes and dimensions to quantify and measure the customer satisfaction concept. Through a general perspective, customer satisfaction entails that the needs of the customers are met, expected services are provided, which in turn leads to a positive consumption experience (Drosos, et al., 2020). However, depending on the sector, it could still be interpreted from different standpoints. A broadly used model that can be used to study this concept is the customer satisfaction analysis model.

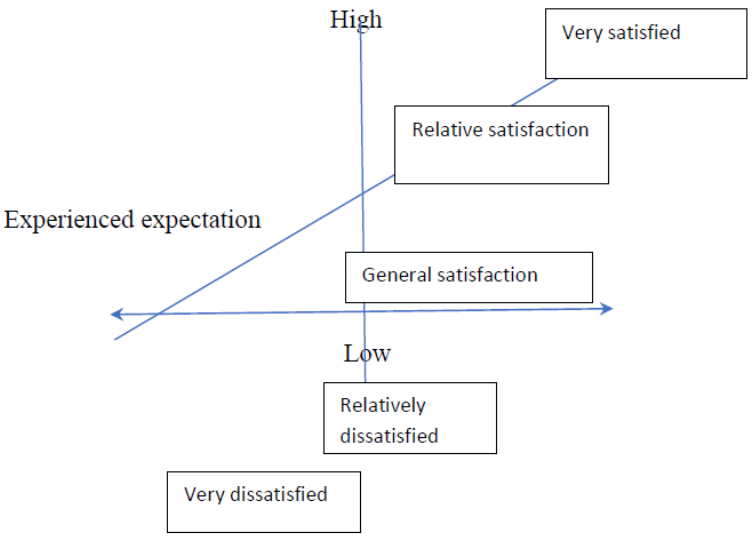

Figure 12: the customer satisfaction analysis model (Kotler & Armstrong, 2012).

With this model, Kotler and Armstrong (2012) related customer satisfaction with: “The complacence or discontent of a person while comparing his/her expectations with the performance or the result of a product or service” (Drosos et al., 2020, p. 2). Therefore, it describes not only the customer satisfaction levels, but also considers the generated expectations from the post-purchase evaluation of the products. In other words, customer satisfaction could be described as the expectancy-(dis)conformation principle.

As a result, the term ‘customer satisfaction’ is in this report defined as: “A person’s feelings of pleasure or disappointment resulting from comparing a product’s perceived performance (or outcome) in relation to his or her expectations" (Kotler, 2000). Johnson et al (2001) describes this as a cumulative construct where the expectancy-(dis)confirmation (expectations vs perceived quality) functions as the one of the most determinant factor. "These expectations are argued to positively affect customer satisfaction since they serve as cognitive anchors in the evaluation process" (Johnson, 2001, p. 221). Therefore, it provides the underpinning of customer satisfaction levels, which is positive if the customer expectations are met.

5) Customer complaints (CC)

According to the methodology of ACSI (2021): "Customer complaints are measured as a percentage of respondents who indicate they have complained to a company directly about a product or service within a specified time frame". In general, the relationship between satisfaction levels and customer complaints is negative. as satisfied customers are less likely to have specific complaints about the perceived quality. In addition, one of the most important determinants for customer satisfaction, in terms of the customer complaints, is how companies and organisations ultimately deal with the complaints they receive. The customer complaints are in principle self-explanatory and do not require a model to study its influence.

6) Customer Loyalty (CY)

According to the methodology of ACSI (2021): "Customer loyalty is a combination of the customer's professed likelihood to repurchase from the same supplier in the future, and the likelihood to purchase a company's products or services at various price points (price tolerance)". Therefore, it is measured by the repurchase intention and by the intention to recommend products or services to others (Ciavolino & Dahlgaard, 2007, p. 546). It is a crucial determinant in terms satisfaction as it is a proxy for profitability. Therefore, the loyalty of customers increases significantly if customers are generally satisfied with the service and product quality. This significant relationship is analysed through the customer loyalty model.

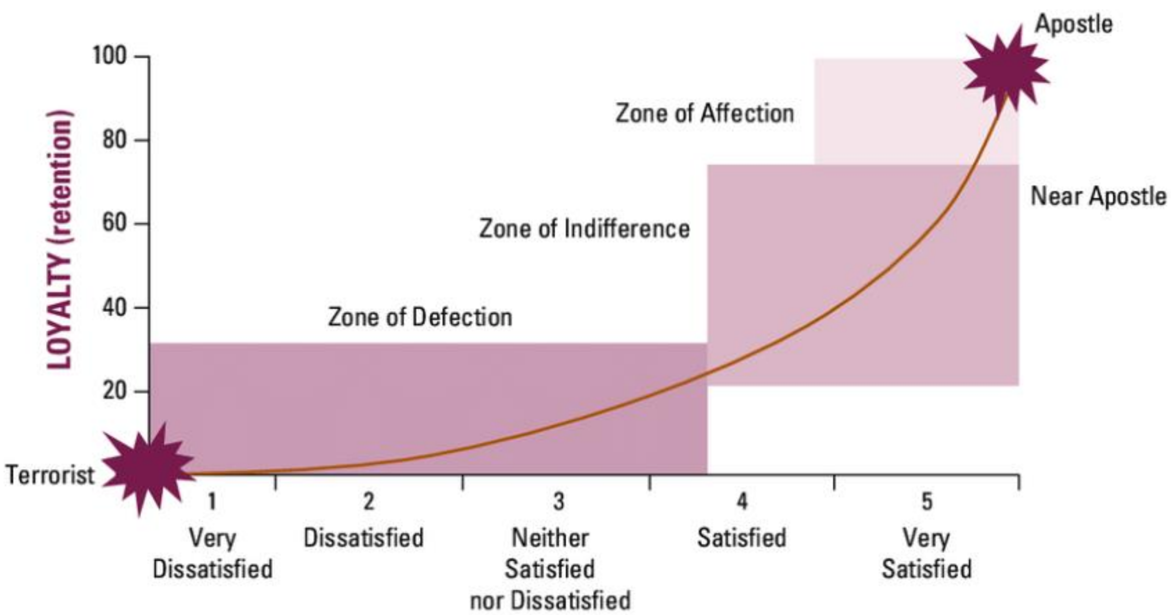

Figure 13: The customer loyalty model (Jones, 1995, p. 91).

This model describes the relationship between the customer satisfaction levels and customer loyalty. It is divided into three components and zones within the model. Customers who are extremely dissatisfied are described as ‘terrorists’. These are customers who are inside the zone of defection and generally give a negative word of mouth. Customers who are considered ‘near apostles’ are generally within the zone of indifference. Within the zone of affection are customers that are called the ‘apostles’. These customers are extremely satisfied, are mostly ready to pay more, and are therefore the most loyal (Heskett, 2008).

Burnham et al (2003) describe the customer’s loyalty and, the intentions to maintain them, as one of the most significant outcomes of the customer satisfaction. In terms of district heating networks, it leads to the retainment of future revenues, an increase in public/private investments, reducing price elasticities and decrease attractiveness for consumers to opt for different heating alternatives (Burnham et al., 2003).

3.6 Conceptual model

The conceptual framework (shown in figure 14) represents the theoretical foundation and the synthesis of the literature, in which the main research question could be answered. As mentioned before, the main research question of this report aims to provide insights into the relationship between the organizational design and the level of customer satisfaction in district heating networks in the Netherlands. Therefore, the conceptual model measures the unknown satisfaction impact between the four different design types.

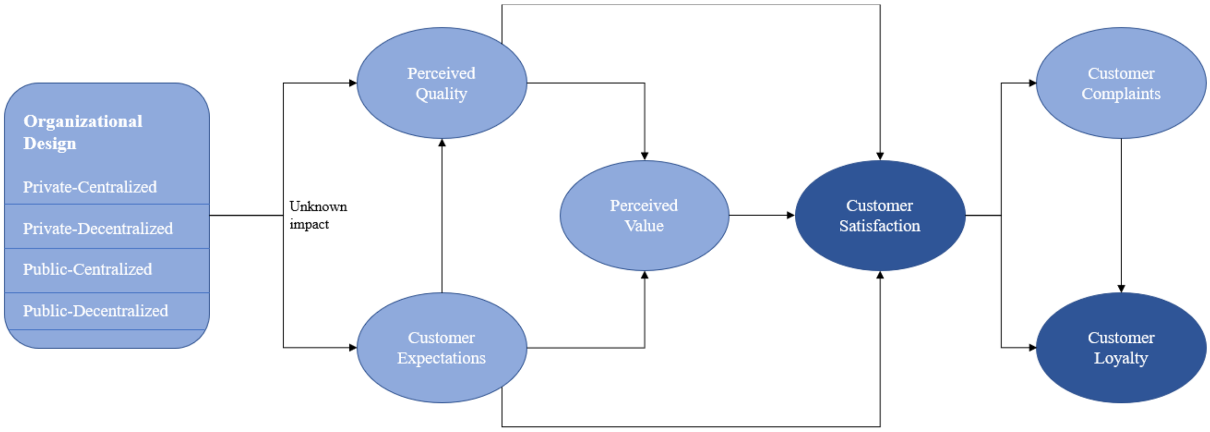

Figure 14: Conceptual model.

3.6.1 Model relationships

In this report, the ACSI model is utilized as an advanced tool in order to establish the satisfaction levels of heat consumers within district heating networks, drive customer loyalty and thereby also increase the attractiveness of new district heating solutions. Here, the objective is to measure the impact of the design types on customer satisfaction, by measuring its effect on the customer expectations, and therefore, on the perceived quality. Both determinants are in turn positively related to the customer’s perceived value. The perceived value is, in turn, directly related to the customer satisfaction as it provides a rating of the price(s) paid for the quality received and a rating of the quality received for the price(s) paid, also known as ‘value for money’ (Loughlin & Coenders, 2002). It could thus be stated that the model is comprised with indexes for drivers of satisfaction on the left side (CE, PQ & PV). These indexes are thus positively related to the overall customer satisfaction (CS) in the centre. In turn, the consequence indexes and the outcomes of the overall customer satisfaction (CC & CY) are described on the right side of the model.

According to Johnson et al (2001): “The immediate consequences of increased satisfaction are decreased customer complaints and increased customer loyalty” (p. 221). Therefore, it could be stated that the CC is negatively related to the overall CS, and CY is positively related, as it serves as the outcome variable, because of its function as a proxy for customer retention and potential profitability. In the end, it can be concluded that the ACSI model assumes that if the expectations and perceived quality of the customers increase, the customer value and thus satisfaction of heat consumers also increase. In turn, this should also create an increase in the customer’s loyalty and an decrease in the overall complaints of customers.

4 Research Methodology

This chapter elaborates on the research methodology that will be used throughout this study. In order to gain the right insights, the following concepts will be discussed: research philosophy, research strategy and design, data collection, data analysis and research quality. This chapter describes the methodological foundation on which this study is built upon, and provides the strategies to answer the research questions.

4.1 Research Philosophy

Before a thorough inquiry can be conducted, it is important to first describe the research philosophy and thus the paradigm in which the author positions himself. Schwandt (2001) defined a research paradigm as: "A shared worldview that represents the beliefs and values in a discipline that guides how problems are solved" (p. 183). Generally, academics that measure customer satisfaction are grounded within the paradigm of objectivism (positivism). This is the worldview that social entities exist in a reality external to social actors concerned with their existence, and that knowledge can only be acquired about the reality by following a scientific method of measurements or testing hypotheses (Saunders et al., 2009, p. 111).

However, the main objective of this study is to identify the relationship between organizational designs in district heating networks and the customer satisfaction of heat consumers. Therefore, this research is more explorative in nature, as it is not proven if these differences actually exist, and there have been no hypotheses developed that could predict these outcomes. Furthermore, new insights are also needed into the occurring market failures and potential solutions in order to improve the customer satisfaction. In addition, customer (dis)satisfaction is based on the expectations that the heat consumers have, and how these are met. These expectations and energy values are subjective and thus are also context dependent.

Therefore, in this study, measuring customer satisfaction is still considered a tangible reality, however, it is also based on theory building where more in-depth data is needed on the grounds where quantitative data is dominant. Although customer satisfaction could be measured objectively, data is still dependent and influenced on theory biases of the researcher and respondents. Therefore, this research grounds itself within the epistemological paradigm of post-positivism. This research philosophy assumes that: "reality is multiple, subjective, and constructively biased by researchers (Crossan 2003, p. 54). It is focussed on the complexity of understanding and also interpreting the process and factors of satisfaction evaluation (interpretivist approach), rather than on rational prediction and control of data (Beeftink, 2005, p. 346).

4.2 Research design

The main research question of this study is based on the impact that the organizational design has on the customer satisfaction in district heating networks, and how this could be improved among district heat consumers in the Netherlands. In order to provide the right insights, the customer satisfaction levels of four different organizational design types will be compared by conducting a case study. This strategy is chosen because a case study is considered an effective method to study the unknown phenomena and/or relationships in natural settings. In this study, the phenomenon is the unknown relationship and impact between the organizational design in district heating and the customer satisfaction of the heat consumers.

Case studies can be identified as: “An empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident” (Yin, 2003, p. 13). It is used to generate an multi-faced understanding of a complex issue. The main aim is to study: “One or multiple carriers of a social phenomenon, during a certain period and with help of multiple data sources, in order to compare/produce statements about the phenomenon’s underlying patterns and processes” (Bleijenbergh, 2013). This approach is considered an effective tool for the exploration of unknown problems, to get the first impression of the functioning of a system or if the aim of the study is to: “delve deeper into the concrete processes and gain insights into the mechanisms that explain the connections between those processes in that system” (Van der Zwaan, 1990, p. 76). The latter is of great importance in this study, as the unknown relationship of the organizational design within district heating networks is evaluated on the customer’s satisfaction levels.

Yin (2003) describes that there are generally three criteria that determine if a case study is an appropriate design for inquiry. First it is important that the type of research question is considered a ‘how’ or ‘is’ question. Second, the case study must relate to a contemporary set of events. Finally, the researcher in question should have a lack of controllability over the events. All three criteria are met within this study, as the main research question consists of both a ‘is’ and ‘how’ question. In addition, constructing and making the build environment more sustainable is highly contemporary, as the Dutch government aims to connect 750.000 households by 2030 (Mulder & Perey, 2018). Finally, the last criteria is met, because this study relates to mapping out customer satisfaction. Therefore, there is no appreciable control over the research results and events, as this falls within the frame reference of all the respondents in question.

Yin (2009) also distinguishes between four types of case study designs. For example, a case study can be organized holistically or embedded. Here, an embedded case study contains multiple units of analysis. A holistic case study does not distinguish between different subunits and only analyses the phenomenon as a whole (p. 46). Since the phenomenon (customer satisfaction of residents) is examined as a whole in this study, it consists of a holistic research design. In addition, Yin (2009) also distinguishes between a single or multiple case study design. Here, a single case study is mainly focussed on a single case and a multiple case study focuses on multiple research units. Therefore, as the overall focus of this research is based on multiple units of analysis (heating networks with different organizational designs), it could be stated that this study consists of a multiple- and holistic case study design. According to Yin (2009), the results of multiple case studies are considered more powerful and robust than single case designs (p.53).

4.2.1 Case selection

The choice for a multiple case study design enables the researcher to make comparisons and explore the differences within and across cases (Boeije, 2005). Therefore, a careful selection of cases is imperative to predict contrasting or similar results between cases separately and also across settings (Yin, 2009). It is used to measure the impact of the organizational design on customers satisfaction, in which it can be assumed that there will be differences and similarities. In order to select the appropriate cases, purposive sampling was used which is an applicable and non-probability sampling method, in which the researcher "relies on his/her own judgement when choosing members of the population to participate" (Dudovskiy, 2016). In this study, this relates to the consumers and stakeholders of predetermined heating networks.

The primary purpose of this multiple case study design is not necessarily to make generalizations of the customer satisfaction across the entire population, but rather on its relationship with the organizational design (Yin, 2009). Therefore, cases have been selected on the theory of theoretical replication, in which cases are selected to predict contrasting results but for theoretical reasons (Ridder, 2017, p. 287). In this study, its reasoning is based on the occurring satisfaction differences within organizational design types.

4.2.2 Case description

In order to assure theoretical replication, four cases have been selected that are based on city districts in which in district heating networks are operational with the organizational design types mentioned before.

Cases	Design type	Owner	Connections x1000	Producer	Transportation	Distribution	Supplier
1) Almere	Private-centralized	Vattenfall	52,9	Vattenfall	NUON	NUON	Vattenfall
2) Arnhem, Duiven & Westervoort	Private-decentralized	Vattenfall	16,1	AVR & Veolia	NUON	NUON	Vattenfall
3) Purmerend	Public-centralized	Gemeente Purmerend	28,2	WKC-Purmerend	Stadsverwarming Purmerend	Stadsverwarming Purmerend	Stadsverwarming Purmerend
4) Zaanstad	Public-decentralized	Gemeente Zaanstad	2,4	Engie & Bio Forte	Firan Zaanstad	Firan Zaanstad	Engie

Table 4: Used cased selection (Warmtemonitor, 2019); (Dekker et al., 2020).

Case 1: Almere

Almere has a district heating network of which Vattenfall is the owner, producer and also the supplier. This entails that the district heating network functions with a private and centralized character. Heat is transported from the Diemer power station (Natural gas CHP) to Almere Poort, Almere Stad and Almere Noorderplassen by means of an 8.5 kilometre long transport pipeline that passes under the IJmeer. There are natural gas-fired auxiliary boilers at two HWC locations in Almere. In the district of Noorderplassen west, a solar power station, which consists of 520 ground-based m2, supplies solar collectors with a total surface area of 7,000 solar panels which convert electricity into heat. In 2019, the district heating system had 52,9 thousand connections and 2.1 PJ of heat was supplied to the network(Warmtemonitor, 2019).

Figure 15: District heating network in Almere (Warmtemonitor, 2019).

Case 2: Arnhem, Duiven & Westervoort

There is a linked district heating network in Arnhem, Duiven and Westervoort. At the end of 2014, the heating networks of Arnhem and Duiven/Westervoort were linked to each other. Vattenfall is the owner of the district heating network and supplies the consumers. The main heat source is AVR Duiven, which is a waste-to-energy plant, which is also in the possession of a heat buffer. In 2017, Veolia's natural gas-fired heat installation at the Kleefsewaard business park in Arnhem was also linked to the district heating network, which therefore also competes as a heat producer. This means that the district heating network functions with a private and decentralized character. In addition, Vattenfall also has auxiliary heat plants (HWCs), which are fired on both natural gas and gas oil. In 2019, the district heating network had 16,1 thousand connections and a total of 0.9 PJ of heat was supplied to the network (Warmtemonitor, 2019).

Figure 16: District heating network in Arnhem, Duiven & Westervoort (Warmtemonitor, 2019).

Case 3: Purmerend

Stadsverwarming Purmerend is the owner, heat supplier and heat producer of this district heating system. However, the Municipality is the full owner of this heating company. This means that the Municipality is therefore integrally responsible for the entire heat chain (Dekker et al., 2020). This network therefore functions with a centralized and public character. At the moment, heat is mainly supplied with the help of BioWarmtecentrale (BWC), which is also known as the Purmer. The BWC runs on wood chips from the maintenance of the forests of Staatsbosbeheer. In addition, there are two natural gas-fired auxiliary heat plants (HWCs) for supply and peak consumption. In 2019 there were 28,2 thousand connections to the district heating network and also 1.1 PJ of heat was supplied to the network (Warmtemonitor, 2019).

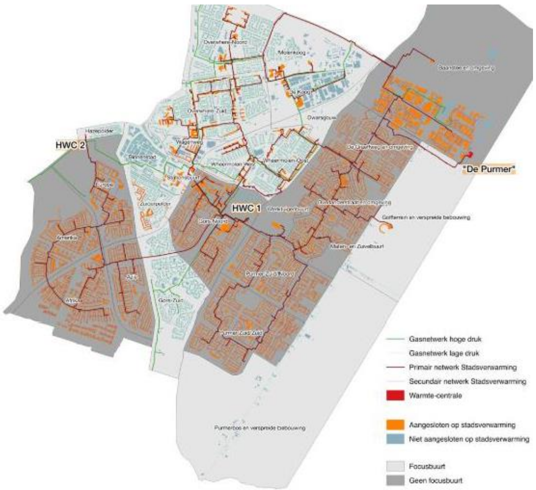

Figure 17: District heating network in Purmerend (Warmtemonitor, 2019).

Case 4: Zaanstad

In Zaanstad, the municipality of Zaanstad, in collaboration with Firan (part of Alliander), Engie (heat supplier and producer) and Bio Forte (producer of local biomass), has developed an open district heating network that is fed from various heat sources. Biomass is therefore supplied by Bio Forte and residual heat from the connected industry by Engie. This is therefore an open heating network, in which several heat sources are fed into the network, so that several parties in the chain are responsible for production and the supply of heat. The municipality has opted for a large shareholding in transport and distribution within the district heating network. This means that the network has a public and decentralized character. In 2019, this district heating network had ultimately 2,4 thousand connections (Dekker et al., 2020).

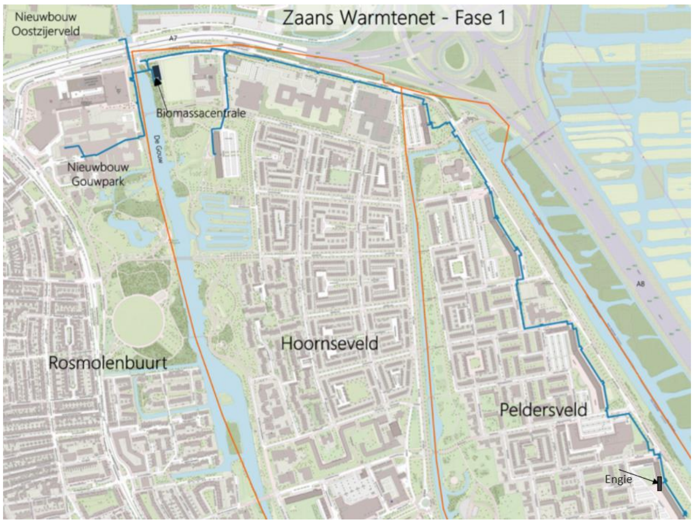

Figure 18: District heating network in Zaanstad (Warmtemonitor, 2019).

4.3 Research strategy

The first section describes the technological characteristics of heating networks and also conceptualizes the organizational design and customer satisfaction. Then, the customer satisfaction within four different organizational design types will be evaluated by conducting a survey. Furthermore, the differences and similarities will be further elaborated by statistical analysis. With these results, a literature study will be conducted to identify occurring market problems that caused these outcomes and the potential solutions.

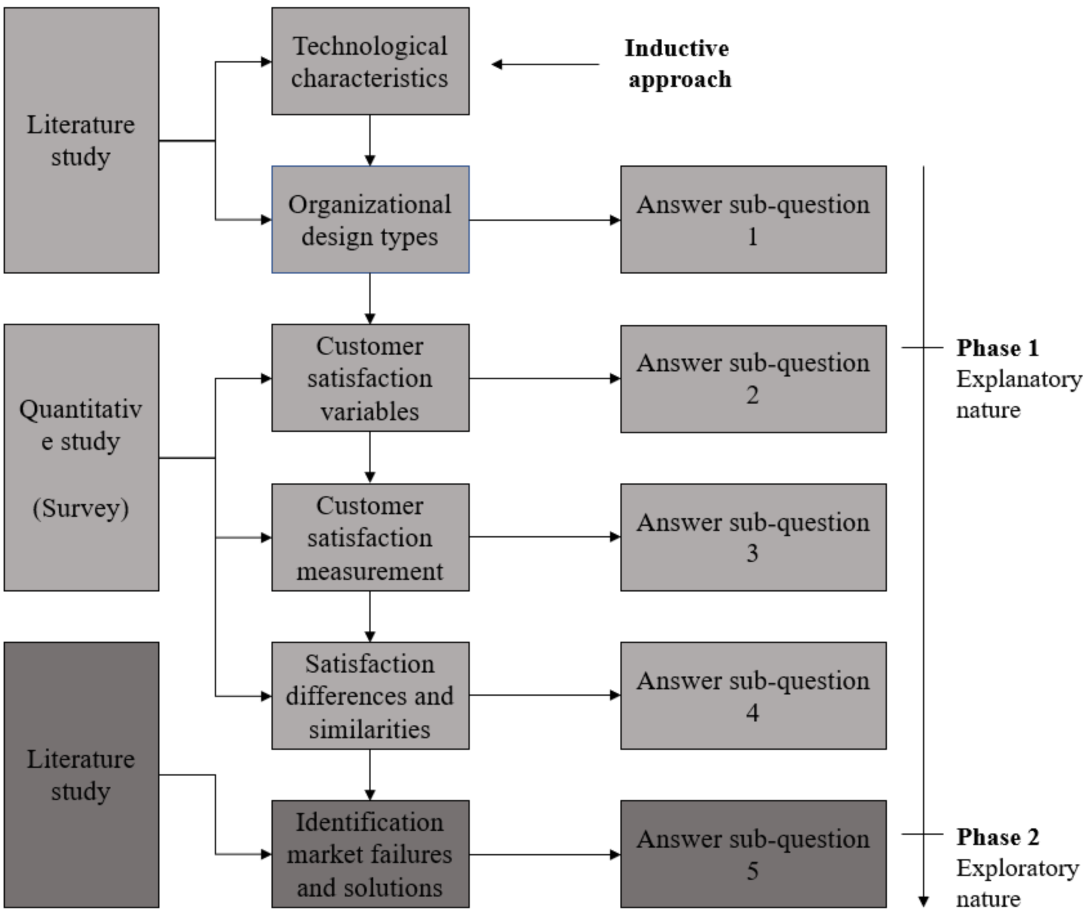

Figure 19: Research strategy.

The first phase of this study was focussed on customer satisfaction evaluation of heat consumers within district heating networks with different organizational designs. Furthermore, the relationship between both concepts were investigated by means of a statistical analysis of the acquired data. In order to do so, numerical and measurable data was needed on customer satisfaction, which lends itself perfectly for quantitative research. Therefore, phase 1 is considered more explanatory, as explanations are sought for the degree of customer satisfaction among heat consumers within urban areas, by conducting a survey.

However, although the first phase of this study is more explanatory in nature, the second phase of this study is considered explorative in nature. The reasoning behind this is that an important objective of this phase is to gain insights into the market failures and also potential solutions, which are needed in order to improve the customer's satisfaction among heat consumers. Phase 2 is thus slightly more focussed on theory building, on the grounds where the quantitative data is dominant. The original plan was to ground this phase on expert interviews, however, it had to be done with a literature study due to time constraints. This study follows an inductive approach to inquiry, as there is an unknown relationship with the overall customer satisfaction and the organizational design. Moreover, no general observations have been made that could predict these outcomes. Therefore, inductive reasoning is used in order to observe the relations between customer satisfaction and the organizational design and analyse the differences and similarities. The objective is to create and support new research perspectives on the grounds where theory is lacking.

4.4 Data collection

Data collection is defined is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses and evaluate outcomes (Kabir, 2016, p. 202). Irrespective of the field of study, this process is generally considered as one of the primary steps for inquiry. However, depending on the data that is required, the collection of data differs within many research approaches. In this study, data was collected as followed:

4.4.1 Survey (Questionnaire)

As mentioned before, in this study, a survey was conducted in order to measure the customer satisfaction among heat consumers within district heating networks with different organizational designs. A survey can be defined as "the collection of information from a sample of individuals through their responses to questions" (Ponto et al., 2015, p. 168). In this study, the survey is conducted to collect quantitative data with numerically rated items of customer satisfaction by means of an questionnaire. It can be defined as "a series of questions asked to individuals to obtain statistically useful information about a given topic. When properly constructed and responsibly administered, questionnaires become a vital instrument by which statements can be made about specific groups and/or populations" (Roopa & Rani, 2012, p. 273). In this study, the questionnaire is used as a data instrument for collecting the primary data of customer satisfaction, in which the questions are based on the ASCI-model and thus also on the conceptual model.

In order to answer sub-question 2, the questionnaire describes 20 questions (Appendix A). Each question was measured by a five point liker-scale in which scale 1 represents extreme dissatisfaction levels and scale 5 represents the optimum satisfaction levels. This enables customers to make better discriminations (Joshi et al., 2015). Within table 5, variable one and two describe the inclusion conditions which are necessary in order to participate; variable three and four describes the prior customer expectations (CE1 & CE2); variable five till twelve analyse the perceived quality (PQ1-PQ8); variable thirteen and fourteen describes the perceived value (PV1 & PV2); variable fifteen and sixteen describe the overall customer satisfaction by using the expectancy-(dis)conformation principle (CS1 & CS2); variable seventeen and eighteen describe the number of service and product complaints (CC1 & CC2) and ultimately, variable nineteen and twenty describe the overall customer loyalty within the designated networks (CL1 & CL2).

Indicators	Items	Variables
Inclusion criteria	IC1	Consumption from designated network
	IC2	Consumption <2 years
Customer Expectations	CE1	Basic demand
	CE2	Performance demand
Perceived quality	PQ1	Energy quality
	PQ2	Price
	PQ3	Comfort
	PQ4	Transparency
	PQ5	Sustainability
	PQ6	Flexibility
	PQ7	Customer protection
	PQ8	Additional service products
Perceived value	PV1	Price to product quality ratio
	PV2	Price to service quality ratio
Customer Satisfaction	CS1	Expectancy-(dis)conformation products
	CS2	Expectancy-(dis)conformation services
Customer Complaints	CC1	Product complaints
	CC2	Service complaints
Customer Loyalty	CL1	Rebuying intentions
	CL2	Recommend intentions

Table 5: Questionnaire variables.

In order to obtain the required data that represents the population, it is important to map out the sampling design. "The sampling design is a finite plan for obtaining the samples from a given population; It is the process used in statistical analyses where a predetermined number of observations is taken from a larger population" (Taherdoost, 2016). In this study, purposive sampling and the logic of replication was used to obtain the data. This was the appropriate method to use as the purpose of this study was not necessarily to generalize results to a larger population, but rather to gain an deeper understanding of the relationship between the organizational design and customer satisfaction. By doing so, quantitative data will be used for hypotheses building in which differences and similarities, for predictable reasons, will be analysed.

Cases	Design type	Connections	Residential area	N	%
1) Almere	Private-centralized	52.900	Literatuurwijk	32	7,8%
			Muziekwijk	34	8,3%
			Almere Poort	37	9,1%
2) Arnhem, Duiven & Westervoort	Private-decentralized	16.100	Presikhaaf	36	8,8%
			Duiven Zuid-Oost	31	7,6%
			Hoogeind	35	8,5%
3) Purmerend	Public-centralized	28.200	Purmer-Zuid	33	8,0%
			Purmer-Noord	35	8,5%
			Gors-Noord	32	7,8%
4) Zaanstad	Public-decentralized	2.400	Rosmolenbuurt	34	8,3%
			Hoornseveld	30	7,3%
			Peldersveld	41	10%
Total		**99.600**		**410**	**100%**

Table 6: Case selection and response rate.

Cases were selected based on purposive sampling, also known as subjective sampling, which is a non-probability sampling method in which researchers rely on their own judgement when choosing members of the population to participate in the study and obtain a representative sample. Etikan (2016) described it as "the deliberate choice of a participant due to the qualities the participant possesses (p. 2). Here, the population consists of number of connections from the prior designated district heating networks, which are 99.600 connections in total (table 6). The target respondents are purposive selected and based on the organizational designs of the district heating systems in which they consume heat. The respondents were also carefully selected based on the residential areas in which they live. Neighbourhoods that consists of newly built homes have been chosen (table 6). These buildings are generally well insulated and can therefore create a representative picture of customer satisfaction and be compared properly as a result.

4.4.2 Literature research

Within the first section (see figure 19) a literature review has been conducted, which can be defined as: "a comprehensive review of the literature available for any given research question; It is a summary, analysis and evaluation of the literature and an explanation of what research has already been performed for a research area (University of Wolverhampton, 2018, p. 1). Therefore, it helps researchers to identify and organize the concepts into relevant literature and other sources. "A comprehensive literature review needs to draw on and evaluate a range of different types of sources including academic and professional journal articles, books, and web-based resources" (Rowley & Slack, 2004, p. 31). When developing an deeper understanding of the subject area, literature is generally derived from the conceptual framework.

However, in this study, the potential market problems that have caused the overall satisfaction outcomes of heat consumers, and the solutions that could combat these problems, were investigated by means of a literature study. Originally, the plan was to gain these insight by conducting semi-structured interviews with experts in the field. Nevertheless, although it could be considered an unusual research structure, it has provided relevant insights, not only in gaining knowledge on potential market problems, but also on how these problems within district heating networks could be solved in favour of heat consumers. This ultimately led to the insights that were required in order to answer sub-question five in a correct manner.

In order to identify potential market problems and solutions, the following databases and sources have been used: Radboud University, Google Scholar, municipal documents and previously executed theses. One of the most prominent authors used within the literature review was the thesis of Janssen (2015). In this study, Janssen (2015) conducted a comprehensive analysis of the needs and expectations of district heat consumers. In addition, as no research has yet been carried out in the Netherlands into the customer satisfaction within district heating networks with different organizational designs, most of the additional literature was based on studies that were conducted abroad, like the UK and the Scandinavian countries. Lastly, all conducted studies within the literature research were appropriately validated by other authors.

4.5 Data analysis

A data analysis is the thorough and careful review and interpretation of data collected through the study. The data analysis then produces results that can be used to properly answer the research questions. Here, in this study, the data analysis mainly takes place with the data outcomes of the conducted questionnaire.

Ali (2020) describes that: “Quantitative data analysis is a systematic process of both collecting and also evaluating measurable and verifiable data; It contains a statistical mechanism of assessing or analysing quantitative data (p. 2). Here, numerous research methods could be used in order to quantify the findings as inferential statistics. With the help of SPSS software, the following methods were used in this study:

4.5.1 Descriptive statistics

According to Ali (2020): “Descriptive statistics is used to describe or present data in an easily accessible, quantitative form; This analytical process helps researchers to illustrate and sum up an observation” (p. 2). In other words, descriptive statistics are used in the preliminary phase of the analysis, and could be described as the collection, interpretation and presentation of the main features of quantitative data-sets. Since this study concerns research that is related to customer satisfaction, in which Likert scales are used with a classification from highest to lowest, the variables (table 5) were measured form an ordinal scale.

In order to present the main findings of customer satisfaction levels within district heating networks, the following descriptives were used: Mean values, Standard Deviations and Frequency statistics. Here, the Mean Values indicate the averages in which the consumers are satisfied with the used variables and the frequency statistics are used to map out the arrangement of each measurement from the highest to lowest.

However, as the Likert scale is represented from 1 (lowest satisfaction level) to 5 (highest satisfaction level), an occurring problem arises as the mean for one and/or the mean for five almost never occurs. In order to correct this problem, and thus eliminate biases, it was necessary to make the differences between each scale uniform. Therefore, this study followed a frequently used scheme of thresholds, derived from a report of Pimentel (2019), in which the weighted mean values are categorized by the following scales:

Likert scale	**Range**	**Difference**	**Description**
1	1.00 - 1.79	0.79	Very dissatisfied
2	1.80 - 2.59	0.79	Dissatisfied
3	2.60 - 3.39	0.79	Neutral
4	3.40 - 4.19	0.79	Satisfied
5	4.20 - 5.00	0.80	Very satisfied

Table 7: Weighted mean values categorized by the scales used in the descriptive analysis (Pimentel, 2019).

4.5.2 Correlation matrix

The correlation matrix was used to analyse the correlations between the chosen variables of the ACSI-model. This correlation matrix shows whether there is a relationship between two or more variables and thus provides a representation of the degree of correlation and how the variables influence each other. The value of the correlation coefficient is always between -1 and +1. Here, a positive correlation means that both variables increase or decrease together. Furthermore, a negative correlation means that one of the variables increases while the other variable decreases. If the correlation coefficient is equal to zero, it could be stated that there is ultimately no relationship that exists between the variables (Aarts, 2019).

Before a correlation analysis can be performed, however, a number of rules must be taken into account. First of all, it is important that the correlations have a correspondence factor at level 0.3. This is thus the minimum representation of a correlation and is considered as the ultimate measure of validity. It is also crucial that the coefficients between the chosen variables do not load under two factors simultaneously (≥ 0.8). In addition, the overall determinants, which are indicated at the bottom, must be greater than the value 0.00001 and the correlations need to be significant at a 2 tailed level of 0.01 (Fabrigar et al., 1999). To conclude, the correlation matrix only indicates coherence and not causation. Therefore, based on the correlation matrix, it was in this study only observable whether the variables are related with each other.

4.5.3 Multiple Linear Regression

In order to gain insights into the causality (causation) of the related variables, it was decided to perform a multiple linear regression analysis. A multiple linear regression analysis describes the extent to which multiple variables describe a particular outcome measurement. By doing so, it takes several independent variables into account that are used to predict the dependent variable. Therefore, since the ACSI-model describes PQ as the main drivers for overall customer satisfaction, the impact of the variables related to PQ (independent variables) will be analysed on the overall customer satisfaction (dependent variable).

Before a multiple linear regression can be performed, it is first important to analyse if the model is an acceptable predictor of the dependent variable. In order to do so, the Adjust R Square is frequently used. According to Karch (2019): “The Adjusted R Squared is a modified version of R-squared that has been adjusted for the number of predictors in the model; It is a statistical measure that describes the proportion of the variance for a dependent variable that is explained by multiple independent variables” (p. 3).

The model also needs to be tested on any signs of multicollinearity. In order to do so, a frequently used metric is the Variance Inflation Factor (VIF). This metric could be defined as: “A measure of collinearity among predictor variables within a multiple regression; it is calculated by taking an independent variable and regressing it against every other predictor in the model” (HIS, 2021). Pallant (2016) describes that there is no sign of multicollinearity within the model if the VIF shows values below the threshold of 4.

In order to evaluate if the variables related to PQ have any influence on the overall customer satisfaction, B values are analysed. B-values, also known as unstandardized Beta values, are the so-called regression coefficients. This value represents the slope of the line between the predictor variable and the dependent variable, and thus represent the measures of the weight each variable holds in the scale as a predictor of the dependent variable (Aarts, 2018). In this report, it has been taken into account that variables exert a high influence if these B-values show a regression coefficient above the threshold of 0.2. Furthermore, probability metrics (P-value) are also taken into account. This value estimates if the independent variable influences the dependent variable significantly, in which the threshold is below 0.05 (Sedgwick, 2014).

4.6 Research quality

In order to ensure a high quality of the research, both the validity and reliability of the chosen methods must be taken into account. According to Roberts et al (2006): "Validity describes the extent to which a measure accurately represents the concept it claims to measure" (p. 42). Moreover, Verhoeven (2014) stated that: "reliability refers to how consistently a method measures something". This means that the same results should be consistently achieved by using the same methods and circumstance. However, it is first important to understand what research quality entails in case study research, as this differs highly.

4.6.1 Research quality in case studies

According to Quintáo & Andrade (2020): "Case studies are used to understand a phenomenon in depth; The main advantage is its high applicability to human situations and contemporary contexts of real life (p. 266). However, although it offers a deep and integrated vision of complex phenomena, its application rather complex. Ensuring the ultimate research quality in case study research is often considered difficult as it does not offer well-defined protocols, provides little basis for generalization as it often describes a specific phenomenon in time, is difficult to replicate and inherently vulnerable to the researcher's biases. Case studies are associated with low validity and reliability characteristics (Quintáo & Andrade, 2020).

4.6.2 Internal and external validity

This study used an empirical mixed-methods research design as both data from the questionnaire and literature was collected to answer the research questions (see figure 19 p. 40). According to Erlandson (1993), this so-called method of triangulation "lends credibility to the findings by incorporating multiple sources of data, methods, investigators, or theories" (p. 34). Therefore, a literature review was conducted in order to gain insights into the relevant literature regarding the organizational design of district heating networks, improving construct and content validity of the study, and into the measurement of the overall customer satisfaction. This aspect was ultimately detrimental for the construction of the questionnaire. Another important element that was highly beneficial for increasing the study's overall validity has been the usage of a multiple case study design. According to Quintáo & Andrade (2020): "Choosing multiple studies are considered more convincing and robust because they allow analysis between cases; While individual analyses consolidate the information from each case, the analyses between the cases identify patterns, providing elements for the construction of hypotheses and the development of theories (p. 269). In terms of the overall validity, a distinction is made between the internal and external validity. Quintáo & Andrade (2020) state that: "internal validity is particularly important in explanatory case studies, in which the researcher is seeking to demonstrate relationships and cause and effect between the elements; It is the internal validity that assures the researcher that the results can be accepted based on the research design" (p. 269). In order to evaluate if the chosen variables accurately represent the concept of customer satisfaction, and influence each other just like the ACSI-model predicted, the internal validity has been ensured by conducting a model test using Principal Component Analysis (PCA). Here, the Kaiser-Meyer Olkin (KMO) test and thus the Bartlett's sphericity test were used to determine whether the sample was adequate and if the items correlated sufficiently. An SME of 0.7 and an significant Bartlett's were here considered acceptable. Moreover, the Simple Regression Coefficients and the Total Variance explained were used to analyse if the variables are properly correlated and/or all load under the same components.

As mentioned before, in terms of external validity, conducting a case study is considered rather difficult. According to Quintáo & Andrade (2020): "here it is fundamental to explain that the phenomenon studied can be replicated in other environments; The objective is not a statistical generalization, something that is not possible in single or multiple cases, but to look at their analytical generalization; Here, we seek to have a process of generalization of empirical observations into theory, rather than population" (p. 270). Therefore, the findings are generalized at the theoretical level; in other words, what is observed will be translated from the conceptual model in the form of general observations, as it is not possible to draw conclusions from a limited amount of cases. Therefore, in order to ensure that the occurring phenomenon (customer satisfaction) could be replicated in other environments (district heating systems with different organizational design types), the following conditions have been taken into account within this study:

Conditions	Inclusion criteria	Exclusion criteria	Units
1) Operationality	Cases must relate to functioning district heating networks which are currently operational.	Non-operational district heating networks are excluded.	Yes/No
2) Location	Cases must be operational to heat consumers in the Netherlands.	Networks that are operational in other countries are excluded.	Yes/No
3) Designation	Cases must relate to specifically designated municipality areas or urban city districts.	Industrial district heating networks and heat provision are excluded.	Yes/No
4) Design type	Cases must consist of the right organizational design in question.	Other organizational design types are excluded.	Yes/No
5) Structure	Decentralized cases must be decentralized on the production and/or on the delivery side.	Fully decentralized market structures are excluded.	Yes/No
6) Ownership	Cases must be publicly or privately owned.	Public-private or cooperative ownership is excluded.	Yes/No
7) Size	Cases must provide heat for at least 400 connected heat consumers within the area.	Networks with less than 400 connected consumers are excluded.	> 400
8) Residents	Residents must consume heat from the designated district heating network.	Demographics play no role in this study and are therefore excluded.	Yes/no
9) Consumption	Residents must have consumed heat for at least 2 years from the designated district heating network.	Residents with less than 2 years of heat consumption are excluded.	>2

Table 8: Inclusion and exclusion conditions.

These conditions have been mapped out by the researcher himself, as no research has yet been conducted to compare different organizational designs of district heating networks in a multiple case study. Here, *condition 1* is important as no relevant data on customer satisfaction can be acquired from district heating networks that are non-operational. *Condition 2 and 3* are also important as it sets the geographical scope on which the research questions are founded on. Furthermore, *condition 4, 5 and 6* have been set up, as it relates to the specific organizational designs. Therefore, statements about the wrong research domains can be avoided. *Condition 7* is considered important as a survey with too few respondents does not yield reliable data. To conclude, *condition 8 and 9* are important as consumers with a lack of experience in district heat consumption cannot make reliable statements about their own customer satisfaction levels.

4.6.3 Reliability

According to Roberts et al (2006): "Reliability refers to how consistently a method measures something; If the same result can be consistently achieved by using the same methods under the same circumstances, the measurement is considered reliable (p. 42). In order to ensure internal consistency, with a confidence interval of 95% and a margin error of 5%, a sample of at least 400 respondents was sought to achieve. The internal consistency of the questions, subscales and thus the variables were also determined by using Cronbach's Alpha. This method is a reliability test which estimates the internal reliability of the data-sets. According to Bryman & Bell (2011) the acceptable threshold for the coefficient is $\alpha = \geq 0.60$. This was calculated for the chosen (sub)variables within in the ACSI-model (CE, PQ, PV, CS, CC and CL).

The questionnaire (Appendix A) has been set up and analysed with the digital program 'Survio'. In the end, 410 questionnaires have been filled in by heat consumers. The quantitative study has been held by going door-to-door within the designated district heating networks, based on their organizational design. This method was chosen to provide additional explanations if the respondents explicitly needed more information to understand the concepts. However, this has also created a longer study period as a result. It also provided respondents with possibilities to be questioned in their own natural setting of their home. Furthermore, the same survey was conducted for each respondent, and analysed through SPSS software. To conclude, two important conditions were tested before the conversations (see Appendix A) that have described whether the respondents (heat customers) really consume heat from the designated networks.

5 Results

This chapter elaborates on the research outcomes resulting from the conducted inquiries. Within the first section, the model will be tested in order to analyse if the chosen variables influence each other just like the ACSI-model predicted. The second section provides an deeper understanding of the overall customer satisfaction of heat consumers within the designated district heating networks, in which all the data-sets, and thus organizational design types, are combined. In the sections afterwards, customer satisfaction is evaluated through the four organizational design types outlined before. Here, the data-sets are organized into the following heating networks: private-centralized (Almere), private-decentralized, (Arnhem, Duiven & Westervoort), public-centralized (Purmerend) and public-decentralized networks (Zaanstad). The chosen methods were: Principal Component Analysis, Descriptive Analysis, Reliability Statistics and Simple/Multiple Regression Analysis. These methods were all analysed using SPSS software. Here, table 8 provides a schematic representation of the main results that have arisen from the overall analysis:

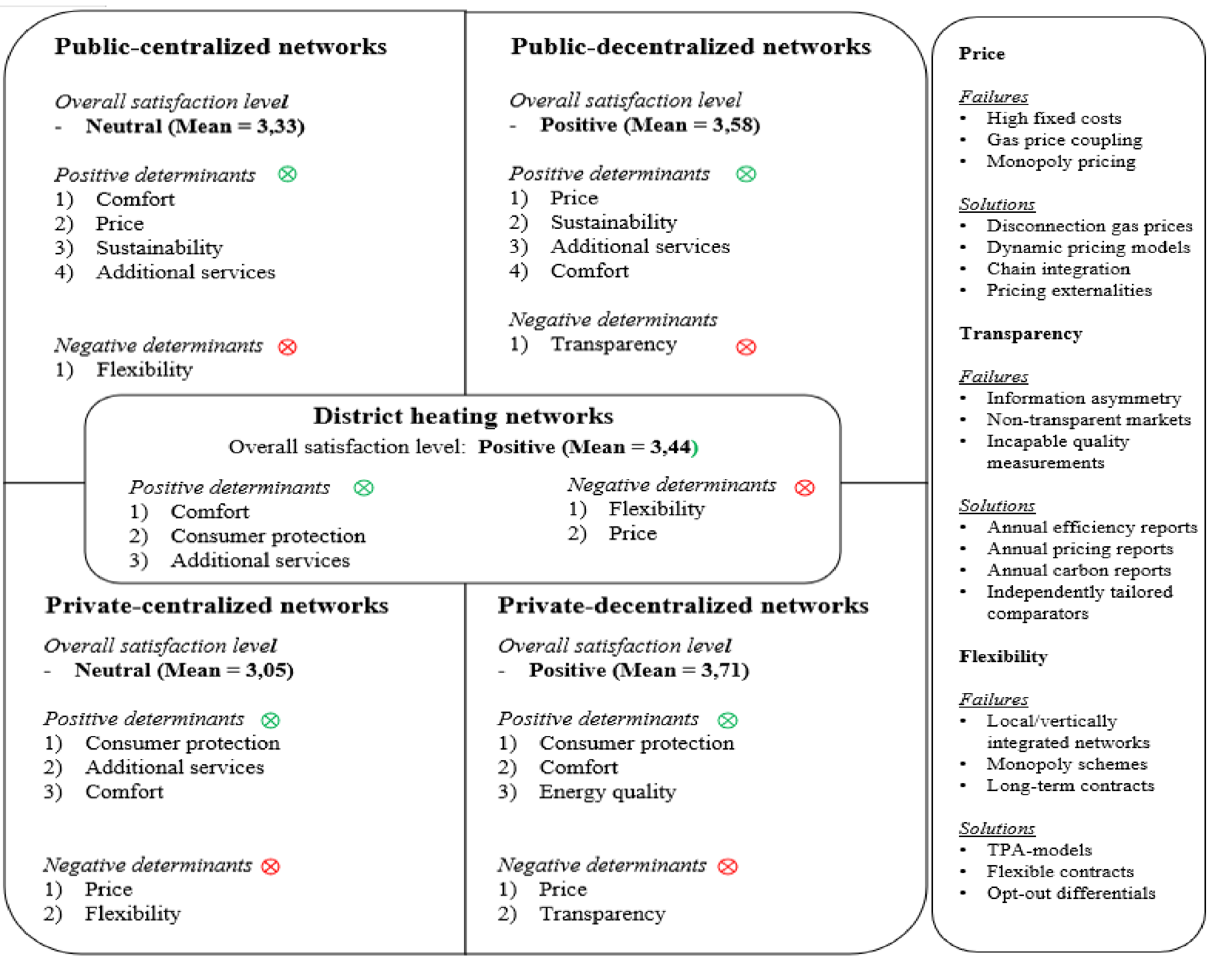

Figure 20: Result summary of the main satisfaction determinants and potential market failures and/or solutions.

5.1 Model testing

In order to be sure that the chosen variables all measure the same construct (customer satisfaction), just like the ACSI-model predicted, a Factor Analysis was performed using PCA. Here, the individual data-sets (table 5) were grouped into the six main variables of the ASCI-model: customer expectations (CE), perceived quality (PQ), perceived value (PV) customer satisfaction (CE), customer complaints (CC) and customer loyalty (CL). In order to perform a clear Factor Analysis, the KMO statistic was first analysed. The Kaiser-Meyer-Olkin is a measure of how suited the data set is for Factor Analysis. Within the data-set, the Kaiser-Meyer Olkin (see Appendix B, table 1) shows a strong correlation with a compact pattern (.862). This value is also significant (*P* = .000). Since the KMO indicates a value above the appropriate threshold (≥ 0.8), it can be assumed that the sampling is adequate. It also entails that the data-set is well suited for conducting a Factor Analysis. Therefore, the Total Variance Explained needs to be evaluated.

Table 9: Total variance explained when all data-sets (design types) are combined (using PCA).

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,566	59,434	59,434	3,566	59,434	59,434
2	1,015	16,913	76,347	1,015	16,913	76,347
3	,506	8,434	84,780			
4	,420	6,995	91,775			
5	,307	5,117	96,892			
6	,186	3,108	100,000			

Table 9 shows that the six items form a two-dimensional scale, in which component 1 represents an Eigen Value of 3,566 with a variance of 59,43% on the total variance explained. Component 2 represents an Eigen Value of 1,015 with a variance of 16,91% on the total variance explained. Therefore, it can be assumed that all of the variables within the model are related to two different constructs. In order to gain an deeper understanding into these two different components, the Component Matrix was analysed.

Table 10: Component Matrix when all data-sets (design types) are combined (using PCA).

	Component	
	1	2
Customer Expectations (N=2)	,018	,996
Perceived Quality (N=8)	,851	,094
Perceived Value (N=2)	,778	-,076
Customer Satisfaction (N=2)	,920	,021
Customer Complaints (N=2)	-,803	-,018
Customer Loyalty (N=2)	,864	-,083

When looking into the component matrix (table 10) it could be assumed that almost all variables measure the same construct (component 1). It could be highly likely that this component appears to measure the customer satisfaction of heat consumers within district heating networks. However, table 10 also shows that the variable related to CE relates to a different factor (component 2) than all of the other variables. In order to test this assumption, a simple regression analysis (table 11) was performed. This is a statistical analysis in which the strength of the independent variable could be measured on the dependent variable. In this report, (un)standardized regression coefficient (*B)*, t-values (*t*) and significance (*P*) is measured.

Model	Path	Unstandardized Coefficient		Standardized Coefficient	t-value	Sig.	Status
	Ind → dpnd	*B*	*Std.Error*	*Beta*	*t*	*P*	
1	CE → PQ	.053	.034	.078	1.586	.113	Rejected
2	CE → PV	-.035	.055	-.0.31	-.636	.525	Rejected
3	CE → CS	.038	.060	.031	.630	.529	Rejected
4	PQ → PV	.981	.065	.597	15.018	***	Accepted
5	PQ → CS	1.299	.060	.729	21.481	***	Accepted
6	PV → CS	.687	.042	.633	16.534	***	Accepted
7	CS → CC	-.659	.031	-.724	-21.182	***	Accepted
8	CS → CL	.746	.031	.771	24.447	***	Accepted
9	CC → CL	-.633	.042	-.595	-14.963	***	Accepted

Table 11: Simple Regression and path analysis when all data-sets (design types) are combined.

It could be stated that, for the most part, the variables do influence each other, just like the ACSI-model predicted. As shown in table 11, the coefficients of PQ have a strong and significant influence on PV (*B = .98; P <.001).* and CS (*B = 1.30; P <.001).* Therefore, if the quality is higher perceived, customers are more satisfied and willing to pay higher prices for the quality received. In turn, PV has a significant and an strong effect on CS (*B = .687; P <.001).* In other words, if the 'perceived value' increases, there is also an increase in the 'customer satisfaction'. In the same manner, CC is also highly and significantly influenced by CS (*B* = -.659; *P <.001).* Therefore, if the customers are satisfied, customers have fewer complaints. To conclude, CL is also highly influenced by CS (*B* = .747; *P <.001).* and also negatively influenced by CC (*B* = -.633; *P <.001)*. Both coefficients are significant. In other words, if the 'customer satisfaction' increases and 'customer complaints' decrease, there is an increase in the Customer Loyalty.

However, as shown in table 11, CE has regression coefficients with PQ, PV and CS that are relatively low and not significant. The assumption that CE does not relate to the same factor as the other variables was thus valid. Therefore, it could be stated that CE does not influences CS when all data-sets, and thus organizational design types, are combined. This has also been noticed when the data-sets are organized into the organizational design types that have been outlined before (See Appendix B, table 3, table 4, table 5 & table 6). This remarkable as the ACSI-model predicted that a high or low CE does effects CS.

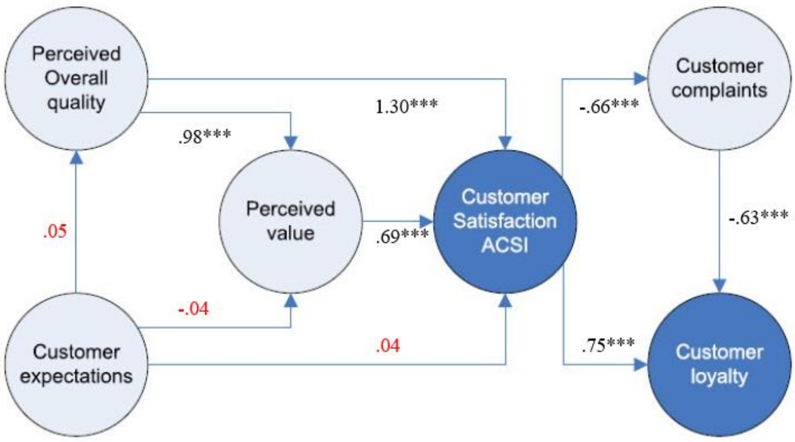

Figure 21: Results of model testing when all data-sets, and thus design types, are combined.

When excluding CE from the model, the Kaiser-Meyer Olkin indicates an increase to .870 (Appendix B, table 2). This value is also significant (*P* = .000). When CE is excluded, the five remaining items also form a one-dimensional scale, in which component 1 represents an Eigen Value of 3,566 with the total variance explained of 71,32% (table 12). It could be assumed that component 1 appears to measure the customer satisfaction of heat consumers within district heating networks. Since this is the main objective of this study, the variable related to CE will be excluded from further analysis within all the data groups.

Table 12: Total Variance Explained when CE is excluded from the model.

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,566	71,316	71,316	3,566	71,316	71,316
2	,507	10,148	81,464			
3	,420	8,409	89,873			
4	,319	6,376	96,249			
5	,188	3,751	100,000			

Extraction Method: Principal Component Analysis.

5.2 Customer satisfaction → district heating networks

This section evaluates the overall customer satisfaction within the district heating networks. Therefore, all the data-sets, and thus all organizational design types, will be combined and also analysed as a whole.

5.2.1 Descriptive Analysis

The descriptive statistics provide an overview of the collected data resulting from the quantitative study. Here, the weighed means are categorized by the scales that have been mapped out before in chapter 4.6.

Table 13: Combined descriptive statistics when all data-sets (design types) are combined.

	N	Minimum	Maximum	Mean	Std. Deviation
Perceived Quality (N=8)	410	2	5	3,34	,647
Perceived Value (N=2)	410	1	5	3,20	1,064
Customer Satisfaction (N=2)	410	1	5	3,44	1,154
Customer Complaints (N=2)	410	1	5	2,70	1,050
Customer Loyalty (N=2)	410	1	5	3,32	1,117
Valid N (listwise)	410				

Table 13 indicates that most heat consumers are still reasonably neutral (Mean = 3,34) with the perceived quality of district heating networks. This means that heat consumers are within the range of indifference. This also entails for the Perceived value (Mean = 3,20) and, in turn, customer loyalty (Mean = 3,32). In addition, table 13 also indicates that most heat consumers are overall reasonably satisfied (Mean = 3,44) and do not regularly complain about their provision of heat (Mean = 2,70). However, as these values are almost near the range of indifference, the overall customer satisfaction is still divided among consumers. The Frequency table (Appendix C, table 7) confirm this as 21,7% is still dissatisfied with the heat supply. In order to see where the (dis)satisfaction levels of heat consumers are derived form, it is important to analyse the combined variables, which are shown in table 14, separately. In order to do so, every question of the quantitative inquiry will be analysed individually. Therefore, as CE is excluded from the analysis, table 14 describes the mean values of the questions related to PQ & PV, and table 15 of CS, CC & CL.

	N	Minimum	Maximum	Mean	Std. Deviation
PQ1: Energy quality	410	1	5	3,85	1,140
PQ2: Price	410	1	5	3,11	1,322
PQ3: Comfort	410	1	5	3,90	1,187
PQ4: Transparency	410	1	5	2,68	1,181
PQ5: Sustainability	410	1	5	3,69	1,141
PQ6: Flexibility	410	1	5	2,74	1,406
PQ7: Consumer protection	410	1	5	3,48	1,160
PQ8: Additional services	410	1	5	3,19	1,263
PV1: Price to product ratio	410	1	5	3,28	1,112
PV2: Price to service ratio	410	1	5	3,13	1,157
Valid N (listwise)	410				

Table 14: Descriptive statistics of PQ and PV when all data-sets (design types) are combined.

Table 14 shows that heat consumers are generally satisfied with the energy quality (Mean = 3,85), level of comfort (Mean = 3,90), sustainability (Mean = 3,69) and consumer protection (Mean = 3,48). All the other variables are within the scope of indifference (neutral). Within this group of variables, the variables that are almost near the range of satisfaction are: price (Mean = 3,11), additional services (Mean = 3,19), price to product ratio (Mean = 3,28) and price to service ratio (Mean = 3,13). Furthermore, the variables that are within the range of indifference are transparency (Mean = 2,68) and flexibility (Mean = 2,74). This means that the consumers experiences are divided in the transparency of communication about the development of prices or quality and in their freedom in choosing their own heat suppliers or producers.

Table 15: Descriptive statistics of CS, CC and CL when all data-sets (design types) are combined.

	N	Minimum	Maximum	Mean	Std. Deviation
CS1: Exp-(dis)conform product	410	1	5	3,52	1,249
CS2: Exp-(dis)conform service	410	1	5	3,36	1,202
CC1: Product complaints	410	1	5	2,67	1,135
CC2: Service complaints	410	1	5	2,73	1,117
CL1: Rebuying intention	410	1	5	3,36	1,226
CL2: Recommend intention	410	1	5	3,29	1,188
Valid N (listwise)	410				

Table 15 indicates that most heat consumers within district heating networks are generally satisfied, as the expectancy-(dis)conformation principle of both the product (Mean = 3,52) and service (Mean = 3,36) is high. This means that for both components, the level of quality has exceeded their prior expectations. Also, as the ACSI-model predicted, customer satisfaction is highly correlated with CC & CL (table 11). Satisfied customers are thus prone to complain less about the products and/or services and also to have an increased loyalty. Table 15 describes this phenomenon as consumers have reasonably few complaints about the product (Mean = 2,67) and services (Mean = 2,73). In turn, as the heat consumers are generally satisfied, rebuying (Mean = 3,36) and recommend intentions (Mean = 3,29) are also reasonably positive. However, most values still remain near the neutral range of indifference, which means it is still divided.

5.2.2 Reliability Analysis

In order estimate if the chosen variables can be used in the analysis, the reliability coefficient was tested using a Cronbach's Alpha. This method is a reliability test which estimates the internal reliability of the data-sets. According to Bryman & Bell (2011) the acceptable threshold for the coefficient is α = ≥ 0.60.

Table 16: Reliability Analysis when all data-sets (design types) are combined.

Sum Variables	*N* Questions	C.A. Coefficient	Questions used
Perceived Quality	8	.628	PQ1: Energy Quality
			PQ2: Price
			PQ3: Comfort
			PQ4: Transparency
			PQ5: Sustainability
			PQ6: Flexibility
			PQ7: Consumer Protection
			PQ8: Additional services
Perceived Value	2	.863	PV1: Price/product ratio
			PV2: Price/service ratio
Customer Satisfaction	2	.872	CS1: Exp-(dis)conform (quality)
			CS2: Exp-(dis)conform (service)
Customer Complaints	2	.850	CC1: Product complaints
			CC2: Service complaints
Customer Loyalty	2	.833	CL1: Rebuying intention
			CL2: Recommend intention

The results (table 16) indicate that all the Cronbach's Alpha coefficients indicate a value of α = ≥ 0.60. There are, according to SPSS, no higher values possible if other variables were to be removed. Therefore it could be assumed that the variables and data-sets are internally reliable and accepted for the analysis. Whereas PV (α = .863), CS (α = .872), CC (α = .850) and CL (α = .833) indicate a value of α = > 0.80, PQ shows a value that is much closer to the > 0.60 threshold. One of the main reasons for this is that PQ consists of more questions, which makes the internal reliability also more vulnerable for inconsistencies.

5.2.3 Correlation matrix

In order to understand how the variables correlate with each other, the Correlation Matrix was analysed:

Table 17: Correlation Matrix when all data-sets (design types) are combined.

		Perceived Quality	Perceived value	Customer Satisfaction	Customer Complaints	Customer Loyalty
Perceived Quality	Pearson Correlation	1				
Perceived Value	Pearson Correlation	,597**	1			
Customer Satisfaction	Pearson Correlation	,729**	,633**	1		
Customer Complaints	Pearson Correlation	-,572**	-,507**	-,724**	1	

Customer Loyalty	Pearson Correlation	,681**	,579**	,771**	-,595**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation matrix (table 17) shows that there is generally a positive relationship between the chosen variables. Therefore, if one of the variables increases, the other variables also increase. Moreover, just as the ACSI-model predicted, there is a negative relationship between CC and the remaining variables. The correlation matrix (table 17) also shows that most correlations have a correspondence factor at level 0.4. This is considered as the benchmark for validity (Fabrigar, et al., 1999). The correlations between these variables also do not load under two factors simultaneously (≥ 0.8) and are considered significant.

It could be stated that when all data-sets, and thus design types, are combined, the variables do relate to each other just as the ACSI-model predicted. Here, PQ correlates positively and strongly with PV and CS, which in turn correlates strongly with CC and CL. This means that if the satisfaction levels of PQ increase, customers are overall more satisfied. This leads, in turn, to less product and service complaints, creates more loyal consumers which, therefore, have an increased rebuying and recommend intentions.

5.2.4 Multiple Regression Analysis

It could be stated that the overall customer satisfaction is reasonably divided among the heat consumers. It is therefore important to gain an understanding where this division is coming from. In order to evaluate the main determinants, a Multiple Regression Analysis has been performed (table 18). Since the ACSI-model describes PQ as the main driver for overall customer satisfaction, the impact of the variables that are related to PQ (independent variables) will be analysed on customer satisfaction (dependent variable).

Table 18: Multiple Regression Analysis when all data-sets (design types) are combined.

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-,586	,227		-2,584	,010		
	Energy Quality	,085	,047	,084	1,819	,070	,510	1,962
	Price	,342	,033	,392	10,417	,000	,775	1,290
	Comfort	,169	,044	,174	3,854	,000	,541	1,849
	Transparency	,034	,035	,035	,991	,322	,882	1,134
	Sustainability	,086	,035	,085	2,419	,016	,897	1,115
	Flexibility	,148	,029	,187	5,030	,000	,797	1,255
	Consumer Protection	,169	,045	,170	3,801	,000	,549	1,823
	Additional Services	,179	,040	,196	4,453	,000	,566	1,767

a. Dependent Variable: Customer Satisfaction
b. All design types are combined

Within the SPSS outcome, the Adjusted R Square shows a value of .679. This means that the model is an acceptable predictor of customer satisfaction, as 68% of the variance from the dependent variable is explained through the independent variables. In addition, there is no sign of multicollinearity as the VIF shows values that are below the threshold of 4 (Pallant, 2016). The model is also significant as a whole. Table 18 indicates that the main determinant for customer satisfaction is related to the price (B = .342). This means that if the satisfaction of prices increases with a value of 1, the customer satisfaction in turn also increases with a value of .342. In terms of customer satisfaction, this could be an crucial determinant for division across consumers, as the mean for price is in the neutral the range of indifference (table 14).

Other important determinants are related to the level comfort (B = .169), consumer protection (B = .169) and additional services (B = 179). Here, the level of comfort and the consumer protection are important determinants for an increased customer satisfaction, as the means for both variables were generally high (table 14). Furthermore, in terms of customer satisfaction, offering additional services could also be an important determinant for divisions among consumers, as the mean is near the neutral range (table 14).

Furthermore, the variable that is related to flexibility could also be an important determinant in terms of an decreased customer satisfaction, as the regression coefficient (B = .148) indicates a strong relation and the mean is almost near the range of dissatisfaction (table 14). Other determents within the Multiple Regression Analysis indicate little to no effect on overall customer satisfaction or are also not significant (P = >0.05), such as the variables related to energy quality (B = .085), transparency (B = .034) and sustainability (B = .086). The latter (sustainability) is remarkable as increasing sustainability levels has been one of the main objectives of governments to implement district heating networks in the first place.

5.3 Customer satisfaction → private-centralized networks (Almere)

This section evaluates the customer satisfaction within the private-centralized district heating networks. Therefore, the combined data-set has been categorized into one of the four organizational design types.

5.3.1 Descriptive Analysis

Table 19: Combined descriptive statistics of private-centralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
Perceived Quality (N=8)	103	2	5	3,15	,631
Perceived Value (N=2)	103	1	5	3,05	1,194
Customer Satisfaction (N=2)	103	1	5	3,33	1,248
Customer Complaints (N=2)	103	1	5	2,76	1,089
Customer Loyalty (N=2)	103	1	5	3,20	1,151
Valid N (listwise)	103				

a. Design type = private-centralized

Table 19 indicates that most heat consumers within private-centralized networks are within the range of indifference (neutral) when it comes to overall customer satisfaction (Mean = 3,33). However, although the consumers are reasonably neutral, it is almost near the range of satisfaction (> 3,39). This also entails for PQ (Mean = 3,15), CC (Mean = 2,76) and in turn CL (3,20). However, the overall level of satisfaction is still divided. The frequency table (Appendix C, table 8) confirm this as 30,1% is still dissatisfied with their provision of heat. In addition, it is remarkable that most consumers are almost dissatisfied with the perceived value (Mean = 3,05). This means that within private-centralized networks most consumers are still divided with the quality of the product and/or service of their heat supply under the given price.

Table 20: Descriptive statistics of PQ and PV in private-centralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
PQ1: Energy Quality	103	1	5	3,82	1,091
PQ2: Price	103	1	5	2,54	1,211
PQ3: Comfort	103	1	5	3,78	1,260
PQ4: Transparency	103	1	5	2,76	1,272
PQ5: Sustainability	103	1	5	2,97	1,052
PQ6: Flexibility	103	1	5	2,06	1,251
PQ7: Consumer Protection	103	1	5	3,83	1,067
PQ8: Additional Services	103	1	5	3,45	1,219
PV1: Price to product ratio	103	1	5	3,10	1,317
PV2: Price to service ratio	103	1	5	3,01	1,217
Valid N (listwise)	103				

Table 20 shows that heat consumers are generally satisfied with the energy quality (Mean = 3,82), level of comfort (Mean = 3,78), consumer protection (Mean = 3,83) and the additional services (Mean = 3,45). However it is remarkable that most consumers are generally dissatisfied with the prices (Mean = 2,54). This in turn also effects the price to product ratio (Mean = 3,10) and price to service ratio (Mean = 3,01), which are both within the range of indifference. Furthermore, consumers are also dissatisfied with the level of flexibility (Mean = 2,06), in which they experience little freedom in choosing their own suppliers and heat producers. To conclude, the remaining variables are all within the neutral range of indifference.

Table 21: Descriptive statistics of CS, CC and CL in private-centralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
CS1: Exp-(dis)conform product	103	1	5	3,42	1,397
CS2: Exp-(dis)conform service	103	1	5	3,24	1,248
CC1: Product complaints	103	1	5	2,68	1,139
CC2: Service complaints	103	1	5	2,84	1,109
CL1: Rebuying intention	103	1	5	3,21	1,265
CL2: Recommend intention	103	1	5	3,18	1,203
Valid N (listwise)	103				

a. Design type = private-centralized

Table 21 indicates that the product quality has exceeded the prior expectations of heat consumers within private-centralized networks (Mean = 3,42). However this high expectancy-(dis)conformation principle does not apply for the service quality (Mean = 3,24), as it is within the neutral threshold of indifference. Table 21 also shows that consumers within private-centralized networks are very divided when it comes to the customer complaints and loyalty, as all variables related to CC and CL are within the neutral range of indifference. This is no surprise as customer satisfaction is mostly highly correlated with CC and CL.

5.3.2 Reliability Analysis

Table 22: Reliability Analysis (Cronbach's Alpha) of private-centralized networks.

Sum Variables	*N* Questions	C.A. Coefficient	Questions used
Perceived Quality	8	.643	PQ1: Energy Quality
			PQ2: Price
			PQ3: Comfort
			PQ4: Transparency
			PQ5: Sustainability
			PQ6: Flexibility
			PQ7: Consumer Protection
			PQ8: Additional services
Perceived Value	2	.872	PV1: Price/product ratio
			PV2: Price/service ratio
Customer Satisfaction	2	.873	CS1: Overall satisfaction
			CS2: Expectation-(dis)conformation
Customer Complaints	2	.933	CC1: Product complaints
			CC2: Service complaints
Customer Loyalty	2	.850	CL1: Rebuying intention
			CL2: Recommend intention

a. Design type: private-centralized

The results (table 22) indicate that all the Cronbach's Alpha coefficients indicate a value of α = ≥ 0.60. There are, according to SPSS, no higher values possible if other variables were to be removed. Therefore it could be assumed that the variables and data-sets are internally reliable and accepted for the analysis.

5.3.3 Correlation matrix

Table 23: Correlation matrix of private-centralized networks.

		Perceived Quality	Perceived value	Customer satisfaction	Customer complaints	Customer Loyalty
Perceived Quality	Pearson Correlation	1				
Perceived Value	Pearson Correlation	,543**	1			
Customer Satisfaction	Pearson Correlation	,727**	,526**	1		
Customer Complaints	Pearson Correlation	-,513**	-,386**	-,714**	1	
Customer Loyalty	Pearson Correlation	,727**	,557**	,776**	-,531**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation matrix (table 23) shows that there is generally a positive relationship between the chosen variables. Therefore, if one of the variables increases, the other variables also increase. Moreover, there is a negative relationship between CC and the remaining variables. Therefore, it could be stated that in the private-centralized networks, the variables do relate to each other just like the ACSI-model predicted. The correlation matrix (table 23) also shows that most correlations have a correspondence factor at level 0.4. This is considered as the benchmark for validity (Fabrigar, et al., 1999). The correlations between these variables also do not load under two factors simultaneously (≥ 0.8) and are considered significant.

5.3.4 Multiple Regression Analysis

It can be stated that the overall customer satisfaction is very divided in private-centralized networks. In order to evaluate the main determinants of this outcome, a Multiple Regression Analysis was performed.

Table 24: Multiple Regression Analysis of private-centralized networks.

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-,797	,576		-1,384	,170		
	Energy Quality	,019	,103	,016	,181	,856	,580	1,724
	Price	,366	,092	,356	3,999	,000	,593	1,686
	Comfort	,197	,100	,198	1,959	,043	,457	2,186
	Transparency	,115	,086	,117	1,336	,185	,607	1,647
	Sustainability	,089	,098	,075	,901	,370	,681	1,469
	Flexibility	,134	,089	,134	1,510	,048	,596	1,679
	Consumer Protection	,233	,106	,199	2,199	,030	,573	1,746
	Additional Services	,184	,090	,179	2,040	,044	,607	1,648

a. Dependent Variable: Customer Satisfaction
b. Selecting only cases for which Design type = Private-centralized

Within the SPSS outcome, the Adjusted R Square shows a value of .589. This means that the model is an acceptable predictor of customer satisfaction, as 59% of the variance from the dependent variable is explained through the independent variables. In addition, there is no sign of multicollinearity as the VIF shows values that are below the threshold of 4 (Pallant, 2016). The model is also significant as a whole.

Table 24 shows that the main determinant for customer satisfaction, which is also significant, is related to price (B = .366). In terms of customer satisfaction, this could be an crucial determinant for the division as consumers are generally dissatisfied with the price in the private-centralized networks (see table 20). Furthermore, another important determinant for a decreased level of customer satisfaction is related to flexibility, as the coefficient (B = .134) indicates a strong relation and heat consumers within the private-centralized networks are generally dissatisfied with the levels of freedom of choice of their heat supply.

Other important elements are related to the level of comfort (B = .197), consumer protection (B = .233) and additional services (B = 184). Here, all three variables are important determinants for an increased customer satisfaction within private-centralized networks as the means for the variables were generally high (table 20). To conclude, the remaining variables (energy quality, sustainability and transparency) have shown little to no effect on customer satisfaction, as the coefficients are weak and/or not significant.

5.4 Customer satisfaction → private-decentralized networks (Arnhem, Duiven, Westervoort)

This chapter evaluates the customer satisfaction within private-decentralized district heating networks. Therefore, the combined data-set has been categorized into one of the four organizational design types.

5.4.1 Descriptive Analysis

Table 25: Combined descriptive statistics of private-decentralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
Perceived Quality (N=8)	102	2	4	3,45	,612
Perceived Value (N=2)	102	1	5	3,00	,945
Customer Satisfaction (N=2)	102	1	5	3,58	1,207
Customer Complaints (N=2)	102	1	5	2,46	1,020
Customer Loyalty (N=2)	102	1	5	3,31	1,181
Valid N (listwise)	102				

a. Design type = private-decentralized

Table 25 shows that most heat consumers within private-decentralized networks are reasonably satisfied with the overall perceived quality of their heat supply (Mean = 3,45). Furthermore, this also entails for the overall customer satisfaction (Mean = 3,58) and, in turn, for the customer complaints (Mean = 2,46). The Frequency table (Appendix C, table 9) confirm this as only 17,8% is dissatisfied with their supply. This means that most heat consumers do not regularly complain about their provision of heat and supply. However, table 25 also indicates that heat consumers within private-decentralized networks are within the neutral range of indifference when it comes to the perceived value (Mean = 3,00). This in turn could also affect the customer loyalty levels (Mean = 3,31) which also belongs to the category of indifference.

Table 26: Descriptive statistics of PQ and PV in private-decentralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
PQ1: Energy Quality	102	1	5	3,87	1,183
PQ2: Price	102	1	5	2,49	1,158
PQ3: Comfort	102	1	5	4,02	1,108
PQ4: Transparency	102	1	5	2,58	1,147
PQ5: Sustainability	102	1	5	3,77	1,089
PQ6: Flexibility	102	1	5	3,40	1,347
PQ7: Consumer Protection	102	1	5	3,72	1,028
PQ8: Additional Services	102	1	5	3,67	1,221
PV1: Price to product ratio	102	1	5	3,04	,974
PV2: Price to service ratio	102	1	5	2,95	1,047
Valid N (listwise)	102				

a. Design type = private-decentralized

Table 26 indicates that the heat consumers within private-decentralized networks are generally satisfied with the energy quality (Mean = 3,87), level of comfort (4,02), sustainability (3,77), flexibility (3,40), consumer protection (Mean = 3,72) and additional services (Mean = 3,67). However, most consumers have indicated to be dissatisfied with the price (Mean = 2,49) and also with the transparency (Mean = 2,58). This in turn effects the price to product ratio (Mean = 3,04) and the price to service ratio (2,95). Both variables are in the neutral range, which means that the quality is low in terms of the prices paid.

Table 27: Descriptive statistics of CS, CC and CL in private-centralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
CS1: Exp-(dis)conform product	102	1	5	3,71	1,207

CS2: Exp-(dis)conform service	102	1	5	3,45	1,157
CC1: Product complaints	102	1	5	2,41	1,120
CC2: Service complaints	102	1	5	2,50	1,051
CL1: Rebuying intention	102	1	5	3,43	1,263
CL2: Recommend intention	102	1	5	3,20	1,298
Valid N (listwise)	102				

a. Design type = private-decentralized

Table 27 indicates that both the product (Mean = 3,71) and service (Mean = 3,45) quality has exceeded the prior expectations of heat consumers within private-decentralized networks. Therefore, it could be stated that the expectancy-(dis)conformation principle, and thus also the customer satisfaction, is high. Table 27 also shows that consumers in private-decentralized networks do not have regularly complaints about the product (Mean = 2,41) and services (Mean = 2,50). Furthermore, the consumers are also prone to have high rebuying intentions (Mean = 3,43), but have neutral recommend intentions (Mean = 3,20).

5.4.2 Reliability Analysis

Table 28: Reliability Analysis (Cronbach's Alpha) of private-decentralized networks.

Sum Variables	*N* Questions	C.A. Coefficient	Questions used
Perceived Quality	8	.608	PQ1: Energy Quality
			PQ2: Price
			PQ3: Comfort
			PQ4: Transparency
			PQ5: Sustainability
			PQ6: Flexibility
			PQ7: Consumer Protection
			PQ8: Additional services
Perceived Value	2	.855	PV1: Price/product ratio
			PV2: Price/service ratio
Customer Satisfaction	2	.754	CS1: Overall satisfaction
			CS2: Expectation-(dis)conformation
Customer Complaints	2	.866	CC1: Product complaints
			CC2: Service complaints
Customer Loyalty	2	.826	CL1: Rebuying intention
			CL2: Recommend intention

a. Design type: private-decentralized

The results (table 28) indicate that all the Cronbach's Alpha coefficients indicate a value of $\alpha = \geq 0.60$. There are, according to SPSS, no higher values possible if other variables were to be removed. Therefore it could be assumed that the variables and data-sets are internally reliable and accepted for the analysis.

5.4.3 Correlation Matrix

Table 29: Correlation matrix of private-centralized networks.

		Perceived Quality	Perceived value	Customer Satisfaction	Customer Complaints	Customer Loyalty
Perceived Quality	Pearson Correlation	1				
Perceived Value	Pearson Correlation	,553**	1			
Customer Satisfaction	Pearson Correlation	,645**	,497**	1		

Customer Complaints	Pearson Correlation	-,571**	-,563**	-,776**	1	
Customer Loyalty	Pearson Correlation	,564**	,420**	,702**	-,617**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation matrix (table 29) shows that there is generally a positive relationship between the chosen variables. Therefore, if one of the variables increases, the other variables also increase. Moreover, there is a negative relationship between CC and the remaining variables. Therefore, it could be stated that in the private-centralized networks, the variables do relate to each other just like the ACSI-model predicted. The correlation matrix (table 29) also shows that most correlations have a correspondence factor at level 0.4. This is considered as the benchmark for validity (Fabrigar, et al., 1999). The correlations between these variables also do not load under two factors simultaneously (≥ 0.8) and are considered significant.

3.4.4 Multiple Regression Analysis

Table 30: Multiple Regression Analysis of private-centralized networks.

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-,037	,481		-,077	,939		
	Energy Quality	,250	,088	,279	2,846	,005	,513	1,948
	Price	,231	,079	,252	2,936	,004	,670	1,493
	Comfort	,214	,086	,224	2,487	,015	,607	1,648
	Transparency	,077	,072	,083	1,066	,289	,821	1,218
	Sustainability	-,036	,075	-,037	-,475	,636	,821	1,218
	Flexibility	-,057	,059	-,080	-,972	,334	,723	1,384
	Consumer Protection	,374	,090	,363	4,168	,000	,651	1,536
	Additional Services	-,013	,074	-,015	-,174	,862	,685	1,460

a. Dependent Variable: Customer Satisfaction
b. Selecting only cases for which Design type = Private-decentralized

Within the SPSS outcome, the Adjusted R Square shows a value of .567. This means that the model is an acceptable predictor of customer satisfaction, as 58% of the variance from the dependent variable is explained through the independent variables. In addition, there is no sign of multicollinearity as the VIF shows values that are below the threshold of 4 (Pallant, 2016). The model is also significant as a whole.

Table 30 shows that the main determinants for customer satisfaction is related to the consumer protection (B = .374) and energy quality (B = .250). Both variables are considered significant and could be crucial determinants for the overall high satisfaction levels, as consumers in private-decentralized networks are reasonably satisfied with both components (see table 26). Furthermore, another important determinant for the increased level of customer satisfaction is related comfort, as the coefficient (B = .214) indicates a significant and strong relation to overall customer satisfaction and the mean for this variable was high.

However, it could be stated that an important determinant that influenced a decreased level of customer satisfaction is related to the price, as the coefficient (B = .231) indicates a significant and strong relation to overall customer satisfaction, and heat consumers within private-decentralized networks are generally dissatisfied with this component (see table 26). All the remaining variables (transparency, sustainability, flexibility and additional services) have shown little effects on customer satisfaction, as the coefficients are weak and/or not significant. Therefore, differences between (de)centralisation are already noticeable.

5.5 Customer satisfaction → public-centralized networks (Purmerend)

This chapter evaluates the customer satisfaction within public-centralized district heating networks. Therefore, the combined data-set has been categorized into one of the four organizational design types..

5.5.1 Descriptive Analysis

Table 31: Combined descriptive statistics of public-centralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
Perceived Quality (N=8)	100	2	4	3,18	,547
Perceived Value (N=2)	100	2	5	3,23	,941
Customer Satisfaction (N=2)	100	1	5	3,11	1,106
Customer Complaints (N=2)	100	1	5	2,88	1,057
Customer Loyalty (N=2)	100	1	5	3,08	1,017
Valid N (listwise)	100				

a. Design type = public-centralized

Table 31 indicates that most heat consumers within public-centralized networks are within the neutral range of indifference when it comes to the perceived quality of their supply (Mean = 3,18). Furthermore, this also entails for the overall customer satisfaction (Mean = 3,11), customer complaints (Mean = 2,88) and customer loyalty (Mean = 3,08). Therefore, it could be stated that the satisfaction levels of the heat consumers is still reasonably divided in public-centralized networks. The frequency table (Appendix B, table 10) confirms this statement as 26% is still dissatisfied with their heat provision and energy supply.

Table 32: Descriptive statistics of PQ and PV in public-centralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
PQ1: Energy Quality	100	1	5	3,76	1,164
PQ2: Price	100	1	5	3,64	1,097
PQ3: Comfort	100	1	5	3,81	1,134
PQ4: Transparency	100	1	5	2,81	1,152
PQ5: Sustainability	100	1	5	3,97	1,096
PQ6: Flexibility	100	1	5	1,87	,928
PQ7: Consumer Protection	100	1	5	2,95	1,029
PQ8: Additional Services	100	1	5	2,64	1,059
PV1: Price to product ratio	100	1	5	3,27	,941
PV2: Price to service ratio	100	1	5	3,19	1,070
Valid N (listwise)	100				

a. Design type = public-centralized

Table 32 indicates that heat consumers within public-centralized networks are reasonably satisfied with the energy quality (Mean = 3,76), price (Mean = 3,64), level of comfort (Mean = 3,81) and sustainability (Mean = 3,97). However, most heat consumers have indicated to be extremely dissatisfied with the level of flexibility (Mean = 1,87). This means that they experience not much freedom in choosing their own heat suppliers and producers. All the other variables remain within the neutral range of indifference.

Table 33: Descriptive statistics of CC and CL in private-centralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
CS1: Exp-(dis)conform product	100	1	5	3,16	1,135
CS2: Exp-(dis)conform service	100	1	5	3,05	1,158
CC1: Product complaints	100	1	5	2,88	1,166
CC2: Service complaints	100	1	5	2,88	1,200
CL1: Rebuying intention	100	1	5	3,05	1,132
CL2: Recommend intention	100	1	5	3,11	1,091
Valid N (listwise)	100				

a. Design type = public-centralized

Table 33 shows that both the product and service quality (Mean = 3,16; Mean = 3,05) has not exceeded the prior expectations of heat consumers within pubic-centralized networks. Therefore, it could be stated that the expectancy-(dis)conformation principle, and thus the customer satisfaction, is still very divided. Table 33 also indicates that this range of indifference also entails for the product and service complaints (Mean = 2,88; Mean = 2,88), and in turn, for the overall customer loyalty (Mean = 3,05; Mean = 3,11).

5.5.2 Reliability Analysis

Table 34: Reliability Analysis (Cronbach's Alpha) of public-centralized networks.

Sum Variables	*N* Questions	C.A. Coefficient	Questions used
Perceived Quality	8	.603	PQ1: Energy Quality
			PQ2: Price
			PQ3: Comfort
			PQ4: Transparency
			PQ5: Sustainability
			PQ6: Flexibility
			PQ7: Consumer Protection
			PQ8: Additional services
Perceived Value	2	.854	PV1: Price/product ratio
			PV2: Price/service ratio
Customer Satisfaction	2	.926	CS1: Overall satisfaction
			CS2: Expectation-(dis)conformation
Customer Complaints	2	.747	CC1: Product complaints
			CC2: Service complaints
Customer Loyalty	2	.805	CL1: Rebuying intention
			CL2: Recommend intention

a. Design type: public-centralized

The results (table 34) indicate that all the Cronbach's Alpha coefficients indicate a value of α = ≥ 0.60. There are, according to SPSS, no higher values possible if other variables were to be removed. Therefore it could be assumed that the variables and data-sets are internally reliable and accepted for the analysis.

5.5.3 Correlation Matrix

Table 35: Correlation matrix of public-centralized networks.

		Perceived Quality	Perceived Value	Customer Satisfaction	Customer Complaints	Customer Loyalty
Perceived Quality	Pearson Correlation	1				

Perceived value	Pearson Correlation	,748**	1			
Customer Satisfaction	Pearson Correlation	,768**	,782**	1		
Customer Complaints	Pearson Correlation	-,688**	-,650**	-,801**	1	
Customer Loyalty	Pearson Correlation	,668**	,677**	,785**	-,611**	1

**. Correlation is significant at the 0.01 level (2-tailed).
a. Design type = public-centralized

The correlation matrix (table 35) shows that there is generally a positive relationship between the chosen variables. Therefore, if one of the variables increases, the other variables also increase. Moreover, there is a negative relationship between CC and the remaining variables. Therefore, it could be stated that in the private-centralized networks, the variables do relate to each other just like the ACSI-model predicted. The correlation matrix (table 35) also shows that most correlations have a correspondence factor at level 0.4. This is considered as the benchmark for validity (Fabrigar, et al., 1999). The correlations between these variables also do not load under two factors simultaneously (≥ 0.8) and are considered significant.

5.5.4 Multiple Regression Analysis

Table 36: Multiple Regression Analysis of public-centralized networks.

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-1,017	,439		-2,319	,023		
	Energy Quality	,006	,100	,007	,062	,950	,308	3,250
	Price	,292	,096	,289	3,032	,003	,378	2,649
	Comfort	,300	,088	,308	3,409	,001	,422	2,371
	Transparency	-,040	,072	-,042	-,559	,578	,609	1,641
	Sustainability	,118	,077	,117	1,538	,003	,598	1,672
	Flexibility	,260	,086	,218	3,023	,003	,661	1,514
	Consumer Protection	,049	,088	,046	,555	,580	,512	1,953
	Additional Services	,343	,079	,329	4,360	,000	,606	1,649

a. Dependent Variable: Customer Satisfaction
b. Selecting only cases for which Design type = public-centralized

Within the SPSS outcome, the Adjusted R Square shows a value of .659. This means that the model is an acceptable predictor of customer satisfaction, as 65% of the variance from the dependent variable is explained through the independent variables. In addition, there is no sign of multicollinearity as the VIF shows values that are below the threshold of 4 (Pallant, 2016). The model is also significant as a whole. Table 36 shows that the main determinants for customer satisfaction is related to the additional services (B = .343), comfort (B = .300), price (B = .292) and sustainability (B = .118). All four variables are significant and crucial determinants for an increased customer satisfaction, as consumers within public-centralized networks have indicated to be reasonably satisfied with all four components (see table 32).

However, it could also be stated that the variable that is related to flexibility is an important determinant that influenced a decreased level of customer satisfaction, as it shows a strong and significant relation (B = .260), and heat consumers within public-centralized networks are generally dissatisfied with this component (see table 32). The four remaining variables (energy quality, transparency, sustainability and consumer protection) have shown to have little to no effect on the overall customer satisfaction in public-centralized networks, as the coefficients are weak and/or also not considered significant (see table 36).

5.6 Customer satisfaction → public-decentralized networks (Zaanstad)

This chapter evaluates the customer satisfaction within public-decentralized district heating networks. Therefore, the combined data-set has been categorized into one of the four organizational design types.

Table 37: Combined descriptive statistics of public-decentralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
Perceived Quality (N=8)	105	2	5	3,58	,693
Perceived Value (N=2)	105	1	5	3,53	1,081
Customer Satisfaction (N=2)	105	1	5	3,74	1,107
Customer Complaints (N=2)	105	1	5	2,70	1,004
Customer Loyalty (N=2)	105	1	5	3,68	1,033
Valid N (listwise)	105				

a. Design type = Public-decentralized

Table 37 indicates that heat consumers within public-decentralized networks are generally satisfied with the perceived quality (Mean = 3,58). Moreover, this also entails for the perceived value (Mean = 3,53), overall customer satisfaction (Mean = 3,74) and, in turn, customer loyalty (Mean = 3,68). Furthermore, as heat consumers are satisfied, and thus are thus to be more loyal, they are prone to have less complaints (Mean = 2,70). Here, satisfaction levels have shown to be the highest of all the design types in this study. The frequency table (Appendix B, table 11) confirms this statement, as only 15,4% is very dissatisfied.

Table 38: Descriptive statistics of PQ and PV in public-decentralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
PQ1: Energy Quality	105	1	5	3,95	1,130
PQ2: Price	105	1	5	3,77	1,258
PQ3: Comfort	105	1	5	4,00	1,233
PQ4: Transparency	105	1	5	2,56	1,164
PQ5: Sustainability	105	1	5	4,03	1,014
PQ6: Flexibility	105	1	5	3,60	1,229
PQ7: Consumer Protection	105	1	5	3,42	1,299
PQ8: Additional Services	105	1	5	2,98	1,293
PV1: Price to product ratio	105	1	5	3,69	1,068
PV2: Price to service ratio	105	1	5	3,38	1,243
Valid N (listwise)	105				

a. Design type = public-decentralized

Table 38 indicates that heat consumers within public-decentralized networks are generally satisfied with the energy quality (Mean = 3,95), price (Mean = 3,77), the level of comfort (Mean = 4,00), sustainability

(Mean = 4,03), flexibility (Mean = 3,60) and consumer protection (Mean = 3,42). Furthermore, most heat consumers have indicated to be within the neutral range of indifference when it comes to the other remaining variables such as transparency (Mean = 2,86) and also the additional services (Mean = 2.98). As heat consumers are reasonably satisfied with the overall quality and the used prices, heat consumers have also indicated to be satisfied with the price to product and service ratio (Mean =3,69; Mean = 3,38). However, most heat consumers have indicated to be generally dissatisfied with the level of transparency (Mean = 2,56). This means that the overall quality relatively low perceived in terms of the prices paid.

Table 39: Descriptive statistics of CS, CC and CL in public-decentralized networks.

	N	Minimum	Maximum	Mean	Std. Deviation
CS1: Exp-(dis)conform product	105	1	5	3,79	1,158
CS2: Exp-(dis)conform service	105	1	5	3,69	1,163
CC1: Product complaints	105	1	5	2,70	1,082
CC2: Service complaints	105	1	5	2,70	1,082
CL1: Rebuying intention	105	1	5	3,72	1,148
CL2: Recommend intention	105	1	5	3,64	1,093
Valid N (listwise)	105				

a. Design type = public-decentralized

Table 39 indicates that both the product (Mean = 3,79) and service (Mean = 3,69) quality has exceeded the prior expectations of heat consumers within public-decentralized networks. Therefore, it could be stated that the expectancy-(dis)conformation principle, and thus also the customer satisfaction, is high. Table 39 also shows that consumers in public-decentralized networks do not have regularly complaints about the product (Mean = 2,70) and services (Mean = 2,70). Furthermore, as customer satisfaction is high, they are also prone to have high rebuying and recommend intentions (Mean = 3,72; Mean = 3,64).

5.6.2 Reliability Analysis

Table 40: Reliability Analysis (Cronbach's Alpha) of public-decentralized networks.

Sum Variables	*N* Questions	C.A. Coefficient	Questions used
Perceived Quality	8	.656	PQ1: Energy Quality
			PQ2: Price
			PQ3: Comfort
			PQ4: Transparency
			PQ5: Sustainability
			PQ6: Flexibility
			PQ7: Consumer Protection
			PQ8: Additional services
Perceived Value	2	.852	PV1: Price/product ratio
			PV2: Price/service ratio
Customer Satisfaction	2	.902	CS1: Overall satisfaction
			CS2: Expectation-(dis)conformation
Customer Complaints	2	.838	CC1: Product complaints
			CC2: Service complaints
Customer Loyalty	2	.824	CL1: Rebuying intention
			CL2: Recommend intention

a. Design type: public-decentralized

The results (table 40) indicate that all the Cronbach's Alpha coefficients indicate a value of α = ≥ 0.60. There are, according to SPSS, no higher values possible if other variables were to be removed. Therefore it could be assumed that the variables and data-sets are internally reliable and accepted for the analysis.

5.6.3 Correlation Matrix

Table 41: Correlation matrix of public-decentralized networks.

		Perceived Quality	Perceived Value	Customer Satisfaction	Customer Complaints	Customer Loyalty
Perceived Quality	Pearson Correlation	1				
Perceived Value	Pearson Correlation	,610**	1			
Customer Satisfaction	Pearson Correlation	,746**	,796**	1		
Customer Complaints	Pearson Correlation	-,567**	-,589**	-,626**	1	
Customer Loyalty	Pearson Correlation	,732**	,670**	,806**	-,675**	1

**. Correlation is significant at the 0.01 level (2-tailed).
a. Design type = public-decentralized

The correlation matrix (table 41) shows that there is generally a positive relationship between the chosen variables. Therefore, if one of the variables increases, the other variables also increase. Moreover, there is a negative relationship between CC and the remaining variables. Therefore, it could be stated that in the private-centralized networks, the variables do relate to each other just like the ACSI-model predicted. The correlation matrix (table 41) also shows that most correlations have a correspondence factor at level 0.4. This is considered as the benchmark for validity (Fabrigar, et al., 1999). The correlations between these variables also do not load under two factors simultaneously (≥ 0.8) and are considered significant.

5.6.4 Multiple Regression Analysis

Table 42: Multiple Regression Analysis of public-decentralized networks.

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-1,471	,340		-4,322	,000		
	Energy Quality	,074	,085	,075	,871	,386	,325	3,075
	Price	,541	,057	,615	9,452	,000	,575	1,740
	Comfort	,176	,080	,196	2,212	,029	,310	3,223
	Transparency	,224	,052	,073	1,399	,045	,884	1,131
	Sustainability	,272	,060	,249	4,541	,000	,808	1,237
	Flexibility	,108	,060	,120	1,809	,074	,553	1,809
	Consumer Protection	,002	,072	,002	,025	,980	,337	2,966
	Additional Services	,167	,064	,195	2,606	,011	,436	2,293

a. Dependent Variable: Customer Satisfaction
b. Selecting only cases for which Design type = Public-decentralized

Within the SPSS outcome, the Adjusted R Square shows a value of .786. This means that the model is an acceptable predictor of customer satisfaction, as 79% of the variance from the dependent variable is explained through the independent variables. In addition, there is no sign of multicollinearity as the VIF shows values that are below the threshold of 4 (Pallant, 2016). The model is also significant as a whole.

Table 42 indicates that the main determinants for customer satisfaction in public-decentralized networks is related to the price (B = .541), transparency (B = .224), sustainability (B = .272), additional services (B = .167) and comfort (B = 176). All five variables are significant and could be crucial determinants for an increased customer satisfaction, as consumers are reasonably satisfied with all five components. This is especially prevalent for the level of sustainability (Mean = 4,03). This is remarkable as this variable has not shown to be considered important within the private networks. The remaining variables have shown to have little to no effect on customer satisfaction and/or are also not considered significant.

5.7 Market failures and solutions

Based on the results, it could be stated that the components that caused high dissatisfaction levels among heat consumers are: high prices and low levels of transparency and flexibility (see figure 20). Thus, this section will elaborate on potential market failures and solutions in order to increase the overall customer satisfaction. It should be noted that these problems and/or solutions are derived from existing literature, and therefore only represent an indication of measures that involved actors could take for improvements.

5.7.1 Price

Problem**:** District heat consumers have indicated to be dissatisfied with the prices for heat consumption.

Potential market failures: the results of this study indicate that one of the main market failures could be related to privatization and, thus, the entry of private ownership, as the heat consumers within privately owned networks have indicated that prices are perceived to be higher than within publicly owned district heating networks. Although not yet generalizable, this statement is in line with numerous other studies. Egüez (2021) has showed in his study that prices within privately owned heating networks are 3% higher than in municipally owned heating networks (p. 8). In addition, Birgersson (2004) concluded that within dense (urban) cities, heat prices in privately owned heating networks are between 5% and 20% higher than in municipally owned heating networks (Egüez, 2021, p. 9). Both of these studies were conducted in Sweden and Denmark. It showed that in privately owned heating networks, the fixed price component was the main contributor to the price differential. In this context, the fixed fee consists of the customer's load demand. One of the reasons for this is that, according to the study of Egüez (2021), private actors are more inclined to discriminate between types of consumers and establish different alternatives for the fixed and variable components of the prize. This also lines up with a study from Jeude & Midden (2014) who concluded that high standing charges create unsatisfactory results for those who consume less heat.

Aberg et al (2016) describe in their study that: “differences in organizational strategies and goals could also explain lower prices in municipal providers” (Egüez, 2021, p. 9). The authors state that both public as private actors could differ greatly in pricing strategies due to different objective functions. According to Egüez (2021): “Public actors may have broader social objectives that drives them to sacrifice a certain level of profit to achieve the objectives; Therefore, profit may not necessarily be pursued as by a private provider, especially if the municipality’s guidelines discourage high prices that can harm the inhabitants interests (p. 4). This is in line with the study of Egüez (2021) who concluded that: “privately owned district heating providers have better profitability indicators than their public peers” (Egüez, 2021, p. 9). Another market problem is that in the Netherlands heating prices, derived from district heating networks, are linked to gas prices. This coupling was intended to protect people who consume heat from expensive sources. However, although gas prices were always low throughout the years, prices for unbated natural gas have changed dramatically after induced earthquakes and low investments in natural gas due to the geopolitical conflict. Lastly, the consumers are not well protected against monopoly pricing schemes as district heating infrastructure is expensive due to lock-inn effects of already established gas connections.

Potential solutions: one of the major solutions would require a deliberate collaboration between both the private and public actors in which the municipalities have to keep some form of regulation and oversight. Although classic economic theory assumes that private actors are profit-maximizing, municipally owned heating systems are not exempt from the notion of profit generation. However, there could be differences in the way that both actors set their prices. According to Birgersson (2004): “After liberalization, private heating providers became more inclined towards using a value-based pricing strategy and setting prices according to the costs of district heating substitutes rather than setting prices to cover costs, which was the practice prior to liberalization” (Egüez, 2021, p. 9). However, in publicly owned heating networks, profits are mainly still based on cost-recovery pricing, which is focussed on political goals and acquiring only its initial return of investments, instead of focusing and prioritizing financial goals (Egüez, 2021). Another major solutions would be to disconnect the prices of district heat from the ever-rising gas prices. This policy has been announced for the new heat law, which will be accepted in 2023. In addition, new regulation could be introduced that improves the balance between the fixed and variable costs, making high consumption more expensive due to dynamic pricing models (Which?, 2015). Also, introducing chain integration between heating infrastructures would allow grid operators and suppliers to make rational decisions whether established gas infrastructures needs to be renovated or new district heating solutions would be feasible. To conclude, another solution would be to price climate externalities, such as CO2 emissions, to prompt more investments and additional pricing instruments into heating solutions.

5.7.2 Transparency

Problem**:** District heat consumers have indicated to be dissatisfied with the overall level of transparency.

Potential market failures: the results of this study indicate that one of the main market failures could be related to the notion of decentralization, as consumers within decentralized networks have indicated that the level of transparency is conceived to be lower than within centralized networks. These problems can be linked to information asymmetry between producers, suppliers and consumers, which is problematic in centralized networks as there are less incentives for transparent communication between stakeholders. According to a study of Which? (2015) most district heating sectors are fragmented, in which many organisations are involved in the design, construction and maintenance of the networks (p. 12). These fragmented actors work within their own frameworks, which could, therefore, hinder thoughtful and transparent ways of communicating, not only towards each other, but also towards the heat consumers. There may also exist non-transparent markets due to complex contracts, opaque pricing structures and also incapacities to measure the quality of heat. Hereby, it is impossible for consumers to make well-constructed decisions regarding their own heat supply (EIB, 2011). Other complaints stem from a lack of transparency within their housing insulation properties, making district heating consumption rather expensive, and also the inability to compare metering schemes with other heating alternatives (Janssen, 2015). Although, sometimes unjustified, this could lead to significant dissatisfaction levels and distrust.

Potential solutions: One of the major solutions in order to improve the overall transparency would be to promote more cooperative ownership within new district heating solutions. This would include formal and informally owned network systems in which (citizen-led) energy cooperatives propose collaborative solutions to facilitate, operate and manage distribution networks locally. Support for sustainable heating projects is also expected to be much more extensive when residents themselves experience co-ownership over their own energy supply in which complete transparency is needed over the requirements of pricing. This concept of co-ownership is one of the fundamental foundations, according to the concept developed by E. Ostrom and her colleagues, which emphasizes the need for citizens to self-organize and participate in order to serve the common good. In terms of establishing district heating networks, this entails a local participation in the production, distribution, transport and delivery of collective heat in order to enhance local trust and social acceptance of new sustainable heating technologies among users (Loonen, 2020). It is thus most urgent to improve the transparency regarding overall reporting, both on pricing and the distribution of accurate information. According to Switch? (2015): “All district heating schemes should be registered and heat suppliers required to report key information annually, including price data” (p. 27). It should also include annual monitored information databases for heat prices, maintenance costs, margins of profits, heat efficiency reports and potential measures on carbon (CO_2) intensities, that need to be made available for consumers and governments. Another solution would be to introduce new marks for quality control, in which consumers gain the ability to make better assessments of their heat supply. Switch? (2015) also stated that: “All fixed and variable charges should be clearly separated out in bills; Secondly, an independent tailored and easy-to-use heat price comparator should be developed for all home-owners (p. 29). These should be independently monitored with the ability to make predictions on future price increases accurately and make comparisons across alternative sustainable heating solutions.

5.7.3 Flexibility

Problem: District heat consumers have indicated to be dissatisfied with the overall level of flexibility.

Potential market failures: the results of this study indicate that one of the main market failures could be related to the notion of centralization, as heat consumers within centralized networks have indicated that the level of transparency is conceived to be lower than within decentralized networks. This seems logical as consumers within centralized networks have less freedom to choose their own producers and supply. Some of the heat consumers do not feel authority to make their own decisions regarding switching to other producers and/or suppliers. One of the main reasons could be that traditional networks are local and vertically integrated and, thus, have monopolistic characteristics (Janssen, 2015). There are also no possibilities for consumers to op-out or redress when the service or billing falls short. Another reason would be the long-term contracts which consumers have to comply with. These contracts are set up as building heating infrastructure is capital intensive in which all parties involved only commit when given extensive connection certainties (Aberg et al., 2016). Lastly, heat consumers have to content with the locality characteristics of most district heating networks. In contrast to the production of electricity, there are only certain sources where (residual) heat is available. Furthermore, the production of heat has relatively high transportation loses. For many district heating networks, especially the smaller ones, this means that there is little room for alternative producers, which gives parties involved high market power.

Potential solutions: One of the major solutions would be the opening up of networks for decentralization in which more actors are providing and competing for heat. Bauwens & Holstenkamp (2016) concluded in their report that: “Decentralized systems are said to present several advantages over centralized ones, including reduced costs for transmission and distribution systems, reduced grid power losses, more efficient data management systems and a larger share of zero-carbon technologies” (p. 3). This requires new introduction models that grand third party access (TPA-models). Hereby, new producers could be granted access on an existing network (TPA model 1) or get full network access in which producers not only feed in, but can also supply heat consumers via an existing network of another heat company (TPA model 2). Here, consumers can choose their own producers and suppliers (Nillesen & Hensgens, 2015). Other options would be to introduce new, and more flexible, contracts in which the heat consumers have op-out possibilities including price and product differentiations. Here, consumers should have the option to “install their own sustainable heaters, if costs were shown to be higher than the most cost effective alternative, without the liabilities of paying exit fees” (Switch?, 2015, p.30). However, implementing a decentralized network comes with its costs. In decentralized heating networks, the heat consumers have indicated that the level of transparency is perceived to be lower than within centralized heating networks.

6 Conclusion

This study has provided a contribution into the exploration the organizational design of district heating networks and its relation with overall customer satisfaction in the Netherlands. The results could be used as an tool in order to establish the satisfaction levels of heat consumers in other regions, drive consumer loyalty and increase the attractiveness of new district heating solutions. These solutions are desperately needed in order to eliminate the dependencies of natural gas production and consumption and contribute to the sustainable transformation of the entire building stock and reach the climate goals set up for 2050.

This study used an explanatory form of inquiry to identify, not only overall customer satisfaction levels, but also evaluate similarities and differences across multiple organizational design types. Thereby, using a multiple- and holistic case study design, in which four cases have been selected and divided according to their market structure and ownership composition. Subsequently, quantitative research was conducted into the customer satisfaction and the most important determinants that influence these levels, using the highly acclaimed ACSI-model. Furthermore, the second phase of this study was based on the evaluation of market problems and solutions that could potentially improve these satisfaction levels, on the grounds where quantitative data was dominant. The results serve to answer the following main research question:

Is there an observable relationship between customer satisfaction and the organizational design of district heating networks in the Netherlands, and how could these satisfaction levels be improved?

In order to answer the main question from this study, the following sub questions need to be addressed:

Sub question 1: Which organizational design types can be identified when it comes to district heating networks in the Netherlands?

Although it has proven difficult to define the 'organizational design' in energy infrastructures, this study conceptualized it into two different design components. Here, first component is conceptualized in the notion of 'ownership' which describes the ways in which the distribution network is owned and operated by certain actors. Traditionally, district heating had been organized mainly as municipal utilities in the Netherlands. The district heating sector was, however, liberalized in 1995, making it possible for other actors to enter the market. This has led to the entry of private actors who took ownership of the networks. The second design component describes the way that heat is supplied or exploited within the distribution network, also known as the 'market structure'. Here, the networks could be centralized (closed) and also decentralized (open). In an centralized network, there is one actor that completely fills in the heat chain, from the production to the delivery of heat. Here, monopolistic tariff regulation leads to price formation. In an decentralized (open) network, several heat producers/suppliers compete within the same network.

The main objective of decentralized heat markets was to promote market competition in district heating and thereby ensuring cost efficiency, market transparency, knowledge sharing and consumer protection. It describes competitive markets in which supply and demand creates competition, ensuring low prices, more freedom for heat consumers and create confidence in the market, increasing willingness to invest.

In the end, the following organizational design types are identified: *private-centralized* (privately owned distribution network and one responsibility that fills in the heat chain), *private-decentralized* (privately owned distribution network in which several producers and suppliers are connected to the grid), *public-centralized* (publicly owned distribution network and one responsibility that fills in the heat chain) and *public-decentralized* (publicly owned distribution network in which several producers and suppliers are connected to the grid). Furthermore, the following cases have been mapped out that relate to city districts with the mentioned characteristics: Almere, Arnhem/Duiven & Westervoort, Purmerend and Zaanstad.

Sub-question 2: How could the overall customer satisfaction be measured within district heating networks with different organizational designs?

The ACSI model was used utilized as an advanced and acclaimed tool in order to measure the customer satisfaction levels of heat consumers within the designated district heating networks and the occurring determinants that influence these outcomes. It is comprised with indexes for drivers of satisfaction on the left side (customer expectations, perceived quality and perceived value), overall satisfaction levels in the centre and outcomes of satisfaction on the right side (customer complaints and customer loyalty). The ACSI model is a measurement system developed for evaluating the performance and satisfactions of companies, industries, economic sectors and national economies. The model is designed to be able to perform benchmark studies and can therefore also be used as a model to measure customer satisfaction. In the end, the ACSI model assumes that if the expectations and perceived quality of customers increase, the customer value and thus the overall satisfaction of heat consumers also increase. In turn, this should create an increase in the customer's loyalty and should decrease in the overall complaints of customers. Therefore, with the exception of customer complaints, all variables are positively related to each other.

However, by conducting a model test, using PCA, the variable that was related to customer expectations had regression coefficients that were relatively low and not significant. Therefore, it could be stated that CE does not influences CS when all data-sets, and thus organizational design types, are combined and/or were separated. CE had also little to no effect on all the other variables of the ACSI-model. Therefore, the choice was made to exclude the customer expectations from the model, and also from the analysis.

Sub-question 3: What is the overall satisfaction level among heat consumers within the district heating networks, and what are the main determinants of this outcome?

When all data-sets, and thus all organizational design types, are combined, the results indicate that most heat consumers are overall reasonably satisfied. However, these values are almost near the neutral range of indifference. This is also noticeable within the other variables of: the perceived quality, the perceived value, customer complaints and the level of customer loyalty. Therefore, although heat consumers have indicated to be reasonably satisfied, these satisfaction levels are still divided in district heating networks. The main determinants that have an important influence on an increased customer satisfaction are related to the level of comfort, consumer protection and the additional services that the networks provide. This means that most heat consumers have perceived adequate temperature control, easiness with installation processes and high radiator capacities. Furthermore, consumers perceive that they are legally protected for non-compliance with contractual agreements and that service complaints are believed to be resolved. Lastly, most heat consumers have indicated to be satisfied with the additional services provided, which could entail monitoring services, internet services enabling comparisons and Keys-in-the-hand services.

However, there are also determinants that have an important influence on an decreased level of customer satisfaction. These determinants are related to the experienced level of flexibility and high prices. Here, both determinants mentioned have been ranked on their significance and importance. This means that, in terms of the products and services, many heat consumers have indicated high prices, as they are still reasonably divided. Furthermore, most heat consumers have indicated to experience and perceive a low level of flexibility, and therefore, of freedom in choosing their own heat suppliers and/or also producers. This has led to an overall decreased customer satisfaction within the district heating networks as a whole.

Sub-question 4: What satisfaction differences and similarities can be observed across district heating networks with different organizational designs, and what are the main determinants of these outcomes?

When the data is divided according to their organizational design, the first observable difference relates to the overall customer satisfaction measurement. Here, it has been observed that heat consumers within private- and public decentralised networks have indicated to be reasonably satisfied. These satisfaction levels are the highest within the public-decentralized networks, although both values are in close range. Furthermore, another observation is related public- and private centralized networks, in which most heat consumers have indicated to be in the neutral range of indifference when it comes to the overall customer satisfaction. Here, it could be observed that heat consumers within the public-centralized networks have indicated to be more satisfied than the heat consumers within the private-centralized heating networks.

When looking into the determinants that have caused these outcomes, some of the observable similarities that indicate a positive influence on customer satisfaction relate to the level of comfort and the additional services provided. Within all the four organizational design types, most heat consumers have indicated to be reasonably satisfied with both components (figure 20). In addition, when looking into the notion of 'ownership', it could be stated that, within the publicly owned networks, most of the heat consumers have indicated to be satisfied with the price and the perceived level of sustainability. This is not observed within the privately owned networks, which is remarkable as increasing sustainability practises was one of the primary objectives to implement new district heating solutions. Furthermore, within the privately owned networks, a remarkable similarity could be attributed to a satisfied level of consumer protection, which is not observed within the publicly owned networks. This is remarkable as both types of networks have to work within the same legal frameworks, in accordance with the heating act accepted from 2018.

When looking into the notion of 'market structures', it could be stated that within the centralized heating networks, most heat consumers have indicated to be dissatisfied with the perceived level of flexibility. This is a predictable result, as consumers have few options to choose their own suppliers and producers of heat, however, it has contributed to a significant decrease in overall customer satisfaction. Therefore, it is conceived to be a real liability when choosing to close third party access within the heating networks.

Furthermore, within the decentralised heating networks, it could also be stated that most heat consumers have indicated to be reasonably dissatisfied with the level of transparency. One of the main contributors could be related to information asymmetry, which increases if more producers and/or suppliers have the exclusive rights to deliver heat within a network. Lastly, one of the most remarkable observations would be that only in the private-decentralized networks, the energy quality has been perceived as a significant determinant attributed to an increased customer satisfaction level. One of the reasons could be that this is seen by most consumers as a basic requirement and thus has no influence on overall satisfaction levels.

To conclude, when looking into the data, it could be said that there is an observable relationship between the organizational design of district heating networks in the Netherlands and customer satisfaction. Here, the following made observations serve as the answer to the first sentence of the main research question:

- Within privately owned district heating networks, heat consumers have indicated that the prices are perceived to be higher than within publicly owned district heating networks.
- Within privately owned district heating networks, heat consumers have indicated that the level of sustainability is perceived to be lower than within publicly owned district heating networks.
- Within publicly owned district heating networks, heat consumers have indicated that the level of consumer protection is perceived lower than in privately owned district heating networks.
- Within decentralized district heating networks, heat consumers have indicated that the level of transparency is perceived to be lower than within centralized district heating networks.
- Within centralized district heating networks, heat consumers have indicated that the level of flexibility is perceived to be lower than within decentralized district heating networks.

However, it should be noted that these results do not represent generalizable representations across all heating networks in the Netherlands. This will be further elaborated upon in next chapter (Discussion).

Sub-question 5: Based on the literature, what potential market failures and solutions could be identified in order to improve the satisfaction levels among district heat consumers in the Netherlands?

Within the designated district heating networks, that have been purposively selected, it could be stated that the three components that caused major dissatisfaction levels across consumers are: high prices, the experienced level of transparency and the experienced level of flexibility. According to the study results, it can be stated that the main determinant for high prices is related to the notion of privatization and thus the entry of private ownership. Here, differences in organizational goals and pricing mechanisms could explain lower prices in municipal ownership. Other contributors stem from the fixed price components, the linkage of heat to current gas prices and a low level of protection against monopoly pricing schemes. Potential solutions to combat these problems would be introducing new deliberate collaboration between both the private and public actors in which the municipalities have to keep some form of regulation and oversight, new regulation that disconnects heat prices from the ever-increasing gas prices, improve the balance between the fixed and variable costs, create chain integration between infrastructure and to price climate externalities into new district heat solutions to prompt more investments and pricing instruments.

The main market problems that are attributed to low experienced levels of flexibility could be related to the notion of decentralization, as there are less incentives for every stakeholder to communicate clearly. Other market failures stem from information asymmetry, sector fragmentation, non-transparent market structures, complex contracts, the inability to measure the heat quality and to compare metering schemes with heating alternatives. In order to combat these problems, cooperative ownership, and thus, citizen-led energy solutions, need to be promoted within new district heating infrastructures. In addition, overall reporting on pricing and distribution needs to be improved and marks for quality control and independent tailored and easy-to-use comparators need to be introduced to gain abilities to make better assessments.

The main market problems that are attributed to low experienced levels of flexibility could be related to the notion of centralization, as consumers within centralized networks have less freedom to choose their own producers and supply. Other contributors stem from locally, vertically and, thus, monopolistically integration, few op-out possibilities and long-term contracts that heat consumers have to comply with. Potential solutions would be the opening up of networks for decentralization or to introduce new, and more, flexible contracts with op-out schemes. Here, consumers should have the option to "install their own sustainable systems, if costs are higher than heating alternatives, without the liability of paying exit fees. To conclude, the statements made serve as the answer to the second sentence of the main question.

7 Discussion

This chapter reflects on the research data, accompanying results and the methodological and theoretical choices that have been made throughout this research study. Furthermore, these results will be linked to expectations and an indication will be given of the achieved representativeness and validity of the study.

7.1 Reflection and limitations

In the Netherlands, in order to support municipalities in realizing the intended increase in district heating networks, a new market organization was introduced for the heat sector. An important condition of this new market organization assumes classic economic theory of free markets. Therefore, a new shift was proposed from centralized markets, where tariffs are regulated by one public authority, to decentralized markets where competition among private actors leads to price formation. However, studies have shown that there were increasingly more complaints within Dutch urban residential areas about the new market structures. Therefore, as has been the case numerous times throughout history, the consequences for the heat consumers were neglected, which could impede them for opting for new district heating solutions.

In theory, a new market organization proposes competitive markets in which supply and demand create competition, ensuring that the best goods and services are delivered at the lowest price, heat consumers are granted more freedom options and increase the willingness to invest in district heating infrastructure. However, the results of this research describe a slightly different narrative. Although it could be stated that decentralization does relate to a higher perceived customer satisfaction, mostly due to an increased level of flexibility, and privatization increases the experienced consumer protection, implementing both structures come with its costs. Prices are perceived higher within privately owned networks and the level of sustainability is believed to be lower. Lastly, the level of transparency is perceived to be lower when networks are decentralized. These are contradictory results in terms of the advantages that the economic theory of classical free markets have assumed. Furthermore, these results could also be great incentives for municipalities to keep some form of regulation and oversight within their overall heating strategies.

These consequences increase the complexities for municipalities when choosing for new district heating solutions. Municipalities are obligated to map out the appropriate organizational design for each type of heat consumer within different city urban districts. Therefore, a thoughtful and thorough trade-off must be made between the appropriate market structure and the resulting market problems and solutions, since these indicate that there is no ‘one size fits all’ solution. Here, it is advisable that municipalities consider their own available resources, private and public connections and interests, infrastructures and opinions of their own residents. Furthermore, municipalities or private actors that already have functional district heating networks have to consider two options in order to increase the overall customer satisfaction; 1) Further strengthen the determinants in which heat consumers are already satisfied; or 2) strengthen the determinants in which heat consumers are dissatisfied. Both are necessary steps that could not be carried out on a national level, but within smaller regions of the Netherlands as they are project specific. It could also accelerate the heat transition, as consumers bear the responsibilities for overall strategy acceptance.

However, it should be noted that all the results do not represent generalizable representations across all district heating networks in the Netherlands. The results of this study are just the observations that the heat consumers believed and conceived to be true, within designated district heating networks that were purposively selected. This has a negative effect on the overall generalizability of the research results. For example, in order to make accurate and generalizable predictions, other factors like the social demographics need to be taken into account. Here, heat consumers with a lower income, for example, are more inclined to find the consumption of heat rather expensive than consumers with a high income. Therefore, their statements can be really experienced, however, can also represent unjustified opinions. Although there could be an observable relationship identified within this specific data-set, more studies are needed in order to really state that customer satisfaction is influenced by the organizational design.

Theoretical reflection

The ACSI-model was used to analyse customer satisfaction within multiple organizational design types. This model has proved itself to be a useful tool, not only to map out levels of customer satisfaction, but also in identifying the main determinants that have caused these satisfaction outcomes. Furthermore, it has brought structure to the all-encompassing notion of 'customer satisfaction', which has been difficult to define. By doing so, it even went further then only customer satisfaction by introducing the customer's complaints and there ultimate loyalty. Both concepts have proven to be significant conditions for overall customer satisfaction within energy infrastructures. In addition, in most data-sets, the variables related with each other just like the ACSI-model predicted, however, not entirely. In all the analysed data-sets, and thus organizational design types, the variable that is related to 'customer expectations' showed to have no effect on the overall customer satisfaction. Although this is a relevant discovery on its own, this has negatively influenced the validity of the research outcomes and made it difficult to analyse the data. Thus, if this study needs to be repeated among other regions in the Netherlands, it is therefore advisable to ask consumers what these expectations are, instead of just mapping out whether they are high or not.

Another main limitation of using the ACSI-model would be that most of the used variables were quite superficial on their own, and therefore needed to be operationalised with other theoretical models. This has negatively impacted the usability of the ACSI-model and made it quite time consuming. Ultimately, customer satisfaction has been defined as the (dis)confirmation principle, however, whether this truly represented the overall satisfaction levels in district heating infrastructures is not yet clear. Furthermore, another limitation of the ACSI-model would be that the customer complaints can also be seen as a driver and not just a consequence of customer satisfaction. If this study would be replicated, there has to be an consideration to implement this within the theoretical model. Also, the variables of the perceived quality and the perceived value quite overlap with each other. By creating separate price indexes, values can be removed from the model and better correlations could be obtained (Johnson, et al., 2001). To conclude, the whole (theoretical) concept of the functionalities of district heating networks, and especially theories on the organizational design, was quite difficult to understand, which added significant time constraints.

Methodological reflection

Choosing an holistic- and multiple case study design has been the appropriate strategy in order to analyse the phenomena (customer satisfaction levels) as a whole. Moreover, investigating multiple complex and social units consisting multiple variables have greatly improved the robustness of the study results and made it possible to gain accurate predictions. However, one of the main limitations of this study would be that is was difficult to attain generalizable results, as the observations are just derived from only four cases. Therefore, the findings are generalized at the theoretical level; in other words, what is observed will be translated into the in the form of general observations, as it is not possible to draw representative conclusions from a limited amount of cases. Here, the results of this study represent a prototype for other studies in the future, where the same strategy could be transferred to similar regions in the Netherlands. Lastly, one of the main challenges was to eliminate any vulnerabilities of researcher's biases. Therefore, respondents have been purposively selected, but, only within their organizational design characteristics.

In terms of the research methods, choosing a quantitative study in the form of a questionnaire has proven to be the most appropriate strategy in order to evaluate customer satisfaction levels. In the end, it became a vital instrument in order acquire the numerical data that was needed to make the comparable statements about specific groups and/or populations. Furthermore, the internal and external validity has been greatly improved with the introduction of model testing (PCA), methods of triangulation and inclusion criteria.

However, one of the big limitations of the survey would be the way that the questionnaire was ultimately set up. Although all variables of the ACSI-model were accurately represented, the questions only created an overall indication of customer satisfaction, in which the reasons for answering some of the questions have been ignored. In the future, it will therefore also be necessary to examine why some heat consumers are satisfied or dissatisfied with certain variables within the appropriate model. Furthermore, in order to increase the reliability of the study results, it has been chosen to conduct the questionnaire by going door to door. This method was conducted to provide additional explanations if respondents explicitly needed more information to understand the concepts. However, this also attributed to a long writing process as a result. Moreover, these time constraints ultimately also led to the exploration of the potential solutions and market problems through a literature research, instead of the original plan to conduct semi-structured expert interviews. This method composition is not a regular way of conducting research, and thus, only took place because specific data was needed, from a certain group within a purposively selected region.

7.2 Recommendations

This study aimed to further elaborate on existing academic knowledge of district heating network design principles and gain new insights into how these structures could be orchestrated in order to support the needs of heat consumers most effectively. Ultimately, the research outcomes could be used as an tool in which municipalities and heat producers/suppliers are better equipped to serve consumers from different regions, provide customized solutions for each municipality, drive customer loyalty and, thus, increase the attractiveness of new district heating solutions in the Netherlands. However, as mentioned before, it should be noted that these results are not generalizable or representative of the entire district heat market.

Therefore, although an observable relationship was identified within this specific study, more research is needed in order to make concluding statements about the relationship of customer satisfaction and the organizational design. The same research structure could be used to measure satisfaction levels in other regions in the Netherlands, however, while taking into account the aforementioned limitations. Here, it is important that these studies include the reasoning behind the participant's statements, instead of just the satisfaction levels, as this was not possible in this research due to severe time constraints. The results of these studies could be used in the formulation of the new heat law, which will be accepted in the year 2023, where the current customer's needs are still heavily underestimated, neglected and unrepresented.

Furthermore, more research is needed that takes other heating alternatives into account, as there is still blind reliance on the positive functionalities and capabilities of district heating networks. New solutions of heat, such as heat pumps and new insulation technologies, are making these alternatives increasingly more attractive. In some cases, housing associations have even indicated that these new heat alternatives could be considered as cost-effective and pressure-reducing mechanisms for heat consumers. Moreover, municipalities will have to conduct more studies into how district heating networks could be constructed and operated most sustainably, as many networks are still operational by inducing carbon externalities.

To conclude, it could be stated that introducing privatization and decentralization within energy markets could be highly beneficial to the consumer's needs. However, as concluded in this study, implementing both component come with the cost of new introduced market problems, in which trade-offs have to be made on a local level between the needs of the consumer and the appropriate organizational design. This requires a deliberate collaboration between both private and public actors where choices have to be made between the overall efficiency of private sectors and/or keeping some form of oversight by governments. The consumer's needs should be the main priority in these considerations to eliminate gas dependencies.

"When you're looking at sustainable development there's no 'one size fits all' solution. It depends how rural, how urban, how traditional, how literate, there are so many factors that come into it.
Clive Smith, 2015.

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Appendix A: Questionnaire on customer satisfaction of consumers within district heating networks with different organizational designs

Organizational design types:

1) *Public-centralized (Purmerend)*
2) *Public-decentralized (Zaanstad)*
3) *Private-centralized (Almere)*
4) *Private-decentralized (Arnhem, Duiven/Westervoort)*

Questionnaire design

Variabelen	Items	Vragen	Instructies	Tekst gerelateerd	
				Yes	No
				1	2
General Conditions (GC)	GC1	Bent u al minimaal twee jaar eigenaar van deze woning?	*Indien nee (Beëindig de vragenlijst)*		
	GC2	Neemt u warmte af doormiddel van Stadsverwarming?	*Indien nee (Beëindig de vragenlijst)*		

- (Selecteer één antwoord)

Variabelen	Items	Stellingen	Instructies	Likertschaal				
				ZO	O	N	E	ZE
				1	2	3	4	5
Customer Expectations (CE)	CE1	Voor het gebruik van stadsverwarming had ik de verwachting dat ik in mijn basis behoeften zou worden voorzien.	*Voorafgaande verwachtingen basisbehoeften*					
	CE2	Voor het gebruik van stadsverwarming had ik de verwachting dat het meer voordelen zou opleveren dan een reguliere warmtevoorziening.	*Voorafgaande verwachtingen prestatiebehoeften*					
Perceived Quality (PQ)	PQ1	Ik ben tevreden met de kwaliteit van mijn warmtevoorziening.	*Beschikbaarheid, Betrouwbaarheid & veiligheid*					
	PQ2	Ik ben tevreden met de huidige prijs van mijn warmtevoorziening	*Vaste en variabele prijs component*					
	PQ3	Ik ben tevreden met het gemak dat mijn warmtevoorziening mij biedt	*Regelen van de temperatuur & installatieproces*					
	PQ4	Ik ben tevreden met de transparantie van mijn warmtevoorziening	*Transparante communicatie in prijs en kwaliteit*					
	PQ5	Ik ben tevreden met de duurzaamheid van mijn warmtevoorziening	*Duurzaam opgewekte warmte*					

	PQ6	Ik ben tevreden met de flexibiliteit van mijn warmtevoorziening	*Opties keuze in producenten en leveranciers*					
	PQ7	Ik ben tevreden met de bescherming dat mijn warmtevoorziening mij biedt	*Wettelijke bescherming*					
	PQ8	Ik ben tevreden met de aanvullende diensten die worden aangeboden binnen mijn warmtevoorziening	*Digitale service diensten & onderhoud*					
Perceived Value (PV)	PV1	Ik ben tevreden met de kwaliteit van mijn warmtevoorziening onder de gegeven prijs	*Prijs-kwaliteit verhouding*					
	PV2	Ik ben tevreden met de service verlening binnen mijn warmtevoorziening onder de gegeven prijs	*Prijs-service verhouding*					
Customer Satisfaction (CS)	CS1	Mijn voorgaande verwachtingen van de kwaliteit van het product zijn overtroffen	*Verwachting-bevestiging principe*					
	CS2	Mijn voorgaande verwachtingen van de kwaliteit van de service zijn overtroffen	*Verwachting-bevestiging principe*					
Customer Complaints (CC)	CC1	Ik heb regelmatig geklaagd over de kwaliteit van mijn warmtevoorziening	*Aantal klachten over de energie voorziening*					
	CC2	Ik heb regelmatig geklaagd over de serviceverlening binnen mijn warmte-voorziening	*Aantal klachten over de serviceverlening*					
Customer Loyalty (CL)	CL1	Ik zal weer stadsverwarming afnemen als ik opnieuw de keuze had	*(Her)aankoop intenties*					
	CL2	Ik zal stadsverwarming aanbevelen aan anderen in de toekomst	*Klant loyaliteit*					

- (1 = Zeer mee oneens; 2 = Oneens; 3 = Neutraal; 4 = Eens; 5 = Zeer mee eens)

Appendix B: Tables and Graphs

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,862
Bartlett's Test of Sphericity	Approx. Chi-Square	1268,720
	df	15
	Sig.	,000

Table 1: KMO and Barlett's Test when all data-sets (design types) are combined.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,870
Bartlett's Test of Sphericity	Approx. Chi-Square	1256,265
	df	10
	Sig.	,000

Table 2: KMO and Barlett's Test when CE is excluded from the model.

Model	**Path**	**Unstandardized Coefficient**		**Standardized Coefficient**	**t-value**	**Sig.**	**Status**
	Ind → dpnd	*B*	*Std.Error*	*Beta*	*t*	*P*	
1	CE → PQ	.170	.102	.163	1.675	.097	Rejected
2	CE → PV	.028	.117	.024	.242	.809	Rejected
3	CE → CS	.471	.113	.384	4.183	.301	Rejected
4	PQ → PV	1.026	.158	.543	6.492	***	Accepted
5	PQ → CS	1.436	.135	.727	10.627	***	Accepted
6	PV → CS	.550	.088	.526	6.215	***	Accepted
7	CS → CC	-.623	.061	-.714	-10.244	***	Accepted
8	CS → CL	.716	.058	.776	12.378	***	Accepted
9	CC → CL	-.561	.089	-.531	-6.296	***	Accepted

Table 3: Simple Regression and path analysis of private-centralized networks (Almere).

Model	**Path**	**Unstandardized Coefficient**		**Standardized Coefficient**	**t-value**	**Sig.**	**Status**
	Ind → dpnd	*B*	*Std.Error*	*Beta*	*t*	*P*	
1	CE → PQ	-.110	.059	-.183	-1.857	.066	Rejected
2	CE → PV	-.183	.091	-.196	-2.000	.052	Rejected
3	CE → CS	-.178	.103	-.170	-1.729	*	Accepted
4	PQ → PV	.854	.129	.553	6.630	***	Accepted
5	PQ → CS	1.117	.132	.645	8.439	***	Accepted
6	PV → CS	.557	.097	.497	5.730	***	Accepted
7	CS → CC	-.747	.061	-.776	-12.289	***	Accepted
8	CS → CL	.783	.079	.702	9.856	***	Accepted
9	CC → CL	-.715	.091	-.617	-7.841	***	Accepted

Table 4: Simple Regression and path analysis of private-decentralized networks (Arnhem, Duiven & Westervoort).

Model	Path	Unstandardized Coefficient		Standardized Coefficient	t-value	Sig.	Status
	Ind → dpnd	*B*	*Std.Error*	*Beta*	*t*	*P*	
1	CE → PQ	-.081	.050	-.163	-1.631	.106	Rejected
2	CE → PV	-.224	.084	-.260	-2.661	.079	Rejected
3	CE → CS	-.212	.100	-.209	-2.120	.037	Accepted
4	PQ → PV	1.287	.115	.748	11.162	***	Accepted
5	PQ → CS	1.553	.131	.768	11.881	***	Accepted
6	PV → CS	.919	.074	.782	12.411	***	Accepted
7	CS → CC	-.766	.058	-.801	-13.261	***	Accepted
8	CS → CL	.722	.058	.785	12.542	***	Accepted
9	CC → CL	-.588	.077	-.611	-7.648	***	Accepted

Table 5: Simple Regression and path analysis of public-centralized networks (Purmerend).

Model	Path	Unstandardized Coefficient		Standardized Coefficient	t-value	Sig.	Status
	Ind → dpnd	*B*	*Std.Error*	*Beta*	*t*	*P*	
1	CE → PQ	.097	.065	.144	1.481	.142	Rejected
2	CE → PV	.170	.102	.163	1.675	.097	Rejected
3	CE → CS	.109	.105	.102	1.043	.300	Rejected
4	PQ → PV	.951	.122	.610	7.808	***	Accepted
5	PQ → CS	1.191	.105	.746	11.355	***	Accepted
6	PV → CS	.815	.061	.796	13.354	***	Accepted
7	CS → CC	-.567	.070	-.626	-8.143	***	Accepted
8	CS → CL	.752	.054	.806	13.839	***	Accepted
9	CC → CL	-.695	.075	-.675	-9.297	***	Accepted

Table 6: Simple Regression and path analysis of public-decentralized networks (Zaanstad).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	zeer ontevreden	36	8,8	8,8	8,8
	ontevreden	53	12,9	12,9	21,7
	neutraal	89	21,7	21,7	43,4
	tevreden	125	30,5	30,5	73,9
	zeer tevreden	107	26,1	26,1	100,0
	Total	410	100,0	100,0	

a. Customer Satisfaction / expectancy-(dis)conformation principle

Table 7: Frequency statistics of the overall customer satisfaction when all data-sets (design types) are combined.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	zeer ontevreden	15	14,6	14,6	14,6
	ontevreden	16	15,5	15,5	30,1

	neutraal	9	8,7	8,7	38,8
	tevreden	37	35,9	35,9	74,8
	zeer tevreden	26	25,2	25,2	100,0
	Total	103	100,0	100,0	

a. Customer Satisfaction / expectancy-(dis)conformation principle

Table 8: Frequency statistics of the overall customer satisfaction in private-centralized networks.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	zeer ontevreden	7	6,9	6,9	6,9
	ontevreden	11	10,8	10,8	17,6
	neutraal	18	17,6	17,6	35,3
	tevreden	35	34,3	34,3	69,6
	zeer tevreden	31	30,4	30,4	100,0
	Total	102	100,0	100,0	

a. Customer Satisfaction / expectancy-(dis)conformation principle

Table 9: Frequency statistics of the overall customer satisfaction in private-decentralized networks.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	zeer ontevreden	9	9,0	9,0	9,0
	ontevreden	17	17,0	17,0	26,0
	neutraal	36	36,0	36,0	62,0
	tevreden	25	25,0	25,0	87,0
	zeer tevreden	13	13,0	13,0	100,0
	Total	100	100,0	100,0	

a. Customer Satisfaction / expectancy-(dis)conformation principle

Table 10: Frequency statistics of the overall customer satisfaction in public-centralized networks.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	zeer ontevreden	5	4,8	4,8	4,8
	ontevreden	9	8,6	8,6	13,3
	neutraal	26	24,8	24,8	38,1
	tevreden	28	26,7	26,7	64,8
	zeer tevreden	37	35,2	35,2	100,0
	Total	105	100,0	100,0	

a. Customer Satisfaction / expectancy-(dis)conformation principle

Table 11: Frequency statistics of the overall customer satisfaction in public-decentralized networks.