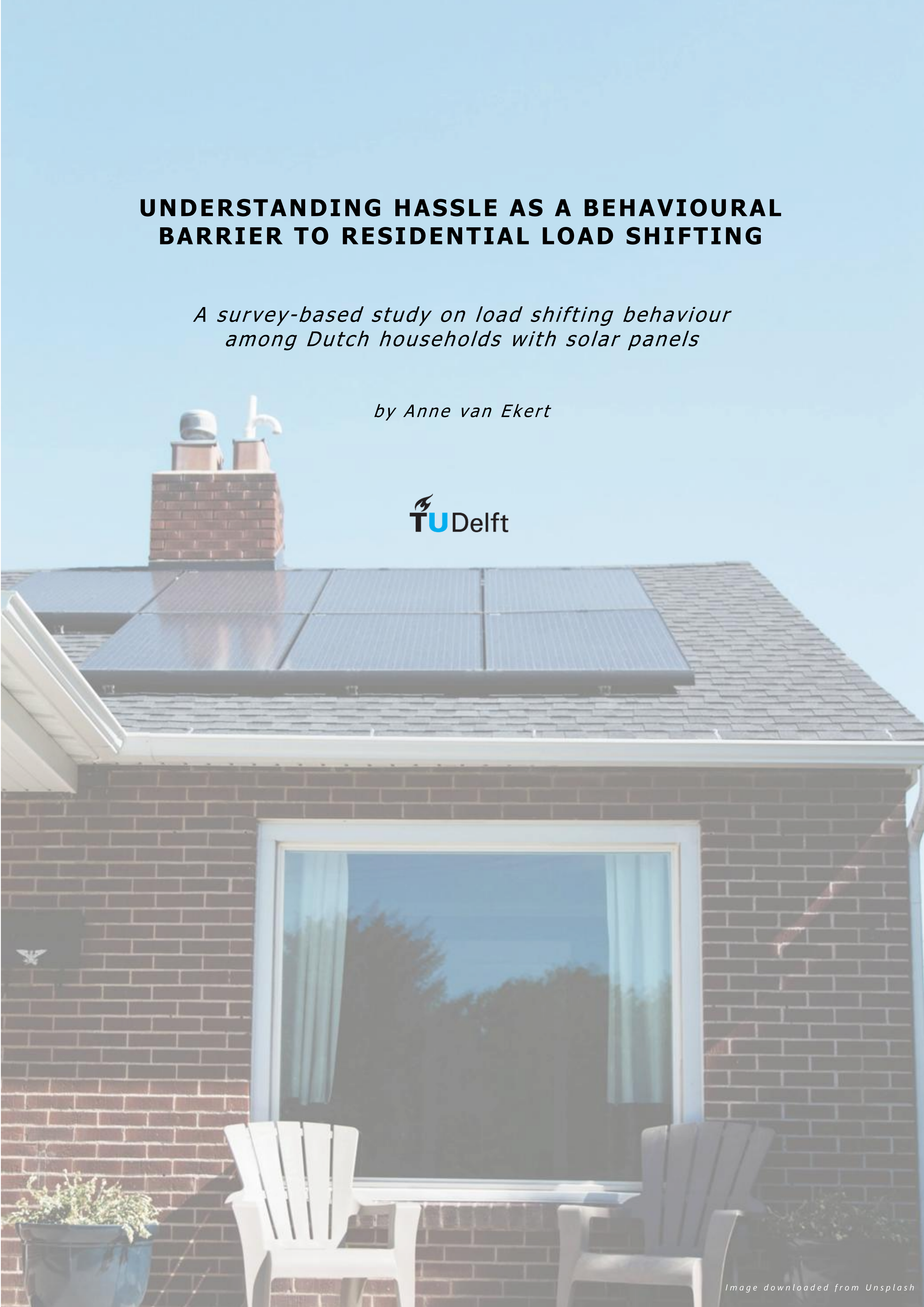
UNDERSTANDING HASSLE AS A BEHAVIOURAL BARRIER TO RESIDENTIAL LOAD SHIFTING

A survey-based study on load shifting behaviour among Dutch households with solar panels

by Anne van Ekert

TU Delft



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A survey-based study on load shifting behaviour among Dutch households with solar panels

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Anne van Ekert

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Anne van Ekert
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Executive summary

This thesis investigates the role of hassle as a behavioural barrier to residential load shifting in Dutch households with solar panels. As the energy system becomes more decentralised and the Netherlands moves toward phasing out the net metering scheme by 2027, the need for energy flexibility at the household level is increasing. One way to achieve this is through load shifting, which involves using electrical appliances during periods of high solar production. However, many households do not consistently load shift currently. One possible explanation is that it is perceived as a hassle, an everyday obstacle that may be invisible or seem minor, but can strongly influence behaviour.

This study aimed to describe how different types of hassle, also referred to as hassle factors, influence load shifting behaviour, and what contextual and internal factors shape the perception of hassle among Dutch households with solar panels. This is the first study to empirically test such hassle factors in the specific context of residential load shifting. It contributes to a more detailed understanding of hassle as a behavioural barrier within the energy transition. A survey was conducted among Dutch households with solar panels, focusing specifically on load shifting using a dishwasher and washing machine. These appliances are widely used, embedded in household routines, and technically suitable for load shifting. The survey included both closed- and open-ended questions to capture not only the frequency of hassle factors and causes of hassle perception but also their meaning in the context of load shifting behaviour.

To support the analysis, this study developed a conceptual model combining elements from the Unified Theory of Acceptance and Use of Technology (UTAUT) and habit theory. In this model, hassle is positioned within UTAUT's effort expectancy component, which relates to how easy or difficult individuals expect a behaviour to be. Hassle perception is assumed to directly influence load shifting. To strengthen the model, internal and contextual factors were added as antecedents to explain differences in hassle perception among participants. Habits related to dishwasher and washing machine use were also included as an internal factor, using habit theory, which considers habits as a psychological construct. The model helps identify which types of hassle affect behaviour, and how contextual and internal factors contribute to the perception of hassle in residential load shifting.

The findings show that PV monitoring effort, the effort of checking self-generated solar production, was perceived as the most discouraging hassle factor for load shifting. Respondents who experienced much PV monitoring effort were significantly less likely to shift appliance use to solar hours, both for dishwashers and washing machines. Other hassle factors, such as the inconvenience of running half-full machines, were often mentioned but did not consistently predict lower load shifting. Instead, three other hassle types showed a clear negative effect: manual planning effort, decision uncertainty, and overloaded machine inconvenience. These effects varied by appliance as decision uncertainty and overloaded machine inconvenience were more relevant for dishwashers, while manual planning effort played a larger role in washing machine use.

In addition to these quantitatively measured hassle factors, the qualitative findings highlighted the importance of other types of hassle. Specifically, family-related hassle was particularly relevant. Many participants reported difficulties in coordinating appliance use or load shifting efforts with other household members, especially in families with children. A lack of shared routines or limited support from others made it harder to consistently shift. Besides, other types of hassle included hygiene-related concerns, such as bad smells when postponing use, and technical hassle, for

example, when appliances lacked a delayed start function. Although not measured in the survey, these factors shaped how participants experienced load shifting.

The study also examined which factors shape the perception of hassle. Both internal and contextual influences played a role. Participants with busy household schedules, limited personal flexibility, or stress in other areas of life tended to experience more hassle in load shifting. Habit strength was also a key predictor: participants who reported using the dishwasher or washing machine without planning or thinking were significantly less likely to load shift. Fixed routines in dishwasher use, such as always running the machine after dinner, were also linked to higher perceived effort. These findings suggest that hassle is shaped by automatic and embedded existing behaviours in daily life. Interestingly, energy awareness appeared to reduce hassle perception. Participants who enjoyed monitoring their solar production reported lower levels of hassle across multiple factors. Stimulating energy engagement should therefore be a priority by improving access to user-friendly monitoring tools and organising local workshops or campaigns to increase familiarity with solar systems. This also directly addresses the prominent hassle factor of PV monitoring effort.

The value of this research lies in providing a better understanding of hassle as a behavioural barrier, an understudied factor in the context of household energy behaviour. From a societal perspective, these insights can support the shift toward more flexible energy use, which is increasingly relevant as the energy system decentralises. In addition to improving energy engagement, policymakers and industry should consider family-related hassle. Supporting households in sharing the responsibility of load shifting, for example, through practical tips, awareness campaigns, or tools that promote shared routines, could reduce hassle and make load shifting easier to fit into family life. Some limitations should also be noted. The study focused on two appliances and measured expected hassle at one point in time, which does not reflect how it may change as people adapt. The sample also overrepresented certain groups, such as retirees and larger households, which may limit generalisability. Future research could include a broader range of appliances, such as electric vehicle charging or home batteries, apply longitudinal methods, or examine how household dynamics and expectations about policy changes influence hassle over time.

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List of Abbreviations

Abbreviation	Definition
DR	Demand response
DSM	Demand-side management
EV	Electric vehicle
HEMS	Home Energy Management Systems
PCA	Principal Component Analysis
PV	Photovoltaic
UTAUT	Unified Theory of Acceptance and Use of Technology

1. INTRODUCTION

This chapter introduces the research by providing background information on residential solar systems and the concept of load shifting. It presents the problem statement and discusses common barriers to residential load shifting. Hassle is introduced as a recently identified behavioural barrier. Following, the research gap and scope of this study are outlined, as well as the theoretical and practical relevance of the study are discussed. Furthermore, the main research question and sub-questions are introduced. Also, the alignment of this study with the master's programme is argued, and this chapter concludes with a brief outline of the thesis structure.

1.1 Background of research

The Dutch energy transition is accelerating to mitigate the negative effects of climate change. By 2030, 39% of the Dutch final energy consumption should come from renewable sources, compared to 17% in 2023 (Centraal Bureau Voor De Statistiek, 2024a). In recent years, climate policy has increased the share of renewable energy in the energy mix, with nearly half of all electricity produced in the Netherlands in 2023 coming from renewable sources (Centraal Bureau Voor De Statistiek, 2024a). The energy system is becoming increasingly decentralised, with the rapid adoption of rooftop solar panels by households over the last years being an important driver (Centraal Bureau Voor De Statistiek, 2024b). In 2024, almost 3 million households had solar panels installed (Centraal Bureau Voor De Statistiek, 2025b).

In the Netherlands, a net metering scheme ("salderingsregeling") has been in place since 2004 to incentivise the installation of solar panels (Londo et al., 2019). Prosumers, energy consumers who both generate and consume electricity, can feed surplus electricity back into the grid through net metering and receive remuneration for it (Iliopoulos et al., 2020). Under this scheme, the amount of electricity that prosumers feed into the grid is subtracted from the electricity drawn from the central grid. As a result, the electricity costs for households with solar panels are based on the annual difference between their electricity consumption and production. Net metering policy, along with the significant decrease in photovoltaic (PV) systems costs, has led to a rapid reduction of the payback times of residential PV systems (Londo et al., 2019). Consequently, this policy has been a major driver behind the rapid growth of PV systems in the Netherlands. Although cost-effective, this policy has unintended distributional effects. Masciandaro et al. (2024) conclude that households without solar panels face higher electricity bills due to the scheme, while households with solar panels benefit, even after accounting for their investment costs. Additionally, net metering schemes offer no incentives for prosumers to align their electricity generation with consumption, and they contribute to increased pressure on the electricity grid (Pató, 2024). The policy also leads to losses in government tax revenue (Londo et al., 2019). Political debate regarding these issues has led to the decision to end the scheme on January 1, 2027 (Eerste Kamer Der Staten-Generaal, 2024). After that, owners of solar panels who supply electricity back to the grid will no longer be allowed to offset this against their electricity usage. However, they will receive a still unknown compensation from their energy supplier for all electricity fed back into the grid.

The growing share of renewable energy puts increasing pressure on the capacity of the electricity grid, leading to grid congestion (Rijksoverheid, 2024). Congestion can occur on both the low-voltage grid (local), the medium-voltage grid (regional), and/or the high-voltage grid (national) (TNO, 2024). However, in the Netherlands, congestion mainly occurs at the high-voltage and mid-voltage grid (RVO, 2024). Grid congestion leads to an unreliable energy supply, which may result in power outages or blackouts. It can also result in businesses being unable to secure new grid connections, difficulties in charging electric vehicles (EVs), and delays in construction projects (Hanze, 2024). Households with PV panels also experience the effects of grid congestion. Excess solar electricity, the portion of self-generated electricity not consumed by the household, is fed into the low-voltage grid (Centraal Bureau Voor De Statistiek, 2024a). However, this low-voltage grid is also increasingly experiencing congestion. Overvoltage in low-voltage grids is almost always related to an oversupply of generated solar power (Brandligt, 2023).

To address grid congestion, upgrades to the grid infrastructure are necessary, but these are capital-intensive and time-consuming (Tomaselli et al., 2024). In addition to such technical solutions, behavioural measures play a crucial role. The concept of demand-side management (DSM) is defined as "the planning and implementation of those activities designed to influence consumer use of electricity in ways that will result in changes in the utility's load shape—i.e., changes in the time pattern and magnitude of a utility's load" (Gellings, 2016). DSM includes strategies related to energy efficiency, energy conservation, and demand response (Boshell & Veloza, 2008). Energy efficiency refers to the installation of energy-efficient technologies or the elimination of energy losses in existing systems. Energy conservation involves using less of a resource, usually by making a behavioural choice or change, such as lowering the thermostat. Demand response (DR) is a form of DSM in which electricity consumption is adjusted to better align with supply or other constraints. This can be done by decreasing, increasing, or shifting demand, commonly referred to as peak shaving, valley filling, and load shifting, respectively (Williams et al., 2023). Demand response has numerous benefits for the electricity system. It increases power system flexibility, improves generation and network utilisation, and improves the integration of variable sources of renewable energy (McPherson & Stoll, 2020).

Load shifting refers to shifting loads from peak demand periods to off-peak periods, to minimise peak energy consumption and enhance the reliability of the grid (Mota et al., 2023). An important step in enabling load shifting is to involve and motivate consumers (Manembu et al., 2023). Households with solar panels, being prosumers, can load shift by consuming electricity when PV panels generate during the day instead of in the evening (Stikvoort et al., 2020). Research has shown that solar panel adoption can lead to changes in consumption behaviour, such as users shifting some of their EV charging to the hours in which self-generated electricity is available (Liang et al., 2022). Load shifting will become more important in the Netherlands when the net metering scheme ends on January 1, 2027, as prosumers will have more financial incentive to load shift. Aligning energy consumption with solar generation not only increases the utilisation of self-generated electricity but also supports the overall stability of the electricity system. This is especially important as an increasing amount of self-generated solar power cannot always be fed into the grid. While congestion on the low-voltage grid does not occur continuously, it is particularly common during peak hours, typically between 4 p.m. and 9 p.m. (Rijksoverheid, 2023).

Although technologies such as home batteries are sometimes considered as a future solution to reduce grid pressure, research shows that their effectiveness in mitigating grid congestion is uncertain (Vendrik et al., 2024). Such residential batteries may even increase peak loads under current policy conditions. Additionally, there is currently no viable business case for residential batteries, even after the net metering scheme ends (Vendrik et al., 2024). This highlights the importance of promoting behavioural solutions such as load shifting.

1.2 Problem statement

As more households generate solar electricity, the challenge of effectively managing local grid capacity becomes increasingly urgent. Grid congestion has therefore evolved from a technical issue into a broader societal problem, affecting both the reliability of the electricity system and the pace of the energy transition. Recognising this, the Dutch government launched *Zet ook de knop om* in 2022. This multi-year public campaign targets households and businesses, aiming to raise awareness about energy savings through simple and practical measures. Currently, the campaign encourages citizens to shift their electricity use to off-peak hours, to reduce pressure on the grid between 16:00-21:00, and adopt smarter energy habits (Ministerie van Klimaat en Groene Groei, 2025).

This reflects the growing importance of behavioural measures, alongside technical upgrades, in addressing grid congestion. However, despite these policy efforts and the clear system-level benefits of residential load shifting, achieving effective behavioural change remains difficult. Dutch prosumers still use on average only about 30% of their self-generated electricity directly (Vendrik et al., 2024). The remaining electricity is largely fed back into the grid, often during peak solar production hours when local grid congestion is already high. Through behavioural changes in electricity use, it is expected that this percentage of self-consumption can be increased to about 40-45% (Vendrik et al., 2024). However, motivating households to actively adjust their energy use appears to be difficult in practice. Understanding the barriers that prevent households from changing their electricity use patterns is therefore essential to improve the resilience of the electricity system and support the energy transition.

1.3 Theoretical background on load shifting

1.3.1 Shiftability of household loads and supporting technologies

A key factor in residential load shifting is the shiftability of household appliances. Various studies aim to determine which types of electricity consumption can be most effectively shifted to minimise energy costs or best align with users' habits to maintain comfort (Mota et al., 2023; Schrammel et al., 2023). In this research, simulations are often conducted at the appliance level to estimate the load shifting potential of certain electrical appliances (Manembu et al., 2023). According to O'Reilly et al. (2023), appliances most often involved in demand response programmes include washing machines, dishwashers, EVs, and water heaters. Among these, appliances with more flexible routines were considered most adaptable to load shifting (Carmichael et al., 2014).

To better understand appliance flexibility, Yildiz et al. (2017) propose a typology that distinguishes between four categories of electrical loads. These are:

1. Uncontrollable loads, such as lighting and computing equipment, which are essential to immediate user needs and should not be altered without affecting comfort or functionality. These are unsuitable for load shifting due to their immediate demand.
2. Uninterruptible loads, including appliances such as washing machines and dishwashers, which can have a delayed start but must complete their full cycle once started. These loads are particularly relevant for residential load shifting, as they can be scheduled to run during periods of high solar generation or off-peak hours.
3. Controllable loads, such as electric vehicle charging, which can be interrupted and resumed with limited impact on user experience. This category offers high potential for flexibility, as charging can be paused or shifted to times with excess solar supply or lower grid congestion.
4. Regulating loads, such as Heating, Ventilation, and Air Conditioning (HVAC) systems and electric water heaters, whose operation of the loads is important for the comfort and well-being of occupants. These loads are less suitable for load shifting as comfort considerations may limit their flexibility.

This categorisation helps identify which appliances are suitable for load shifting. It clarifies that uninterruptible and controllable loads are generally more suitable for load shifting in households. Their routines allow for timing adjustments without major disruption to user convenience.

1.3.2 Barriers to load shifting behaviour

Various studies have explored why households are hesitant or unable to participate in demand-side management (DSM), including adopting load shifting behaviour (Hesselink & Chappin, 2019; Nolan & O'Malley, 2015; Parrish et al., 2020). Hesselink & Chappin (2019) provide a helpful framework to categorise these barriers into four types: structural, economic, behavioural, and social. These range from system-level constraints to household-level factors.

Structural barriers are typically beyond the control of individual households. These include limitations in the supply infrastructure, a lack of codes and standards, and split incentives, occurring when the distribution of investments and benefits between parties in a transaction is misaligned (Hesselink & Chappin, 2019). Economic barriers are more closely related to the household level and typically involve the financial resources and perceptions of individual consumers. These include a lack of capital for technological investment, high upfront costs, a lack of information, and transaction costs (Hesselink & Chappin, 2019). A key factor here is the uncertainty regarding the potential financial benefits of participation. When consumers cannot estimate whether long-term savings on electricity bills will offset their investment in DR technologies, their motivation to adopt such programmes diminishes (Nolan & O'Malley, 2015). This barrier is also observed by Parrish et al. (2020), who describe how a mismatch between the effort required and the perceived financial reward may discourage households from participating in load shifting.

Behavioural barriers are central to this study and include psychological limitations and everyday constraints that shape household decision-making. Hesselink & Chappin (2019) have identified several relevant factors. A key factor is bounded rationality, which implies that people, in real-world decision-making, do not possess full information, unlimited cognitive capacity, or infinite time to make perfectly rational choices (Zhang et al., 2023). Instead, their decisions are shaped by limitations in information availability, mental processing capacity, and time constraints. Rather than always striving for the optimal solution, individuals often settle for an option that satisfies their minimal needs under the circumstances. This process is known as satisficing (Zhang et al., 2023), also mentioned by Hesselink & Chappin (2019). In the context of load shifting, bounded rationality implies that households may not always make optimal or well-informed energy choices because they lack the time, attention, or mental resources to fully consider their options. Another key factor is availability bias, where people rely on knowledge and information that is easily accessible rather than comprehensive data (Hesselink & Chappin, 2019). In this context, households might overlook the benefits of load shifting because they are less immediately visible. Additionally, inertia, the tendency for people to stick to their current routines rather than change their behaviour, plays a role (Hesselink & Chapping, 2019). This often stems from a desire to avoid hidden costs or effort associated with switching routines. Also, individuals may continue with existing behaviours due to sunk cost considerations or because they are loss- or risk-averse, as well as due to competing priorities in household decision-making.

Research has shown that load shifting often conflicts with existing habits concerning household routines, and the effort required to shift behaviour can lead to resistance (Good et al., 2017). Even when real-time energy feedback is available, households may continue using their appliance as always out of habit (Nolan & O'Malley, 2015). This also suggests that access to information alone may not be enough to influence behavioural change. These habits are often deeply embedded in household schedules, which can vary depending on factors such as time spent at home, household composition, or enabling technologies like smart appliances (Parrish et al., 2020). Furthermore, limited awareness of the impact of shifting influences how load shifting is perceived (Bradley et al., 2016; Good et al., 2017). The extent to which these behavioural barriers are experienced varies not only with the perceived shiftability of different household appliances but also according to the individual participants and their perceptions of what is practical (Bradley et al., 2016). Manual monitoring and adjustment of electricity use in load shifting increases user effort and attention, forming a barrier to participation (Sloot et al., 2023). The potential disruption to existing daily patterns and habits is also mentioned as a barrier (Bradley et al., 2016). Furthermore, the need to reschedule household chores or run appliances at different times to load shift can be perceived as inconvenient and may hinder adoption (Sloot et al., 2023; Good et al., 2017). Lastly, social behavioural barriers arise from the comparisons with peers regarding energy technology adoption, or a lack of trust in new technologies (Hesselink & Chappin, 2019). Concerns around trust in DR programmes were also observed by Parrish et al. (2020) as a barrier to adoption.

According to recent research, a significant yet understudied barrier to household load shifting is the perceived hassle associated with the behaviour (Hubert et al., 2024). Hassles are defined as "the irritating, frustrating, distressing demands that to some degree characterise everyday transactions with the environment" (Kanner et al, 1981). Hassles are micro-stressors and can become potent sources of stress when experienced cumulatively (McLean, 1976).

While many of the behavioural barriers discussed above relate to broader psychological or structural routines, the concept of hassle captures the smaller, everyday inconveniences individuals face when trying to shift their energy use. These hassles can accumulate over time, forming a psychological barrier to adopting sustainable behaviours (de Vries et al., 2020). Because hassle involves the experience of stressors, it can result in behavioural inertia. People either need to add more effort to complete a certain task or choose to avoid it altogether. Hubert et al. (2024) found that the perception of hassle is strongly linked to habit strength, suggesting that households with stronger habits also perceive more hassle.

1.4 Research gap

Although existing research provides substantial insight into behavioural factors that influence load shifting, including habits, routines, and cognitive limitations, the specific role of hassle has remained unexplored. Since hassle can act as a barrier to behavioural change, it is important to understand its impact on household load shifting behaviour.

The concept of hassle has been explored for several decades across various domains, including psychology, healthcare, and economics. It is recognised as a minor but persistent stressor that can accumulate over time and influence decision-making and behaviour (Kanner et al., 1981; Handranata et al., 2023; Udayar et al., 2023). In the energy domain, however, hassle remains a relatively new and understudied concept. Some studies have introduced hassle as a psychological transaction cost or behavioural barrier. Existing research primarily examines hassle in the context of energy efficiency renovations, adoption of green home technologies, and recycling behaviours (de Vries et al., 2020; Ebrahimigharehbaghi, 2022; Mogensen & Thøgersen, 2024; Pegels et al., 2022). These studies have demonstrated that hassle negatively impacts behavioural adoption. However, only one study explicitly mentions hassle in load shifting behaviour (Hubert et al., 2024).

In existing research on behavioural barriers, the concept of hassle is often implicitly embedded within broader, established terms such as transaction costs, friction, effort, inconvenience, or sludge (Ebrahimigharehbaghi, 2022; van Lieren et al., 2018; Bermúdez, 2024; Shahab & Lades, 2021). While these concepts reflect similar ideas of small yet cumulative obstacles, hassle has not yet been systematically examined as a distinct behavioural barrier within the specific context of load shifting. As a result, a clear conceptualisation of hassle in this context is currently missing. Moreover, the only study mentioning hassle in load shifting behaviour primarily identifies it as a potential barrier to adoption (Hubert et al., 2024). Current literature neither empirically studies nor categorises the various types of hassle, also referred to as hassle factors in this study, that may discourage households from adopting load shifting behaviour. Gaining insight into which hassle factors create stress and contribute to the avoidance of load shifting is important. This can help identify key obstacles that discourage households from adopting this practice. Additionally, current literature does not examine the underlying internal or contextual factors contributing to hassle perceptions. As a result, it remains unclear whether perceived hassle predominantly originates from contextual factors, including the individual's environment (Ziemann et al., 2019), or internal psychological factors, including the characteristics of an individual (Reeve, 2018). Understanding this distinction is essential for developing strategies that reduce perceived hassle and support greater adoption of load shifting among Dutch households with solar panels, especially in light of the upcoming end of the net metering scheme. Therefore, empirical research is needed to systematically explore how hassle is perceived in household load shifting behaviour.

The theoretical relevance of this study concerns the contribution to behavioural energy research by examining hassle as a distinct barrier to household load shifting. This study aims to address the research gap by improving the academic understanding of how hassles, being small everyday obstacles, can shape energy-related behaviours. It combines insights from psychology and demand response literature with empirical findings to explore this relationship. In addition, the study distinguishes between internal and contextual causes of hassle, providing a useful starting point for future research into consumer participation in demand response programmes.

1.5 Scope

This study focuses on household load shifting using self-generated solar power in the Netherlands, specifically examining the role of hassle as a behavioural barrier. Hassle in load shifting is especially relevant for households with solar panels, who could align their consumption with self-generated power, but may be held back by perceived difficulties. The choice of this geographical focus is based on the rapid adoption of solar panels in Dutch households. This Dutch 'solar explosion' has resulted in Europe's highest PV capacity per capita (Pató, 2024), making it an interesting area to study. Additionally, as the net metering scheme will end in 2027, prosumers will be incentivised to align their electricity consumption with their generation patterns because they cannot offset their electricity production against their consumption anymore. This results in higher energy bills and longer payback times (Vendrik et al., 2024). However, increasing the use of self-generated solar electricity, through practices such as load shifting, can significantly reduce the payback period of PV systems after the abolition of the net metering scheme. It may even approximate the current payback period under the net metering scheme (Vendrik et al., 2024).

Specifically, this study focuses on shifting the use of washing machines and dishwashers to empirically assess perceived hassle in the context of load shifting. These appliances are widely used in households, require regular operation, and are frequently included in demand response programmes (O'Reilly et al., 2023). Furthermore, these appliances are classified as uninterruptible loads using the typology of Yildiz et al. (2017), making them well-suited for load shifting. According to this typology, electric vehicle charging is also particularly useful for load shifting. However, the percentages of dishwasher and washing machine ownership are significantly higher than EV charger ownership. In the Netherlands, almost all households have a washing machine (98%) while the majority have a dishwasher (76%) (Centraal Bureau voor de Statistiek, 2022). However, only about 10% of the Dutch passenger cars are either plug-in hybrid or fully electric (Centraal Bureau voor de Statistiek, 2025a), and about 72% of the electric vehicle owners have an EV charger at home in 2024 (Wolterman et al., 2024). Furthermore, both the dishwasher and washing machine are energy-intensive, meaning that shifting their use to align with renewable energy generation could contribute significantly to demand response efforts (Shipman et al., 2013). At the same time, the operation of these appliances is often embedded in daily routines and requires coordination with household schedules (Bourgeois et al., 2014), which may increase the perception of hassle. These appliances are often equipped with delay-start options via timers (Stamminger & Schmitz, 2016; Kobus et al., 2015), allowing users to shift appliance use to periods of solar generation, even when no one is home. The inclusion of two different appliances also enables a comparative analysis of hassle perception across devices with different user interactions. Dishwashers typically require limited manual effort beyond loading and unloading, while washing machines often involve multiple steps, such as transferring laundry between cycles and arranging for drying. By including both appliances, the research can explore whether hassle factors are appliance-specific or applicable across different types of household energy use.

Furthermore, this study does not aim to categorise the effects of hassle perception. Instead, the focus lies on identifying specific perceived hassle factors and understanding their underlying causes. In doing so, it provides insight into both contextual and internal causes that may prevent households from load shifting. Emphasising causes rather than effects is considered more useful from a policy perspective, as it allows for the development of targeted strategies to reduce perceived hassle by tackling its root causes. This study can help policymakers to develop strategies that, for example, simplify the process, reduce perceived effort, and enhance the adoption of load shifting behaviours among households. The findings may also offer valuable insights for other industry actors. If practical barriers to using appliances with smart features to load shift are significant, improving usability or incorporating automation could help improve adoption. Conversely, if internal factors, such as habitual behaviour, are more influential, behavioural nudges or awareness campaigns may be more effective strategies.

This study aims to address the research gaps outlined in section 1.4 by:

- Synthesising insights from existing research on hassle across different domains to clarify and refine the concept of hassle in behavioural research.
- Identifying and categorising the different types of hassle relevant to household load shifting, specifically among Dutch homeowners with solar panels.
- Distinguishing between contextual and internal factors contributing to hassle perceptions, specifically among Dutch homeowners with solar panels.

The main research question guiding this research is:

Which types of hassle act as a barrier to load shifting behaviour among Dutch households with solar panels?

Additionally, five sub-questions have been formulated. Sub-question 1, 2, and 3 focus on synthesising existing knowledge on hassle, while sub-question 4 and 5 involve empirical research.

1) *How is the concept of hassle defined and applied in psychological, energy, environmental and economic domains?*

This sub-question aims to develop a clear understanding of the concept of hassle by exploring how it is defined and applied across different domains. This thesis uses the term domain to refer to academic disciplines (e.g. psychology, economics) in which hassle has been conceptually or practically addressed. The studied domains in this sub-question include psychology, energy, environmental studies, and economics. The aim is to synthesise insights from these domains and identify how hassle is often embedded in related concepts such as effort, friction, or transaction costs. This helps to clarify how the concept is used in this study and to position it within the relevant literature.

2) *What types of hassle can be identified in demand response literature?*

This sub-question aims to identify different types of hassle mentioned in demand response literature, particularly in residential settings. The aim is to understand what hassle factors might be relevant when households want to shift their electricity use.

3) *What contextual and internal factors contributing to hassle perception can be identified in demand response and psychological literature?*

This sub-question identifies the causes of hassle perception described in existing demand response and psychological literature. It aims to categorise these causes into contextual factors, arising from an individual's surroundings, and internal factors, arising from the individual itself.

4) *How does hassle perception differ between dishwasher and washing machine use in the context of load shifting among Dutch households with solar panels?*

This sub-question examines how the perception of hassle is different between dishwasher and washing machine use in the context of load shifting among Dutch households with solar panels. It aims to identify which hassle factors are more commonly associated with each appliance when shifting their use to solar production hours, and how these differences reflect distinct usage patterns. By comparing the two appliances, the analysis provides insight into how hassle is shaped by the specific characteristics and everyday use of these two household appliances.

5) *What contextual and internal factors contribute to hassle perception in load shifting among Dutch households with solar panels?*

This sub-question investigates which of the identified contextual and internal causes contribute to the perception of hassle in load shifting among Dutch households with solar panels. It aims to explore which of these factors help explain differences in how hassle is perceived within this group.

1.6 Master program relevance

This research aligns with the master program Complex Systems Engineering and Management (CoSEM), which emphasises the interplay between technical systems and human behaviour in complex socio-technical environments. The Dutch energy grid, particularly in the context of increasing decentralised energy production, represents such a complex socio-technical system. It comprises technical infrastructure alongside social, regulatory, and economic components that shape and constrain behaviour. Therefore, load shifting as a response to grid congestion is not only a technical challenge, but is mainly dependent on consumer decision-making, habits, and perceptions. Exploring the concept of hassle in the context of load shifting can highlight how the psychological behaviour of humans can act as a barrier to achieving system change.

1.7 Outline

The thesis is structured in the following way. First, Chapter 2 outlines the methodology, including the research approach, survey design, and data analysis methods. It explains how both quantitative and qualitative elements are used to gain insight into hassle perception. Chapter 3 presents a literature review of the concept of hassle and explores its application in behavioural research, particularly in the context of demand response. It synthesises previous studies that mention hassle factors and introduces internal and contextual factors acting as causes of hassle, as discussed in existing literature. It also constructs a conceptual model that guides this research. Overall, this chapter aims to answer sub-questions 1, 2 and 3. Next, Chapter 4 describes the construction, structure and distribution of the survey. Additionally, it describes which data analysis methods have been used. Chapter 5 presents the survey results, including descriptive statistics, t-tests, correlation analyses, multiple linear regression models, and principal component analyses. It also includes a thematic analysis of open-ended responses. This chapter aims to answer sub-questions 4 and 5. Following, Chapter 6 interprets and discusses the findings of the statistical analyses and qualitative responses in the context of existing literature and the constructed conceptual model. In addition, this chapter outlines implications for industry stakeholders and policymakers, highlights the strengths and limitations of the study, and offers recommendations for future research. Finally, Chapter 7 formulates an answer to the main research question and provides a concluding remark on this research.

2. METHODOLOGY

This chapter outlines the methodology used in this research, which combines a primarily quantitative approach with supporting qualitative elements to explore perceived hassle in residential load shifting. First, this chapter explains the research approach and rationale for selecting a survey-based method. It also describes the literature review process to identify relevant hassle factors and their underlying causes. Next, the use of a survey is argued, while the construction, distribution and analysis are further explained in Chapter 4. Finally, an overview of the research flow diagram of this study is presented.

2.1 Research approach

This research applies a primarily quantitative approach, supported by qualitative elements. A quantitative approach is chosen because it enables data collection from a larger group of respondents within a relatively short timeframe and with limited resources (Nardi, 2018). It allows using standardised questions, ensures anonymity, and enables statistical analysis of opinions, attitudes, and behaviours related to hassle perception in residential load shifting. In addition, quantitative data can offer generalisable insights that reflect broader behavioural patterns among Dutch prosumers. A survey is used to collect this data, which is further explained in section 2.3. The survey construction is based on a literature review, for which the approach is described in section 2.2. The inclusion of open-ended questions introduces qualitative elements that complement the quantitative data. This allows respondents to elaborate in their own words, which helps to capture subjective interpretations that may be overlooked in closed-ended questions. As hassle is still an unexplored concept in this context, combining qualitative and quantitative elements is considered valuable to better understand how it functions as a behavioural barrier.

2.2 Literature review

The literature review forms the foundation of this research, as it addresses sub-questions 1, 2, and 3, and provides input for the survey. It aims to synthesise existing knowledge on the concept of hassle across various research domains, including psychology, economics, environmental, and energy literature. It outlines how hassle is defined in these domains and how it is embedded in related concepts. Based on this, a conceptualisation and definition of hassle is developed for this research. This helps to identify hassle factors relevant to demand response behaviour. In addition, the literature review explores possible causes of hassle perception mentioned in earlier studies. For this review, the database Scopus was used to search relevant literature, including journal articles, books, and reports.

As the concept of hassle is much understudied in the context of load shifting using solar panels, the literature research is broadened to identify hassle factors. The search was broadened to include concepts in which hassle is embedded, such as transaction costs, sludge, friction, effort and inconvenience, which is further explained in Chapter 3. Furthermore, the search was extended to include demand response in general, to capture other forms of demand response beyond load shifting. The search focuses on residential load shifting by including search terms such as household, homeowner, prosumer, consumer, etc. However, to find more articles, the presence of solar systems in households was also not specifically included in the search criteria. Two different search strings, outlined below, were used to search for relevant articles in the English language. These search strings were used to search for keywords appearing in the title, abstract, or keyword fields:

1. ("hassle" OR "transaction cost" OR "sludge" OR "friction" OR "effort" OR "inconvenience") AND ("load shift*" OR "loadshift*" OR "demand response" OR "time shift*") AND ("household" OR "homeowner" OR "resident" OR "prosumer" OR "consumer") AND ("behavior*" OR "behaviour*" OR "decision-making" OR "decision making" OR "adopt*" OR "participat*" OR "engage*")
2. ("load shift*" OR "loadshift*" OR "demand response" OR "time shift*") AND ("household" OR "homeowner" OR "resident" OR "prosumer" OR "consumer") AND ("behavior*" OR "behaviour*" OR "decision-making" OR "decision making" OR "adopt*" OR "participat*" OR "engage*" OR “adapt*”) AND (“routine” OR ((“household” OR “everyday” OR “daily”) AND “practices”))

The first search string resulted in 119 articles using Scopus. Relevant articles were selected by a systematic process, outlined in Figure 1.

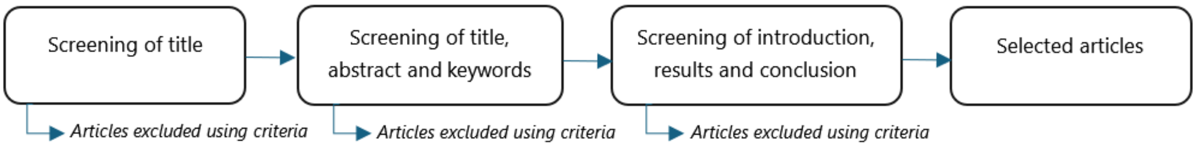

Figure 1 Literature selection process

Three exclusion criteria were chosen to ensure relevance to the research aim and focus. First, articles on load modelling, technical analysis or optimisation models were excluded, as these primarily address engineering perspectives and fall outside the behavioural scope of this study. Second, articles focused on industry or business behaviour were not included, since this research specifically examines household-level decisions. Lastly, articles that mention factors that cannot be conceptually linked to hassle or related constructs (as defined in Chapter 3) were excluded to maintain conceptual clarity and consistency in the analysis.

After selection on suitability, three articles were found using the first search string that mention a hassle factor that might form a behavioural barrier. Additionally, a second search string was added to include more articles. This second search string was added to search for articles that describe demand response, or load shifting behaviour, in the context of household routines or daily practices. This search string resulted in 73 articles using Scopus. The same selection procedure was used, after which five articles were identified that mention a hassle factor that forms a behavioural barrier.

The eight articles selected for hassle factor identification have also been examined for factors that might cause hassle perception. In this research, a division is made between contextual and internal factors leading to hassle perception. Internal factors include the characteristics of the individual consumer, and contextual factors include the surroundings. Additionally, as hassle is defined as a minor stressor in psychological research, the causes of hassle are also identified by searching for psychological literature describing causes for the perception of such minor stressors.

2.3 Survey

This research uses a structured survey as a quantitative research method to assess the perception of hassle factors in load shifting and potential underlying causes. This survey addresses sub-questions 4 and 5 by further exploring and validating findings from the literature review to uncover key insights and themes.

A survey methodology is well-suited for this research as it allows for data collection from a large sample of Dutch prosumers within the study’s time constraints. Additionally, the survey allows for quantification of hassle factors and their internal and contextual causes, which can provide statistical insights into their prevalence and significance. In this way, the survey can validate insights from the literature review with empirical data. The survey consists primarily of closed-ended questions, complemented by several open-ended questions allowing respondents to share their insights. Surveys are specifically useful for uncovering perceptions, beliefs, and attitudes that are difficult to observe through other data collection methods (Stantcheva, 2022). Since hassle perception is a subjective experience, using a structured survey that combines closed- and open-ended questions enables respondents to directly express their experiences and challenges with load shifting.

There are, however, also limitations to this research approach. First, quantitative surveys rely on self-reporting, which assumes participants' ability to read and interpret questions accurately, and may lead to bias in reporting behaviours or attitudes (Nardi, 2018). For example, there is a risk that respondents overestimate their load shifting adoption, underreport certain hassle perceptions or interpret these terms differently. In addition, closed-ended questions may restrict the expression of complex thoughts or emotions. While open-ended responses can address this, they can be more difficult to analyse systematically and allow for less elaboration compared to interviews. Another limitation is that the survey captures perceptions of hassle at a single point in time. This static view may overlook how hassle perceptions evolve, for instance, as people become more familiar with their solar systems or as external incentives change. Despite these limitations, a structured survey is still chosen as the primary data collection method because it is well-suited to answer the research questions formulated in this study. The open-ended questions allow respondents to formulate unexpected forms of hassle that may not have been anticipated during the literature review. In this way, the survey helps validate findings from previous literature and generate new insights. The survey was constructed based on insights from the literature review. The survey design, distribution, and analysis strategy are outlined in Chapter 4.

2.4 Research flow diagram

The research design is visualised in a research flow diagram in Figure 2. This diagram outlines the research steps, inputs and outputs, methods and sub-questions addressed in each research phase, corresponding to a chapter.

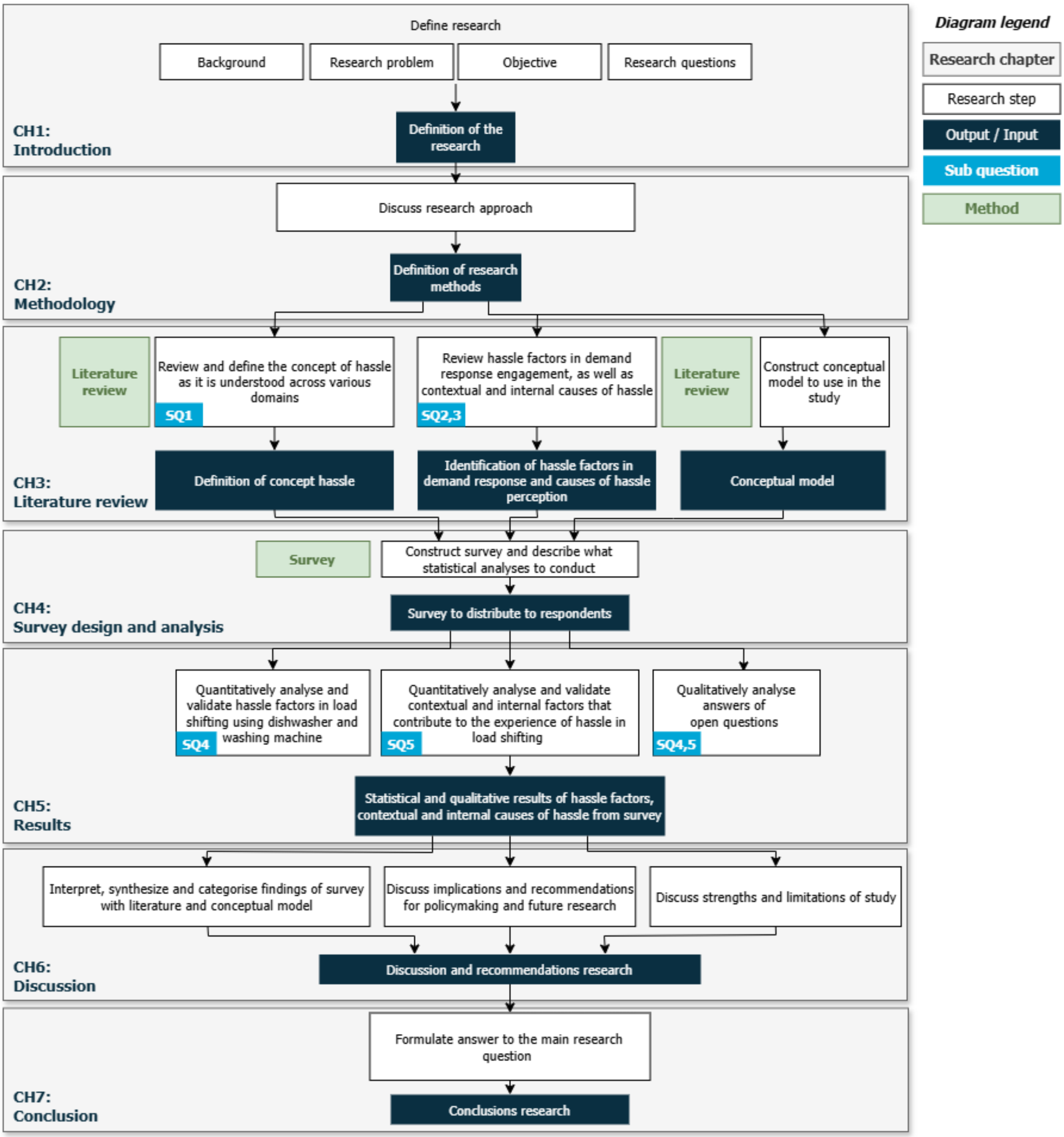

Figure 2 Research Flow Diagram

3. LITERATURE REVIEW

This chapter reviews literature to synthesise existing knowledge on the concept of hassle across various domains. It provides insight into how hassle has been reported as a behavioural barrier in previous research and defines how hassle is used in this research. A synthesis is made on the types of hassle reported in existing research concerning demand response. Also, the possible causes of hassle perception reported in psychological and demand response literature are outlined. Furthermore, a constructed conceptual model is introduced in which hassle, causes of hassle and load shifting can be placed. This conceptual model integrates insights from the Unified Theory of Acceptance and Use of Technology (UTAUT), habit theory, and existing literature on hassle. Ultimately, the findings of this chapter are used to answer:

- Sub-question 1: How is the concept of hassle defined and applied in psychological, energy, environmental and economic domains?
- Sub-question 2: What types of hassle can be identified in demand response literature?
- Sub-question 3: What contextual and internal factors contributing to hassle perception can be identified in demand response and psychological literature?

3.1 Hassle

3.1.1 Definitions

The concept of hassle has been studied since the 1980s, primarily within psychology but later also in other domains. Kanner et al. (1981) defined hassles as "the irritating, frustrating, distressing demands that to some degree characterise everyday transactions with the environment". They are the minor, though sometimes very disturbing, daily annoyances of life that can impair morale, social functioning, and health (Lazarus, 2006; Maybery, 2003). Lazarus & Folkman (1984) transactional theory of stress and coping is one of the foundational psychological theories in which hassle is embedded. In this framework, individuals continuously evaluate environmental stimuli, and when perceived as threatening, challenging, or harmful, it triggers stress and initiates coping strategies. Coping efforts lead to an outcome reappraised as favourable, unfavourable, or unresolved. Favourable resolutions generate positive emotions, while unresolved or negative outcomes result in distress. Hassles, being minor stressors, are used in research as a measure of stress (Chamberlain & Zika, 1990). In research, daily hassles are also distinguished from major life events (e.g., divorce, job loss). Despite being minor, they are more predictive of stress-related outcomes such as anxiety or burnout because they accumulate over time (Lazarus, 2006). Also, what constitutes a hassle varies greatly from person to person. Tools such as checklists, daily hassle scales (e.g., Udayar et al., 2023), and open-ended questions are used to measure exposure to stressors such as daily hassles. The LIVES scale, for example, categorises hassles into five domains: physical (hassles in physical and mental health problems), professional (hassles in job search and job insecurity), relational (hassles in conflicts with others), environmental (hassles in sources of insecurity of a country/place), and financial aspects (hassles in various everyday financial issues) (Udayar et al., 2023). Psychological research also highlights the phenomenon of spillover effects, as stressors occurring in one specific domain (e.g. stressful job conditions) can also spill onto another domain (e.g. conflict with partner) (Pearlin & Bierman, 2013).

The concept of hassle has also been studied in various other domains, although relatively few studies explicitly explore hassle in the context of energy behaviour. In the environmental and energy domain, it has been studied in the context of household adoption of green home measures, energy efficiency renovations, home heating systems such as heat pumps and energy retrofitting (de Vries et al., 2020; Mogensen & Thøgersen, 2024; Meles et al., 2022; Ebrahimigharehbaghi, 2022). Furthermore, hassle has been studied in the context of sustainable building measures adoption by actors in the building industry and household waste separation and recycling of dry waste (Hofman et al., 2022; Pegels et al., 2022). Hassle has also been studied in car sharing, consumer adoption of innovative technologies in the ICT industry, and stock market participation (Jain et al., 2021; Choy & Park, 2016; Handranata et al., 2023).

In the environmental and energy domains, hassle is defined as a psychological transaction cost, a micro-stressor or a psychological barrier, causing stress and an avoidance of specific behaviour (Mogensen & Thøgersen, 2024; Hofman et al., 2022; Ebrahimigharehbaghi, 2022; Hubert et al., 2024). For example, De Vries et al. (2020) introduced perceived hassle as an explanation for why homeowners often do not implement green home measures. Their study outlines that homeowners encounter hassles at multiple stages of the decision process (from finding information, comparing options, to installation logistics), and that the anticipated stress from these accumulated hassles leads to avoidance of implementing green home measures. Lastly, a study regarding stock market participation defined hassle as something that causes stress and frustration, which leads to psychological barriers and usually relates to costs in terms of money and time (Handranata et al., 2023). Recurring for the definition of hassle is that it relates to stress and can create a psychological barrier.

3.1.2 Hassle hidden in other terms

In research on behavioural barriers, the concept of hassle is often embedded within related terms such as transaction costs, friction, sludge, inconvenience, and effort. While these terms may not explicitly refer to hassle, they all describe small, cumulative obstacles that discourage certain behaviours. In economics, transaction costs are the costs beyond the product or service costs required to exchange a product or service between two entities (Sarkis et al., 2011). Williamson (1989) uses the analogy between mechanical frictions and transaction costs. He argues that if engineers look for frictions in mechanical systems, economists need to take account of transaction costs, the economic counterpart of friction. Ebrahimigharehbaghi (2022) identifies non-monetary transaction costs such as time, effort, complexity, nuisance, uncertainties, etc., in the context of energy renovations, that often lead to avoidance. Hassle also aligns with behavioural economic concepts such as friction and sludge. Friction is generally seen as a barrier to performing the desired behaviour (van Lieren et al., 2018), as described in the analogy between friction and transaction costs of Williamson (1989).

Sludge is the excessive or unjustified friction that makes it harder for people to do what they wish (Shahab & Lades, 2021). Examples of sludge include burdensome paperwork or overly complex procedures. Shahab & Lades (2021) distinguish four forms of sludge: search, evaluation, implementation, and psychological costs. The latter is closely linked to hassle. The term inconvenience also captures hassle and describes things that hinder certain activities. Inconveniences include, for example, teachers talking too fast and dealing with household chores, which hinder studying during a pandemic (Zalech & Jaczynowski, 2020). Finally, effort, both mental and physical, is often used as a predictor of behaviour. An action is seen as mentally effortful if one feels that one is approaching the limit of one's mental abilities (for concentration, information processing, or sustained attention), and physical effort requires the expenditure of metabolic resources (Bermúdez, 2024). Research by Ramboll (2022) highlights this connection between effort and hassle, framing a hassle factor as the perceived or actual effort involved in a decision. As hassle may be discussed under these alternative terms in different domains, it is important to recognise this when reviewing literature.

3.1.3 Hassle in this research

In this research, hassle is conceptualised as a micro-stressor that creates psychological transaction costs, influencing household load shifting behaviour using solar panels. Importantly, hassle is in the research based on perceived or expected inconvenience rather than actual experience. People may anticipate that load shifting will be a hassle and therefore avoid it, even if the behaviour might turn out to be manageable once attempted. This means that perceived hassle can act as a psychological barrier before the behaviour takes place.

Hassle can shape household energy decisions through repeated minor disruptions rather than large obstacles. While hassle overlaps with other barriers such as habit, complexity, and effort, it is distinct as it captures the cumulative burden of minor inconveniences that cumulatively discourage load shifting. The term hassle factor is used in this research, which refers to a single type of hassle. This research considers factors as a hassle when they contribute to additional cognitive, logistical, or emotional strain on users, such as the perceived complexity of planning energy use or the mental burden of monitoring PV generation. By recognising hassle as an independent factor, this research aims to capture barriers often embedded within other concepts such as transaction costs, friction, and inconvenience, which have not been explicitly identified as hassle in previous studies.

3.2 Conceptual model

This study uses a constructed conceptual model based on the Unified Theory of Acceptance and Use of Technology (UTAUT), extended with insights from habit theory (Verplanken & Orbell, 2003). By combining elements from both theories, the conceptual model aims to explain how perceived hassle shapes load shifting behaviour and why the perception of hassle differs between individuals. The overall constructed model is visualised in Figure 4, presented at the end of this chapter. This model contains insights from the literature review outlined in sections 3.3 and 3.4

First, UTAUT is used to explore the role of hassle in household load shifting behaviour. UTAUT integrates and extends various theories to explain how individuals accept and use technologies (Venkatesh et al., 2003). It suggests that the actual use of technology is determined by behavioural intention, which is influenced by four key factors: performance expectancy, effort expectancy, social influence, and facilitating conditions. These factors are moderated by gender, age, experience, and voluntariness of use. It is argued that by examining the presence of each of these constructs, researchers can assess an individual's intention to use a specific system. Performance expectancy refers to the perceived benefits of a behaviour. The effort expectancy is the degree of ease associated with a technology's use or behaviour. The social influence refers to the degree to which an individual perceives that others believe he or she should use the new system. The facilitating conditions refer to the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system. A visualisation of the model can be seen in Figure 3.

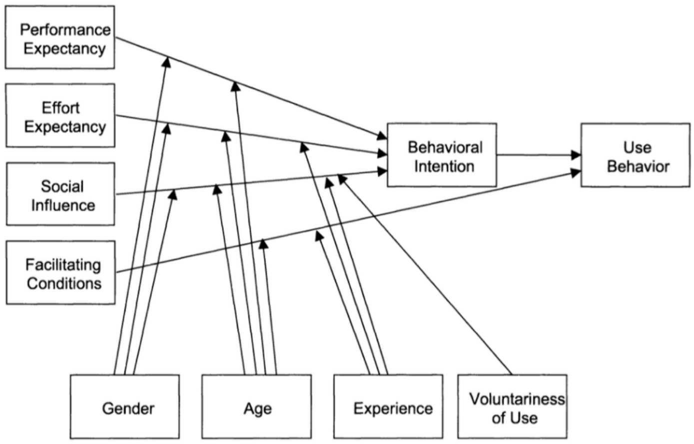

Figure 3 UTAUT model (Venkatesh et al., 2003)

This study incorporates the relation between effort expectancy and use behaviour in the constructed model. Load shifting can be conceptualised as the intended use behaviour, as it requires individuals to adopt a new energy consumption pattern facilitated by technology. Additionally, perceived hassle can be integrated into effort expectancy. Perceived ease of use is a key root construct of this, which is defined as the extent to which an individual believes that using a system requires minimal effort (Venkatesh et al., 2003). Importantly, this refers to anticipated rather than experienced effort. Since hassle is inherently linked to perceived effort, it can be embedded within effort expectancy as a determinant of how effortful individuals expect load shifting to be. The identified hassle factors can be structured within the construct of effort expectancy, as components of perceived hassle. In contrast, the constructs performance expectancy, social influence and facilitating conditions were not included in the model, as they were not central to the scope of this research. Similarly, the moderating variables (gender, age, experience, and voluntariness of use) were not included as such in the model. This was done because the study does not focus on explaining differences in strengths of how effort expectancy (hassle perception) influences the use behaviour (load shifting), moderated by certain variables. Lastly, behavioural intention is also not used in the model as this research focuses on studying load shifting behaviour itself rather than the intention to perform this behaviour.

The model suggests that when individuals perceive a behaviour as requiring little effort, they have more behavioural intention. In the context of this study, this means that higher perceived hassle is expected to be associated with lower load shifting behaviour. However, UTAUT does not account for the underlying causes of perceived effort, meaning it does not explain why individuals perceive certain behaviours as effortful. The internal and contextual causes of hassle identified in the literature review cannot be directly placed in the existing UTAUT model, as these are not moderators of the relation between hassle perception and load shifting. To conceptualise these causes of hassle in the model, they need to be integrated as antecedents that shape effort expectancy. Also, other limitations of the use of UTAUT to construct the model should be recognised. The theory is technology-focused rather than behaviour-focused, as it was originally developed to explain technology adoption instead of habitual behaviour change (Venkatesh et al., 2003). While it can help explain why some individuals load shift due to low effort expectancy, it does not address why some individuals perceive more hassle than others based on, for example, their routines or cognitive load. Still, adapting UTAUT to integrate hassle into effort expectancy provides a structured approach to understanding how hassle factors influence load shifting behaviour.

Second, to address the underlying causes of perceived hassle, the model is extended with insights from habit theory using research of Verplanken & Orbell (2003). Hubert et al. (2024) found a strong positive correlation between habits and perceived hassle in the context of household energy use. Their findings suggest that hassle perception is influenced by the existence of habitual patterns. To empirically test this, habits are integrated into the conceptual model as an antecedent of perceived hassle. It is considered an internal factor as it concerns the characteristics of an individual. In this study, habits refer to the habitual use of a dishwasher and washing machine, which are the appliances examined for load shifting.

Verplanken and Orbell (2003) describe habits as a psychological construct, meaning that habits are not just about observable behaviour (such as frequency of action), but about internal mental processes that drive that behaviour. A habit is understood as a mental representation that enables behaviour to be triggered automatically by situational cues, especially in the context of recurring goals. This perspective highlights that habits are not simply what people do, but how their behaviour is internally regulated. Once a behaviour has been repeated in a stable context, it becomes automatic, requiring little to no conscious deliberation. This interpretation is important because it allows habit to be measured psychologically, not only through observed actions, but through self-reported automaticity. The Self-Report Habit Index (SRHI) measures habit strength by breaking it down into several features of habit, including the history of repetition, automaticity (lack of control, lack of awareness, efficiency), and expression of one's identity. In the context of this research, understanding habit as a psychological construct helps explain why individuals with stronger habits may perceive more hassle when asked to change their behaviour. Chapter 4 further explains how the SRHI is used in this study to measure habit strength.

3.3 Hassle factors

The literature review outlines eight hassle factors perceived during various forms of demand response, as limited research has been conducted on load shifting specifically. It reflects the mentioned factors that were found using the applied search terms and selection criteria. However, it should be recognised that this list might not be fully complete. The hassle factors were mainly hidden in other closely related concepts of transaction costs, friction, inconvenience, effort, etc. Table 3.1 presents an overview of the factors. These hassle factors are integrated into the constructed conceptual model of this study, being embedded in the element perceived hassle. The identification of these hassle factors directly answers sub-question 2. Additionally, these factors are used in the survey to empirically measure hassle perception in load shifting, which is further outlined in Chapter 4.

Table 3.1 Hassle factors

	Factors	Explanation	Source
1	Planning effort	Complicated to plan appliance use based on sun hours. This relates to the effort in manually shifting when PV panels are generating and the effort in using timers and automation to delay start.	Hubert et al. (2024), Aasen & Christensen (2024), Khalid et al. (2019), Malakhatka et al. (2024)
2	PV monitoring effort	The effort to check if PV panels generate electricity to use an electrical appliance.	Hubert et al. (2024), Gram-Hanssen et al. (2020), Tellarini et al. (2024)
3	Weather forecasting effort	The effort to check the weather forecast to see which days the sun is shining.	Gram-Hanssen et al. (2020)
4	Decision uncertainty	Doubt about which appliance usage to shift.	Aasen & Christensen (2024)
5	Load size inconvenience	The inconvenience of running half-full machines or overloaded machines.	Malakhatka et al. (2024), Friis & Christensen (2016)
6	Simultaneous appliance use inconvenience	The inconvenience of running multiple appliances simultaneously.	Tellarini et al. (2024)
7	Unmonitored use concern	The hesitance to run an appliance while not at home or asleep due to possible accidents.	Malakhatka et al. (2024), Hansen & Aagaard (2025)
8	Household coordination effort	The effort to coordinate load shifting of appliances with other household members.	Tellarini et al. (2024)

Hubert et al. (2024) identified a hassle factor related to the planning of appliance use to match solar production, see also the master thesis by Hubert (2022). Similarly, Aasen & Christensen (2024) notice that the administration and planning of electricity use is complicated and results in too much workload, being stressful to users. This can result from strong household habits relating to schedules from work, children, household chores, etc. (Bradley et al., 2016). A specific challenge is setting timers, particularly for individuals with daytime jobs who depend on automation. Khalid et al. (2019) found that using timers to shift usage while away or asleep requires extra effort, while Malakhatka et al. (2024) reported low awareness, let alone understanding of such features. Therefore, additional **planning effort** is required for both manual shifting during daylight hours and automated shifting via timers.

Additionally, Hubert et al. (2024) researched a **PV monitoring effort** hassle factor, which relates to whether it is too much work to check if the PV system generates enough energy to use an electrical appliance. PV generation can usually be checked through an inverter or monitoring app connected to the installed solar panels. Gram-Hanssen et al. (2020) also found that it requires effort to check the inverter to see how much the PV panels are generating. Prosumers might not know how much energy they produce, as they do not monitor it, making load shifting difficult. Once users learn how to monitor their PV output and make it a habit, they are more likely to shift energy usage accordingly, though this may depend on factors such as the inverter's location and ease of access (Tellarini et al., 2024).

Furthermore, the **weather forecasting effort** can be considered a hassle factor. This captures the need to check whether the sun is shining today or tomorrow to time appliance use accordingly (Gram-Hanssen et al., 2020). This effort places an extra burden on users.

Decision uncertainty about which appliance to shift is also identified as a hassle factor. According to Aasen & Christensen (2024), this uncertainty stems from limited knowledge of the energy consumption of individual appliances and their actual impact on the grid, which increases the cognitive effort required to make informed decisions.

Additionally, shifting tasks like dishwashing or laundry may influence usage frequency. Postponing appliance use can cause an unwanted accumulation of laundry or dishes, as Malakhatka et al. (2024) noted that users found such overloaded machines inconvenient. On the other hand, appliances may run with smaller loads. Running half-full machines leads to higher water, detergent, and energy consumption, and may disrupt established routines (Friis & Christensen, 2016). As such, it presents both cognitive and practical burdens. Overall, such hassle can be interpreted as **load size inconvenience**.

Some prosumers respond to sunny weather by running multiple appliances simultaneously (e.g., washing machine and dryer) to maximise PV production (Tellarini et al., 2024). However, this can be inconvenient for others, as it requires managing several appliances simultaneously and unloading them in quick succession. Therefore, **simultaneous appliance use inconvenience** can also be considered a hassle factor.

Furthermore, Malakhatka et al. (2024) observe that participants are hesitant to run appliances while not being at home, as they are afraid that, for example, a water leakage may occur while running the dishwasher, which is not covered by their home insurance when not at home. Hansen & Aagaard (2025) also notice the fear of accidents, as running appliances such as a dishwasher and washing machine during the night was stressful for participants, as this might start a fire. The fear of potential accidents when running appliances while away from home or asleep can be considered an **unmonitored use concern**, as it gives extra stress.

Hassle may also arise from the need to coordinate appliance use with other household members when shifting use. Tellarini et al. (2024) observed that one household member wanted to use the dishwasher during daylight hours to align with PV generation. However, the other household member starts running the dishwasher at night to unload it in the morning for their convenience. Effort is needed to coordinate appliance use, which requires extra cognitive and logistical strain on users. Therefore, **household coordination effort** is also considered a hassle factor.

3.4 Causes

This section discusses possible causes of hassle perception, with a specific focus on how hassle affects household behaviour in the context of demand response. These causes have been identified in psychological literature as well as in reviewed literature for hassle factors. A distinction is made between contextual and internal factors, as psychological stress is shaped by the dynamic interaction between individuals and their environment (Lazarus, 2006). Table 3.2 provides an overview of the found contextual and internal factors. These causes are also integrated into the conceptual model of this study as antecedents of hassle perception. The identification of these contextual and internal factors directly answers sub-question 3. Additionally, a selection of these causes of hassle are used in the survey to measure causes of hassle perception in load shifting, used to answer sub-question 5, further outlined in Chapter 4.

Table 3.2 Contextual and internal factors

Contextual factors	Source	Internal factors	Source
Household dynamics	Friis & Christensen (2016), Malakhatka et al. (2024)	Stress sensitivity	Lazarus (2006)
Neighbour proximity	Malakhatka et al. (2024), Aasen & Christensen (2024)	Stress coping mechanisms	Lazarus (2006)
		Coping flexibility	Cheng (2001)
		Neuroticism	Suls & Martin (2005)
		Spillover effect	Pearlin & Bierman (2013)
		Gender	Udayar et al. (2023)
		Habits	Hubert et al. (2024), Öhrlund et al. (2020), Malakhatka et al. (2024)
		Flexibility in changing habits	Bradley et al. (2016)

3.4.1 Contextual factors

Two key contextual causes are household dynamics and neighbour proximity. First, **household dynamics**, relating to different routines and schedules of household members, might influence hassle perception. Families with small children, for example, are sensitive to experiencing load shifting as more stressful because of routines such as bedtime, mealtime, and school preparation. Friis & Christensen (2016) discuss that households with small children tend to find load shifting more stressful and inconvenient because of the already tight schedules. In contrast, Malakhatka et al. (2024) found that single-person households often experience less effort to load shift due to more flexibility in their schedule. Additionally, **neighbour proximity** plays a role. People living in apartments or shared buildings may avoid running noisy appliances at night out of concern for disturbing others (Malakhatka et al., 2024; Aasen & Christensen, 2024). This makes time-shifting less appealing, especially in such high-density buildings.

3.4.2 Internal factors

An individual's personality plays an important role in the stress process, and consequently, in the perception of hassle. **Stress sensitivity** or vulnerability is an important determinant of daily hassle experience (Lazarus, 2006). To generate a stress reaction, both stressful stimulus conditions and a vulnerable person, whereby vulnerability varies per individual, are needed. Additionally, the individual's **stress coping mechanisms** impact daily hassle experiences. Coping is a key mediator between stressors and their psychological consequences, determining whether daily hassles are overwhelming or are managed effectively. Lazarus (2006) emphasises that coping plays a crucial role in managing stress, as when coping is ineffective, the stress level is high, and when coping is effective, the stress level tends to be low. Personality traits associated with coping resources, such as optimism, self-efficacy, hope and resilience, can buffer against stress by shaping how individuals interpret and respond to daily challenges (Lazarus, 2006). Also, **coping flexibility**, the capacity to adjust one's coping strategies to meet the demands of different stressful situations, plays a role in how daily hassles are perceived (Cheng, 2001). In the context of energy load shifting, a person high in coping flexibility is more likely to perceive minor disruptions (e.g., changing appliance use routines) as manageable rather than overwhelming. Additionally, the personality dimension of **neuroticism** may increase the likelihood of experiencing daily hassles (Suls & Martin, 2005). Also, **spillover effects** may occur (Pearlin & Bierman, 2013), where stress from other life domains (e.g., work or family) might increase perceived hassle in load shifting. **Gender** also seems to play a role, as women report more frequent and more intense daily stressors (Udayar et al., 2023).

Furthermore, **habits** are a crucial factor in how individuals perceive hassle. Individuals with strong, automatic habits often find it more challenging to adjust their routines, as outlined earlier using Verplanken and Orbell (2003). Habits play an important role in hassle perception, which was also observed in the reviewed literature. Studies show householders often struggle to shift practices like cooking or laundry due to embedded daily rhythms (Öhrlund et al., 2020; Malakhatka et al., 2024). The fear of disrupting these routines can increase perceived hassle. Also, Bradley et al. (2016) argue that habits directly act as a barrier to load shifting.

The contrast between households with different levels of routine flexibility is highlighted by Bradley et al. (2016), who found that participants working from home and with more flexible sleep schedules found it easier to adjust the timing of energy-related practices than those with rigid schedules. Nowadays, households often have tightly scheduled routines, with limited possibility for behavioural flexibility (Southerton, 2003). Even minor routine adjustments can be experienced as inconvenient and disruptive in such contexts. Therefore, the **flexibility in changing habits** plays an important role. Barsanti et al. (2024) also note that appliance use often follows habitual patterns, such as always running the dishwasher at the same time. Doing this intentionally or unconsciously can affect how burdensome a change is perceived. Also, Hubert et al. (2024) found a strong positive correlation between habitual behaviour and hassle perception.

3.5 Constructed model

The constructed model uses UTAUT, habit theory, and insights from the literature review regarding hassle factors and causes of hassle perception. The model is visualised in Figure 4. Within the model, habits, being a psychological construct, are included as an internal factor. This study examines habits in dishwasher and washing machine use. Furthermore, gender, which was a moderating variable in the original UTAUT, is used as an antecedent of hassle perception in this model. This was done because it is used as a cause explaining variation in hassle perception rather than an aspect moderating the relationship between perceived hassle and load shifting behaviour. Lastly, it should be noted that not all elements of the conceptual model were included in the survey, due to considerations of scope, time, and survey suitability as outlined in section 4.1. Rather, the model reflects the broader insights gained from the literature review and provides a theoretical foundation for interpreting the empirical findings.

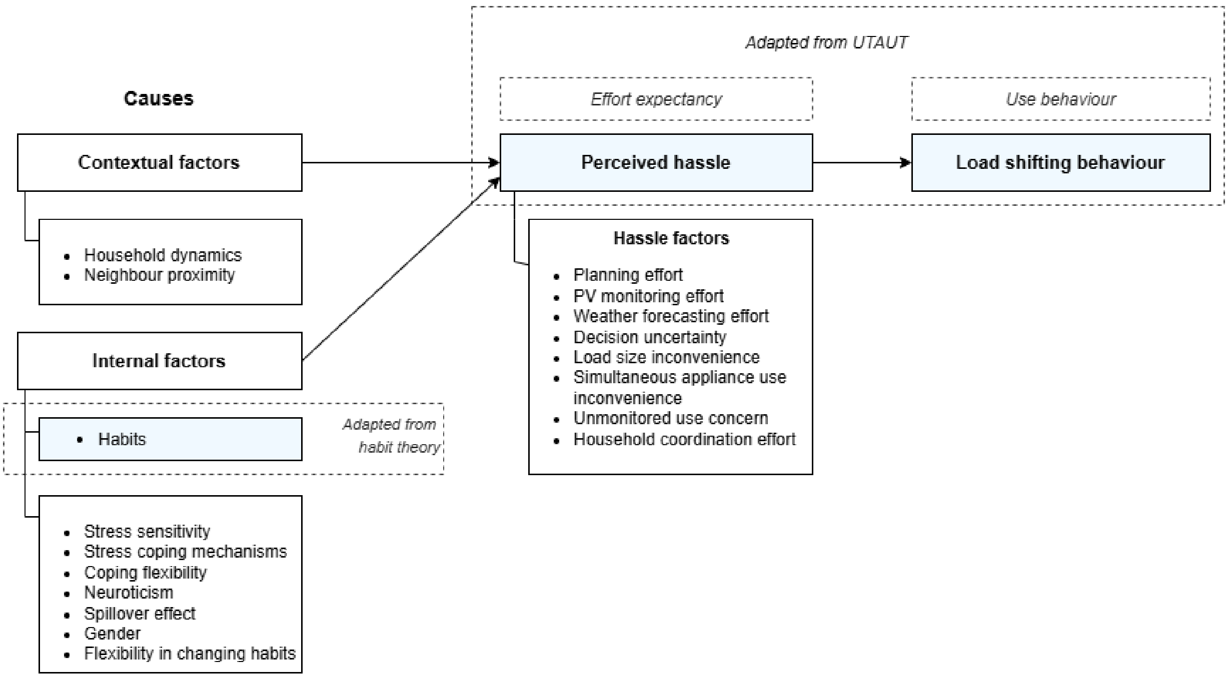

Figure 4 Constructed model

4. SURVEY DESIGN AND ANALYSIS

This chapter outlines the methodology applied in this research in more detail. It describes the construction, structure and distribution of the survey. At the end of this chapter, Table 4.1 is presented which gives an overview of all the survey questions, response options and scale, what is measured, variable type, SPSS codenames and corresponding question numbers. Additionally, the data analysis methods used for survey response analysis are outlined.

4.1 Survey construction and structure

The survey was designed to examine hassle factors in load shifting and their causes, as identified in the literature review. The survey has been constructed using Qualtrics software. The majority of the survey questions are closed-ended, allowing for structured data collection, while a few open-ended questions were included to enable respondents to provide their insights of hassle perception. Questions were formulated by the researcher, using the survey guide of Stantcheva (2022), and with input and feedback from the research team to ensure clarity and relevance. The word "hassle" was not mentioned in the survey introduction and questions to minimise response bias. Explicitly mentioning the term could prime respondents and influence their answers, leading them to interpret questions through the lens of inconvenience rather than their actual experience. This approach aligns with Stantcheva's (2022) survey guide, which advises against revealing the explicit purpose of the research upfront. Given that the target group consists of Dutch households, the survey was conducted in Dutch to ensure clarity and ease of participation. The survey included an introduction (informed consent), validation and six sections with questions.

This study empirically tests the occurrence of hassle factors in shifting the use of two appliances, a dishwasher and a washing machine, as argued in Chapter 1. Consequently, to manage survey length and ensure focused responses, participants were only asked about one of the two appliances in sections 2 and 4 (see Table 4.1). The appliance grouping was based on ownership, which was determined after section 1. Respondents who owned both appliances were randomly assigned to one, while those with only one had to answer questions about that specific appliance. This logic structure was configured in Qualtrics to ensure a balanced distribution of responses across the two appliance types. The survey started with an informed consent form, based on the template provided by the TU Delft Human Research Ethics Committee (TU Delft, n.d.). It explained the research purpose, its role in a master's thesis and broader promotion project, and outlined the voluntary and anonymous nature of participation. The estimated completion time was indicated based on test runs, along with information on data handling, confidentiality, and contact details for the researcher and supervisor. The Dutch version of the consent form is provided in Appendix A. After consenting, respondents faced a validation check to confirm that they were homeowners or renters in the Netherlands with installed solar panels. The survey was terminated for those who did not meet this criterion. The Qualtrics settings were configured to automatically remove respondents who did not progress beyond this validation step within 72 hours.

The first section of the survey collected data regarding general demographics, household and property characteristics. Questions are formulated to measure the variables gender, occupant status, household composition, number of children and retired persons in the household, occupancy patterns throughout the week, PV capacity, the presence of a battery system, and ownership of a dishwasher and washing machine. These variables serve as control variables and provide important context for interpreting variation in hassle perception and load shifting behaviour. Some also directly relate to constructs included in the conceptual model (Figure 4). Gender is included in the model as an internal factor. Gender differences are also relevant in psychological literature, where research has shown that women report higher stress levels and more frequent daily hassles (Udayar et al., 2023). The number of children and household composition relate to the construct of household dynamics, a contextual factor in the model. This was included as households with children may experience more rigid routines and less flexibility (Friis & Christensen, 2016), potentially increasing perceived hassle. Each variable was measured using a single question. Additionally, a time matrix was used to assess typical household occupancy during different parts of the day across the week. This provides crucial context for evaluating the practical potential for load shifting.

To explore the link between habits and hassle perception, the second section of the survey focused on habitual behaviour regarding either the dishwasher or washing machine, depending on the respondent's group. Habit strength, also part of the constructed model, was measured using three adapted items from the Self-Report Habit Index (SRHI) developed by Verplanken & Orbell (2003) and commonly used in behavioural studies. Rather than focusing solely on behavioural frequency, the SRHI captures habits as automatic, routine-based actions that are triggered by context and require minimal conscious thought.

The original SRHI contains twelve items to measure habit strength. However, a reduced number of items was chosen to keep the survey concise, considering the large number of other survey questions presented. Three items were selected that represent the core of the habit construct, being the automaticity and routine-based nature of the behaviour. These were selected based on suitability for measuring habits in dishwasher and washing machine use. The items were rephrased to fit the context of appliance use and to enhance clarity for respondents. These items were included in the survey:

- Appliance use without planning (rephrased from 'I do it automatically')
- Appliance use as part of routine (rephrased from 'it belongs to my routine')
- Appliance use without thinking (rephrased from 'I do it without thinking')

All items were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). In addition, respondents reported the weekly frequency and timing of appliance use through a separate time matrix. This allowed for deeper insight into the daily rhythms of use and the extent to which routines might be flexible or fixed, which is essential for understanding the feasibility of behavioural change through load shifting.

The third section measured experience with load shifting, which is essential as it provides insight into current load shifting behaviour and enables an analysis of whether hassle factors may act as barriers to adoption. Load shifting experience was measured using a range of variables, including current behaviour, frequency, methods used, and appliances shifted. This approach contributed to a more comprehensive understanding of the load shifting experience and enabled its use in various analyses throughout the study. The questions in this section assessed:

- Whether respondents consciously adjust their appliance use to match solar generation
- Frequency of load shifting on a weekly scale
- Methods used for load shifting
- Which appliances are generally shifted, and how often this is done weekly. It was decided to add two other appliances here that also consume a lot of energy and offer usage flexibility according to load type. A dryer, also classified as an uninterruptible load, and an electric vehicle, a controllable load, both of which are interesting for load shifting.
- Motivations to shift or not shift, through an open-ended question

The fourth section empirically tested the eight hassle factors identified in the literature review, see Table 3.1. These include planning effort, PV monitoring effort, weather forecasting effort, decision uncertainty, load size inconvenience, simultaneous appliance use inconvenience, unmonitored use concern and household coordination effort. All these factors were considered relevant for this research and were translated into a statement rated on a 5-point Likert scale (1 = never experienced, 5 = always experienced). A Likert scale is particularly suitable here as it enables a structured comparison of hassle perceptions across different respondents. To gain more detailed insights, two hassle factors were each split into two separate survey statements. The planning effort factor was divided into one item addressing the manual effort required to align appliance use with PV generation, and another focusing on the effort involved in using timers and automation. This distinction was made because both types of planning-related effort were identified separately in the literature, and measuring them individually allows for a more nuanced understanding. Similarly, the load size inconvenience factor was separated into two items: one addressing the inconvenience of running a half-full machine, and the other focusing on the hassle of dealing with an overloaded machine. This split was based on findings in the literature, where these situations were reported as distinct sources of inconvenience.

The fifth section measured internal and contextual factors causing hassle perception derived from the literature, see Table 3.2, to examine what drives hassle perception. Statements were presented on a 5-point Likert scale, measuring to what extent respondents agreed, and an open-ended question was added to capture additional causes. The literature outlines two contextual factors that influence hassle perception: household dynamics and neighbour proximity. Household dynamics were assessed through two statements: one measuring whether the respondent's schedule makes it difficult to load shift, and another addressing whether the work or school schedules of other household members pose a barrier. Neighbour proximity was measured by a statement asking whether respondents are concerned about disturbing neighbours when shifting appliance use. While most literature focuses on nighttime disturbances, this study considers daytime noise concerns due to the focus on aligning use with solar generation. Regarding the internal factors, a selection was made, of which the following factors were included:

- Stress sensitivity was measured through a statement assessing whether respondents experience stress when their routines are disrupted.
- Hassle in life was measured through whether respondents experienced hassle in other domains, such as work or family life.
- Gender was included as a control variable, as prior research indicated differences in how men and women experience daily hassles.
- Habit strength was measured separately in section 2
- Flexibility was measured with two statements: one assessing whether respondents find it difficult to change their daily routines, and another evaluating their preference for following their own schedule over one based on sun hours.

Factors such as neuroticism, coping mechanisms, and coping flexibility were not included based on survey length constraints and the difficulty in accurately measuring such psychological traits in a survey. Furthermore, a statement was added to measure whether respondents enjoy monitoring their energy generation and consumption. This was done because engagement with energy monitoring has been found to encourage users to reflect on and better understand their energy use, which can lead to behavioural adjustments such as load shifting (Kendel et al., 2017). Both direct learning through feedback and indirect learning through self-monitoring have been shown to foster a sense of involvement and control, potentially reducing the perceived effort or disruption associated with changes in energy use.

In the sixth section, respondents were thanked for participating and informed about when and where the research would be published. They could voluntarily leave contact details for follow-up interviews. However, after data collection, the research team decided not to proceed with interviews, as the collected survey data was sufficient.

The final survey consisted of 43 questions. However, due to a conditional logic structure in Qualtrics, not all respondents had to answer every question. Based on their previous responses, participants were shown only the questions relevant to their situation. To minimise order bias, the statements in sections 2, 4, and 5 were presented in random order. As noted by Stantcheva (2022), the order in which questions appear can influence responses, for example, by making participants more likely to agree with the first or last item shown. In Table 4.1, the applied logic structure can be seen. The complete Dutch version, as implemented in Qualtrics, is included in Appendix B.

4.2 Survey distribution

The Human Research Ethics Committee of TU Delft approved the distribution of the survey. Following this approval, the survey was published through Qualtrics on March 21, 2025, and remained open for responses until April 6, 2025. Before the publication, various municipalities, energy cooperatives and other relevant organisations engaged in sustainability were contacted to help distribute the survey online. These organisations were considered relevant due to their engagement with sustainable energy initiatives and their ability to reach households that have adopted PV systems. By contacting multiple organisations, the aim was to increase the diversity and representativeness of respondents.

The Dutch municipalities of Hilversum, Voorschoten and Middelburg agreed to promote the survey via their sustainability platform and/or social media channels, while the municipality of Zeist spread the survey through internal groups. The energy cooperatives Energie van Rotterdam and Amsterdam Energie shared the survey through relevant WhatsApp groups, social media and/or a newsletter. Furthermore, several sustainability foundations agreed to share the survey. Duurzaam Amersfoort-Zuid and Duurzaam Woerden shared the survey through its newsletter. Duurzaam den Haag and Buurkracht shared it via resident initiatives.

Convenience sampling, a non-probability sampling method involving easily accessible participants (Etikan et al., 2016), was applied to increase the number of respondents. The survey was shared via the researcher and the supervisors' LinkedIn network and a local neighbourhood WhatsApp group. In addition, snowball sampling, another non-probability method, was used by asking the researcher's network to further distribute the survey.

These sampling strategies, combined with distribution through municipal sustainability platforms and energy cooperatives, introduce a potential sampling bias. Participants reached through sustainability-focused networks may differ systematically from the general population of PV owners, as they might be more environmentally engaged and proactive in optimising self-generated electricity use. Moreover, individuals willing to complete a survey may generally be less sensitive to hassle, as completing a survey may itself be perceived as a hassle. Convenience sampling may further skew the sample toward demographic or social groups connected to the researcher, while snowball sampling tends to overrepresent socially connected individuals, potentially reducing sample diversity (Etikan et al., 2016; Parker et al., 2019). To mitigate these risks, the survey was also distributed via municipal networks not explicitly focused on sustainability, to reach a broader group of respondents. Nevertheless, these limitations must be acknowledged when interpreting the results, as the findings may not be fully generalisable to the entire population.

4.3 Data analysis

The collected survey data were analysed using SPSS statistical software (version 29) to identify patterns, correlations, and relationships among variables. The closed-ended survey responses were analysed using a combination of descriptive statistics, t-tests, multiple linear regression analyses, correlation analyses, and principal component analyses. The statistical significance was set at p-value < 0.05. In the following subsections, the SPSS codenames, as indicated in Table 4.1 at the end of this chapter, are used to refer to variables.

4.3.1 Variable preparation

Several composite and recoded variables were constructed to prepare the dataset for analysis. For general load shifting behaviour, a new variable (*LS_experience_frequency*) was created by combining *Shifting_experience* (yes, no, sometimes) and *Shifting_frequency* (daily to never), both rescaled for consistency, from 1 (no) to 3 (yes) and 1 (never) to 5 (daily). Respondents who reported no experience were assigned the lowest frequency score in the composite variable, as they did not answer the frequency question. This approach ensured that whether and how often respondents load shift was reflected in a single variable. For appliance-specific load shifting, the variables *Shifting_appliance_1_recoded* (dishwasher) and *Shifting_appliance_2_recoded* (washing machine) were derived from survey questions assessing weekly shifting frequency. These were rescaled to a consistent 1 (never) to 5 (daily) scale for use in regression models.

Habit strength was measured using three items based on the Self-Report Habit Index (SRHI) by Verplanken & Orbell (2003). Before combining these into a single habit scale, internal consistency of the three variables was tested using Cronbach's alpha. A score of .70 or higher is typically considered acceptable (Taber, 2017). In both appliance groups, however, the full three-item scale fell below this threshold (α = .572 for the dishwasher and α = .442 for the washing machine). The item "routine" showed a very low item-total correlation, indicating weak alignment with the other two items. Routine may involve some degree of conscious scheduling, whereas the other two items more directly capture the automatic nature of habitual behaviour. After removing this item, internal consistency improved significantly. Cronbach's alpha for the two items in the dishwasher group was .863, and for the two items in the washing machine group it was .800. Therefore, only the items "without planning" and "without thinking" were used to create the composite variables *Habit_strength_dishw* and *Habit_strength_washi*. The excluded "routine" item (*Appliance_routine1* and *Appliance_routine2*) was included separately in regression models to examine its individual effect.

Several grouping variables were also recoded for t-tests:

- *Children_yes_no:* recoded from *Children* into a binary variable with 1 (yes), n=85, and 2 (no), n=175.
- *Household_composition_recoded*: recoded from *Household_composition* to single- and two-person households (n=138) and multi-person households (n=121). The limited number of single-person households in the dataset (n=20) was considered insufficient for valid statistical comparison. Therefore, it was decided to add two-person households to this category.
- *LS_method_group*: respondents were grouped as those who shift manually (n=132) and those who use a timer or delayed start function (n=41). Participants who reported using both methods were excluded for a more consistent comparison

4.3.2 Descriptive statistics

Descriptive statistics were conducted in both SPSS and RStudio to gain an initial understanding of the dataset. Frequency tables were created to explore demographic and household characteristics. Specifically, these variables were analysed using frequency tables: *Gender, Occupant_status, Household_composition, Children, Retirement, Battery_system, Appliance_possession_1,* and *Appliance_possession_2*. Also, load shifting behaviour was explored descriptively using: *Shifting_experience, Shifting_frequency,* and *Shifting_methods*. Furthermore, the descriptive function was mainly used for variables measured on Likert scales, measured on a scale from 1 to 5, to provide insights into means. This included variables *Hassle_factors_dishw_1 to 10* for the dishwasher group and *Hassle_factors_washi_1 to 10* for the washing machine group. Also, the eight causes of hassle were analysed using descriptive function, using *Causes_hassle_1 to Causes_hassle_8*. Additionally, the dataset was imported into RStudio to create cleaner visual outputs. The gtsummary and ggplot2 packages have been used to create bar charts, including weekly average dishwasher and washing machine use patterns, occupancy patterns and PV capacity installed, using the corresponding variables.

4.3.3 T-tests

Independent-samples t-tests were conducted to compare mean hassle scores across several demographic groups between respondent groups. This was done mainly based on what was found in the literature regarding factors affecting hassle perception. Separate tests were run for the dishwasher and washing machine groups using the ten hassle factor variables: *hassle_factors_dishw_1 to 10* and *hassle_factors_washi_1 to 10*. The following groupings were used as independent (grouping) variables:

- Gender: male (n=158) vs. female (n=95)
- Children: using *Children_yes_no*, grouping households with vs. without children
- Household composition: using *Household_composition_recoded*, grouping 1–2-person households vs. 3+ person households
- Load shifting method: using *LS_method_group*, with manual shifting (n=132) vs. timers use (n=41).

Levene's Test was applied to check for equality of variances, and the appropriate row from the SPSS output was used accordingly.

4.3.4 Other quantitative analysis

In addition to descriptive statistics and t-tests, three additional types of quantitative analyses were performed to explore and test the relationships between key variables in this study. These analyses are briefly introduced in this section, while the full details on how these analyses have been performed, as well as their outcomes, are presented in Chapter 5.

First, Principal Component Analyses (PCA) were conducted to explore whether the ten individual hassle factors could be grouped into broader components. PCA was performed separately for the dishwasher and washing machine groups to account for appliance-specific patterns.

Second, bivariate correlation analyses were carried out to assess the relationship between habits and perceived hassle, as well as between perceived hassle and its potential internal and contextual causes. These correlations provided initial insights into whether and which constructed habit variables and causes of hassle are most consistently associated with hassle perception.

Third, a series of multiple linear regression analyses were conducted to examine whether hassle factors significantly predict load shifting behaviour. All regression analyses were constructed separately for the dishwasher group and washing machine group with the relevant variables. Separate regression models were constructed for general load shifting behaviour and appliance-specific shifting behaviour. In addition, regression models were used to explore the predictive relationship between habits and load shifting. Also, to explore the relationship between potential causes of hassle perception and specific hassle factors that were found to be significant in the linear regression models.

4.3.5 Thematic analysis

The open-ended responses were analysed using thematic analysis to provide depth and context to the statistical results. An inductive coding method was used, in which all responses were read and grouped based on recurring themes relevant to the research objective. Excel has been used to group the data. The themes, based on the open questions in the survey, include: motivation to load shift, motivation to not load shift, dishwasher or washing machine-specific load shifting hassles, and causes of hassle perception. Quotes provided by respondents were translated from Dutch to English and included in the study to illustrate respondents' perspectives.

Table 4.1 All questions with response options, scale, SPSS codename and question number

To measure	Survey question	Response options and scale	SPSS codename	Number
Validation	Please select if you are a homeowner/renter in the Netherlands, over 18 years and have solar panels installed in your household	Multiple choice (nominal) • Yes • No *(if No, survey ends)*	Validation	1
Section 1: General demographics & household and property characteristics (control variables)				
Gender	Please select your gender.	Multiple choice (nominal) • Male • Female • Other/I prefer not to say	Gender	2
Occupant status	Please select your occupancy status.	Multiple choice (nominal) • Homeowner • Renter • Other	Occupant_status	3
Household composition	How many people are living in your household?	Multiple choice (ordinal) • 1 • 2 • 3 • 4 • 5 • 6+	Household_composition	4
Children	Are there children (17 years or below) living in your household?	Multiple choice (nominal) • Yes, 1 • Yes, 2 • Yes, 3 or more • No	Children	5

Retirement	Is anyone in your household retired?	Multiple choice (nominal) • Yes, myself • Yes, my partner and I • Yes, my partner, but not me • No	Retirement	6
Household occupancy patterns	At what times of the day is someone usually at home in your household?	Matrix Scale points: • Morning (6:00-10:00), • Daytime (10:00-17:00), • Evening (17:00-22:00) Statements: • Monday • Tuesday • Wednesday • Thursday • Friday • Saturday • Sunday	Household_occupancy_1_1 - Household_occupancy_1_3 until Household_occupancy_7_1 - Household_occupancy_1_3	7
PV capacity	Please indicate the number of solar panels	Open (ratio, >0)	PV_capacity	8
Battery system	Please select if your house has a battery storage system to store PV-generated electricity.	Multiple choice (nominal) • Yes • No, and I don't want this • No, but I am considering buying this	Battery_system	9
Dishwasher and washing machine ownership	Please select which of these appliances you have in your home.	Multiple choice (nominal) • Dishwasher • Washing machine	Appliance_possession_1[1] Appliance_possession_2	10
Section 2: Current appliance use				

[1] 1 refers here to dishwasher, 2 refers here to washing machine

Appliance usage frequency	How many times a week do you use the appliance [2]on average?	Multiple choice (ordinal) • 0-1 times • 2-3 times • 4-5 times • 6+ times	Appliance_frequency1[3] Appliance_frequency2	11
Appliance usage timing	At what times of the day do you typically use the appliance?	Matrix Scale points: • Morning (6:00-10:00), • Daytime (10:00-17:00), • Evening (17:00-22:00) • Night (22:00-06:00) Statements: • Monday • Tuesday • Wednesday • Thursday • Friday • Saturday • Sunday	Appliance_timing1_1_1 - Appliance_timing1_1_4 until Appliance_timing1_7_1 - Appliance_timing1_7_4 and Appliance_timing2_1_1 - Appliance_timing2_1_4 until Appliance_timing2_7_1 - Appliance_timing2_7_4	12
Appliance usage planning	I use the appliance without planning it.	5-point Likert scale (interval) (Strongly disagree → strongly agree)[4]	Appliance_planning1 Appliance_planning2	13
Appliance usage routine	I use the appliance at a certain time as part of my routine.	5-point Likert scale (interval)	Appliance_routine1 Appliance_routine2	14
Appliance use thinking	I do not think about when I use the appliance, I do dishes/the laundry when it suits me.	5-point Likert scale (interval)	Appliance_thinking1 Appliance_thinking2	15
Section 3: Experience with load shifting				

[2]Appliance in this section refers to either a dishwasher or washing machine, depending on grouping of respondents
[3] 1 refers in this section to dishwasher, while 2 refers to washing machine
[4] Used for all other statements in this section

Shifting experience	Do you actively shift electricity use to match PV generation?	Multiple choice (nominal) • Yes • No *(if No, Q17-20 not shown)* • Sometimes	Shifting_experience	16
Shifting frequency	If yes or sometimes, how often do you shift your electricity use?	Multiple choice (nominal) • Daily • A few times per week • Once a week • Less often • Never	Shifting_frequency	17
Shifting method	How do you load shift these appliances?	Multiple choice (nominal) • I manually turn them on when my solar panels are generating electricity • I use a timer or a delay start function • I use a smart home system or automation that shifts appliance use based on solar generation. • Other (open)	Shifting_method_1 – Shifting_method_4	18
Shifting appliances	How often do you shift the use of these appliances in a week?	Matrix Scale points: • Daily • A few times per week • Once a week • Less often • Never • Not applicable Statements: • Dishwasher • Washing machine • Dryer • Electric vehicle	Shifting_appliances_1 - Shifting_appliances_4	19

Motivation shifting	Why are you doing this already?	Open	Motivation_shift	20
Motivation to not shift	Why are you currently not doing this yet?	Open *(only if No indicated in Q16)*	Motivation_not_shift	21
Section 4: Hassle in load shifting				
Manual planning effort	Turning on the appliance[5] manually when the sun is shining takes too much effort.	5-point Likert scale (interval) (I never experience this → I always experience this)[6]	Hassle_factors_dishw_1 and Hassle_factors_washi_1	22
Timer planning effort	Shifting the appliance use to when the sun shines with timers or automation is too complicated.	5-point Likert scale (interval)	Hassle_factors_dishw_2 and Hassle_factors_washi_2	23
PV monitoring effort	I find it too much work to check my PV panel generation before using the appliance.	5-point Likert scale (interval)	Hassle_factors_dishw_3 and Hassle_factors_washi_3	24
Weather forecasting effort	Checking the weather forecast to decide when to run the appliance is inconvenient.	5-point Likert scale (interval)	Hassle_factors_dishw_4 and Hassle_factors_washi_4	25
Half-full machine inconvenience	I find it inconvenient to run the appliance with half-full loads.	5-point Likert scale (interval)	Hassle_factors_dishw_5 and Hassle_factors_washi_5	26
Overloaded machine inconvenience	I find it inconvenient that the number of dishes on the countertop/laundry in the laundry basket piles up too much when I want to shift my use.	5-point Likert scale (interval)	Hassle_factors_dishw_6 and Hassle_factors_washi_6	27
Household coordination effort	Coordinating the appliance use with household members is difficult.	5-point Likert scale (interval)	Hassle_factors_dishw_7 and Hassle_factors_washi_7	28
Unmonitored use concern	I worry about potential safety risks when running the appliance while I'm not at home.	5-point Likert scale (interval)	Hassle_factors_dishw_8 and Hassle_factors_washi_8	29
Decision uncertainty	I often feel uncertain about which appliances I should shift.	5-point Likert scale (interval)	Hassle_factors_dishw_9 and Hassle_factors_washi_9	30
Simultaneous appliance use inconvenience	I find it too much work to operate several appliances (e.g. washing machine, dishwasher, dryer) simultaneously.	5-point Likert scale (interval)	Hassle_factors_dishw_10 and Hassle_factors_washi_10	31

[5] Appliance in this section refers to either a dishwasher or washing machine, depending on grouping of respondents
[6] Used for all other statements in this section

Other hassles	Are there any other barriers you experience when trying to shift your electricity use to hours of sun when your PV panels are generating?	Open	Other_hassles_dishwa and Other_hassles_washing	32
Section 5: Causes of hassle perception				
Changing routines	I find it in general difficult to change daily routines.	5-point Likert scale (interval) (Strongly disagree → strongly agree)[7]	Causes_hassle_1	33
Energy awareness	I like monitoring my energy generation and consumption.	5-point Likert scale (interval)	Causes_hassle_2	34
Personal flexibility	I prefer to keep my own schedule, rather than following a schedule based on sun hours.	5-point Likert scale (interval)	Causes_hassle_3	35
Stress sensitivity	I generally feel stressed when my routines are disrupted.	5-point Likert scale (interval)	Causes_hassle_4	36
Hassle in other parts life	I experience hassle in other parts of my life (e.g. at work or with family).	5-point Likert scale (interval)	Causes_hassle_5	37
Own schedule	My own work/school schedule makes it difficult to shift appliance use.	5-point Likert scale (interval)	Causes_hassle_6	38
Household schedules	The work/school schedules within my household create challenges for shifting appliance use.	5-point Likert scale (interval)	Causes_hassle_7	39
Disturbing neighbours	I worry about disturbing neighbours when shifting appliance use to different hours.	5-point Likert scale (interval)	Causes_hassle_8	40
Other factors	Are there any other reasons why you find load shifting a hassle?	Open	Other_causes	41
Section 6: End and interest in interview				
Interest in interview	Are you willing to participate in a follow-up interview?	Multiple choice (nominal) • Yes • No	Interest_interview	42
Contact details	If yes, please leave your name and email address.	Open *(only shown if Yes indicated in Q42)*	Contact_details	43

[7] Used for all other statements in this section

5. RESULTS

This chapter outlines the survey results based on all conducted statistical analyses. Additionally, it presents the insights from the open-ended survey questions. Ultimately, the findings of this chapter are used to answer:

- Sub-question 4: How does hassle perception differ between dishwasher and washing machine use in the context of load shifting among Dutch households with solar panels?
- Sub-question 5: What contextual and internal factors contribute to hassle perception in load shifting among Dutch households with solar panels?

5.1 Data

A total of 311 respondents participated in the survey. The dataset was first cleaned to ensure data quality and reliable analysis. Because the survey included logical branching based on appliance ownership, the initial cleaning was done within Qualtrics. Respondents who did not reach the final question were excluded, as full completion was required. This step removed 43 cases. A likely reason for this dropout is that some participants may have found the survey too time-consuming, possibly due to several matrix-style questions requiring detailed input. As outlined in Chapter 4, respondents who did not proceed beyond the validation step were automatically removed after 72 hours. The cleaned dataset of 268 responses was then exported to SPSS (version 29) for further processing. In SPSS, eight additional respondents were excluded because they did not indicate ownership of either a dishwasher or a washing machine, and therefore were not assigned to an appliance group. These responses had not been automatically filtered out by Qualtrics. In total, 260 completed and valid responses were retained for analysis.

5.2 Overview sample

An overview of the demographic and household-related characteristics of the sample is presented in Table 5.1. Where possible, the percentages observed in the sample were compared to those in the general population. If no reliable population data were available, this is indicated with a dash (–). For occupancy status and home battery, population percentages were explicitly based on households with solar panels, rather than the general population.

Table 5.1 Demographics and household characteristics

Variable	Values	Frequency in sample (N = 260)	Percentage in sample	Percentage in Dutch population
Gender	Male	158	61%	49.7%[8]
	Female	95	37%	50.3%
	Other	7	2.7%	-
Occupancy status	Homeowner	253	97%	≈82%[9]
	Renter	6	2.3%	≈18%
	Other	1	0.4%	-
Household composition	1	20	7.7%	39.9%[10]
	2	118	46%	32.3%
	3	42	16%	11.6%
	4	62	24%	11.4%
	5	12	4.6%	4.8%*
	6+	5	1.9%	-
Children (17 years or below)	Yes, 1	30	12%	13.9%[11]
	Yes, 2	42	16%	12.8%
	Yes, 3 or more	13	5.0%	4.9%
	No	175	67%	68.4%[3]
Retired	Yes, me	28	11%	18.3%[12]
	Yes, me and my partner	42	16%	-
	Yes, me but my partner not	6	2.3%	-
	No	184	71%	81.7%
Home battery	Yes	12	4.6%	≈1.4%[13]
	No, and I don't want	85	33%	-
	No, but I consider buying	163	63%	-
Appliance possession	Washing machine	260	97%	-
	Dishwasher	244	91%	-
Appliance group	Washing machine	120	46%	-
	Dishwasher	140	54%	-

[8] Centraal Bureau Voor De Statistiek. (2022). Mannen en vrouwen. Centraal Bureau Voor de Statistiek. https://www.cbs.nl/nl-nl/visualisaties/dashboard-bevolking/mannen-en-vrouwen

[9] Solar Magazine. (2024, December 14). Toch recordhoeveelheid zonnepanelen voor huurwoningen, 1 op 3 eengezinswoningen heeft zonnepanelen. Solar Magazine. https://solarmagazine.nl/nieuws-zonne-energie/i39290/toch-recordhoeveelheid-zonnepanelen-voor-huurwoningen-1-op-3-eengezinswoningen-heeft-zonnepanelen and Centraal Bureau Voor De Statistiek. (2025, January 14). Zonnestroom; vermogen en vermogensklasse, bedrijven en woningen, regio. Centraal Bureau Voor De Statistiek. https://www.cbs.nl/nl-nl/cijfers/detail/85005NED. This percentage is based on number of social housing with PV as part of total number of households with PV.

[10] Centraal Bureau Voor De Statistiek. (2024, June 14). Huishoudens; samenstelling, grootte, regio, 1 januari. Centraal Bureau Voor De Statistiek. https://www.cbs.nl/nl-nl/cijfers/detail/71486ned. * This data is reported until five persons or more.

[11] Centraal Bureau Voor De Statistiek. (2024, June 14). Huishoudens; kindertal, leeftijdsklasse kind, regio, 1 januari. Centraal Bureau Voor De Statistiek. https://www.cbs.nl/nl-nl/cijfers/detail/71487ned.

[12] Centraal Bureau Voor De Statistiek. (2024, April 28). Pensioenleeftijd werknemers nadert 66 jaar. Centraal Bureau Voor De Statistiek. https://www.cbs.nl/nl-nl/nieuws/2024/18/pensioenleeftijd-werknemers-nadert-66-jaar

[13] Centraal Bureau Voor De Statistiek. (2025, January 14). Zonnestroom; vermogen en vermogensklasse, bedrijven en woningen, regio. Centraal Bureau Voor De Statistiek. https://www.cbs.nl/nl-nl/cijfers/detail/85005NED and Van Gaalen, D. (2024, October 10). Forse groei in het aantal geïnstalleerde thuisbatterijen in Nederland. Thuisbatterij.nl. https://thuisbatterij.nl/nieuws/forse-groei-aantal-geinstalleerde-thuisbatterijen-nederland/. Calculation based on estimated number of home batteries installed as part of total households with solar panels.

The descriptive statistics show several deviations between the sample and the general Dutch population. Men are overrepresented (61% in the sample vs. 49.7% nationally), as are homeowners (97% vs. ~82%). Single-person households are strongly underrepresented (7.7% vs. 39.9%), while two-, three- and four-person households are overrepresented compared to the general population. Households with children are roughly in line with the general population, although there's a slight overrepresentation of families with two children. The number of retirees is lower than average (71% vs. 81.7%). Finally, a relatively large number of respondents mentioned that they are considering buying a home battery. Because national data on this topic is not available, it's unclear how representative this is. Together, these sample characteristics should be kept in mind when interpreting the results and their generalisability.

Figure 5 presents the distribution of installed solar panels per household. The median number of panels is 12, with a slightly higher mean of 14.6, indicating a right-skewed distribution. Most households in the sample have between 8 and 12 panels, while a smaller number reported substantially more, some exceeding 30 panels. These outliers may reflect households living on farms or renters reporting the total number of shared roof panels. According to Centraal Bureau voor de Statistiek (2024b), the average Dutch residential PV installation had around 4,000 watts in 2023, equivalent to roughly 9–12 panels (HomeQgo, 2025). This indicates that the sample aligns well with the national average regarding the number of installed solar panels.

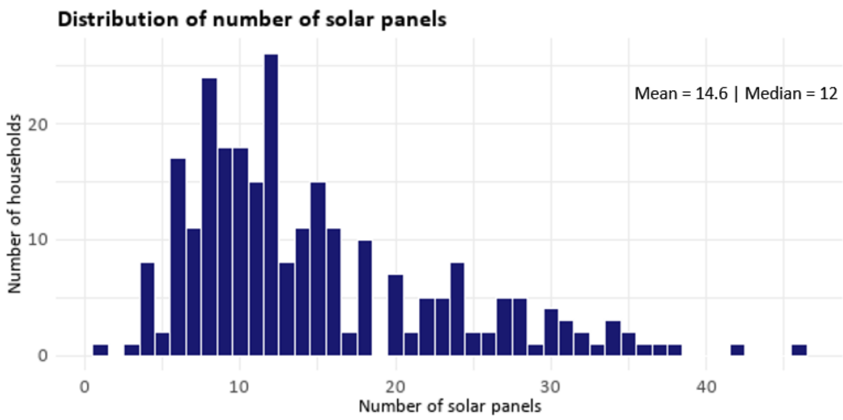

Figure 5 Distribution of number of PV panels in sample

Dishwasher and washing machine usage patterns are visualised in Figures 6 and 7, while Figure 8 illustrates household presence throughout the week. For both appliances, use is concentrated during daytime (10:00–17:00) across all days, especially for the washing machine, which is used significantly less during other moments. Dishwasher use follows a similar pattern but is also commonly used in the evening (17:00–22:00) and night (22:00–06:00). Weekly patterns reveal that washing machine use peaks during weekends, likely because people have more time for laundry. Dishwasher use, in contrast, is more evenly spread across the week, suggesting consistent daily use. Morning use (06:00–10:00) remains low for both appliances, possibly because people are not yet awake or at home. Figure 8 provides additional context. Evening hours (17:00–22:00) have the highest occupancy throughout the week. On weekdays, presence is lower in the morning and at daytime, likely due to work and school restrictions. Weekend days show more balanced occupancy, with higher presence during both the morning and daytime hours. These patterns help explain the appliance use trends observed. For instance, the high daytime presence during the weekend corresponds with increased washing machine use on those days. Similarly, consistent evening presence aligns with dishwasher use after dinner.

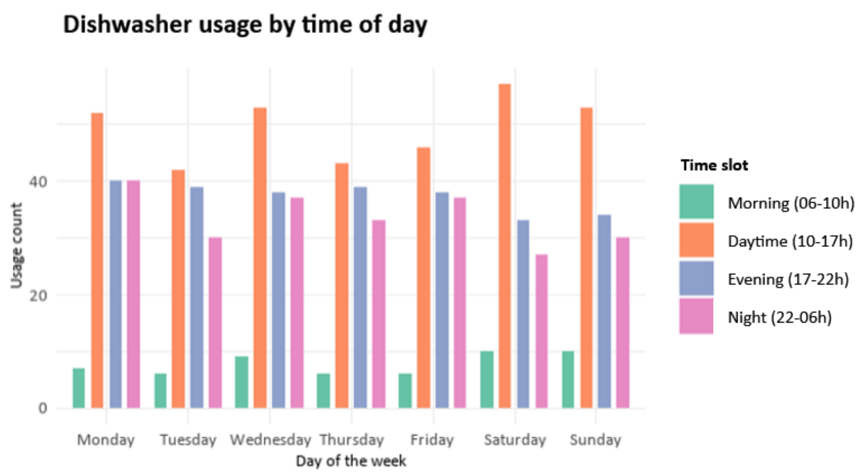

Figure 6 Dishwasher usage

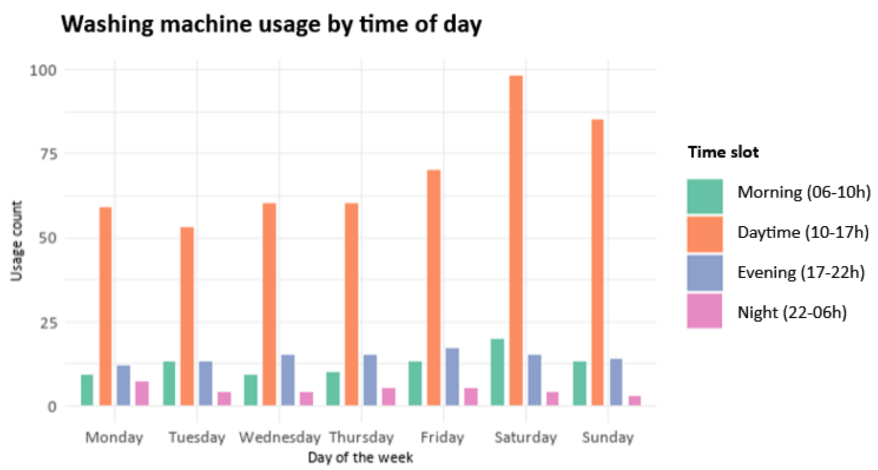

Figure 7 Washing machine usage

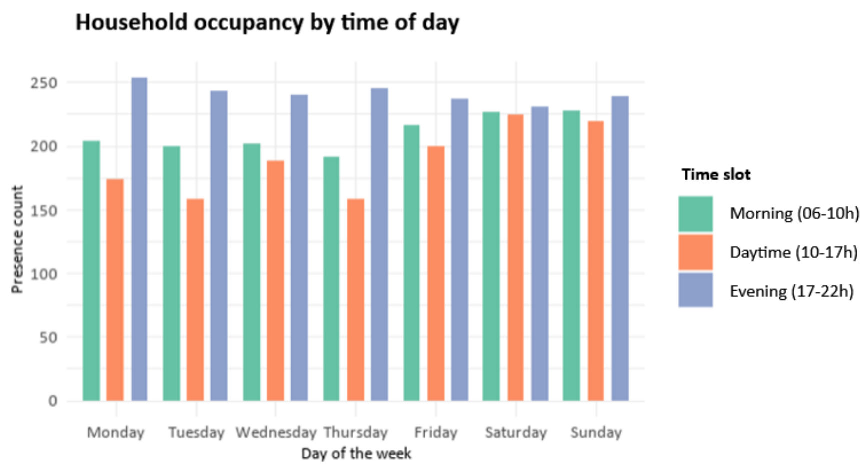

Figure 8 Household occupancy

Descriptive statistics on load shifting behaviour show that a large majority of respondents (71.9%) load shift. About 15.8% indicate they shift electricity use sometimes, while only 12.3% report no shifting at all. Among those who do shift, most do so a few times per week (47.7%), followed by daily (21.5%) and once a week (13.5%). Only a small share (5.0%) shifts less than once a week. In terms of method, 68.8% of respondents report manually turning on appliances when their solar panels generate electricity. Fewer participants use timers (33.8%) or smart home systems (6.9%). These results suggest that load shifting behaviour among participants is relatively high, although it is still largely based on manual actions rather than timers or other automated solutions.

5.3 Hassle factors

This section presents the results related to perceived hassle factors associated with shifting dishwasher and washing machine use. The findings are based on descriptive statistics, t-tests comparing subgroups, and a principal component analysis (PCA) used to identify broader dimensions of hassle. Table 5.2 provides an overview of the average mean scores (M) per hassle factor, with the number of respondents (N) and the standard deviation (SD). Across both appliance groups, the hassle factor with the highest mean score was the inconvenience of running a half-full machine. Other commonly perceived factors included the inconvenience of having an overloaded machine, PV monitoring effort, weather forecasting effort, and timer planning effort. The least reported hassle in both groups was the simultaneous appliance use inconvenience.

Table 5.2 Hassle factors

	Dishwasher group			***Washing machine group***		
Hassle factors	*N*	*M*	*SD*	*N*	*M*	*SD*
Half-full machine inconvenience	119	3.67	1.37	138	3.12	1.42
Overloaded machine inconvenience	120	2.56	1.49	139	2.34	1.32
Weather forecasting effort	120	2.42	1.23	139	2.17	1.23
PV monitoring effort	120	2.34	1.45	138	2.38	1.46
Timer planning effort	120	2.20	1.41	138	1.99	1.26
Coordination household effort	120	1.94	1.24	138	1.51	.96
Manual planning effort	120	1.77	1.10	139	1.88	1.18
Decision uncertainty	119	1.68	1.09	139	1.62	.97
Unmonitored use concern	119	1.58	1.05	138	1.80	1.21
Simultaneous appliance use inconvenience	119	1.57	.94	139	1.40	.76

5.3.1 T-tests

The independent-samples T-tests revealed several significant differences in perceived hassle levels across demographic and behavioural subgroups. All relevant SPSS tables can be found in Appendix C.2.

First, hassle perception was compared based on gender, which showed only one significant difference. In the dishwasher group, female respondents reported a significantly higher PV monitoring effort (M = 2.89, SD = 1.60) than male respondents (M = 2.11, SD = 1.32), with p = .012. Gender differences were not significant in the washing machine group. In general, women tended to report higher hassle levels in the dishwasher group, whereas men reported slightly more hassle in the washing machine group.

Following, hassle perception was compared based on the presence of children (below 18) in the household. The results show that respondents with children consistently rated hassle factors higher compared to those without children. In the dishwasher group, manual planning effort was rated significantly higher by households with children (*M* = 2.24, *SD* = 1.30) than those without (*M* = 1.60, *SD* = .96), with *p* = .013. Similarly, weather forecasting effort (*M* = 3.00, *SD* = 1.50 vs. *M* = 2.21, *SD* = 1.33) with *p* = .006, household coordination effort (*M* = 2.52, *SD* = 1.58 vs. *M* = 1.72, *SD* = 1.01) with *p* = .011, and simultaneous appliance use inconvenience (*M* = 1.94, *SD* = 1.17 vs. *M* = 1.43, *SD* = .81) with *p* = .044, were all rated significantly higher by households with children.

There are similar results in the washing machine group. Households with children also perceive more manual planning effort (*M* = 2.29, *SD* = 1.27 vs. *M* = 1.64, *SD* = 1.06) with *p* = .003, PV monitoring effort (*M* = 2.94, *SD* = 1.48 vs. *M* = 2.06, *SD* = 1.36) with *p* < .000, overloaded machine inconvenience (*M* = 2.77, *SD* = 1.37 vs. *M* = 2.08, *SD* = 1.22) with *p* = .003, decision uncertainty (*M* = 1.87, *SD* = 1.17 vs. *M* = 1.47, *SD* = .79) with *p* = .035 and simultaneous appliance use inconvenience (*M* = 1.58, *SD* = .89 vs. *M* = 1.29, *SD* = .65) with *p* = .044. These results indicate that families with children perceive more hassle in managing and shifting appliance use, potentially due to increased scheduling complexity and time constraints.

Next, hassle perception was compared based on the size of the household. When comparing smaller (1–2 person) households with larger ones (3+ persons), the larger households reported significantly higher hassle scores in both groups. In the dishwasher group, these included manual planning effort (*M* = 2.00, *SD* = 1.25 vs. *M* = 1.56, *SD* = .89) with *p* = .027, weather forecasting effort (*M* = 2.71, *SD* = 1.49 vs. *M* = 2.15, *SD* = 1.30) with *p* = .029, and half-full machine inconvenience (*M* = 3.95, *SD* = 1.33 vs. *M* = 3.41, *SD* = 1.37) with *p* = .032. Household coordination effort showed the largest difference (*M* = 2.31, *SD* = 1.44 vs. *M* = 1.59, *SD* = .88) with *p* = .002.

In the washing machine group, similar results were obtained. Multi-person households scored significantly higher on perceived manual planning effort (*M* = 2.24, *SD* = 1.26 vs. *M* = 1.55, *SD* = .96) with *p* = .001, PV monitoring effort (*M* = 2.95, *SD* = 1.51 vs. *M* = 1.95, *SD* = 1.26) with *p* < .001, and overloaded machines inconvenience (*M* = 2.76, *SD* = 1.38 vs. *M* = 2.01, *SD* = 1.17) with *p* = .001. Additionally, household coordination effort again showed a significant difference (*M* = 1.75, *SD* = 1.15 vs. *M* = 1.32, *SD* = .73) with *p* = .011, as did decision uncertainty (*M* = 1.87, *SD* = 1.14 vs. *M* = 1.42, *SD* = .75) with *p* = .009. These findings suggest that the perceived hassle associated with shifting appliance use increases as household size increases.

As children and household size are likely to be related, a Pearson correlation was computed between the variables measuring household size (*Household_composition_recoded*) and children presence (*Children_yes_no*), both being binary variables. This correlation revealed a strong, statistically significant negative correlation (*r* = –.730, *p* < .001). This indicates that households with children are often also larger. Therefore, the observed differences in hassle perception between smaller and larger households may partly reflect underlying differences related to having children, such as more complex routines or time constraints. This overlap should be taken into account when interpreting the results.

Lastly, hassle perception was compared based on the load shifting method used (manual or timers/delayed start). In the dishwasher group, manually shifting users reported more hassle with using timers (*M* = 2.44, *SD* = 1.52 vs. *M* = 1.74, *SD* = 1.05) with *p* = .027 and unmonitored use concern (*M* = 1.73, *SD* = 1.19 vs. *M* = 1.26, *SD* = .45) with *p* = .011 than those using timers. Furthermore, respondents who use timers rated household coordination effort higher (*M* = 2.42, *SD* = 1.35 vs. *M* = 1.77, *SD* = 1.19) with *p* = .044. In the washing machine group, only the factor of simultaneous appliance use inconvenience differed significantly (*M* = 1.36, *SD* = .60 vs. *M* = 1.14, *SD* = .35) with *p* = .038, with manual users scoring slightly higher.

5.3.2 Principal component analyses

Principal Component Analyses (PCA) were conducted separately for the dishwasher and washing machine groups to explore whether the ten measured hassle factors could be reduced into broader underlying components. The following variables were included: *hassle_factors_dishw_1 to 10* (dishwasher group) and *hassle_factors_washi_1 to 10* (washing machine group). All relevant output tables and figures are presented in Appendix C.3.

PCAs were conducted using Oblimin rotation, based on the assumption that hassle factors may be conceptually related. To test the appropriateness of this oblique rotation, an additional PCA with Varimax rotation, assuming no correlation between components, was conducted. The component structure remained largely consistent across both methods, with variables loading on the same components. Given this consistency and the presence of minor correlations between components using Oblimin rotation, the use of Oblimin was deemed most suitable for interpretation.

The Kaiser-Meyer-Olkin (KMO) values for the dishwasher group (0.838) and the washing machine group (0.823) indicate good sampling adequacy. In both groups, Bartlett's Test of Sphericity was significant ($p < .001$), supporting the suitability of the data for PCA. The number of components to retain was assessed using the scree plot by looking for an elbow in the plot. Also, the Kaiser criterion was examined by retaining the number of components with an eigenvalue above the 1.0 threshold (Abdi & Williams, 2010). In both groups, the scree plot showed a clear inflection after the first component, suggesting the presence of only one component. Using the Kaiser criterion, three components could be identified. However, the second and third components had only slightly higher values than 1.0 (dishwasher group: 1.14 and 1.03; washing machine group: 1.17 and 1.04), which limits their interpretive value. A loading threshold of .50 was used to assign variables to components.

The first component in the dishwasher group, explaining 36.6% of the variance, consisted of six variables with moderate to strong loadings: PV monitoring effort (.786), manual planning effort (.757), timer planning effort (.732), simultaneous appliance use inconvenience (.699), decision uncertainty (.556), and weather forecasting effort (.518). These variables reflect cognitive and operational challenges in load shifting, such as the effort of manually starting appliances, using timers, checking solar generation or the weather forecast, operating appliances simultaneously and deciding which appliance to shift. This component was interpreted as operational hassle.

The second and third components were less robust. Component 2 included only unmonitored use concern (.857), which on its own does not justify defining a distinct component. Component 3 included half-full machine (.874) and overloaded machine (.592), which conceptually align under the broader theme of load size inconvenience, a single hassle factor identified in the literature. However, the eigenvalue for this component was only 1.04, indicating limited explanatory power and undermining its validity as a distinct component.

The component correlation matrix showed modest correlations. Components 1 and 3 were slightly correlated ($r = .336$), which suggests that these components may share some conceptual overlap. In contrast, components 1 and 2 are weakly negatively correlated ($r = -.130$), while components 2 and 3 show barely any correlation ($r = -.056$). This does support the decision to use Oblimin, as the components are not entirely independent.

In the washing machine group, the first component explained 36.3% of the variance and comprised decision uncertainty (.887), simultaneous appliance use inconvenience (.727), and manual planning effort (.561). While this partially overlaps with the component in the dishwasher group, several variables that had loaded strongly in the dishwasher analysis, including PV monitoring effort, timer planning effort, and weather forecasting effort, were absent here. This component includes the cognitive burden of having to decide which appliance to shift, the practical inconvenience of operating multiple appliances at the same time, and the additional effort of manually starting the appliance. While the items share a focus on decision-making and task alignment, the conceptual coherence is less strong than in the dishwasher group. Nevertheless, these items together can be interpreted as cognitive coordination hassle: the mental and organisational effort required to manage appliance use within the competing demands of household routines.

Component 2 again consisted of a single variable: unmonitored use concern (.831), which could not be defined as a distinct component. Component 3 included coordination household (.860) and overloaded machine (.532), though no coherent conceptual theme could be identified between these variables. Again, component correlations were modest: component 1 and 3 (r = .354), component 1 and 2 (r = .081), and component 2 and 3 (r = .069).

The PCA results suggest the presence of one interpretable and meaningful component in each appliance group. In the dishwasher group, this was defined as operational hassle, while in the washing machine group, a slightly different component emerged, described as cognitive coordination hassle. Although two additional components met the eigenvalue > 1.0 criterion, they lacked theoretical clarity and contained either too few items or weak internal coherence.

5.4 Effect of hassle perception on load shifting behaviour

This section presents the results of several multiple linear regression analyses exploring how perceived hassle influences load shifting. Multiple linear regression was used instead of a simple linear regression because there are ten potential predictors in the model instead of one. The results in this section directly contribute to answering sub-question 4. Linear regression analyses were conducted to examine the relationships between perceived hassle and current load shifting behaviour. Two sets of linear regression models were constructed: (1) hassle factors predicting general load shifting behaviour, and (2) hassle factors predicting appliance-specific load shifting behaviour. Each analysis was conducted separately for the dishwasher and washing machine groups, with corresponding variables. All relevant output tables and figures are presented in Appendix C.4 and C.5. The linear regression models included the following predictors and dependent variables:

1) The variables *hassle_factors_dishw_1 to 10* and *hassle_factors_washi_1 to 10* were used as the predictors with *LS_experience_frequency* as the dependent variable to assess how hassle perceptions affect overall load shifting behaviour.
2) The variables *hassle_factors_dishw_1 to 10* and *hassle_factors_washi_1 to 10* were used as the predictors with *Shifting_appliance_1_recoded* and *Shifting_appliance_2_recoded* as the dependent variables to assess how hassle perceptions affect appliance-specific load shifting behaviour.

The predictors were entered into the analysis simultaneously according to the enter method. This method was chosen based on the exploratory nature of the study. No strong a priori assumptions were made about which individual hassle factor would be the most influential. The enter method is particularly appropriate in such cases, as it allows all variables of theoretical interest to be considered equally, without relying on automated selection criteria that may exclude conceptually important predictors (Field, 2013).

Additionally, three assumptions for linear regression models were checked for all models (Poole & O'Farrell, 1971). First, multicollinearity among the hassle factors was evaluated. All Variance Inflation Factor (VIF) values were below the chosen threshold of 3, indicating that multicollinearity was not a concern. Next, the assumption of normality was checked. A Normal P–P Plot of the standardised residuals indicates that the residuals were approximately normally distributed, with points closely following the diagonal line. This suggests that the assumption of normality was sufficiently met. Next, the assumption of homoscedasticity was checked. A scatterplot of standardised residuals against predicted values showed no clear pattern in the distribution. Therefore, this assumption was also sufficiently met.

Both models in the first set of regression analyses were statistically significant. In the dishwasher group, the model predicting general load shifting behaviour explained 35.8% of the variance in behaviour, $F(10, 106) = 5.91$, $p < .001$ (Adjusted $R^2 = .297$). In this group, two hassle factors significantly predicted lower behaviour: **decision uncertainty** ($\beta = -0.318$, $p < .001$) and **PV monitoring effort** ($\beta = -0.273$, $p = .012$). These results suggest that when people feel uncertain about which appliance to shift, they are less likely to load shift. Similarly, perceiving it as too much effort to check the PV panel generation before use also lowers the likelihood of shifting behaviour.

In the washing machine group, the model predicting general load shifting behaviour explained 25.7% of the variance in behaviour, $F(10, 124) = 4.28$, $p < .001$ (Adjusted $R^2 = .197$). In this group, **manual planning effort** ($\beta = -0.280$, $p = .006$) and **PV monitoring effort** ($\beta = -0.238$, $p = .036$) were significant negative predictors. This suggests that when participants experience inconvenience in manually turning the appliance on, as well as in checking PV generation, they are less likely to shift the use.

Both models in the second set of regression analyses were also statistically significant. In the dishwasher group, the model predicting appliance-specific load shifting behaviour explained 24.3% of the variance in behaviour, $F(10, 94) = 3.02$, $p < .002$ (Adjusted $R^2 = .162$). In this group, **overloaded machine inconvenience** was the only significant predictor ($\beta = -0.260$, $p = .012$), indicating that concerns over dishes piling up can discourage shifting. PV monitoring effort showed a negative trend ($\beta = -0.210$, p = .083), though it did not reach significance. In the washing machine group, the model predicting appliance-specific load shifting behaviour explained 27.6% of the variance in behaviour, $F(10, 105) = 4.01$, $p < .001$ (Adjusted $R^2 = .207$). In the washing machine model, **PV monitoring effort** again stood out as a significant negative predictor ($\beta = -0.497$, $p < .001$), confirming that checking PV output was a consistent barrier across both regression models.

5.5 The role of habits

This section presents the results regarding the relationship between habits and hassle perception, as well as between habits and appliance-specific load shifting behaviour. The results in this section contribute to answering sub-question 5. First, to explore the relationship between habits and hassle perception, correlations were calculated between the constructed habit variables and appliance-specific hassle factors. The composite variables of habit strength were based on "use without planning" and "use without thinking", as explained in section 4.3.1, while the routine item was included as a separate variable. All relevant output tables and figures are presented in Appendix C.6 and C.7.

5.5.1 Correlation analyses

Bivariate correlation analyses were constructed using Spearman's rho (ρ), given the ordinal nature of the Likert-scale data (Clason & Dormody, 1994). In the first correlation analysis, the variables *Habit_strength_dishw*, *Appliance_routine1* and *hassle_factors_dishw_1 to 10* were used. In the second correlation analysis, the variables *Habit_strength_washi* and *Appliance_routine2* and *hassle_factors_washi_1 to 10* were used.

In the dishwasher group, significant positive correlations were found between *Habit_strength_dishw* and all hassle factors except for household coordination effort and simultaneous appliance use inconvenience. Strongest associations were observed with decision uncertainty (ρ = .273, p = .003), overloaded machine inconvenience (ρ = .249, p = .006), and manual planning effort (ρ = .226, p = .013). These results suggest that higher levels of automatic habitual behaviour are associated with greater perception of these hassle factors. The routine item (*Appliance_routine1*) also correlated significantly with many of the same hassle items, except for the unmonitored use concern factor. The highest correlations were observed with manual planning effort (ρ = .291, p = .002), PV monitoring effort (ρ = .259, p = .005), and weather forecasting effort (ρ = .228, p = .014), indicating that fixed routines may reinforce perceptions of effort in tasks requiring flexibility or timing.

In the washing machine group, different patterns were observed. The variable *Habit_strength_washi* showed significant correlations with PV monitoring effort (ρ = .381, p < .001), weather forecasting effort (ρ = .257, p = .003) and manual planning effort (ρ = .171, p = .047). However, the routine item (*Appliance_routine2*) did not show significant correlations with any of the hassle factors, suggesting that fixed routines were not consistently associated with perceived hassle in this group.

These results indicate that habitual behaviour is more strongly linked to hassle perception in the dishwasher group than in the washing machine group. Particularly for dishwasher use, both automaticity and routine are associated with higher perceived effort. In contrast, for washing machine use, only unplanned, automatic use shows some relationships with perceived hassle, while fixed routines appear less relevant.

5.5.2 Linear regression analyses

Next, to examine whether habits predict actual load shifting behaviour, separate multiple linear regression analyses were conducted for each appliance group. The variables *Habit_strength_dishw* and *Appliance_routine1* (for dishwasher use) and *Habit_strength_washi* and *Appliance_routine2* (for washing machine use) were used as the predictors, with *Shifting_appliance_1_recoded* and *Shifting_appliance_2_recoded* as the dependent variables. These analyses were conducted not only to test whether habitual behaviour predicts perceived hassle, but also to test whether habits directly influence behavioural outcomes. By conducting these regressions, the study aims to better understand the role of habits as both antecedents to hassle and a direct barrier to load shifting. This was done as literature highlights also the direct effect of embedded routines on residential load shifting (Bradley et al., 2016). The predictors were entered simultaneously using the enter method, following the same rationale outlined earlier.

Before interpreting the results, key assumptions for linear regression were checked in both models. Multicollinearity was not a concern as all Variance Inflation Factor (VIF) values were close to 1 and well below the threshold of 3. The assumption of normality of residuals was assessed using a Normal P–P plot, which showed that the standardised residuals followed the expected diagonal line closely. Additionally, the assumption of homoscedasticity was confirmed by inspecting the scatterplot of standardised residuals versus predicted values, in which no clear funnel or curvature patterns were observed. Together, these insights support the validity of the regression models

In the dishwasher group, the regression model was statistically significant, $F(2, 99) = 16.46$, $p < .001$, and explained 25.0% of the variance in dishwasher-specific load shifting behaviour (Adjusted R^2 = .234). Both predictors significantly contributed to the model. Specifically, the habit strength composite variable was a strong negative predictor (β = –0.366, p < .001), suggesting that automatic use of the dishwasher without planning or conscious thought hinders appliance-specific load shifting behaviour. Similarly, the routine item was also a significant negative predictor (β = –0.306, p < .001), indicating that fixed use patterns, such as always running the dishwasher at a certain time, can reduce behavioural flexibility.

In the washing machine group, the regression model was statistically significant, $F(2, 113) = 14.26$, p < .001, and explained 20.2% of the variance in washing machine-specific load shifting behaviour (Adjusted R^2 = .187). The habit strength composite variable was again a strong negative predictor (β = –0.434, p < .001), while routine was not significant (β = –0.096, p = .254). This suggests that for washing machine use, unplanned and automatic behaviour is a stronger barrier to shifting than following a fixed routine alone.

5.6 Causes of hassle perception

This section presents the results related to the assessment of the underlying causes of hassle perception in load shifting. The findings are based on descriptive statistics, correlation analyses, and multiple linear regression analyses used to assess the relationship between hassle perception and various internal and contextual factors. The results in this section contribute to answering sub-question 5. All relevant output tables and figures are presented in Appendix C.8.

First, Table 5.3 provides an overview of the average mean scores for each contextual and internal factor, the number of respondents and the standard deviation. This offers a first indication of their presence. The highest average mean was found for energy awareness, suggesting that many respondents enjoy monitoring their PV generation and usage. This was followed by schedule own, personal flexibility, changing routines and household schedules, which all scored almost equally.
Conversely, disturbing neighbours was the least reported cause, suggesting that the participants were generally not concerned about disturbing others when shifting appliance use to different moments during the day. Also, hassle in life and stress sensitivity scored low compared to the other causes. This suggests that most respondents do not experience much hassle in their family or work life, or feel easily stressed when their daily routines are disrupted.

Table 5.3 Descriptive overview causes of hassle

Contextual factors	*N*	*M*	*SD*	**Internal factors**	*N*	*M*	*SD*
Schedule own	257	2.38	1.35	Energy awareness	260	3.64	1.14
Household schedules	259	2.34	1.39	Personal flexibility	259	2.35	1.23
Disturbing neighbours	258	1.35	.78	Changing routines	258	2.34	1.14
				Stress sensitivity	260	1.95	1.07
				Hassle in life	258	1.92	1.12

5.6.1 Correlation analysis

A bivariate correlation analysis was conducted to examine relationships between individual hassle factors and their potential causes. Spearman's rho was again used given the ordinal nature of the Likert-scale data. The analysis focused on a subset of hassle factors that significantly predicted load shifting behaviour, as described in section 5.4. This selection allowed for a more targeted exploration of which contextual and internal factors are most strongly related to the hassle dimensions that actually influence behavioural outcome.

Correlations were calculated between the eight variables *Causes_hassle_1 to Causes_hassle_8* and the hassle factors decision uncertainty (*hassle_factors_dishw_9)*, PV monitoring effort (*hassle_factors_dishw_3*) and overloaded machine inconvenience (*hassle_factors_dishw_6*) in the dishwasher group. Manual planning effort (*hassle_factors_washi_1*) and PV monitoring effort (*hassle_factors_washi_3*) were used from the washing machine group. Also, the half-full machine factor (*hassle_factors_dishw_5 / hassle_factors_washi_5*) was included due to the highest mean score in both appliance groups (see section 5.3).

The correlation analyses indicate that some causes are more consistently associated with hassle factors than others. Household schedules, schedule own, personal flexibility, changing routines and general hassle in life all showed significant positive correlations with most of the used hassle factors. The correlations were particularly strong between the hassle factor PV monitoring effort and the causes personal flexibility (in the dishwasher group: ρ = .401, p < .001, in the washing machine group: ρ = .500, p < .001), and schedule own (in the dishwasher group: ρ = .349, p < .001, in the washing machine group: ρ = .443, p < .001), This indicates that participants who prefer to follow their own schedule or who report low flexibility in their daily routines tend to perceive checking PV generation as more burdensome. Stress sensitivity was also positively correlated with several hassle factors, though less consistently. Disturbing neighbours only had a significant correlation with decision uncertainty and is therefore considered irrelevant for further interpretation, also considering its very low mean score.

The hassle factor half-full machine inconvenience showed no significant correlations in both appliance groups and was excluded from further interpretation. In both groups, energy awareness was the only cause significantly negatively correlated with hassle, most strongly with PV monitoring effort (in the dishwasher group: ρ = –.410, p = <.001, in the washing machine group: ρ = –.186, p = .029).

5.6.2 Regression analyses

Several multiple linear regressions were conducted to identify which causes significantly predict the specific hassle factors influencing load shifting behaviour (see section 5.4). The linear regression models included *Causes_hassle_1 to 7* as the predictors and the significant hassle factors as the dependent variables in separate analyses, following the same reasoning as outlined in section 5.6.1. The cause disturbing neighbours was excluded due to weak correlations in section 5.6.1. The used dependent variables were (1) decision uncertainty *(hassle_factors_dishw_9)*, (2) PV monitoring effort *(hassle_factors_dishw_3)*, (3) overloaded machine inconvenience *(hassle_factors_dishw_6)* in the dishwasher group, and (4) manual planning effort *(hassle_factors_washi_1)* and (5) PV monitoring effort *(hassle_factors_washi_3)* in the washing machine group. The predictors were entered into the analysis simultaneously according to the enter method, using the same reasoning as described before.

Before interpreting the regression results, key assumptions for multiple linear regression were assessed for all five models. Multicollinearity was examined using VIF values. All predictors fell below the threshold of 3, except for the variable schedule own, which showed a slightly elevated VIF in several models, with a maximum of 3.396. While this exceeds the more conservative threshold of 3, it remains below the more widely accepted cut-off of 5 (James et al., 2013), suggesting that multicollinearity is not a major concern. The assumption of normality of residuals was evaluated using Normal P–P plots. In all five models, the standardised residuals followed the expected diagonal line reasonably well, with only minor deviations at the tails. These small deviations do not appear to undermine the overall normality assumption. Homoscedasticity was checked by inspecting scatterplots of the standardised residuals versus predicted values. Although some plots showed slight clustering at lower predicted values, no clear patterns or heteroscedasticity were observed. Taken together, these checks provide sufficient support for the validity of the regression analyses.

The first regression model predicting decision uncertainty in the dishwasher group was statistically significant, $F(7, 107) = 4.592$, $p < .001$, and explained 23.1% of the variance in decision uncertainty (Adjusted $R^2 = .181$). Three predictors contributed significantly to the model: changing routines ($\beta = .350$, $p = .004$), household schedules ($\beta = .335$, $p = .010$), and hassle in life ($\beta = .233$, $p = .017$). This suggests that participants who find it difficult to change their daily routines, experience scheduling conflicts within the household, or feel burdened by hassle in other areas of life are more likely to feel uncertain about which appliance to shift.

The second regression model predicting PV monitoring effort in the dishwasher group was also statistically significant, $F(7, 108) = 8.981$, $p < .001$, and explained 32.7% of the variance in PV monitoring effort (Adjusted $R^2 = .327$). This hassle factor was primarily predicted by energy awareness, which had a significant negative effect ($\beta = –0.364$, $p < .001$). This indicates that participants who enjoy or are engaged with monitoring their energy usage perceive less effort in checking solar generation.

The third regression model predicting overloaded machine inconvenience in the dishwasher group was also statistically significant, $F(7, 108) = 6.407$, $p < .001$, and explained 29.3% of the variance in this hassle factor (Adjusted $R^2 = .248$). This hassle factor was significantly predicted by changing routines ($\beta = .348$, $p = .003$) and household schedules ($\beta = .351$, $p = .005$). This means that participants who find it difficult to deviate from established routines or who experience scheduling conflicts within the household are more likely to perceive the accumulation of dishes as a burden when attempting to shift appliance use.

The fourth regression model predicting manual planning effort in the washing machine group was also statistically significant, $F(7, 128) = 6.897$, $p < .001$, and explained 27.4% of the variance in this hassle factor (Adjusted $R^2 = .234$). The only significant predictor in this model was personal flexibility ($\beta = .239$, $p = .016$). This suggests that individuals who prefer to maintain their own schedule, rather than adjusting to solar electricity production hours, experience more hassle when they need to manually start the appliance at specific moments.

The fifth regression model, predicting PV monitoring effort in the washing machine group, was also statistically significant, $F(7, 127) = 10.856$, $p < .001$, and explained 37.4% of the variance in this hassle factor (Adjusted $R^2 = .340$). This hassle factor was significantly predicted by personal flexibility ($\beta = .326$, $p < .001$) and energy awareness ($\beta = –.184$, $p = .012$). These findings suggest that individuals who prefer to keep their own schedule are more likely to perceive PV monitoring as effortful. Conversely, energy awareness was again negatively associated with perceived effort, indicating that participants who enjoy tracking their energy usage find it less of a hassle to monitor PV generation. This aligns with earlier findings in the dishwasher group.

5.7 Qualitative insights into load shifting behaviour

This section presents the qualitative analysis of the open-ended responses provided by survey participants. These responses provide additional context to the quantitative findings, offering insight into motivations for (not) load shifting, perceived hassles during the process, and their underlying causes. In this way, they contribute to answering sub-questions 4 and 5. The open responses were categorised into themes based on their content and relevance to this study. Additionally, quotes have been used to illustrate participant perspectives. The original Dutch quotes are included in Appendix D.

5.7.1 Motivations and reasons for (not) load shifting

This section explores both the broad motivations for load shifting and the reasons why some respondents choose not to. Together, these insights provide a more nuanced view of motivations and barriers to load shifting.

Among those who actively load shift, motivations could be grouped into three main themes: financial considerations, anticipation of policy changes, and sustainability and lifestyle considerations. The most common reason mentioned was the desire to make better use of self-generated solar energy and to reduce reliance on the grid. As one respondent mentioned, *"To use as little power from the grid as possible."* Lower energy costs were frequently mentioned, particularly by those with dynamic contracts: *"I check if the sun is shining so I have free power",* and *"Sometimes power is almost free."* Several respondents referred to the upcoming end of the net metering scheme as a reason to change their behaviour: *"To get used to the end of net metering",* and *"To make a conscious effort to use your own generated energy since the scheme will disappear."* Some were motivated to build a habit of load shifting in advance: *"To develop the habit so it becomes a standard practice."* Also, respondents express concern about potential fines for feeding electricity back into the grid after 2027. Specifically, a home renter indicates that they did not choose solar panel installation themselves, but they try to start load shifting now, as they have to pay more when the net metering ends. Besides financial reasons, other motivations included reducing grid congestion. A respondent was motivated by "*using when there is self-generation, but also by avoiding net congestion between 17:00-21:00*". Environmental concerns were also present, including the desire to reduce CO_2 emissions and contribute to sustainability. One participant mentioned they shifted laundry use specifically *"to prevent noise at night from the washing machine."*. These responses reflect that people are not only motivated by short-term financial gains, but are already anticipating policy changes in the future.

In contrast, other respondents explained why they do not load shift. Their reasons could also be grouped into three broad themes: lifestyle considerations, financial considerations and policy considerations. A common reason was a lack of attention or priority: *"I don't think about it"* or *"Just not something I've been consciously working on."*. Some did not see enough personal benefit: *"There's no benefit for me. In fact, it causes all kinds of hassle"*, or *"Postponing use is often just impractical."*. These statements illustrate that perceived hassle was not only measured in the survey but also explicitly mentioned by respondents in the open-ended responses as a key reason for not load shifting. Furthermore, contractual conditions were another factor. Participants with fixed-rate contracts under the current net metering indicated that they saw no financial reason to shift: *"As long as net metering is in place, I don't worry about it"*. Several responses also showed that people don't shift because of habit or convenience. Using appliances to fit in their household routines is more important than aligning with solar production. The terms convenience and routine are used, but also *"I want to use appliances when I need them. My life is already too busy and not flexible enough."*. Some respondents had a more principled reason for not adjusting their habits. One explicitly pointed to grid operators as the responsible party: *"I'm not going to complicate my life just because grid operators failed to innovate. If it doesn't benefit me personally, I won't change my behaviour"*. Others referred to the limited range of appliances available for shifting, or that they already use their devices during peak solar hours: *"There's not much to shift. Only the washing machine, which we use only occasionally."* and *"We already use electricity during sun peak hours, so we don't shift"*.

These motivations and barriers to load shifting observed in the qualitative data are grouped by theme in Table 5.4.

Table 5.4 Motivations and barriers to load shifting

Theme	***Motivations for load shifting***	***Barriers to load shifting***
Financial considerations	- Reduce energy costs - Be more self-sufficient - Benefit from dynamic contracts - Avoid possible future financial penalties (e.g. after 2027)	- No incentive under net metering - Fixed-rate contract
Sustainability and lifestyle considerations	- Reduce grid congestion - Reduce CO_2 emissions - Build sustainable habits - Noise reduction (e.g. at night)	- Lack of attention or priority - Established routines - Perceived hassle - Limited flexibility in daily life - Limited shiftable appliances - Already using energy during solar peak hours
Policy considerations	- Anticipate the end of net metering	- Belief that system/grid operators should take responsibility

5.7.2 Hassles related to load shifting the dishwasher use

Many respondents mentioned various practical and behavioural barriers when attempting to shift dishwasher use. Common challenges included timing, daily routines, the need for clean dishes, and a lack of smart features/automation. These hassles often reflected integration difficulties rather than unwillingness to shift.

One frequently mentioned issue was that the dishwasher is not full during sunny hours: *"The dishwasher is not yet full"* and *"Sometimes it's full after dinner. Then I don't want to wait until the next day"*. This relates to the load size inconvenience hassle factor, illustrating that participants prefer not to overfill the dishwasher to use it at a time when the sun is shining. Also, it is argued that delaying a cycle can lead to bad smells in the dishwasher or the need for more intensive programs: "*The machine starts smelling extremely if there are long dirty dishes in it that are not washed*" and *"when dishes stay dirty too long, we need to run a more energy-consuming program."*. This suggests a potential new hassle factor related to hygiene and smell concerns.

Also, several respondents referred to needing specific items, like lunchboxes or pans, to be ready the next day. For these users, postponing a dishwasher cycle is simply not an option: *"The lunchboxes need to be clean again for school the next day, so the dishwasher runs outside school hours"*. Another frequently mentioned hassle was that people were not home during the hours when solar production peaks, making it difficult to start the dishwasher manually: *"We're often not home during the day"*. Some respondents also expressed concerns about their dishwasher's lack of smart features or automation, such as *"No automatic start possible, that would be the most convenient."*. Furthermore, household dynamics also played a role, as some reported that they were the only ones in the household making an effort. This was indicated by *"My partner doesn't join in, finds it too much hassle"* and *"The dishwasher is used by three out of four people at home. I'm the only one trying to change the habit"*. Daily routines also played a major role. Many households are simply used to running the dishwasher at night, after dinner: *"The majority of dishes are created at dinner, so we've been running it at night for years"*. Some preferred night-time use due to cheaper electricity or to avoid daytime noise: *"The dishwasher makes a lot of noise. My partner works from home."*. Lastly, a few respondents highlighted the unpredictability of the weather as a significant barrier: *"If the sun was shining every day from 8 to 17, it wouldn't be a problem. But we live in the Netherlands, it's often cloudy or raining"*. Some also noted that forecasts are not always reliable.

5.7.3 Hassles related to load shifting the washing machine

Many of the challenges associated with dishwasher use also applied to washing machines, though several were more specific to laundry routines. The most common themes were timing, risk of leaving wet laundry too long, and limited flexibility in busy households.

A key concern of load shifting washing machine use was not being home when the program finishes: *"If I'm not home, I can't take the laundry out or put it in the dryer. Then it sits there wet all day.* As a result, respondents are concerned about getting smelly or wrinkled clothes: *"If you leave it too long in the machine, the clean laundry smells bad"*. This also shows the presence of hygiene-related hassle. However, in the washing machine group, this concerns rather the timing of unloading. Such hassle in the timing of unloading reflects the practical inconveniences of delayed unloading, such as unwanted odours or wrinkled clothes.

Another common concern was the lack of a timer or smart scheduling feature. Several people pointed out that their washing machine can't start automatically or only allows for a basic delay function: *"There's no timer on the washing machine, so I have to set an alarm on my phone when I want to start it manually."*. Also, the lack of a smart scheduling feature on the washing machine is perceived as a hassle: *"I can start the washing machine later, but only pre-programmed by time. So not on generation."*. Some responses reflected how laundry is integrated into daily routines, making it difficult to time around solar hours. For example: *"Everything has to align, enough laundry, being home, having time, sun shining. If one of these things is missing, it won't work."* And "*I have to do so much laundry that I can't wait for the sun"*. Others also mentioned a lack of enough laundry at the right time, or that running a half-full machine doesn't feel energy-conscious: "*There isn't enough laundry, and running a half-full machine isn't environmentally friendly—even if the sun is shining*".

Furthermore, some respondents mentioned that not all household members actively participate in load shifting, which can lead to complications. Load shifting also seems to depend on what kind of laundry people are doing, as a respondent indicates that "*sometimes it's just inconvenient, for example when we want to wash all the bedding*". Respondents with young children or tight household schedules also shared that it is hard to fit all washing into sunny hours, especially when multiple loads need to be done: *"Not enough hours in the day, or too much laundry, especially with kids"*. This highlights again the strong connection between children and hassle, also observed in the quantitative analyses. The weather was another frequently mentioned factor. Several respondents explained that checking the weather is inconvenient or that they find it challenging to plan when solar production is low or unpredictable. This is indicated by responses such as: *"If the sun doesn't shine much in a week, I don't know if it's worth planning around it"*. Some also mentioned that they never check solar generation before using an appliance, meaning they have no idea whether load shifting would make a difference. Also, a few indicated that they worry about safety when running the washing machine while not at home, especially when the machine is older. Lastly, a few people said they simply forget to shift or don't feel it's worth the effort: *"I often think of it too late"*, and *"It's too much hassle, I don't even know if it helps"*.

5.7.4 General causes of hassle

Respondents described a range of reasons why load shifting was perceived as a hassle. In these responses, a few types of hassle could be identified, including family-related hassle, technical hassle and mental hassle. A frequently mentioned issue was the need to be at home to shift electricity use. For those with children, jobs, or irregular routines, planning around solar hours was challenging: *"Work and school times make it hard to deal with electricity use during the day"*, and *"With work and kids, I can't just wait for the sun."* Others said shifting *"doesn't fit in the rhythm of the day"* and *"adds an extra layer of time and attention."*, indicating mental hassle. Some, however, noted it wasn't a hassle, but just not yet a habit: *"It's not really a hassle, we're just not used to shifting yet."*. Many respondents said that their current way of doing things had become fixed over time, and that changing those habits would require effort. It is *"the power of habit"* and *"the only issue is that I would need to change my routine, especially when the routine has been there for years"*. This indicates that habits were not only important in the statistical analyses but also highlighted in the open questions. Household dynamics also made consistent shifting difficult: *"Not everyone in the household thinks the same. I might want it, but that doesn't mean others do."*. This indicates family-related hassle.

Furthermore, technical limitations and a lack of smart applications or automation played a role, indicating technical hassle. Several participants explained that their appliances couldn't start automatically or that appliances are not smart enough: *"The equipment, cars, and inverters aren't aligned. A smart grid in the neighbourhood would really help"*. Also, some were interested in using home batteries once they become more accessible. Additionally, some participants expressed uncertainty about which load shifting strategies are most effective in practice. One respondent expressed uncertainty about the optimal timing of appliances such as the heat pump, boiler, dishwasher, and washing machine. They were unsure whether to prioritise eco-friendly settings or coordinated scheduling across devices. These doubts led to trade-offs and added mental effort in managing energy use. Others also reflected on the mental effort required to coordinate shifting behaviour, including checking the weather, calculating energy prices, or simply remembering to shift at the right time. As participants mentioned: "*It takes time and attention. It would be nice if it were easier to program"*, and *"I just want to think about fewer things, if it could be automated, yes"*. Such responses indicate the presence of mental hassle. Lastly, a few participants questioned whether the effort of load shifting was really worthwhile. Some felt that policy makers were placing too much responsibility on individual households, such as that *"the causes of the problem are being pushed onto us"*. These responses show that the causes of hassle are not necessarily about unwillingness to shift, but about broader lifestyle, habits, and psychological challenges.

6. DISCUSSION

In this chapter, the findings of this study are interpreted and discussed in the context of existing literature and the developed conceptual model. It synthesises results from the statistical analyses and qualitative responses to explore how different forms and causes of hassle shape load shifting behaviour. In addition, this chapter outlines implications for industry stakeholders and policymakers, highlights the strengths and limitations of the study, and offers recommendations for future research to build on these findings.

6.1 Synthesis

This section integrates the statistical analyses, open responses and existing literature. It explains how hassle perception, habits in appliance use and other causes of hassle perception are reflected in the constructed conceptual model, using UTAUT and habit theory.

6.1.1 General load shifting behaviour and appliance use patterns

The results indicated that most respondents primarily use their dishwasher and washing machine at daytime, which generally aligns well with solar energy generation. This pattern was in particular observed for washing machine use, where daytime use was dominant throughout the week. Dishwasher use showed more variation, with substantial use also taking place during the evening and night. This suggests that many prosumers already align their appliance use with solar availability, either consciously or unconsciously, which was also reflected in the high percentage of respondents who already load shift (71.9%). Open responses supported this, with participants describing how they consciously shifted appliance use, motivated by financial considerations, anticipated policy changes, or broader sustainability and lifestyle goals. Some noted they had started shifting in preparation for the end of the net metering scheme, using the transition period to establish new habits. Others mentioned that they valued being more self-sufficient or wanted to make optimal use of their solar panels.

Still, especially for dishwasher use, there is potential for further alignment with solar energy generation. Occupancy patterns help explain these trends. The daytime presence is higher on weekends, corresponding with increased daytime washing machine use, while high evening presence during weekdays aligns with more frequent dishwasher use at that time.

Survey results also revealed that the majority of participants load shift manually (68.8%), with fewer using timers (33.8%) or automation (6.9%). This reliance on manual shifting may limit the consistency of shifting behaviour, as it requires presence at home and constant attention to solar production. The qualitative data confirm this, with several respondents noting they are not always home during solar hours or tend to forget to start appliances. This highlights the potential of timers or smart automation to support better alignment, especially during weekday afternoons when occupancy is lower. However, open responses also indicate that not all respondents feel comfortable using appliances in their absence. Concerns were raised about safety risks, especially with older machines, and about appliances lacking delay start functions. These practical barriers may reduce the attractiveness or feasibility of automation for some households, even when they are motivated to shift.

6.1.2 Hassle perception

The hassle factor with the highest mean score across both groups was the half-full machine inconvenience factor, indicating the inconvenience of using appliances when they are not fully loaded yet. This highlights a common practical problem: people want to align appliance use with solar hours while also preferring to wait until the machine is full due to perceived inefficiency, increased costs and environmental concerns. In the dishwasher group, this was accompanied by high scores for overloaded machine inconvenience, particularly when dishes accumulate after dinner and a cycle needs to be completed before the next morning. These results confirm the finding of Malakhatka et al. (2024), who also noted that users found such overloaded machines inconvenient. Respondents frequently mentioned that postponing dishwasher use was avoided to prevent smelly machines, which may require using more intensive programs. Such hassle can be interpreted as a new type of hygiene-related hassle, relating to hygiene and smell concerns. Additionally, it was mentioned that load shifting was inconvenient, as specific items such as lunchboxes or pans would need to be cleaned for the next day.

Overloaded machine inconvenience scored also relatively high in the washing machine group, although this concern of having too much laundry was not frequently mentioned in the open responses. Instead, hassle related to washing machine use is more often centred on the timing of unloading. Participants indicated that they preferred to be home when the programme finished so they could transfer the laundry to the dryer or hang it up. If not, the clean laundry might become smelly or wrinkled, reflecting a hygiene-related hassle. These responses point to a specific form of hassle linked to the timing of unloading, which seems to be important when washing machine use is shifted.

Beyond load size inconveniences, other hassle factors with relatively high mean scores in both appliance groups included PV monitoring effort, weather forecasting effort, timer planning effort, household coordination effort, and unmonitored use concern. Respondents described the mental burden of having to check solar output or weather conditions, confirming the relevance of both the PV monitoring and weather forecasting effort hassle factors. This aligns with the findings of Gram-Hanssen et al. (2020), who described the effort of checking PV output and weather forecasts as a major inconvenience. The open responses further highlighted the presence of mental hassle. Participants mentioned the need to actively remember to shift and to plan shifting behaviour alongside other daily responsibilities. For some, this constant need for attention and decision-making added a layer of complexity to an already busy routine, suggesting that even with motivation, the cognitive demands of shifting can be too overwhelming.

Moreover, the presence of the timer planning effort factor was elaborated in the open responses. The absence of user-friendly timers or smart features was a recurring issue. Some participants noted that their appliances only allowed for basic time delays, not for solar-based scheduling, and described this as not smart enough to support consistent shifting. Others mentioned that their appliances lacked any delayed start function, leading to practical inconveniences such as needing to set an alarm on their phone to start the machine manually. This indicates the relevance of technical hassle. These experiences also reflect the manual planning effort factor, as users must actively remember and coordinate appliance use. This aligns with findings by Khalid et al. (2019), who similarly observed that manual operation is perceived as burdensome.

The household coordination effort factor was also reflected in the qualitative responses. Several participants mentioned that they were the only ones in the household making an effort to shift. This type of family-related hassle made it harder to be consistent and went beyond practical planning issues, as it also involved a lack of support or interest from others in the household.

Furthermore, some worried about leaving machines unattended because of safety concern, in specific when the machine is older. This aligns with findings by Hansen & Aagaard (2025) and Malakhatka et al. (2024), who also reported that users may be hesitant to operate appliances in their absence. Although the hassle factor decision uncertainty was less prominent in the quantitative data, the qualitative responses did reveal some uncertainty about optimal timing and usage strategies, supporting observations by Aasen & Christensen (2024). For example, some respondents were unsure whether to prioritise eco-programmes or to avoid using multiple appliances simultaneously. Lastly, the hassle factor of simultaneous appliance use inconvenience showed the lowest mean score and was not specifically reflected in the open responses, suggesting it played a limited role in perceived hassle.

These findings largely support the way hassle was positioned in the constructed conceptual model, as part of the effort expectancy component from the UTAUT framework. Several of the defined hassle factors in the model, such as PV monitoring effort, timer planning effort, manual planning effort, weather forecasting effort, and household coordination effort, were consistently reported and confirmed to play a role in shaping load shifting behaviour. At the same time, the qualitative data suggest that perceived hassle is broader than operationalised in the model. Participants described family-related hassle, hygiene-related hassle, technical hassle, and hassle related to the timing of unloading machines. These were not included in the conceptual model as hassle factors but appeared to be relevant in open responses. In contrast, some factors such as simultaneous appliance use inconvenience played a very limited role.

The principal component analyses (PCA) offered further insight into how different hassle factors relate to each other. In both appliance groups, one dominant and interpretable component emerged. In the dishwasher group, this component reflected what could be described as operational hassle, including cognitive and operational challenges in load shifting, such as the effort of manually starting appliances, using timers, checking solar generation or the weather forecast, operating appliances simultaneously and deciding which appliance to shift. In the washing machine group, a slightly different component emerged, interpreted as cognitive coordination hassle and sharing a focus on decision-making and task alignment. This captures the cognitive burden of having to decide which appliance to shift, the practical inconvenience of operating multiple appliances at the same time, and the additional effort of manually starting the appliance. While not all hassle factors loaded strongly on these components, and additional components lacked coherence, these results support the idea that hassle extends beyond individual inconveniences. Rather, it can be understood as a broader dimension involving overlapping operational, cognitive, and decision-making related hassle.

6.1.3 Difference in hassle perception across groups

Several significant differences in hassle perception were observed across participant groups based on gender, household composition, the presence of children, and the use of timers or manual shifting. Households with children reported higher levels of hassle in both appliance groups, particularly for manual planning effort, PV monitoring effort, and household coordination effort. These findings likely reflect the additional logistical and cognitive demands that children bring into household routines. This was also observed in the qualitative responses, where participants mentioned that more laundry or dishes and less flexibility made load shifting more difficult. This aligns with earlier research by Friis & Christensen (2016), who found that families with children experienced load shifting as more stressful. Although no data was collected on children's ages, nor on whether parenting itself affects general hassle perception, these factors may play a role in hassle perception related to load shifting behaviour.

Larger households similarly reported higher levels of hassle around household coordination effort, manual planning effort, weather forecasting effort and overloaded or half-full machines in both appliance groups. Since household size and the presence of children were strongly correlated in this study, likely, these effects are at least partly overlapping. The increased hassle in larger households may therefore reflect the more complex routines or time constraints associated with having children.

Gender differences, although mentioned in previous studies as a possible factor influencing hassle (Udayar et al., 2023), played a limited role in this study. The only statistically significant difference was that women in the dishwasher group reported a higher PV monitoring effort. However, the descriptive statistics showed that women generally reported higher perceived hassle levels for the dishwasher, whereas men reported slightly higher hassle levels for the washing machine. This difference might be explained by a gendered division of household responsibilities, with women potentially more involved in using the washing machine and men the dishwasher, which could influence perceived hassle levels. However, this remains largely speculation. Grünewald & Diakonova (2020) do note that women generally operate both appliances more frequently than men, with only a slight predominance in washing machine use.

Furthermore, differences also appeared between respondents who shifted manually versus those who used timers. Manual shifters in the dishwasher group reported higher levels of hassle related to timer planning effort and unmonitored use concern. This may indicate that timers or automation are either not available or perceived as too complex to operate. The lower unmonitored use concern among timer users could suggest a greater willingness to leave appliances running while away from home, potentially due to increased trust in automation or because appliances with timers are typically newer and perceived as safer. Interestingly, timer users also reported higher household coordination effort, possibly because using timers requires more planning in advance and negotiation with other household members. This reinforces the family-related hassle. In the washing machine group, only one hassle factor, the simultaneous appliance use inconvenience, differed significantly between shifting methods. Manual users scored slightly higher on this factor, perhaps reflecting a higher burden of managing multiple tasks when load shifting is not automated.

6.1.4 The role of habits

The survey results show a clear and consistent relationship between habitual behaviour and perceived hassle, particularly in the context of dishwasher use. Respondents who reported using the dishwasher without much planning or thought also perceived higher levels of hassle across nearly all measured hassle factors. Notably, strong positive associations were found with decision uncertainty, overloaded machine inconvenience, and manual planning effort. This suggests that when appliance use becomes automatic, small inconveniences, such as dealing with excess dishes, are more likely to be perceived as effortful. Additionally, respondents with fixed routines in dishwasher use also reported higher hassles, especially concerning manual planning, PV monitoring, and weather forecasting. These findings imply that established routines in appliance use can reinforce the perception of hassle. In the washing machine group, the associations were weaker and more selective. Automatic behaviour showed moderate correlations with PV monitoring effort, weather forecasting effort, and manual planning effort, but the routine item did not correlate significantly with any hassle factors. This pattern suggests that for washing machine use, unplanned automatic behaviour plays a more significant role in shaping perceived hassle than fixed routines.

Overall, these findings support earlier research by Hubert et al. (2024), who also found a strong correlation between habitual behaviour and hassle perception in load shifting. Also, they validate the way habits were positioned in the conceptual model, as an antecedent to hassle perception. The observed correlations confirm that stronger habitual behaviour are generally associated with higher perceived effort, and supports the theoretical assumption that habits influence how much effort people believe a new or behaviour will take.

Habits also played a key role in explaining differences in load shifting behaviour. Respondents who indicated that they used the dishwasher or washing machine without planning or thinking were significantly less likely to load shift. This finding aligns with Bradley et al. (2016), who argue that habits directly act as a barrier to load shifting. The qualitative data reinforce this interpretation as one participant referred to the power of habit, while others mentioned they often forget or found it difficult to deviate from established rhythms.

Interestingly, the variable measuring fixed routines only predicted lower behaviour in the dishwasher group. Many participants noted that the dishwasher is typically used in the evening after dinner because it fits the daily rhythm, eventually becoming a habitual pattern. As one respondent mentioned: "*The only issue is that I would need to change my routine, especially when the routine has been there for years*.". However, the results suggest that automatic, unconscious behaviour may pose a stronger barrier than consciously structured routines. Some participants did report trying to build new habits in anticipation of the end of the net metering scheme. These attempts suggest that although existing habits can be a barrier, they are not fixed. With a clear reason and persistence, routines can be adapted, although effort is needed.

These findings confirm the decision to position habits as an internal antecedent of perceived hassle within the conceptual model. In addition, the study went one step further by not only examining the indirect role of habits on behaviour via hassle perception, but also testing their direct relationship with load shifting. This confirmed that habits do not just shape how effortful shifting is perceived to be, but also reduce the likelihood that people shift appliance use in practice.

6.1.5 Causes of hassle perception

The analyses on the causes of hassle perception provide useful insights into why some respondents perceive more hassle in load shifting than others. Both the correlation and regression analyses help to understand how internal and contextual factors contribute to the perception of hassle in aligning appliance use with solar energy availability.

Nearly all proposed causes were significantly associated with key hassle factors that negatively influenced load shifting behaviour. The only exception was disturbing neighbours, which showed no significant correlations and was also not mentioned in open responses. This contextual cause, found by Aasen & Christensen (2024), was likely not observed in this study due to the focus on daytime appliance use, in which noise concerns are less present.

The regression analyses further clarified which causes most strongly predicted hassle perception, using the hassle factors that significantly predicted load shifting behaviour. Household schedules emerged as the most consistent predictor in the dishwasher group. Respondents who indicated that school or work routines of household members complicated appliance use reported higher levels of decision uncertainty and overloaded machine inconvenience. The qualitative data reflect the relevance of schedules of other household members, resulting in hassle, as one participant noted, *"The lunchboxes need to be clean again for school the next day, so the dishwasher runs outside school hours."*. Another relevant factor was changing routines, which increased the perception of decision uncertainty and overloaded machine-related hassle. Many respondents described being used to running the dishwasher after dinner and found it difficult to adjust this routine. Additionally, while hassle in life scored relatively low overall, it was a significant predictor of decision uncertainty in the dishwasher group. This supports the idea of hassle spillover (Pearlin & Bierman, 2013), which describes that micro-stressors in one life domain can increase micro-stressors in other domains such as load shifting. This was also a recurring theme in the qualitative responses. Some participants indicated they already had too much going on to think about energy usage, or described their life as too full to manage extra effort like load shifting.

In the washing machine group, personal flexibility significantly predicted manual planning effort, the manual effort of starting appliances, and PV monitoring effort, the effort to check PV output. The presence of this cause of hassle was also highlighted in the open responses, as a participant expressed: *"I want to use appliances when I need them. My life is already too busy and not flexible enough."*. Finally, energy awareness was the only factor that negatively predicted hassle perception. Respondents who enjoy monitoring their energy use and generation reported lower levels of PV monitoring effort in both appliance groups. This suggests that interest in energy systems can reduce perceived effort. While this internal factor was not included in the initial conceptual model described in section 3.5 and was only added during the survey design phase, the results of this study demonstrate its relevance. These findings suggest that energy awareness should be given a more prominent role in future conceptualisations of hassle perception in energy behaviour.

Overall, these findings confirm the relevance of including both internal and contextual factors as antecedents of hassle perception. The results show that not only individual-level characteristics such as personal flexibility and energy awareness, but also household dynamics shape how much effort people associate with load shifting.

6.2 Implications and recommendations for industry and policymakers

The findings of this study offer a range of practical implications for industry stakeholders and policymakers aiming to encourage residential load shifting. This is particularly relevant given the upcoming end of the net metering scheme.

The identified internal and contextual factors contributing to hassle perception offer relevant insights for designing more targeted interventions. The findings show that hassle is not solely the result of technical obstacles, but often originates from everyday routines, personal preferences, and household dynamics. In the dishwasher group, difficulties with changing established routines and managing conflicting household schedules were strong predictors of hassle. This suggests that interventions should not only focus on promoting the behaviour itself, but also support users in integrating it into their daily rhythm. Given the strong role of habits, it can help to connect load shifting to moments that already have structure, such as running the dishwasher right after lunch or before picking up children from school. Also, simple physical reminders, such as magnets or stickers near appliances, could help people to think about shifting use. In addition, timely digital reminders can support behaviour change. A practical option would be to integrate solar tips or nudges into weather apps that people already use. For example, when sunny weather is forecast, the app could show a small message like "Good moment to run the dishwasher on solar power." This kind of low-effort reminder could make it easier for households to act at the right time, without needing to constantly check their inverter or energy app.

Overall, this study found that household dynamics play a critical role in both appliance groups, indicating the relevance of family-related hassle to load shifting behaviour. Respondents living with children or in larger households consistently reported higher levels of hassle, especially related to planning, coordination, and timing. While these variables were highly correlated, the findings suggest that larger households face more challenges in aligning behaviour across multiple members. Several participants highlighted that they were the only ones in the household who were trying to make load shifting a new habit. Such a lack of shared commitment made it harder to consistently change routines. Social practice theory offers a useful perspective to interpret this, as it frames routines not as isolated individual actions but as socially organised practices shaped by shared norms, material arrangements, and interdependencies (Shove et al., 2012). From this view, shifting appliance use is not only a matter of personal intention but also of negotiating shared routines and expectations within the household. This helps explain why even motivated individuals may struggle to change their behaviour when others do not participate. The presence of family-related hassle also highlights the need for addressing load shifting as a collective household practice. For instance, policymakers could focus on targeting large families by offering practical tools or strategies to coordinate appliance use with other household members. This may include appliance use planning tools, which can help reduce the sense that one person is solely responsible for load shifting.

One notable finding was the role of energy awareness in reducing perceived hassle, especially around PV monitoring. Participants who regularly checked their solar production or found it interesting to track their energy use reported less hassle perception. This suggests that fostering energy engagement should be a priority for policymakers. Awareness campaigns or interactive dashboards that visualise PV production and usage could help increase engagement with energy generation. The need for better tools or apps to monitor real-time solar generation was also highlighted in the open responses, as participants indicated they found it difficult to decide when and which appliance to shift. Beyond improving the availability and usability of monitoring tools, it is also important that municipalities and energy providers start organising local workshops or campaigns to increase familiarity with solar monitoring tools, especially for new prosumers.

In addition, it was observed that many participants who currently shift manually found timers difficult to operate. The importance of hassle factors like manual planning effort, timer planning effort, and PV monitoring effort, along with technical-related hassle observed in the open responses, highlights the need to increase the user-friendliness and accessibility of timers and automation features. Smart technologies can offer an important solution here. Smart appliances, such as washing machines, dishwashers, electric hot water buffers, and buffered heat pumps, allow users to schedule their operation based on energy availability or pricing and can often be remotely controlled, thereby reducing the need for direct user interaction (Papaioannou et al., 2022; Kobus et al., 2015). These technologies are specifically designed to optimise energy consumption while minimising the impact on comfort (Afzalan & Jazizadeh, 2018). In addition, Home Energy Management Systems (HEMS) could also be a solution and go a step further. They integrate smart appliances with real-time energy monitoring and automation, which enables electricity consumption to be optimised without requiring constant user input (Mahapatra & Nayyar, 2019). For households with PV systems, this automation is particularly beneficial, as it supports the use of self-generated solar energy during peak production times, thus reducing reliance on the grid and lowering energy costs (Raza et al., 2024).

It should also be noted that dishwasher use seems to have more potential for additional load shifting than washing machine use, as the latter is already largely used during sun hours. This implies that interventions could prioritise dishwashers when aiming to increase self-consumption through shifting. Furthermore, a majority of respondents indicated to have interest in a home battery, highlighting a clear demand for technological solutions to increase self-generated electricity use.

6.3 Strengths of the study

A key strength of this master thesis is the empirical contribution to the understanding of hassle as a behavioural barrier to residential load shifting. Whereas existing literature mainly frames hassle factors as part of broader constructs such as effort, inconveniences or non-monetary transaction costs, this study systematically identified and analysed specific types of hassle in the context of load shifting behaviour. Through its focus on both dishwasher and washing machine use, the study was able to assess how hassle is perceived differently depending on routines, timing, and interaction patterns specific to the appliances.

An important theoretical strength is the development and application of a conceptual model that combines the Unified Theory of Acceptance and Use of Technology (UTAUT) with habit theory. In this model, hassle perception was positioned as part of effort expectancy, with a direct influence on use behaviour, conceptualised here as load shifting behaviour. This theoretical framing was empirically supported, as the results showed that perceived hassle negatively affects load shifting behaviour. The inclusion of contextual and internal factors, such as household dynamics and hassle in other parts of life (spillover effects), as antecedents further strengthened the model by offering insights into how hassle perception varies across individuals.

Moreover, the distinction between contextual and internal causes of hassle perception is an important strength, as this had previously been unexplored. By analytically separating contextual causes from internal ones, the study provides a more nuanced understanding of why hassle is experienced differently across households. The addition of habits, considered a psychological construct, as an antecedent in the model offered further explanatory value. It demonstrated that both automatic, unplanned, and routinised behaviour can increase perceived effort when attempting behavioural change. In addition, the direct effect of habits on load shifting behaviour was empirically demonstrated. Together, these findings highlight that habits are a meaningful driver of both perceived hassle and actual load shifting behaviour.

Finally, the survey design, incorporating both closed- and open-ended questions, enabled a better exploration of hassle. The open responses not only confirmed many of the quantitative findings but also revealed new insights, such as the presence of hygiene-related hassle and the anticipated impact of future policy changes.

Together, the empirical insights of this study offer valuable input for broader behavioural modelling. The data collected on hassle factors, habits, and the contextual and internal causes of hassle could inform agent-based models (ABMs) that simulate the adoption of load shifting across different household types. Such models can help predict the effects of various interventions, both technological and behavioural, on a larger scale, which supports more effective future policy design.

6.4 Limitations of the study

While the findings of this study provide valuable insights, several limitations should be considered. First, the study focused only on load shifting using the dishwasher and washing machine. While these appliances were selected due to their high energy consumption and shiftability, this narrow scope means that other relevant appliances, such as electric vehicle chargers or electric boilers, were excluded from the analysis. Certain hassle factors, such as PV monitoring effort, weather forecasting effort or household coordination effort, may be generalisable to other electrical appliances, but appliance-specific hassles, such as the inconvenience of running half-full or overloaded machines, are much less generalisable to all household load shifting behaviour. As such, the applicability of the findings to other forms of load shifting remains limited.

Second, several internal factors, including stress sensitivity and personal flexibility, were measured using only a single-item question. While this approach helped reduce survey length and respondent burden, it limits the depth and reliability with which these constructs were captured. Particularly for psychological factors like stress, measuring these using multiple questions would have provided more robust and valid insights.

Third, the composition of the sample may have influenced the results. The survey overrepresented male respondents, retirees, homeowners, and larger households compared to the general population. This skew in the sample means that certain experiences, such as the impact of full-time employment or being a single-person household, may be underrepresented. Moreover, most participants were recruited through sustainability-oriented networks, which likely attracted more energy-conscious or intrinsically motivated individuals. While this does not invalidate the results, it suggests that the sample may be more willing or able to shift load, and less sensitive to hassle, than the average household.

Lastly, the use of a structured survey method also has its drawbacks. While the survey allowed for collecting data from a large group of respondents in a relatively short time, it does limit the depth of the responses. The hassle factors and causes were measured using Likert scales, which make it possible to compare results statistically, but may not fully capture the complexity of how people perceive hassle in daily life. Even though open-ended questions were included, they only gave limited space for detailed explanations. Some of the more subtle or personal reasons why people find load shifting a hassle may therefore not have come through clearly.

6.5 Suggestions for further scientific research

Several recommendations can be made for future research to build on the findings of this study. First, future studies could expand the scope of studying uninterruptible loads, including dishwashers and washing machines, to include controllable loads such as electric vehicle chargers. Whereas dishwashers and washing machines are typically operated around fixed household routines and often require manual input before each cycle, electric vehicle charging is more flexible in timing and increasingly automated. This means that the perception of hassle may take a different form. Comparing hassle perception across these different types of loads could help to refine the categorisation of hassle factors and determine to what extent they are appliance-specific or more generally applicable to flexible energy use. In addition, future research could examine hassle perception in other areas of demand response beyond household appliances. One relevant example is the use of home batteries, which may involve different forms of hassle, such as technical complexity or concerns about reliability. As home batteries are expected to play a key role in reducing pressure on the electricity grid, and given that many respondents in this study indicated they are considering purchasing one, this is a particularly relevant topic for further research.

Second, this study measured perceptions of hassle at a single point in time. As such, it could not capture how hassle perceptions might evolve as people gain more experience with load shifting, or as external circumstances change, for example, through the adoption of automation, changes in energy contracts, or the phase-out of the net metering scheme. Moreover, this study focused on expected hassle, which means the amount of hassle participants expect load shifting to be. Future research could compare this to the actual hassle experienced during or after repeated load shifting attempts. A longitudinal research design could provide valuable insights into how perceived hassle, actual hassle and behavioural patterns develop over time.

Third, given the large influence of household dynamics on hassle perception, more in-depth qualitative research is relevant. Interviews or focus groups, particularly in a neighbourhood with a high concentration of households with solar panels, could offer a better understanding of how households manage to incorporate load shifting into daily life. This could reveal more about household social dynamics, how shifting is negotiated among members, and how neighbours could support each other in load shifting behaviour.

Finally, several participants referred to anticipated changes in policy, in particular the planned end of the net metering scheme, as a reason for already adapting their behaviour. Although this theme emerged in the qualitative responses, it was not part of the survey design. Future research could explicitly examine how expectations of future policy influence present behaviour, and how factors such as trust in government and clarity of communication shape willingness to change. This would be especially relevant in understanding how behavioural shifts occur in response to regulatory changes.

6.6 Note on language support

The tools Grammarly and ChatGPT were used to revise parts of this thesis to improve clarity, grammar, and sentence structure. Specifically, ChatGPT was consulted at an earlier stage of the writing process to provide advice on structuring arguments and improving transitions between sections, particularly in Chapters 1, 3 and 6. Grammarly was used at a later stage to check for grammar and spelling errors and to adjust sentence structure where needed throughout the thesis. These tools were used solely for language-related support and did not contribute to content generation, the analysis or interpretation of data.

7. CONCLUSION

This thesis aimed to synthesise insights from existing research on hassle across different domains to clarify and refine the concept of hassle in behavioural research, to identify relevant types of hassle in the context of residential load shifting, and to distinguish between contextual and internal factors causing hassle perception among Dutch homeowners with solar panels.

To guide the research, this study constructed a conceptual model that integrates the Unified Theory of Acceptance and Use of Technology (UTAUT) with habit theory, complemented by findings from the literature review on hassle perception. Within this model, hassle was positioned as part of the effort expectancy component of UTAUT, directly influencing load shifting behaviour. To strengthen the model's ability to explain hassle perception, both contextual and internal factors, such as household dynamics, personal flexibility, and hassle in other parts of life, were added as antecedents. In addition, habits, conceptualised as a psychological construct, were added as an antecedent to perceived hassle. While not all model elements were directly measured in the survey due to scope limitations, the model served as a guiding framework for analysing how different forms and causes of hassle influence load shifting behaviour.

The study empirically examined the prevalence of perceived hassle in load shifting, focusing on the use of dishwashers and washing machines. Using the quantitative and qualitative findings discussed in the previous chapters, this chapter answers the main research question:

Which types of hassle act as a barrier to load shifting behaviour among Dutch households with solar panels?

The findings of this study show that hassle is a meaningful and measurable behavioural barrier to load shifting. While some types of hassle, such as the inconvenience of running half-full appliances, were frequently mentioned, they did not significantly reduce load shifting behaviour. In contrast, four hassle factors measured in the survey were found to directly reduce load shifting: PV monitoring effort, manual planning effort, decision uncertainty, and overloaded machine inconvenience.

Among these, PV monitoring effort emerged as the most influential barrier, showing a significant negative effect on load shifting behaviour in both the dishwasher and washing machine groups. Respondents who considered it too much effort to check their solar generation were less likely to shift their appliance use to solar generation hours. The importance of this hassle factor also suggests that many prosumers either lack understanding of how to read their inverter or find monitoring tools inconvenient to use, which was further supported in the open responses. Several participants noted that they never checked solar output before using appliances, which left them uncertain about whether shifting their behaviour would make any real difference.

Another barrier was decision uncertainty, which negatively affected load shifting in the dishwasher group specifically. This type of hassle relates to prosumers' uncertainty about which appliance to shift during solar production hours. Several participants expressed doubts about whether to prioritise eco-programmes or to avoid running multiple appliances at the same time. These responses suggest that a lack of clear guidance or understanding of effective load shifting strategies can reduce behaviour.

Furthermore, overloaded machine inconvenience was a significant barrier in the dishwasher group. This hassle factor refers to the inconvenience of accumulating too many dirty dishes while waiting for solar hours to load shift. Open responses frequently mentioned that overloaded dishwashers could lead to unpleasant smells or require more intensive cleaning programmes. Additionally, some participants noted that postponing use was impractical because of the need for specific items, such as lunchboxes or pans, to be clean in time.

Lastly, the hassle factor of manual planning effort was particularly relevant for washing machine use. The results indicated that the perceived burden of starting appliances manually during solar production hours acted as a barrier to load shifting. Manual operation of appliances requires attention and responsibility during busy routines, making it more difficult for households to maintain consistent shifting behaviour.

In addition to these four core barriers, the qualitative findings revealed other relevant forms of hassle that shaped load shifting behaviour, even though they were not captured in the quantitative data. Among those, family-related hassle, referring to the difficulties of coordinating appliance use and aligning shifting behaviour within multi-person households, was particularly prominent. Several participants mentioned they were the only ones actively trying to shift appliance use, which made it harder to establish and maintain new routines. The absence of support or interest from other household members added to the overall effort, particularly in families with children or larger households. Furthermore, another relevant type was technical hassle. Several participants noted that their appliances were outdated or lacked a delayed start function, which made them more dependent on manual operation and less able to shift consistently. Lastly, mental hassle was frequently mentioned in the open responses and refers to the cognitive effort involved in remembering, planning, and deciding when to shift appliance use. Respondents described the mental load of having to constantly monitor solar production, weather conditions, and other household responsibilities, particularly during already busy routines. For some, the additional mental effort required for load shifting felt overwhelming and acted as a barrier, given everything else already demanding mental capacity in daily life.

In conclusion, this study shows that hassle, although only recently explored in energy behaviour literature, is a meaningful and measurable behavioural barrier in the context of residential load shifting. Hassle relates to everyday routines and household dynamics, and can be linked to specific forms of effort, such as remembering, checking, planning, and adjusting appliance use in line with solar generation. The findings show the relevance of positioning hassle perception within the effort expectancy component of the UTAUT model. Specific types of hassle, particularly PV monitoring effort, manual planning effort, decision uncertainty, and overloaded machine inconvenience, clearly reduce load shifting behaviour. The empirical identification, specification, and influence of hassle in this study provide valuable insights for energy behaviour research, highlighting the importance of recognising hassle as a behavioural barrier.

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APPENDICES

Appendix A: Informed consent form survey

Beste deelnemer,

Het elektriciteitsnet raakt steeds voller, waardoor het transport van stroom naar huishoudens steeds uitdagender wordt. Huishoudens met zonnepanelen kunnen een belangrijke rol spelen bij het ontlasten van het elektriciteitsnet door hun energiegebruik te verschuiven naar momenten waarop de zon schijnt (ook wel 'load shifting' genoemd). Het doel van dit onderzoek is om meer inzicht te krijgen in hoe huishoudens hun eigen zonnestroom optimaal kunnen benutten en welke ondersteuning daarbij nodig is.

In deze enquête krijgt u vragen over uw ervaringen met het verschuiven van energieverbruik naar momenten waarop uw zonnepanelen elektriciteit opwekken. Daarnaast wordt gevraagd naar uw gewoonten in het gebruik van een huishoudelijk apparaat. Ook komen mogelijke belemmeringen die u ervaart bij het verschuiven van energieverbruik aan bod en worden er vragen gesteld over factoren die van invloed kunnen zijn op deze belemmeringen.

Dit onderzoek wordt uitgevoerd door Anne van Ekert, masterstudent aan de TU Delft, onder begeleiding van Dr. Gerdien de Vries en Mariëlle Rietkerk. Het invullen van de enquête duurt maximaal 10 minuten. De verzamelde gegevens zullen bijdragen aan een masterscriptie en maakt deel uit van een promotieproject dat over twee jaar wordt afgerond.

Zoals bij elke online activiteit is er altijd een klein risico op een databreuk. Daarom worden uw antwoorden vertrouwelijk behandeld en de enquête kan volledig anoniem worden ingevuld. Als u ervoor kiest om uw contactgegevens achter te laten om deel te nemen aan een vervolginterview, zullen deze gegevens uitsluitend voor administratieve doeleinden worden gebruikt en na afloop van het onderzoek permanent worden verwijderd. Alle gegevens worden veilig opgeslagen op een beveiligde TU Delft-schijf, en alleen geanonimiseerde gegevens zullen worden opgenomen in een publicatie. De publicaties worden opgeslagen in het openbare TU Delft-archief, zoals vereist voor inzage en mogelijk verder onderzoek.

Uw deelname aan dit onderzoek is volledig vrijwillig, en u kunt op elk moment stoppen. U bent ook vrij om vragen over te slaan. Door verder te gaan met de enquête, erkent u dat u voldoende bent geïnformeerd over het onderzoek en stemt u in met deelname.

Als u vragen of opmerkingen heeft, kunt u contact opnemen met Anne van Ekert of Mariëlle Rietkerk.

Appendix B: Survey questions with answer options in Dutch

Validatie

1. Selecteer of u een huiseigenaar/huurder in Nederland bent, ouder dan 18 jaar en er zonnepanelen in uw huishouden zijn geïnstalleerd. *[Ja; Nee]*

Naar einde enquête wanneer nee is geselecteerd

Sectie 1: Algemene demografie en kenmerken huishouden en woning

2. Selecteer uw geslacht. [Man; Vrouw; Anders/ik zeg dat liever niet]
3. Selecteer wat van toepassing is op uw woning. *[Ik ben eigenaar; Ik ben huurder; Anders]*
4. Uit hoeveel personen bestaat uw huishouden? *[1; 2; 3; 4; 5; 6+]*
5. Wonen er kinderen (17 jaar of jonger) in uw huishouden? *[Ja, 1; Ja, 2; Ja, 3 of meer; Nee]*
6. Is iemand in uw huishouden met pensioen? *[Ja, ikzelf; Ja, ikzelf en mijn partner; Ja, mijn partner maar ik niet; Nee]*
7. Op welke momenten van de dag is er doorgaans iemand thuis in uw huishouden? *[Matrix met tijdvakken: Ochtend (6:00-10:00); Overdag (10:00-17:00); Avond (17:00-22:00); en dagen: Maandag; Dinsdag; Woensdag; Donderdag; Vrijdag; Zaterdag; Zondag]*
8. Hoeveel zonnepanelen heeft u? *[Open (getal)]*
9. Heeft u een thuis batterij? (een systeem wat aangeschaft is om zelf opgewekte zonne-energie mee op te slaan) *[Ja; Nee, wil ik ook niet; Nee, maar ik denk erover na om dit aan te schaffen]*
10. Welke van deze huishoudelijke apparaten heeft u in uw huishouden? *[Wasmachine; Vaatwasser]*

Sectie 2: Huidig gebruik apparaten

In dit onderdeel krijgt u enkele stellingen over uw huidige gebruik van uw *vaatwasser/wasmachine (respondent krijgt gerandomiseerd slechts 1 van de 2).*

11. Hoe vaak per week gebruikt u gemiddeld genomen de vaatwasser/wasmachine? *[0-1 keer; 2-3 keer; 4-5 keer; 6+ keer]*
12. Op welke momenten van de dag gebruikt u doorgaans de vaatwasser/wasmachine? *[Matrix met tijdvakken: Ochtend (6:00-10:00); Overdag (10:00-17:00); Avond (17:00-22:00); Nacht (22:00-06:00), en dagen: Maandag; Dinsdag; Woensdag; Donderdag; Vrijdag; Zaterdag; Zondag]*

In welke mate bent u het eens met de volgende uitspraken? *[Likert schaal: Sterk mee oneens; Oneens; Neutraal; Eens; Sterk mee eens]*

13. Ik gebruik de vaatwasser/wasmachine zonder het te plannen
14. Ik gebruik de vaatwasser/wasmachine op een vast moment in de week als onderdeel van mijn routine
15. Ik denk niet na wanneer ik de vaatwasser/wasmachine gebruik, ik doe vaat/was wanneer het mij uitkomt

Sectie 3: Ervaring met load shifting

In dit onderdeel krijgt u enkele vragen over uw huidige gewoonten en ervaringen met het verschuiven van energieverbruik ('load shifting').

16. Verplaatst u het gebruik van elektrische apparaten weleens zodat het gebruik overeenkomt met de elektriciteit die uw zonnepanelen opwekken? *[Ja; Nee; Soms]*
17. Hoe vaak verplaatst u in het algemeen uw elektriciteitsgebruik naar momenten waarop uw zonnepanelen elektriciteit genereren? *[Dagelijks; Een paar keer per week; Eén keer per week; Minder vaak dan één keer per week; Nooit]*

18. Hoe verschuift u uw elektriciteitsverbruik naar momenten waarop uw zonnepanelen elektriciteit genereren? *[Ik zet ze handmatig aan wanneer mijn zonnepanelen elektriciteit opwekken; Ik gebruik een timer of uitgestelde startfunctie; Ik gebruik een smart home-systeem of automatisering die het gebruik van apparaten aanpast op basis van zonne-opwekking; Anders (open)]*
19. Hoe vaak verschuift u het gebruik van onderstaande apparaten in een week? [Matrix met apparaten: Vaatwasser; Wasmachine; Droger; Laden elektrische auto, en frequentie: *[Dagelijks; Een paar keer per week; Eén keer per week; Minder vaak dan één keer per week; Nooit; N.v.t.]*
20. Om welke reden verschuift u uw elektriciteitsgebruik momenteel weleens? *[Open]*
21. Om welke reden verschuift u uw elektriciteitsgebruik momenteel nog niet? *[Open]*

Sectie 4: Gedoe

Dank u wel. In dit onderdeel krijgt u een aantal stellingen te zien die gaan over wat u ervaart bij het verschuiven van het gebruik van uw *vaatwasser/wasmachine (respondent krijgt gerandomiseerd slechts 1 van de 2, dezelfde als in sectie 2).*

Hieronder volgen de stellingen, geef alstublieft aan hoe vaak u dit ervaart. Er zijn geen goede of foute antwoorden. *[Likert schaal: Ik ervaar dit nooit; Ik ervaar dit zelden; Ik ervaar dit soms; Ik ervaar dit regelmatig; Ik ervaar dit heel vaak]*

22. De vaatwasser/wasmachine handmatig aanzetten wanneer de zon schijnt kost te veel moeite.
23. Het verplaatsen van het gebruik van de vaatwasser/wasmachine naar wanneer de zon schijnt met timers of automatisering is te ingewikkeld.
24. Ik vind het te veel werk om mijn zonnepaneelopbrengst te controleren voordat ik de vaatwasser/wasmachine gebruik
25. Het raadplegen van de weersvoorspelling om te bepalen wanneer ik de vaatwasser/wasmachine ga gebruiken is teveel werk.
26. Ik vind het niet fijn om de vaatwasser/wasmachine halfvol aan te zetten
27. Ik vind het niet fijn dat de hoeveelheid vaat op het aanrecht/was in de wasmand teveel opstapelt als ik mijn gebruik wil verschuiven
28. Ik vind het coördineren van het gebruik van de vaatwasser/wasmachine met huisgenoten onhandig
29. Ik maak me zorgen over mogelijke veiligheidsrisico's bij het gebruik van de vaatwasser/wasmachine terwijl ik niet thuis ben
30. Ik weet niet welk apparaat ik moet verschuiven als de zon schijnt
31. Ik vind het teveel werk om meerdere apparaten (bijvoorbeeld de wasmachine, vaatwasser, droger) tegelijk te bedienen

32. Welke belemmeringen ervaart u als u het gebruik van de vaatwasser/wasmachine wilt verschuiven naar wanneer de zon schijnt en uw zonnepanelen elektriciteit opwekken? *[Open]*

Sectie 5: Oorzaken

Hieronder volgen nog een aantal stellingen over uw routines en voorkeuren. Geef alstublieft aan in hoeverre het met deze stellingen eens bent. *[Likert schaal: Sterk mee oneens; Enigszins mee oneens; Neutraal; Mee eens; Sterk mee eens]*

33. Ik vind het in het algemeen moeilijk om mijn dagelijkse routines te veranderen
34. Ik vind het leuk om mijn energie opwek en verbruik precies te monitoren
35. Ik hou graag mijn eigen schema aan zonder rekening te hoeven houden met de zon
36. Ik voel me over het algemeen gestrest wanneer mijn routines worden verstoord

37. Ik ervaar gedoe op belangrijke aspecten in mijn leven (bv. gedoe op werk of met familie)
38. Mijn werk- of schoolschema maakt het moeilijk om het gebruik van huishoudelijke apparaten te verschuiven
39. De werk- en/of schoolschema's binnen mijn huishouden maken het lastig om het gebruik van apparaten te verschuiven
40. Ik maak me zorgen over het storen van de buren wanneer ik het gebruik van apparaten naar andere tijdstippen verschuif

41. Zijn er redenen waarom u het gedoe vindt om uw elektriciteitsgebruik te verschuiven? *[Open]*

Sectie 6: Einde en interesse deelname interview

Hartelijk dank voor uw deelname aan deze enquête. De resultaten zullen na de zomer in mijn masterscriptie op de TU Delft Repository gepubliceerd worden.

Om meer inzichten te krijgen in de resultaten houden we naast deze enquêtes ook een aantal interviews. Deze duren ongeveer 30 minuten en vinden telefonisch plaats. Uw deelname hieraan is volledig vrijwillig en wordt zeer gewaardeerd.

42. Vind u het goed als we u hiervoor benaderen? *[Ja; Nee]*
43. Zo ja, vul dan hieronder uw naam en uw emailadres in. *[Open]*

Appendix C: Statistics output in SPSS

C.1 Descriptive statistics

Table C.1.1 Demographics and household characteristics

Variable	N = 260[1]
Gender	
Man	158 (61%)
Female	95 (37%)
Other	7 (2.7%)
Occupancy status	
Homeowner	253 (97%)
Renter	6 (2.3%)
Other	1 (0.4%)
Household composition	
1	20 (7.7%)
2	118 (46%)
3	42 (16%)
4	62 (24%)
5	12 (4.6%)
6+	5 (1.9%)
Children (17 years or below)	
Yes. 1	30 (12%)
Yes. 2	42 (16%)
Yes. 3 of meer	13 (5.0%)
No	175 (67%)
Retired	
Yes. me	28 (11%)
Yes. me and my partner	42 (16%)
Yes. me but my partner not	6 (2.3%)
No	184 (71%)
Home battery	
Yes	12 (4.6%)
No. and I don't want	85 (33%)
No. but I consider buying	163 (63%)
Appliance possession	
Washing machine	260 (100%)
Dishwasher	244 (94%)

[1] n (%); Mean (SD)

Table C.1.2 Number of solar panels

	N	Minimum	Maximum	Mean	Median	Std. Deviation
Number of solar panels	260	1.00	46.00	14.5962	12.00	8.26833
Valid N (listwise)	260					

Table C.1.4 Hassle factors

	N	Minimum	Maximum	Mean	Std. Deviation
Manual planning effort 1	120	1	5	1.77	1.096
Timer planning effort 1	120	1	5	2.20	1.406
PV monitoring effort 1	120	1	5	2.34	1.452
Weather forecasting effort 1	120	1	5	2.42	1.418
Half-full machine 1	119	1	5	3.67	1.372
Overloaded machine 1	120	1	5	2.56	1.494
Household coordination effort 1	120	1	5	1.94	1.239
Unmonitored use concern 1	119	1	5	1.58	1.054
Decision uncertainty 1	119	1	5	1.68	1.089
Simultaneous appliance use 1	119	1	5	1.57	.944
Manual planning effort 2	139	1	5	1.88	1.180
Timer planning effort 2	138	1	5	1.99	1.235
PV monitoring effort 2	138	1	5	2.38	1.462
Weather forecasting effort 2	139	1	5	2.17	1.225
Half-full machine 2	138	1	5	3.12	1.422
Overloaded machine 2	139	1	5	2.34	1.316
Household coordination effort 2	138	1	5	1.51	.961
Unmonitored use concern 2	138	1	5	1.80	1.213
Decision uncertainty 2	139	1	5	1.62	.966
Simultaneous appliance use 2	139	1	5	1.40	.758
Valid N (listwise)	0				

Table C.1.3 Causes of hassle

	N	Minimum	Maximum	Mean	Std. Deviation
Changing routines	258	1	5	2.34	1.134
Energy awareness	260	1	5	3.64	1.136
Personal flexibility	259	1	5	2.35	1.231
Stress sensitivity	260	1	5	1.95	1.066
Hassle in life	258	1	5	1.92	1.122
Schedule own	257	1	5	2.38	1.353
Household schedules	259	1	5	2.34	1.386
Disturbing neighbors	258	1	5	1.35	.781
Valid N (listwise)	252				

Table C.1.5 Shifting_experience

Engagement in load shifting					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ja	187	71.9	71.9	71.9
	Nee	32	12.3	12.3	84.2
	Soms	41	15.8	15.8	100.0
	Total	260	100.0	100.0	

Table C.1.6 Shifting_frequency

Frequency of load shifting					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Dagelijks	56	21.5	24.6	24.6
	Een paar keer per week	124	47.7	54.4	78.9
	Eén keer per week	35	13.5	15.4	94.3
	Minder vaak dan één keer per week	13	5.0	5.7	100.0
	Total	228	87.7	100.0	
Missing	System	32	12.3		
Total		260	100.0		

Table C.1.7 Shifting_method_1

U - Selected Choice Ik zet ze handmatig aan wanneer mijn zonnepanelen elektriciteit opwekken					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ik zet ze handmatig aan wanneer	179	68.8	100.0	100.0
Missing	System	81	31.2		
Total		260	100.0		

Table C.1.8 Shifting_method_2

U - Selected Choice Ik gebruik een timer of uitgestelde startfunctie					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ik gebruik een timer of uitgestelde	88	33.8	100.0	100.0
Missing	System	172	66.2		
Total		260	100.0		

Table C.1.9 Shifting_method_3

U - Selected Choice Ik gebruik een smart home-systeem of automatisering die het gebruik van apparaten aanpast op basis van zonne-opwekking					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ik gebruik een smart home-systeem	18	6.9	100.0	100.0
Missing	System	242	93.1		
Total		260	100.0		

C.2 Independent t-tests

Table C.2.1 Group statistics T-test with gender as grouping variable and hassle factors as test variables

	Selecteer uw geslacht	N	Mean	Std. Deviation	Std. Error Mean
Manual planning effort 1	Man	82	1.74	.979	.108
	Vrouw	37	1.86	1.337	.220
Timer planning effort 1	Man	82	2.13	1.386	.153
	Vrouw	37	2.38	1.460	.240
PV monitoring effort 1	Man	82	2.11	1.324	.146
	Vrouw	37	2.89	1.595	.262
Weather forecasting effort 1	Man	82	2.29	1.291	.143
	Vrouw	37	2.76	1.640	.270
Half-full machine 1	Man	81	3.54	1.415	.157
	Vrouw	37	3.92	1.256	.206
Overloaded machine 1	Man	82	2.49	1.442	.159
	Vrouw	37	2.76	1.606	.264
Household coordination effort 1	Man	82	1.95	1.206	.133
	Vrouw	37	1.92	1.341	.220
Unmonitored use concern 1	Man	82	1.57	.994	.110
	Vrouw	36	1.61	1.202	.200
Decision uncertainty 1	Man	81	1.63	1.030	.114
	Vrouw	37	1.81	1.221	.201
Simultaneous appliance use 1	Man	82	1.59	.955	.105
	Vrouw	36	1.56	.939	.157
Manual planning effort 2	Man	76	1.97	1.131	.130
	Vrouw	57	1.77	1.239	.164
Timer planning effort 2	Man	75	2.03	1.208	.139
	Vrouw	57	1.95	1.245	.165
PV monitoring effort 2	Man	75	2.43	1.499	.173
	Vrouw	57	2.32	1.454	.193
Weather forecasting effort 2	Man	76	2.24	1.221	.140
	Vrouw	57	2.05	1.260	.167
Half-full machine 2	Man	74	3.15	1.331	.155
	Vrouw	58	3.07	1.509	.198
Overloaded machine 2	Man	76	2.46	1.311	.150
	Vrouw	57	2.21	1.333	.177
Household coordination effort 2	Man	75	1.60	1.053	.122
	Vrouw	57	1.42	.865	.115
Unmonitored use concern 2	Man	75	1.71	1.183	.137
	Vrouw	57	1.91	1.229	.163
Decision uncertainty 2	Man	76	1.70	1.020	.117
	Vrouw	57	1.53	.908	.120
Simultaneous appliance use 2	Man	76	1.41	.677	.078
	Vrouw	57	1.37	.858	.114

Table C.2.2 T-test with gender as grouping variable and hassle factors as test variables

		Levene's Test for Equality of Variances				t-test for Equality of Means		
		F	Sig.	t	df	Two-Sided p	Mean Difference	Std. Error Difference
Manual planning effort 1	Equal variances assumed	4.488	.036	-.555	117	.580	-.121	.218
	Equal variances not assumed			-.494	54.124	.623	-.121	.245
Timer planning effort 1	Equal variances assumed	.329	.567	-.875	117	.383	-.244	.279
	Equal variances not assumed			-.858	66.353	.394	-.244	.285
PV monitoring effort 1	Equal variances assumed	5.175	.025	-2.795	117	.006	-.782	.280
	Equal variances not assumed			-2.605	59.325	.012	-.782	.300
Weather forecasting effort 1	Equal variances assumed	8.953	.003	-1.665	117	.099	-.464	.279
	Equal variances not assumed			-1.522	56.966	.134	-.464	.305
Half-full machine 1	Equal variances assumed	2.795	.097	-1.385	116	.169	-.376	.271
	Equal variances not assumed			-1.448	78.044	.152	-.376	.259
Overloaded machine 1	Equal variances assumed	1.832	.179	-.909	117	.365	-.269	.296
	Equal variances not assumed			-.872	63.258	.386	-.269	.308
Household coordination effort 1	Equal variances assumed	.476	.492	.131	117	.896	.032	.247
	Equal variances not assumed			.125	63.314	.901	.032	.258
Unmonitored use concern 1	Equal variances assumed	.695	.406	-.179	116	.858	-.038	.212
	Equal variances not assumed			-.166	56.966	.869	-.038	.228
Decision uncertainty 1	Equal variances assumed	.524	.470	-.835	116	.405	-.181	.217
	Equal variances not assumed			-.784	60.341	.436	-.181	.231
Simultaneous appliance use 1	Equal variances assumed	.074	.786	.157	116	.876	.030	.190
	Equal variances not assumed			.158	67.934	.875	.030	.189
Manual planning effort 2	Equal variances assumed	.187	.666	.977	131	.330	.202	.207
	Equal variances not assumed			.964	114.456	.337	.202	.209
Timer planning effort 2	Equal variances assumed	.043	.836	.369	130	.713	.079	.215
	Equal variances not assumed			.367	118.758	.714	.079	.216
PV monitoring effort 2	Equal variances assumed	.499	.481	.426	130	.671	.111	.260
	Equal variances not assumed			.428	122.544	.669	.111	.259
Weather forecasting effort 2	Equal variances assumed	.126	.723	.850	131	.397	.184	.217
	Equal variances not assumed			.846	118.698	.399	.184	.218
Half-full machine 2	Equal variances assumed	1.561	.214	.322	130	.748	.080	.248
	Equal variances not assumed			.317	114.504	.752	.080	.251
Overloaded machine 2	Equal variances assumed	.291	.591	1.081	131	.282	.250	.231
	Equal variances not assumed			1.078	119.694	.283	.250	.232
Household coordination effort 2	Equal variances assumed	3.094	.081	1.043	130	.299	.179	.172
	Equal variances not assumed			1.071	129.171	.286	.179	.167
Unmonitored use concern 2	Equal variances assumed	.460	.499	-.973	130	.332	-.206	.211
	Equal variances not assumed			-.968	118.263	.335	-.206	.212
Decision uncertainty 2	Equal variances assumed	.667	.416	1.002	131	.318	.171	.171
	Equal variances not assumed			1.019	127.117	.310	.171	.168
Simultaneous appliance use 2	Equal variances assumed	.014	.905	.297	131	.767	.039	.133
	Equal variances not assumed			.287	103.581	.775	.039	.138

Table C.2.3 Group statistics T-test with children as grouping variable and hassle factors as test variables

	1=yes. 2=no	N	Mean	Std. Deviation	Std. Error Mean
Manual planning effort 1	1.00	33	2.24	1.300	.226
	2.00	87	1.60	.958	.103
Timer planning effort 1	1.00	33	2.36	1.496	.260
	2.00	87	2.14	1.374	.147
PV monitoring effort 1	1.00	33	2.76	1.696	.295
	2.00	87	2.18	1.325	.142
Weather forecasting effort 1	1.00	33	3.00	1.500	.261
	2.00	87	2.21	1.331	.143
Half-full machine 1	1.00	32	4.00	1.320	.233
	2.00	87	3.55	1.379	.148
Overloaded machine 1	1.00	33	2.88	1.709	.298
	2.00	87	2.44	1.395	.150
Household coordination effort 1	1.00	33	2.52	1.584	.276
	2.00	87	1.72	1.008	.108
Unmonitored use concern 1	1.00	33	1.36	.822	.143
	2.00	86	1.66	1.123	.121
Decision uncertainty 1	1.00	32	1.81	1.148	.203
	2.00	87	1.63	1.069	.115
Simultaneous appliance use 1	1.00	33	1.94	1.171	.204
	2.00	86	1.43	.805	.087
Manual planning effort 2	1.00	52	2.29	1.273	.177
	2.00	87	1.64	1.056	.113
Timer planning effort 2	1.00	51	2.22	1.119	.157
	2.00	87	1.86	1.287	.138
PV monitoring effort 2	1.00	51	2.94	1.475	.207
	2.00	87	2.06	1.358	.146
Weather forecasting effort 2	1.00	52	2.38	1.157	.160
	2.00	87	2.03	1.252	.134
Half-full machine 2	1.00	52	3.38	1.430	.198
	2.00	86	2.97	1.401	.151
Overloaded machine 2	1.00	52	2.77	1.366	.189
	2.00	87	2.08	1.222	.131
Household coordination effort 2	1.00	52	1.69	1.164	.161
	2.00	86	1.40	.801	.086
Unmonitored use concern 2	1.00	52	1.83	1.232	.171
	2.00	86	1.79	1.209	.130
Decision uncertainty 2	1.00	52	1.87	1.172	.163
	2.00	87	1.47	.790	.085
Simultaneous appliance use 2	1.00	52	1.58	.893	.124
	2.00	87	1.29	.645	.069

Table C.2.4 T-test with children as grouping variable and hassle factors as test variables

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	**Sig.**	**t**	**df**	**Two-Sided p**	**Mean Difference**	**Std. Error Difference**
Manual planning effort 1	Equal variances assumed	7.220	0.008	2.971	118	0.004	0.645	0.217
	Equal variances not assumed			2.595	45.821	0.013	0.645	0.248
Timer planning effort 1	Equal variances assumed	0.344	0.559	0.784	118	0.435	0.226	0.288
	Equal variances not assumed			0.754	53.700	0.454	0.226	0.299
PV monitoring effort 1	Equal variances assumed	10.930	0.001	1.955	118	0.053	0.574	0.293
	Equal variances not assumed			1.751	47.588	0.086	0.574	0.328
Weather forecasting effort 1	Equal variances assumed	1.452	0.231	2.814	118	0.006	0.793	0.282
	Equal variances not assumed			2.665	52.224	0.010	0.793	0.298
Half-full machine 1	Equal variances assumed	2.702	0.103	1.590	117	0.114	0.448	0.282
	Equal variances not assumed			1.623	57.545	0.110	0.448	0.276
Overloaded machine 1	Equal variances assumed	7.605	0.007	1.454	118	0.149	0.442	0.304
	Equal variances not assumed			1.327	49.048	0.191	0.442	0.333
Household coordination effort 1	Equal variances assumed	22.668	<0.001	3.246	118	0.002	0.791	0.244
	Equal variances not assumed			2.672	42.221	0.011	0.791	0.296
Unmonitored use concern 1	Equal variances assumed	5.709	0.018	-1.392	117	0.167	-0.299	0.215
	Equal variances not assumed			-1.595	78.978	0.115	-0.299	0.188
Decision uncertainty 1	Equal variances assumed	1.207	0.274	0.800	117	0.425	0.180	0.225
	Equal variances not assumed			0.774	51.999	0.443	0.180	0.233
Simultaneous appliance use 1	Equal variances assumed	6.633	0.011	2.704	117	0.008	0.509	0.188
	Equal variances not assumed			2.298	44.112	0.026	0.509	0.222
Manual planning effort 2	Equal variances assumed	5.982	0.016	3.221	137	0.002	0.645	0.200
	Equal variances not assumed			3.074	92.327	0.003	0.645	0.210
Timer planning effort 2	Equal variances assumed	1.208	0.274	1.633	136	0.105	0.354	0.217
	Equal variances not assumed			1.694	116.740	0.093	0.354	0.209
PV monitoring effort 2	Equal variances assumed	1.698	0.195	3.573	136	<0.001	0.884	0.247
	Equal variances not assumed			3.496	97.985	0.001	0.884	0.253
Weather forecasting effort 2	Equal variances assumed	0.412	0.522	1.640	137	0.103	0.350	0.213
	Equal variances not assumed			1.673	114.203	0.097	0.350	0.209
Half-full machine 2	Equal variances assumed	0.008	0.928	1.691	136	0.093	0.419	0.248
	Equal variances not assumed			1.683	105.969	0.095	0.419	0.249
Overloaded machine 2	Equal variances assumed	2.458	0.119	3.075	137	0.003	0.689	0.224
	Equal variances not assumed			2.990	98.118	0.004	0.689	0.230
Household coordination effort 2	Equal variances assumed	8.638	0.004	1.773	136	0.078	0.297	0.167
	Equal variances not assumed			1.622	80.451	0.109	0.297	0.183
Unmonitored use concern 2	Equal variances assumed	0.043	0.836	0.169	136	0.866	0.036	0.214
	Equal variances not assumed			0.169	106.079	0.866	0.036	0.215
Decision uncertainty 2	Equal variances assumed	9.711	0.002	2.366	137	0.019	0.394	0.167
	Equal variances not assumed			2.150	79.007	0.035	0.394	0.183
Simultaneous appliance use 2	Equal variances assumed	9.269	0.003	2.211	137	0.029	0.290	0.131
	Equal variances not assumed			2.041	82.995	0.044	0.290	0.142

Table C.2.5 Group statistics T-test with household composition as grouping variable and hassle factors as test variables

	1=single/two-person. 2=multi-person	N	Mean	Std. Deviation	Std. Error Mean
Manual planning effort 1	1.00	61	1.56	.886	.113
	2.00	59	2.00	1.246	.162
Timer planning effort 1	1.00	61	2.11	1.392	.178
	2.00	59	2.29	1.427	.186
PV monitoring effort 1	1.00	61	2.20	1.352	.173
	2.00	59	2.49	1.547	.201
Weather forecasting effort 1	1.00	61	2.15	1.302	.167
	2.00	59	2.71	1.486	.193
Half-full machine 1	1.00	61	3.41	1.371	.176
	2.00	58	3.95	1.330	.175
Overloaded machine 1	1.00	61	2.43	1.335	.171
	2.00	59	2.69	1.643	.214
Household coordination effort 1	1.00	61	1.59	.883	.113
	2.00	59	2.31	1.441	.188
Unmonitored use concern 1	1.00	61	1.72	1.157	.148
	2.00	58	1.43	.920	.121
Decision uncertainty 1	1.00	61	1.52	.924	.118
	2.00	58	1.84	1.225	.161
Simultaneous appliance use 1	1.00	61	1.39	.640	.082
	2.00	58	1.76	1.159	.152
Manual planning effort 2	1.00	76	1.55	.958	.110
	2.00	62	2.24	1.263	.160
Timer planning effort 2	1.00	76	1.89	1.302	.149
	2.00	61	2.13	1.147	.147
PV monitoring effort 2	1.00	76	1.95	1.264	.145
	2.00	61	2.95	1.510	.193
Weather forecasting effort 2	1.00	76	2.00	1.233	.141
	2.00	62	2.39	1.192	.151
Half-full machine 2	1.00	76	2.91	1.425	.163
	2.00	61	3.36	1.379	.177
Overloaded machine 2	1.00	76	2.01	1.172	.134
	2.00	62	2.76	1.375	.175
Household coordination effort 2	1.00	76	1.32	.734	.084
	2.00	61	1.75	1.150	.147
Unmonitored use concern 2	1.00	75	1.84	1.231	.142
	2.00	62	1.77	1.207	.153
Decision uncertainty 2	1.00	76	1.42	.753	.086
	2.00	62	1.87	1.138	.144
Simultaneous appliance use 2	1.00	76	1.32	.677	.078

Table C.2.6 T-test with grouping variable household composition and test variables hassle factors

		Levene's Test for Equality of Variances				t-test for Equality of Means		
		F	Sig.	t	df	Two-Sided p	Mean Difference	Std. Error Difference
Manual planning effort 1	Equal variances assumed	7.272	0.008	-2.249	118	0.026	-0.443	0.197
	Equal variances not assumed			-2.237	104.436	0.027	-0.443	0.198
Timer planning effort 1	Equal variances assumed	0.064	0.800	-0.674	118	0.502	-0.173	0.257
	Equal variances not assumed			-0.674	117.595	0.502	-0.173	0.257
PV monitoring effort 1	Equal variances assumed	5.338	0.023	-1.113	118	0.268	-0.295	0.265
	Equal variances not assumed			-1.110	114.792	0.269	-0.295	0.266
Weather forecasting effort 1	Equal variances assumed	4.006	0.048	-2.215	118	0.029	-0.564	0.255
	Equal variances not assumed			-2.210	114.871	0.029	-0.564	0.255
Half-full machine 1	Equal variances assumed	1.826	0.179	-2.173	117	0.032	-0.538	0.248
	Equal variances not assumed			-2.175	116.950	0.032	-0.538	0.248
Overloaded machine 1	Equal variances assumed	10.112	0.002	-0.985	118	0.327	-0.269	0.273
	Equal variances not assumed			-0.981	111.702	0.328	-0.269	0.274
Household coordination effort 1	Equal variances assumed	27.325	<0.001	-3.289	118	0.001	-0.715	0.217
	Equal variances not assumed			-3.263	95.556	0.002	-0.715	0.219
Unmonitored use concern 1	Equal variances assumed	5.274	0.023	1.510	117	0.134	0.290	0.192
	Equal variances not assumed			1.519	113.504	0.132	0.290	0.191
Decision uncertainty 1	Equal variances assumed	8.030	0.005	-1.615	117	0.109	-0.320	0.198
	Equal variances not assumed			-1.603	105.877	0.112	-0.320	0.200
Simultaneous appliance use 1	Equal variances assumed	14.654	<0.001	-2.141	117	0.034	-0.365	0.171
	Equal variances not assumed			-2.112	87.791	0.037	-0.365	0.173
Manual planning effort 2	Equal variances assumed	11.611	0.001	-3.644	136	<0.001	-0.689	0.189
	Equal variances not assumed			-3.545	111.639	0.001	-0.689	0.194
Timer planning effort 2	Equal variances assumed	1.055	0.306	-1.113	135	0.268	-0.236	0.212
	Equal variances not assumed			-1.129	133.795	0.261	-0.236	0.209
PV monitoring effort 2	Equal variances assumed	6.532	0.012	-4.234	135	<0.001	-1.003	0.237
	Equal variances not assumed			-4.152	116.865	<0.001	-1.003	0.242
Weather forecasting effort 2	Equal variances assumed	<0.001	0.986	-1.862	136	0.065	-0.387	0.208
	Equal variances not assumed			-1.868	132.090	0.064	-0.387	0.207
Half-full machine 2	Equal variances assumed	0.672	0.414	-1.875	135	0.063	-0.453	0.241
	Equal variances not assumed			-1.882	130.348	0.062	-0.453	0.241
Overloaded machine 2	Equal variances assumed	5.553	0.020	-3.435	136	0.001	-0.745	0.217
	Equal variances not assumed			-3.380	120.326	0.001	-0.745	0.220
Household coordination effort 2	Equal variances assumed	15.893	<0.001	-2.707	135	0.008	-0.438	0.162
	Equal variances not assumed			-2.585	97.355	0.011	-0.438	0.170
Unmonitored use concern 2	Equal variances assumed	0.006	0.939	0.314	135	0.754	0.066	0.209
	Equal variances not assumed			0.315	131.098	0.753	0.066	0.209
Decision uncertainty 2	Equal variances assumed	10.491	0.002	-2.782	136	0.006	-0.450	0.162
	Equal variances not assumed			-2.673	101.809	0.009	-0.450	0.168
Simultaneous appliance use 2	Equal variances assumed	4.503	0.036	-1.422	136	0.157	-0.184	0.130
	Equal variances not assumed			-1.391	115.887	0.167	-0.184	0.132

Table C.2.7 Splitting of sample on shifting method

Shifting method: 1=manual. 2=timer					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	132	50.8	76.3	76.3
	2.00	41	15.8	23.7	100.0
	Total	173	66.5	100.0	
Missing	System	87	33.5		
Total		260	100.0		

Table C.2.8 Group statistics T-test with grouping variable shifting method and test variables hassle factors

	1=manual. 2=timer	N	Mean	Std. Deviation	Std. Error Mean
Manual planning effort 1	1.00	64	1.70	1.122	.140
	2.00	19	1.89	.994	.228
Timer planning effort 1	1.00	64	2.44	1.521	.190
	2.00	19	1.74	1.046	.240
PV monitoring effort 1	1.00	64	2.30	1.444	.180
	2.00	19	2.05	1.311	.301
Weather forecasting effort 1	1.00	64	2.33	1.470	.184
	2.00	19	2.11	1.197	.275
Half-full machine 1	1.00	64	3.53	1.425	.178
	2.00	18	3.72	1.179	.278
Overloaded machine 1	1.00	64	2.27	1.428	.179
	2.00	19	2.74	1.408	.323
Household coordination effort 1	1.00	64	1.77	1.192	.149
	2.00	19	2.42	1.346	.309
Unmonitored use concern 1	1.00	64	1.73	1.185	.148
	2.00	19	1.26	.452	.104
Decision uncertainty 1	1.00	63	1.60	.976	.123
	2.00	19	1.42	.607	.139
Simultaneous appliance use 1	1.00	64	1.63	1.031	.129
	2.00	19	1.53	.697	.160
Manual planning effort 2	1.00	67	1.61	.953	.116
	2.00	22	1.77	1.193	.254
Timer planning effort 2	1.00	67	1.97	1.193	.146
	2.00	22	1.91	1.306	.278
PV monitoring effort 2	1.00	67	2.31	1.395	.170
	2.00	22	2.00	1.447	.309
Weather forecasting effort 2	1.00	67	2.15	1.104	.135
	2.00	22	1.91	1.342	.286
Half-full machine 2	1.00	67	3.16	1.410	.172
	2.00	21	2.76	1.375	.300
Overloaded machine 2	1.00	67	2.25	1.223	.149
	2.00	22	1.77	.973	.207
Household coordination effort 2	1.00	67	1.34	.770	.094
	2.00	21	1.48	.873	.190
Unmonitored use concern 2	1.00	66	1.95	1.258	.155
	2.00	22	1.86	1.283	.274
Decision uncertainty 2	1.00	67	1.51	.842	.103
	2.00	22	1.59	1.008	.215
Simultaneous appliance use 2	1.00	67	1.36	.595	.073
	2.00	22	1.14	.351	.075

Table C.2.9 T-test with shifting method as grouping variable and test variables hassle factors

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Two-Sided p	Mean Difference	Std. Error Difference
Manual planning effort 1	Equal variances assumed	1.875	.175	-.670	81	.505	-.192	.286
	Equal variances not assumed			-.716	32.855	.479	-.192	.268
Timer planning effort 1	Equal variances assumed	14.077	<.001	1.877	81	.064	.701	.373
	Equal variances not assumed			2.289	42.878	.027	.701	.306
PV monitoring effort 1	Equal variances assumed	1.146	.287	.660	81	.511	.244	.370
	Equal variances not assumed			.696	32.105	.491	.244	.351
Weather forecasting effort 1	Equal variances assumed	3.057	.084	.603	81	.548	.223	.369
	Equal variances not assumed			.675	35.680	.504	.223	.330
Half-full machine 1	Equal variances assumed	2.631	.109	-.520	80	.604	-.191	.367
	Equal variances not assumed			-.579	32.379	.567	-.191	.330
Overloaded machine 1	Equal variances assumed	.125	.725	-1.267	81	.209	-.471	.372
	Equal variances not assumed			-1.277	29.877	.212	-.471	.369
Household coordination effort 1	Equal variances assumed	.785	.378	-2.043	81	.044	-.655	.321
	Equal variances not assumed			-1.911	26.931	.067	-.655	.343
Unmonitored use concern 1	Equal variances assumed	11.119	.001	1.691	81	.095	.471	.279
	Equal variances not assumed			2.605	75.965	.011	.471	.181
Decision uncertainty 1	Equal variances assumed	3.482	.066	.768	80	.445	.182	.237
	Equal variances not assumed			.980	48.471	.332	.182	.186
Simultaneous appliance use 1	Equal variances assumed	1.183	.280	.391	81	.697	.099	.253
	Equal variances not assumed			.481	43.745	.633	.099	.205
Manual planning effort 2	Equal variances assumed	.960	.330	-.644	87	.521	-.161	.250
	Equal variances not assumed			-.575	30.302	.570	-.161	.280
Timer planning effort 2	Equal variances assumed	.040	.842	.203	87	.839	.061	.300
	Equal variances not assumed			.194	33.290	.847	.061	.314
PV monitoring effort 2	Equal variances assumed	.026	.871	.906	87	.367	.313	.346
	Equal variances not assumed			.889	34.732	.380	.313	.353
Weather forecasting effort 2	Equal variances assumed	1.301	.257	.838	87	.404	.240	.287
	Equal variances not assumed			.759	30.894	.453	.240	.316
Half-full machine 2	Equal variances assumed	.035	.852	1.147	86	.254	.402	.351
	Equal variances not assumed			1.163	34.228	.253	.402	.346
Overloaded machine 2	Equal variances assumed	5.910	.017	1.677	87	.097	.481	.287
	Equal variances not assumed			1.882	44.633	.066	.481	.256
Household coordination effort 2	Equal variances assumed	1.041	.311	-.669	86	.506	-.133	.199
	Equal variances not assumed			-.626	30.391	.536	-.133	.212
Unmonitored use concern 2	Equal variances assumed	.247	.620	.292	86	.771	.091	.311
	Equal variances not assumed			.289	35.430	.774	.091	.314
Decision uncertainty 2	Equal variances assumed	.408	.525	-.384	87	.702	-.083	.217
	Equal variances not assumed			-.350	31.203	.728	-.083	.238
Simultaneous appliance use 2	Equal variances assumed	13.085	<.001	1.652	87	.102	.222	.134
	Equal variances not assumed			2.125	61.821	.038	.222	.104

Table C.2.10 Pearson correlation children and household size

Correlations			
		Children (1=yes, 2=no)	Household size (1=single/two-person, 2=multi-person)
Children (1=yes, 2=no)	Pearson Correlation	1	-.730**
	Sig. (2-tailed)		<.001
	N	260	259
Household size (1=single/two-person, 2=multi-person)	Pearson Correlation	-.730**	1
	Sig. (2-tailed)	<.001	
	N	259	259
**. Correlation is significant at the 0.01 level (2-tailed).			

C.3 Principal Component Analyses

C.3.1 Hassle factors in dishwasher group

Table C.3.1 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.838
Bartlett's Test of Sphericity	Approx. Chi-Square	279.803
	df	45
	Sig.	<.001

Table C.3.2 Total variance explained

Total Variance Explained				
Component	**Initial Eigenvalues**			**Rotation Sums of Squared Loadings[a]**
	Total	**% of Variance**	**Cumulative %**	**Total**
1	3.660	36.596	36.596	3.407
2	1.141	11.414	48.011	1.207
3	1.033	10.335	58.345	2.018
4	.959	9.586	67.931	
5	.722	7.219	75.150	
6	.611	6.109	81.259	
7	.607	6.065	87.324	
8	.486	4.864	92.189	
9	.410	4.102	96.291	
10	.371	3.709	100.000	
Extraction Method: Principal Component Analysis.				
a. When components are correlated. sums of squared loadings cannot be added to obtain a total variance.				

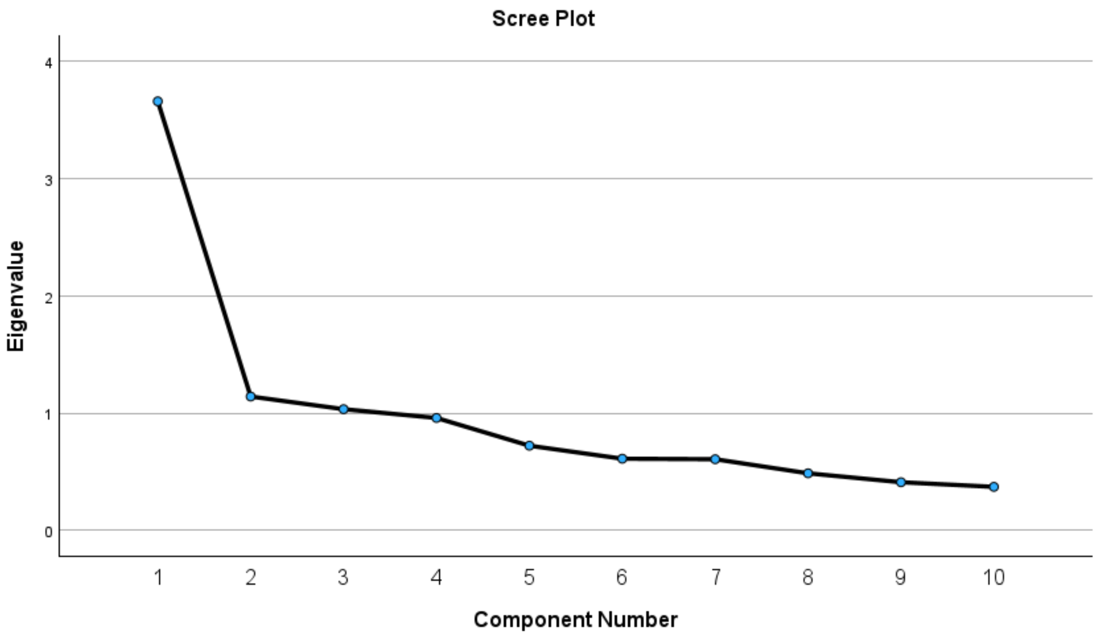

Figure C.3.1 Scree plot

Table C.3.3 Pattern matrix

	Component		
	1	**2**	**3**
Manual planning effort 1	.757	-.110	-.136
Timer planning effort 1	.732	.067	.079
PV monitoring effort 1	.786	.094	.033
Weather forecasting effort 1	.518	-.012	.478
Half-full machine 1	-.145	.186	.874
Overloaded machine 1	.171	-.308	.592
Household coordination effort 1	.340	-.484	.172
Unmonitored use concern 1	.234	.857	.153
Decision uncertainty 1	.556	-.115	.174
Simultaneous appliance use 1	.699	.103	-.115
Extraction Method: Principal Component Analysis.			
Rotation Method: Oblimin with Kaiser Normalization			
a. Rotation converged in 7 iterations.			

Table C.3.4 Component correlation matrix

Component	1	2	3
1	1.000	-.130	.336
2	-.130	1.000	-.056
3	.336	-.056	1.000
Extraction Method: Principal Component Analysis.			
Rotation Method: Oblimin with Kaiser Normalization			

C.3.2 Hassle factors in washing machine group

Table C.3.5 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.823
Bartlett's Test of Sphericity	Approx. Chi-Square	326.406
	df	45
	Sig.	<.001

Table C.3.6 Total variance explained

Total Variance Explained				
Component	**Initial Eigenvalues**			**Rotation Sums of**
	Total	**% of Variance**	**Cumulative %**	**Total**
1	3.634	36.345	36.345	2.957
2	1.172	11.724	48.069	1.339
3	1.040	10.400	58.469	2.522
4	.871	8.711	67.180	
5	.771	7.710	74.890	
6	.680	6.800	81.691	
7	.553	5.526	87.217	
8	.507	5.067	92.284	
9	.463	4.635	96.919	
10	.308	3.081	100.000	
Extraction Method: Principal Component Analysis.				
a. When components are correlated, sums of squared loadings cannot be added to				

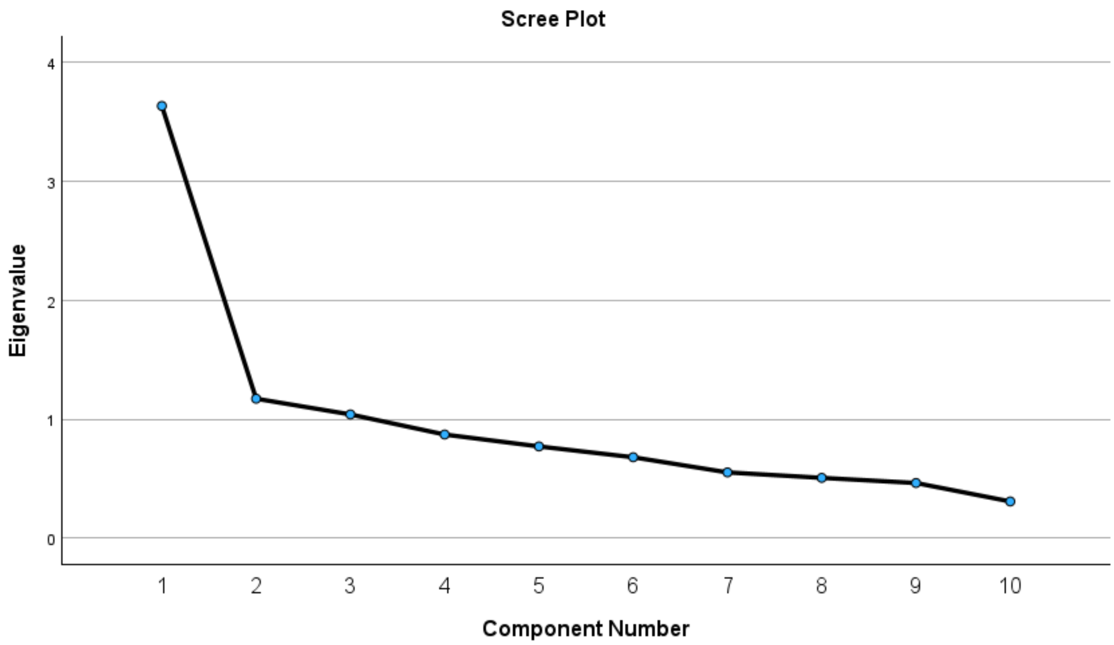

Figure C.3.2

Table C.3.7 Pattern matrix

	Component		
	1	2	3
Manual planning effort 2	.561	.076	.267
Timer planning effort 2	.407	-.196	.383
PV monitoring effort 2	.415	.445	.365
Weather forecasting effort 2	.363	.362	.458
Half-full machine 2	.183	-.364	.487
Overloaded machine 2	.381	.182	.532
Household coordination effort 2	-.270	.026	.860
Unmonitored use concern 2	-.033	.831	-.043
Decision uncertainty 2	.887	-.128	-.178
Simultaneous appliance use 2	.727	.074	-.100
Extraction Method: Principal Component Analysis.			
Rotation Method: Oblimin with Kaiser Normalization			
a. Rotation converged in 24 iterations.			

Table C.3.8 Component correlation matrix

Component	1	2	3
1	1.000	.081	.354
2	.081	1.000	.069
3	.354	.069	1.000
Extraction Method: Principal Component Analysis.			
Rotation Method: Oblimin with Kaiser Normalization.			

C.4 Linear regression hassle factors and load shifting in general

C.4.1 Dishwasher group

Table C.4.1 Model summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,598 a	,358	,297	,97492
a. Predictors: (Constant), Simultaneous appliance use 1, Unmonitored use concern 1, Overloaded machine 1, Half-full machine 1, Decision uncertainty 1, Manual planning effort 1, Household coordination effort 1, Timer planning effort 1, PV monitoring effort 1, Weather forecasting effort 1				
b. Dependent Variable: LS_experience_frequency				

Table C.4.2 ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	56.173	10	5.617	5.910	<.001[b]
	Residual	100.750	106	.950		
	Total	156.923	116			
a. Dependent Variable: LS_experience_frequency						
b. Predictors: (Constant). Simultaneous appliance use 1. Unmonitored use concern 1. Overloaded machine 1. Half-full machine 1. Decision uncertainty 1. Manual planning effort 1. Household coordination effort 1. Timer planning effort 1. PV monitoring effort 1. Weather forecasting effort 1						

Table C.4.3 Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	5.237	.332		15.783	<.001		
Manual planning effort 1	-.121	.100	-.115	-1.211	.229	.669	1.494
Timer planning effort 1	.102	.087	.123	1.162	.248	.539	1.857
PV monitoring effort 1	-.217	.085	-.273	-2.563	.012	.532	1.878
Weather forecasting effort 1	-.087	.089	-.107	-.974	.332	.506	1.976
Half-full machine 1	-.047	.072	-.056	-.655	.514	.840	1.190
Overloaded machine 1	-.101	.071	-.130	-1.431	.155	.736	1.359
Household coordination effort 1	.028	.084	.031	.338	.736	.744	1.345
Unmonitored use concern 1	-.041	.089	-.038	-.463	.644	.924	1.083
Decision uncertainty 1	-.338	.100	-.318	-3.393	<.001	.689	1.452
Simultaneous appliance use 1	.114	.112	.093	1.016	.312	.721	1.388
a. Dependent Variable: LS_experience_frequency							

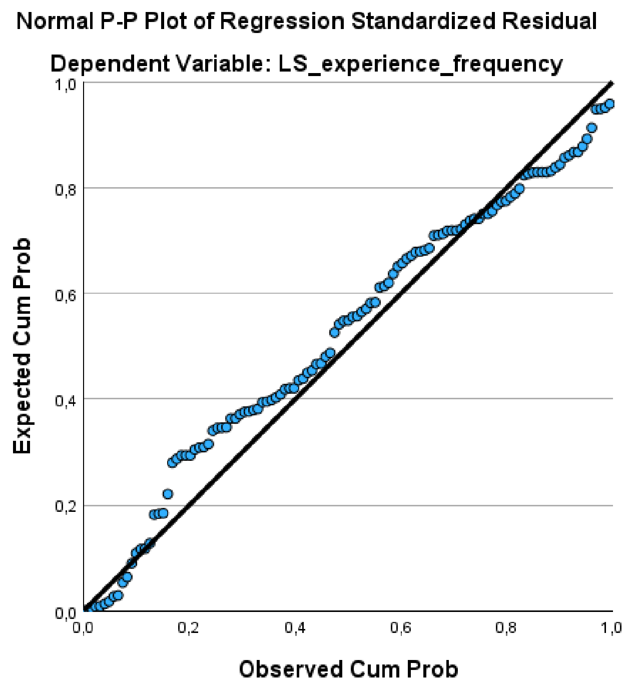

Figure C.4.2 Normal P-P plot (Normality assumption)

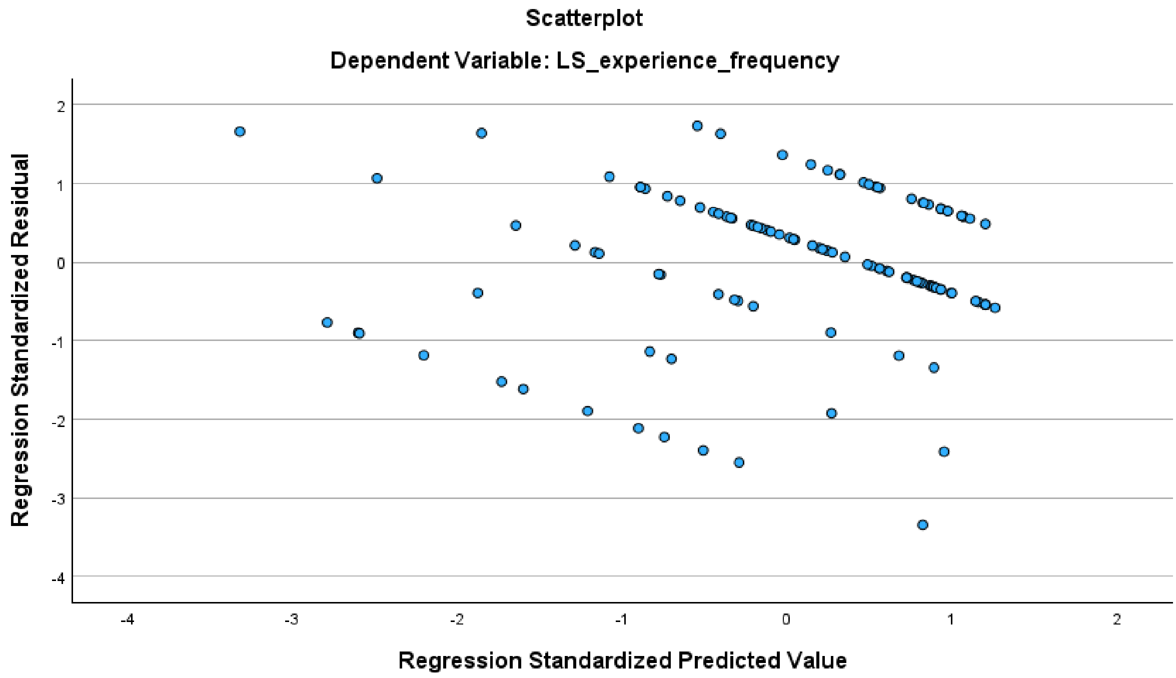

Figure C.4.1 Scatterplot (Homoscedasticity assumption)

C.4.2 Washing machine group

Table C.4.4 Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.506 a	.257	.197	1.13066
a. Predictors: (Constant), Simultaneous appliance use 2, Unmonitored use concern 2, Household coordination effort 2, Half-full machine 2, Timer planning effort 2, PV monitoring effort 2, Decision uncertainty 2, Manual planning effort 2, Overloaded machine 2, Weather forecasting effort 2				
b. Dependent Variable: LS_experience_frequency				

Table C.4.5 ANOVA

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	**Regression**	54.694	10	5.469	4.278	<.001[b]
	Residual	158.521	124	1.278		
	Total	213.215	134			
a. Dependent Variable: LS_experience_frequency						
b. Predictors: (Constant). Simultaneous appliance use 2. Unmonitored use concern 2. Household coordination effort 2. Half-full machine 2. Timer planning effort 2. PV monitoring effort 2. Decision uncertainty 2. Manual planning effort 2. Overloaded machine 2. Weather forecasting effort 2						

Table C.4.6 Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	4.439	.346		12.846	<.001		
Manual planning effort 2	-.308	.104	-.288	-2.969	.004	.639	1.565
Timer planning effort 2	.024	.092	.024	.265	.792	.740	1.351
PV monitoring effort 2	-.204	.096	-.238	-2.123	.036	.479	2.088
Weather forecasting effort 2	.010	.112	.010	.090	.929	.513	1.951
Half-full machine 2	.034	.075	.038	.453	.651	.849	1.178
Overloaded machine 2	-.148	.102	-.155	-1.457	.148	.531	1.883
Household coordination effort 2	.134	.111	.103	1.207	.230	.828	1.208
Unmonitored use concern 2	.081	.084	.078	.962	.338	.909	1.100
Decision uncertainty 2	-.058	.125	-.044	-.463	.644	.673	1.487
Simultaneous appliance use 2	.078	.157	.046	.501	.618	.724	1.381
a. Dependent Variable: LS_experience_frequency							

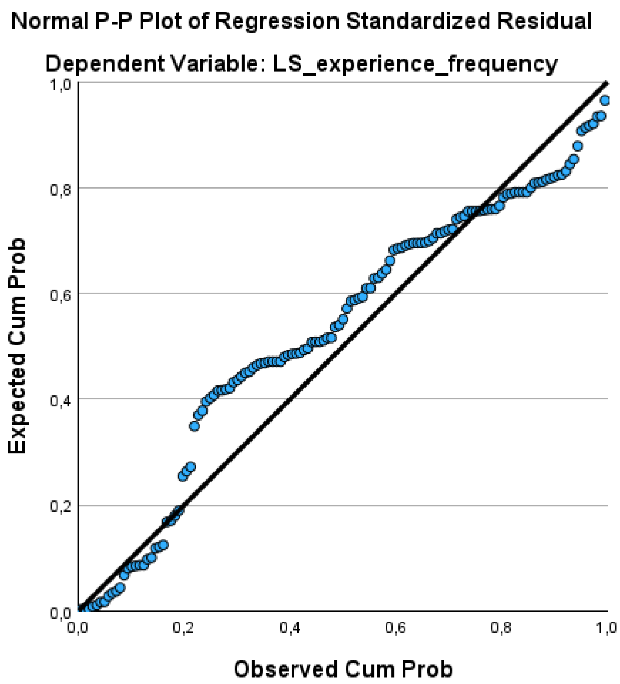

Figure C.4.3 Normal P-P plot (Normality assumption)

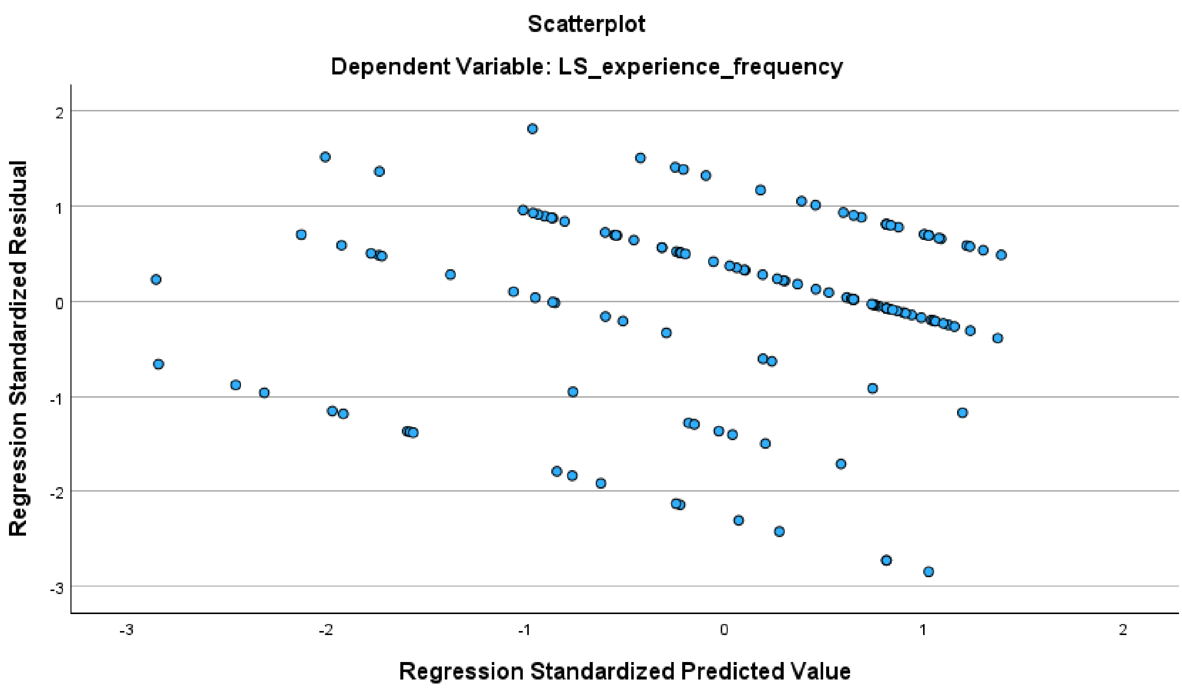

Figure C.4.4 Scatterplot regression (Homoscedasticity assumption)

C.5 Linear regression hassle factors and appliance-specific load shifting

C.5.1 Dishwasher machine group

Table C.5.1 Model summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,493 a	,243	,162	1.12043
a. Predictors: (Constant), Simultaneous appliance use 1, Unmonitored use concern 1, Overloaded machine 1, Half-full machine 1, Decision uncertainty 1, Manual planning effort 1, Household coordination effort 1, Timer planning effort 1, PV monitoring effort 1, Weather forecasting effort 1				
b. Dependent Variable: Shifting dishwasher use				

Table C.5.2 ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	45.649	10	4.565	3.015	.002[b]
	Residual	142.313	94	1.514		
	Total	187.962	104			
a. Dependent Variable: Shifting dishwasher use						
b. Predictors: (Constant). Simultaneous appliance use 1. Overloaded machine 1. Unmonitored use concern 1. Half-full machine 1. Decision uncertainty 1. Manual planning effort 1. Household coordination effort 1. PV monitoring effort 1. Weather forecasting effort 1. Timer planning effort 1						

Table C.5.3 Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	4.812	.435		11.065	<.001		
Manual planning effort 1	-.090	.136	-.073	-.665	.508	.668	1.498
Timer planning effort 1	.011	.118	.011	.092	.927	.545	1.836
PV monitoring effort 1	-.199	.114	-.210	-1.752	.083	.559	1.789
Weather forecasting effort 1	.011	.117	.011	.093	.926	.552	1.811
Half-full machine 1	-.015	.098	-.015	-.151	.880	.784	1.275
Overloaded machine 1	-.244	.096	-.260	-2.547	.012	.771	1.297
Household coordination effort 1	.033	.120	.030	.274	.784	.692	1.446
Unmonitored use concern 1	-.073	.121	-.057	-.601	.549	.898	1.113
Decision uncertainty 1	.035	.165	.024	.215	.830	.660	1.515
Simultaneous appliance use 1	-.255	.160	-.180	-1.591	.115	.632	1.581
a. Dependent Variable: Shifting dishwasher use							

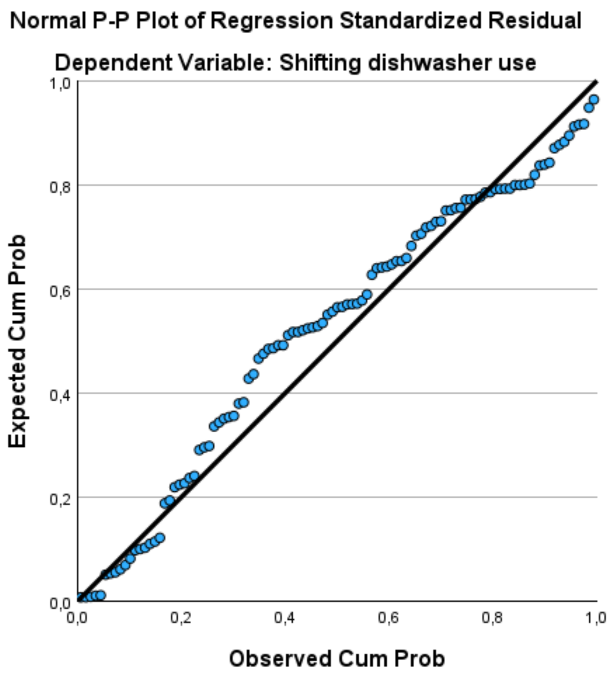

Figure C.5.1 Normal P-P plot (Normality assumption)

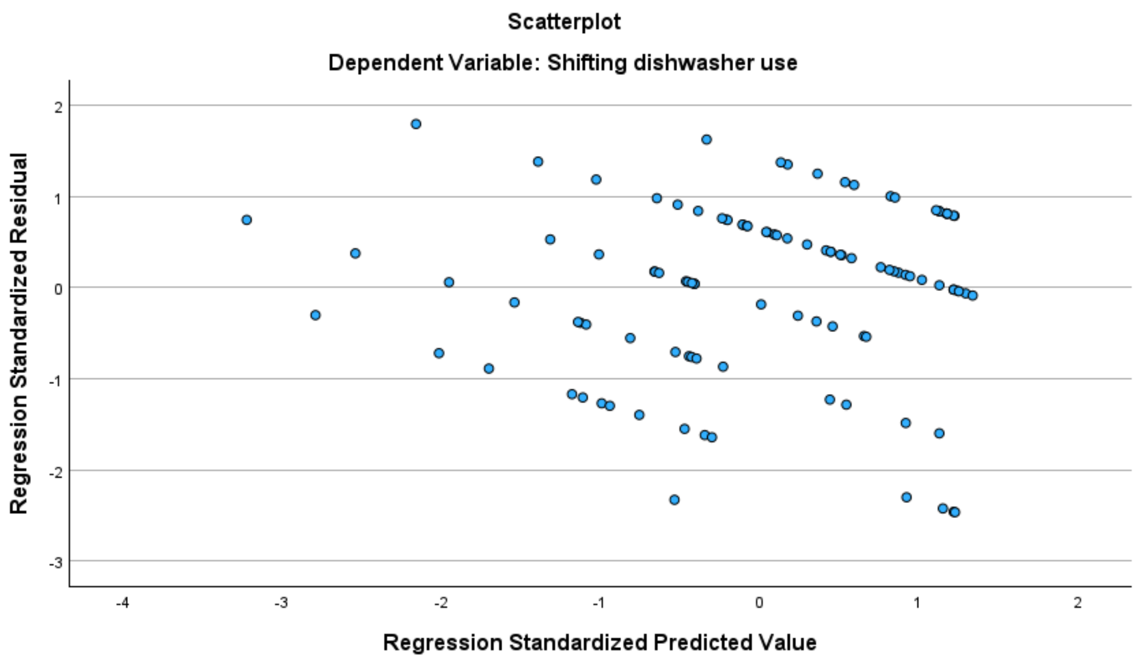

Figure C.5.2 Scatterplot regression (Homoscedasticity assumption)

C.5.2 Washing machine group

Table C.5.4 Model summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,526[a]	,276	,207	,83255

a. Predictors: (Constant), Appliances simultaneously 2, Coordination household 2, Half-full machine 2, Safety concern 2, Manual complicatedness 2, Timers complicatedness 2, Doubt 2, Weather forecast 2, Overloaded machine 2, Monitoring burden 2

b. Dependent Variable: Shifting washing machine use

Table C.5.5 ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	27.797	10	2.780	4.010	<.001[b]
	Residual	72.780	105	.693		
	Total	100.578	115			

a. Dependent Variable: Shifting washing machine use

b. Predictors: (Constant). Simultaneous appliance use 2. Household coordination effort 2. Half-full machine 2. Unmonitored use concern 2. Manual planning effort 2. Timer planning effort 2. Decision uncertainty 2. Weather forecasting effort 2. Overloaded machine 2. PV monitoring effort 2

Table C.5.6 Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	4.096	.298		13.740	<.001		
Manual planning effort 2	-.127	.092	-.137	-1.383	.169	.702	1.425
Timer planning effort 2	-.075	.075	-.097	-1.006	.317	.744	1.344
PV monitoring effort 2	-.334	.081	-.497	-4.128	<.001	.476	2.100
Weather forecasting effort 2	.045	.090	.055	.501	.618	.578	1.731
Half-full machine 2	-.054	.060	-.081	-.906	.367	.851	1.175
Overloaded machine 2	.035	.089	.046	.398	.692	.519	1.927
Household coordination effort 2	.039	.100	.035	.392	.696	.872	1.146
Unmonitored use concern 2	-.047	.065	-.064	-.724	.471	.876	1.141
Decision uncertainty 2	.181	.108	.166	1.680	.096	.707	1.414
Simultaneous appliance use 2	.167	.144	.109	1.157	.250	.781	1.280

a. Dependent Variable: Shifting washing machine use

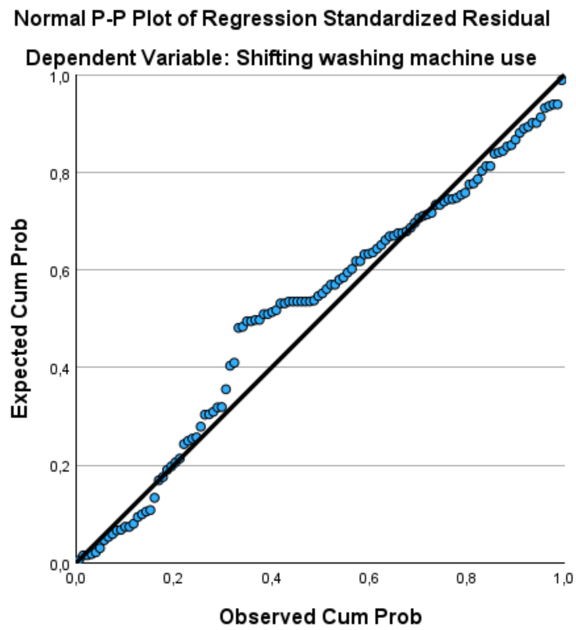

Figure C.5.3 Normal P-P plot (Normality assumption)

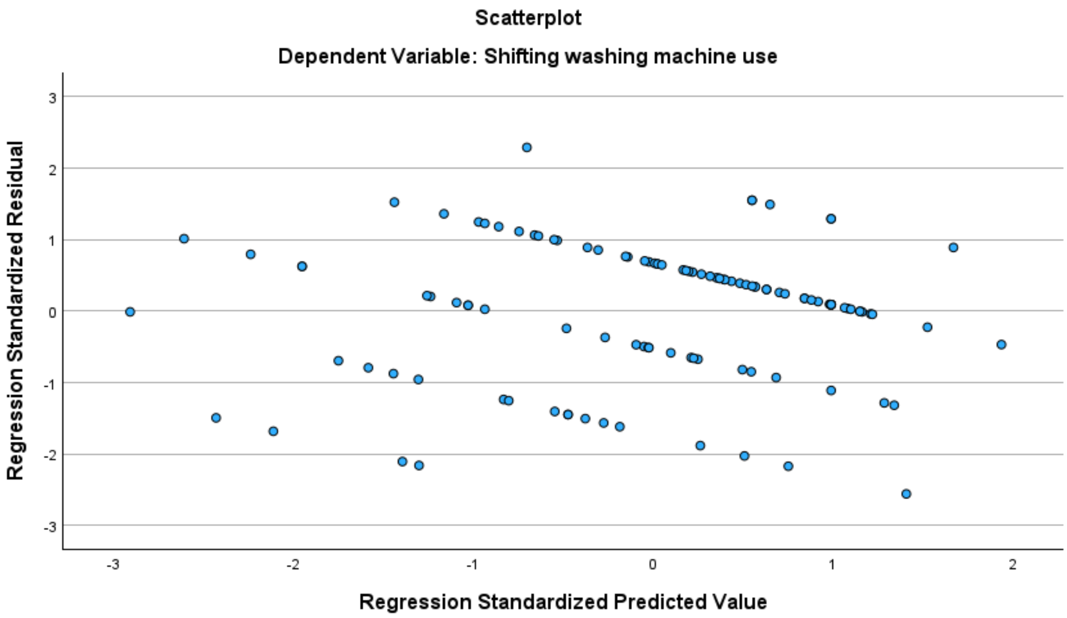

Figure C.5.4 Scatterplot (Homoscedasticity assumption)

C.6 Correlation analyses habits and hassle factors

Table C.6.2 Correlation dishwasher group

			Habit_strength_dishw	Dishwasher use as part of routine
Spearman's rho	**Manual planning effort 1**	Correlation Coefficient	,226*	,291**
		Sig. (2-tailed)	0.013	0.002
		N	120	115
	Timer planning effort 1	Correlation Coefficient	,195*	,185*
		Sig. (2-tailed)	0.032	0.048
		N	120	115
	PV monitoring effort 1	Correlation Coefficient	,210*	,259**
		Sig. (2-tailed)	0.022	0.005
		N	120	115
	Weather forecasting effort 1	Correlation Coefficient	,202*	,228*
		Sig. (2-tailed)	0.027	0.014
		N	120	115
	Half-full machine 1	Correlation Coefficient	0.124	0.089
		Sig. (2-tailed)	0.179	0.348
		N	119	114
	Overloaded machine 1	Correlation Coefficient	,249**	,261**
		Sig. (2-tailed)	0.006	0.005
		N	120	115
	Household coordination effort 1	Correlation Coefficient	-0.029	0.132
		Sig. (2-tailed)	0.754	0.160
		N	120	115
	Unmonitored use concern 1	Correlation Coefficient	,209*	-0.006
		Sig. (2-tailed)	0.022	0.951
		N	119	114
	Decision uncertainty 1	Correlation Coefficient	,273**	,200*
		Sig. (2-tailed)	0.003	0.033
		N	119	114
	Simultaneous appliance use 1	Correlation Coefficient	0.148	0.085
		Sig. (2-tailed)	0.108	0.371
		N	119	114

*. Correlation is significant at the 0.05 level (2-tailed).

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

Table C.6.1 Correlation matrix washing machine group

			Habit_strength_washi	Washing machine use as part of routine
Spearman's rho	**Manual planning effort 2**	Correlation Coefficient	,171*	0.057
		Sig. (2-tailed)	0.047	0.510
		N	135	137
	Timer planning effort 2	Correlation Coefficient	0.100	0.068
		Sig. (2-tailed)	0.249	0.435
		N	134	136
	PV monitoring effort 2	Correlation Coefficient	,381**	0.140
		Sig. (2-tailed)	0.000	0.105
		N	134	136
	Weather forecasting effort 2	Correlation Coefficient	,257**	0.091
		Sig. (2-tailed)	0.003	0.291
		N	135	137
	Half-full machine 2	Correlation Coefficient	-0.051	-0.055
		Sig. (2-tailed)	0.557	0.523
		N	134	136
	Overloaded machine 2	Correlation Coefficient	,293**	0.009
		Sig. (2-tailed)	0.001	0.921
		N	135	137
	Coordination household 2	Correlation Coefficient	0.050	0.027
		Sig. (2-tailed)	0.565	0.759
		N	134	136
	Unmonitored use concern 2	Correlation Coefficient	0.120	0.020
		Sig. (2-tailed)	0.168	0.815
		N	134	136
	Decision uncertainty 2	Correlation Coefficient	0.093	0.011
		Sig. (2-tailed)	0.282	0.902
		N	135	137
	Simultaneous appliance use 2	Correlation Coefficient	0.027	0.120
		Sig. (2-tailed)	0.757	0.164
		N	135	137

*. Correlation is significant at the 0.05 level (2-tailed).

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

C.7 Linear regression habits and load shifting behaviour

C.7.1 Reliability statistics

Table C.7.1 Reliability statistics of Appliance_planning1, Appliance_routine1, Appliance_thinking1

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Dishwasher use without planning	5.29	3.625	.537	.225
Dishwasher use as part of routine	4.70	5.265	.102	.863
Dishwasher use without thinking	5.45	3.359	.592	.121

Table C.7.2 Reliability statistics of Appliance_planning2, Appliance_routine2, Appliance_thinking2

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Washing machine use without planning	5.17	3.136	.413	.058
Washing machine use as part of routine	5.00	5.248	-.030	.800
Washing machine use without thinking	5.25	2.819	.523	-.182[a]

a. The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings

C.7.2 Linear regression dishwasher group

Table C.7.3 Model summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.500 a	.250	.234	1.17568

a. Predictors: (Constant). Dishwasher use as part of routine, Habit_strength_dishw

b. Dependent Variable: Shifting dishwasher use

Table C.7.4 ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45.512	2	22.756	16.463	<.001[b]
	Residual	136.841	99	1.382		
	Total	182.353	101			

a. Dependent Variable: Shifting dishwasher use

b. Predictors: (Constant). Dishwasher use as part of routine. Habit_strength_dishw

Table C.7.5 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	5.131	.353		14.525	<.001		
	Habit_strength_dishw	-.438	.105	-.366	-4.189	<.001	.991	1.010
	Dishwasher use as part of routine	-.314	.090	-.306	-3.495	<.001	.991	1.010

a. Dependent Variable: Shifting dishwasher use

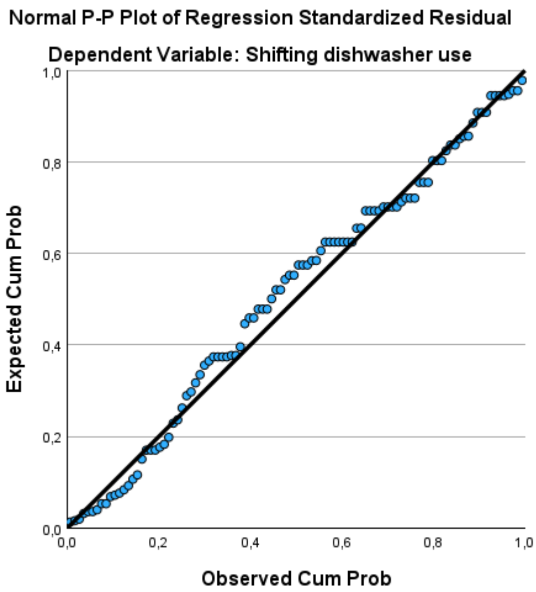

Figure C.7.2 Normal P-P plot (Normality assumption)

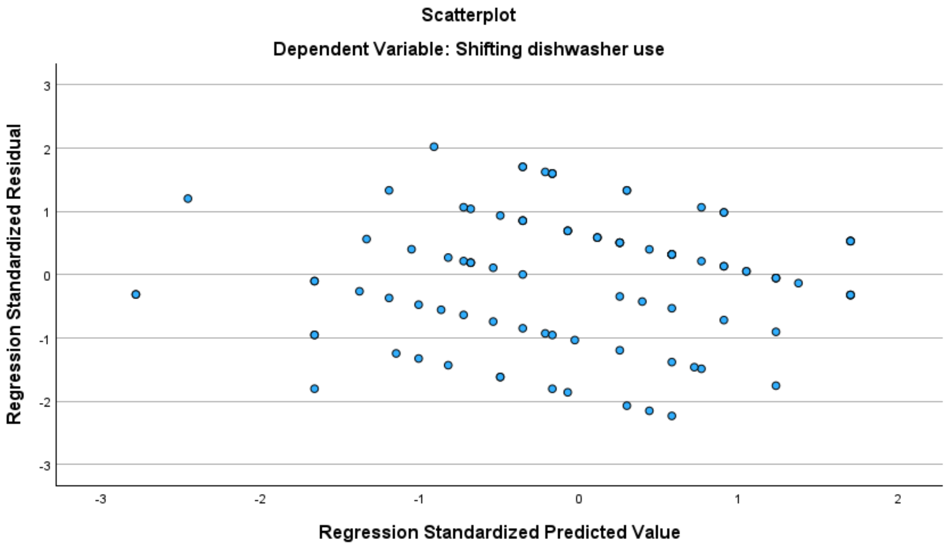

Figure C.7.1 Scatterplot (Homoscedasticity assumption)

C.7.3 Linear regression washing machine group

Table C.7.6 Model summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.449 a	.202	.187	.83507
a. Predictors: (Constant). Washing machine use as part of routine, Habit_strength_washi				
b. Dependent Variable: Shifting washing machine use				

Table C.7.7 ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.890	2	9.945	14.262	<.001[b]
	Residual	78.799	113	.697		
	Total	98.690	115			
a. Dependent Variable: Shifting washing machine use						
b. Predictors: (Constant). Washing machine use as part of routine. Habit_strength_washi						

Table C.7.8 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4.502	.247		18.222	<.001	1	
	Habit_strength_washi	-.366	.071	-.434	-5.154	<.001	.998	1.002
	Washing machine use as part of routine	-.074	.064	-.096	-1.146	.254	.998	1.002
a. Dependent Variable: Shifting washing machine use								

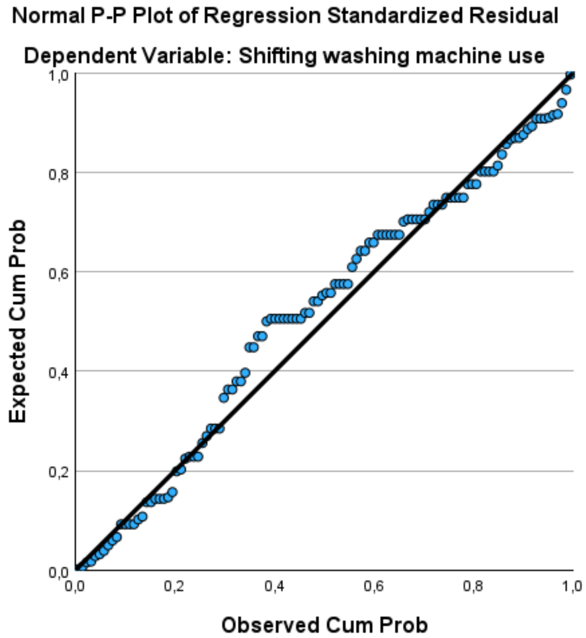

Figure C.7.3 Normal P-P plot (Normality assumption)

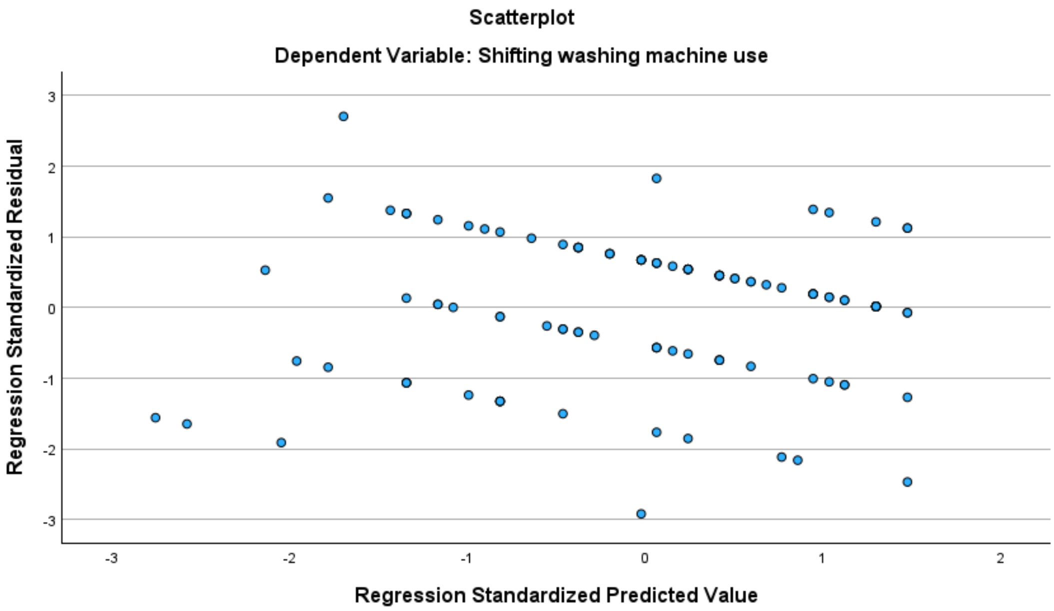

Figure C.7.4 Scatterplot (Homoscedasticity assumption)

C.8 Causes of hassle

Table C.8.1 Causes descriptive

	N	Minimum	Maximum	Mean	Std. Deviation
Changing routines	258	1	5	2.34	1.134
Energy awareness	260	1	5	3.64	1.136
Personal flexibility	259	1	5	2.35	1.231
Stress sensitivity	260	1	5	1.95	1.066
Hassle in life	258	1	5	1.92	1.122
Schedule own	257	1	5	2.38	1.353
Household schedules	259	1	5	2.34	1.386
Disturbing neighbors	258	1	5	1.35	.781
Valid N (listwise)	252				

Table C.8.2 Correlation matrix with hassle factors

			Changing routines	Energy awareness	Personal flexibility	Stress sensitivity	Hassle in life	Schedule own	Household schedules	Disturbing neighbors
Spearman's rho	**PV monitoring effort 1**	Correlation Coefficient	.276**	-.410**	.401**	.252**	.348**	.349**	.289**	0.027
		Sig. (2-tailed)	0.002	<0.01	<0.001	0.005	<0.001	<0.001	0.001	0.768
		N	119	120	120	120	118	119	120	119
	Overloaded machine 1	Correlation Coefficient	.437**	-0.019	.349**	.350**	.208*	.295**	.304**	-0.009
		Sig. (2-tailed)	<0.001	0.841	<0.001	<0.001	0.024	0.001	0.001	0.920
		N	119	120	120	120	118	119	120	119
	Decision uncertainty 1	Correlation Coefficient	.318**	-.182*	.236**	0.176	.368**	.221*	.299**	.233*
		Sig. (2-tailed)	<0.001	0.048	0.010	0.055	<0.001	0.016	0.001	0.011
		N	118	119	119	119	117	118	119	118
	Half-full machine 1	Correlation Coefficient	0.086	-0.022	0.148	0.082	0.161	0.160	.187*	-0.146
		Sig. (2-tailed)	0.355	0.814	0.108	0.375	0.084	0.083	0.042	0.115
		N	118	119	119	119	117	118	119	118
	Manual planning effort 2	Correlation Coefficient	.370**	0.008	.413**	.251**	.314**	.408**	.409**	0.083
		Sig. (2-tailed)	<0.001	0.927	<0.001	0.003	<0.001	<0.001	<0.001	0.335
		N	138	139	138	139	139	137	138	138
	PV monitoring effort 2	Correlation Coefficient	.383**	-.186*	.500**	0.151	.215*	.443**	.420**	0.055
		Sig. (2-tailed)	<0.001	0.029	<0.001	0.077	0.011	<0.001	<0.001	0.524
		N	137	138	137	138	138	136	137	137
	Half-full machine 2	Correlation Coefficient	-0.070	0.068	0.094	-0.008	0.035	0.010	0.028	<0.001
		Sig. (2-tailed)	0.416	0.429	0.275	0.928	0.687	0.911	0.745	0.998
		N	137	138	137	138	138	136	137	137

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

*. Correlation is significant at the 0.05 level (2-tailed).

C.8.1 Linear regression decision uncertainty dishwasher group

Table C.8.3 Model summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.481[a]	.231	.181	.997
a. Predictors: (Constant), Household schedules, Energy awareness, Stress sensitivity, Hassle in life, Personal flexibility, Changing routines, Schedule own				
b. Dependent Variable: Decision uncertainty 1				

Table C.8.4 ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	31.962	7	4.566	4.592	<.001[b]
	Residual	106.386	107	.994		
	Total	138.348	114			
a. Dependent Variable: Decision uncertainty 1						
b. Predictors: (Constant). Household schedules. Energy awareness. Stress sensitivity. Hassle in life. Personal flexibility. Changing routines. Schedule own						

Table C.8.5 Coefficients

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.708	.461		1.535	.128		
	Changing routines	.330	.111	.350	2.965	.004	.516	1.939
	Energy awareness	-.080	.089	-.080	-.906	.367	.932	1.073
	Personal flexibility	.005	.118	.006	.044	.965	.415	2.408
	Stress sensitivity	-.056	.107	-.058	-.523	.602	.575	1.739
	Hassle in life	.243	.100	.233	2.426	.017	.782	1.278
	Schedule own	-.200	.125	-.253	-1.607	.111	.290	3.450
	Household schedules	.267	.102	.335	2.625	.010	.441	2.269
a. Dependent Variable: Decision uncertainty 1								

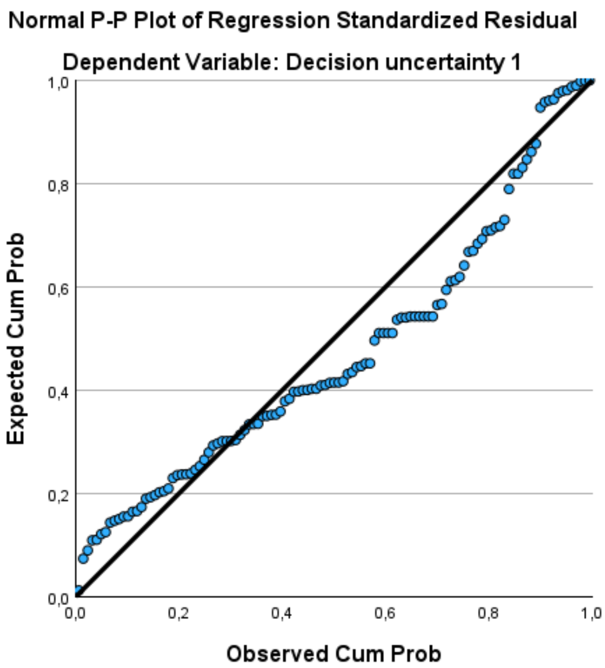

Figure C.8.1 Normal P-P plot (Normality assumption)

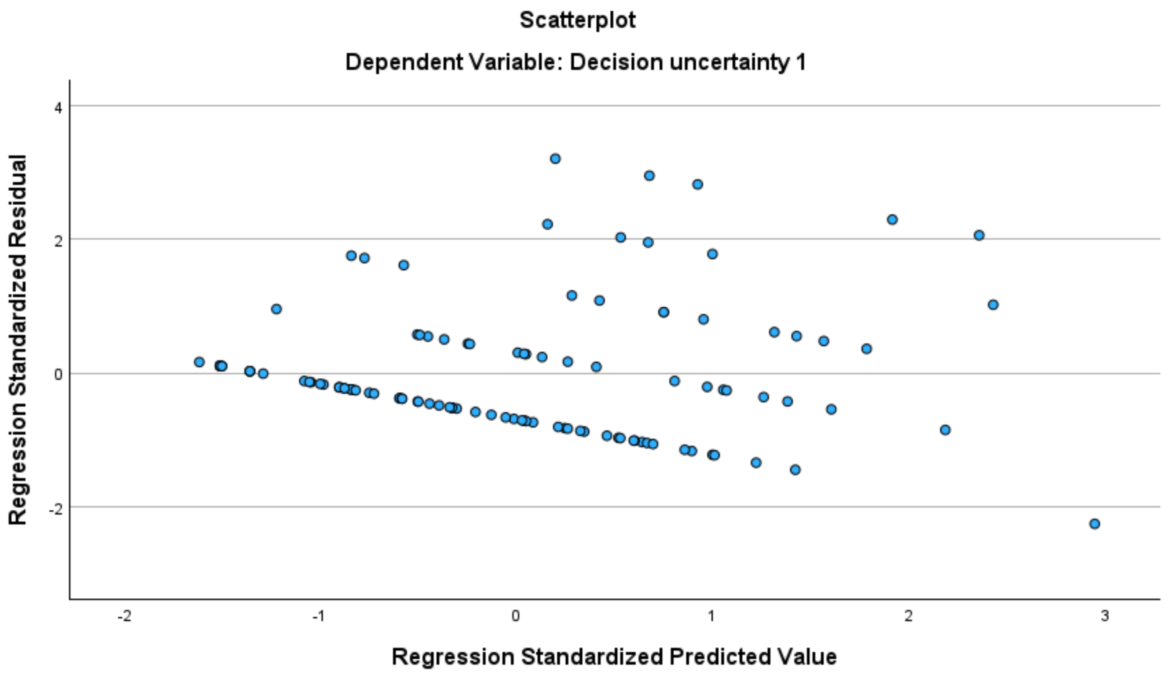

Figure C.8.2 Scatterplot (Homoscedasticity assumption)

C.8.2 Linear regression PV monitoring effort dishwasher group

Table C.8.6 Model summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.607[a]	.368	.327	1.200
a. Predictors: (Constant), Household schedules, Energy awareness, Stress sensitivity, Hassle in life, Personal flexibility, Changing routines, Schedule own				
b. Dependent Variable: PV monitoring effort 1				

Table C.8.7 ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	90.468	7	12.924	8.981	<.001[b]
	Residual	155.420	108	1.439		
	Total	245.888	115			
a. Dependent Variable: PV monitoring effort 1						
b. Predictors: (Constant). Household schedules. Energy awareness. Stress sensitivity. Hassle in life. Personal flexibility. Changing routines. Schedule own						

Table C.8.8 Coefficients

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.562	.553		4.632	<.001		
	Changing routines	.006	.134	.005	.043	.966	.516	1.937
	Energy awareness	-.486	.106	-.364	-4.578	<.001	.924	1.083
	Personal flexibility	.215	.141	.181	1.530	.129	.419	2.385
	Stress sensitivity	.115	.129	.090	.897	.372	.576	1.737
	Hassle in life	.181	.120	.131	1.507	.135	.779	1.283
	Schedule own	.064	.149	.060	.427	.670	.294	3.396
	Household schedules	.148	.122	.139	1.212	.228	.444	2.252
a. Dependent Variable: PV monitoring effort 1								

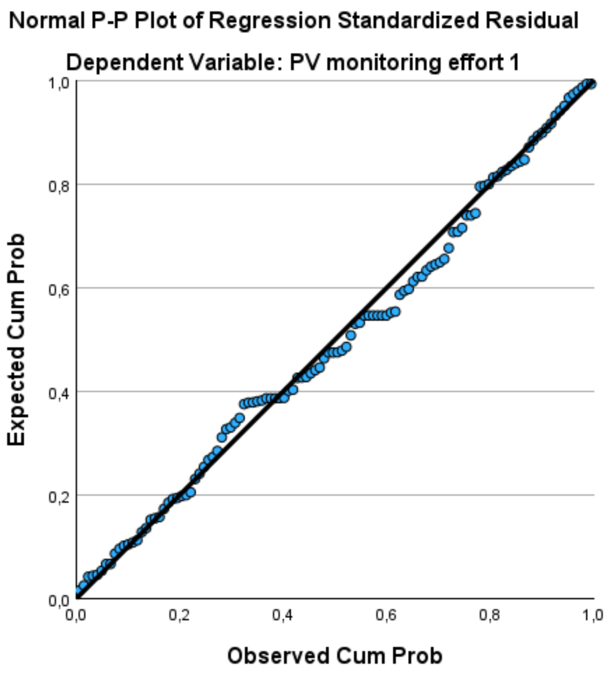

Figure C.8.3 Normal P-P plot (Normality assumption)

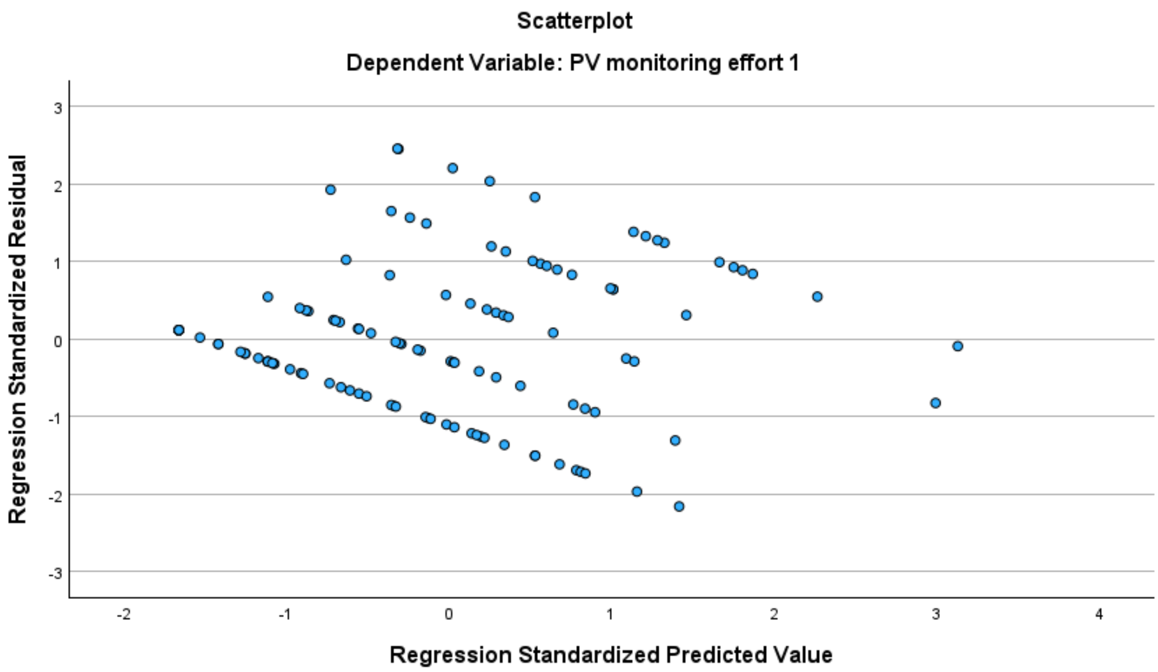

Figure C.8.4 Scatterplot (Homoscedasticity assumption)

C.8.3 Linear regression overloaded machine dishwasher group

Table C.8.9 Model summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.542[a]	.293	.248	1.291
a. Predictors: (Constant), Household schedules, Energy awareness, Stress sensitivity, Hassle in life, Personal flexibility, Changing routines, Schedule own				
b. Dependent Variable: Overloaded machine 1				

Table C.8.10 ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	74.781	7	10.683	6.407	<.001[b]
	Residual	180.081	108	1.667		
	Total	254.862	115			
a. Dependent Variable: Overloaded machine 1						
b. Predictors: (Constant). Household schedules. Energy awareness. Stress sensitivity. Hassle in life. Personal flexibility. Changing routines. Schedule own						

Table C.8.11 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.288	.595		.483	.630		
	Changing routines	.445	.144	.348	3.091	.003	.516	1.937
	Energy awareness	.044	.114	.033	.390	.698	.924	1.083
	Personal flexibility	.061	.152	.051	.405	.687	.419	2.385
	Stress sensitivity	.150	.139	.115	1.083	.281	.576	1.737
	Hassle in life	.070	.129	.050	.543	.588	.779	1.283
	Schedule own	-.181	.160	-.169	-1.132	.260	.294	3.396
	Household schedules	.379	.131	.351	2.894	.005	.444	2.252
a. Dependent Variable: Overloaded machine 1								

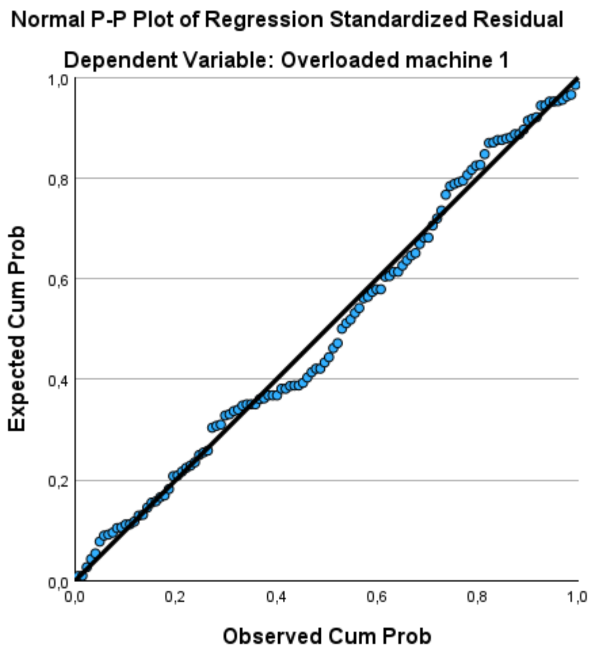

Figure C.8.5 Normal P-P plot (Normality assumption)

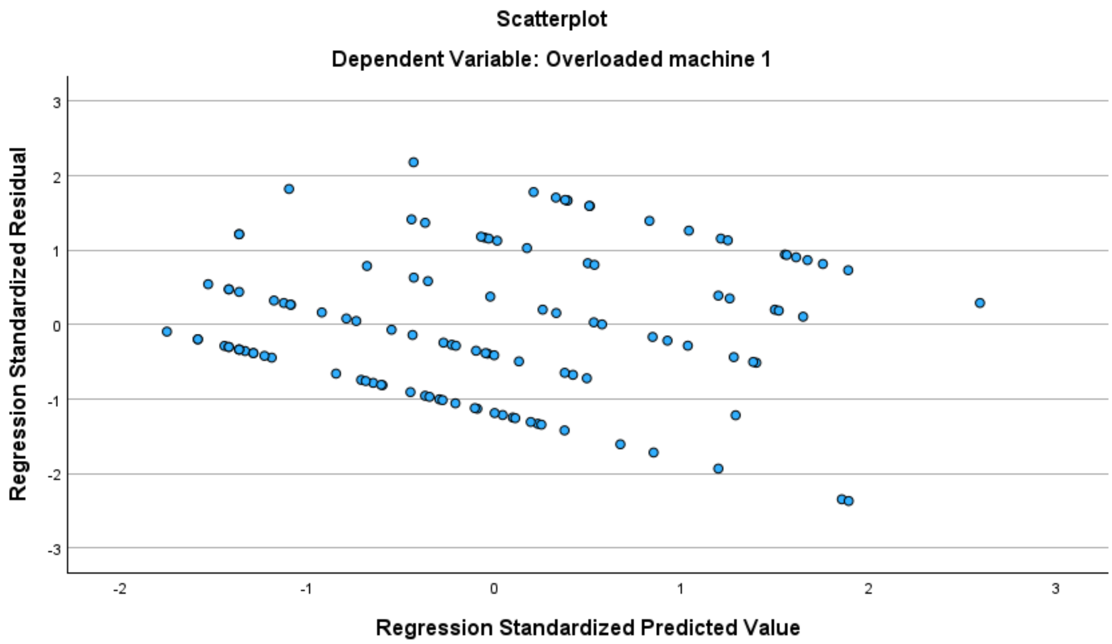

Figure C.8.6 Scatterplot (Homoscedasticity assumption)

C.8.4 Linear regression manual planning effort washing machine group

Table C.8.12 Model summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.523[a]	.274	.234	1.035
a. Predictors: (Constant), Household schedules, Energy awareness, Stress sensitivity, Hassle in life, Personal flexibility, Changing routines, Schedule own				
b. Dependent Variable: Manual planning effort 2				

Table C.8.13 ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	51.731	7	7.390	6.897	<.001[b]
	Residual	137.144	128	1.071		
	Total	188.875	135			
a. Dependent Variable: Manual planning effort 2						
b. Predictors: (Constant). Household schedules, Energy awareness, Stress sensitivity, Hassle in life, Personal flexibility, Changing routines, Schedule own						

Table C.8.14 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.196	.406		.482	.630		
	Changing routines	.143	.107	.135	1.341	.182	.557	1.796
	Energy awareness	.024	.078	.024	.310	.757	.945	1.059
	Personal flexibility	.230	.094	.239	2.452	.016	.595	1.681
	Stress sensitivity	.019	.110	.016	.175	.862	.645	1.550
	Hassle in life	.125	.083	.126	1.506	.134	.809	1.236
	Schedule own	.016	.115	.018	.143	.887	.340	2.939
	Household schedules	.164	.106	.194	1.551	.123	.362	2.765
a. Dependent Variable: Manual planning effort 2								

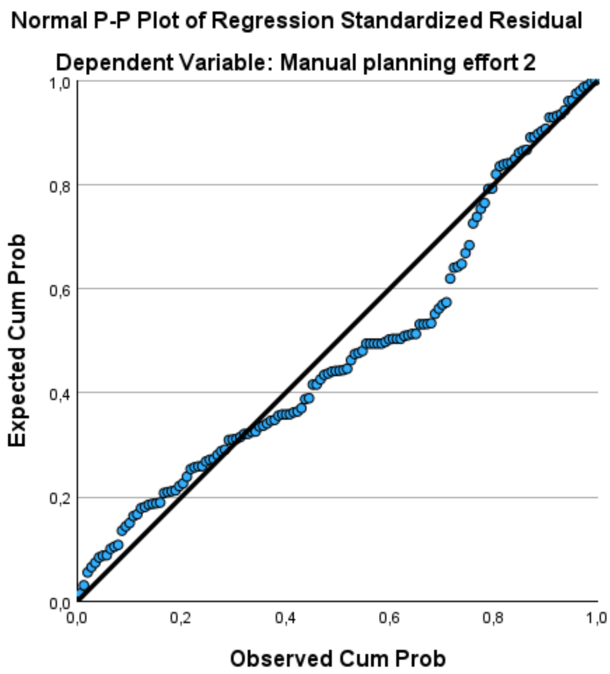

Figure C.8.7 Normal P-P plot (Normality assumption)

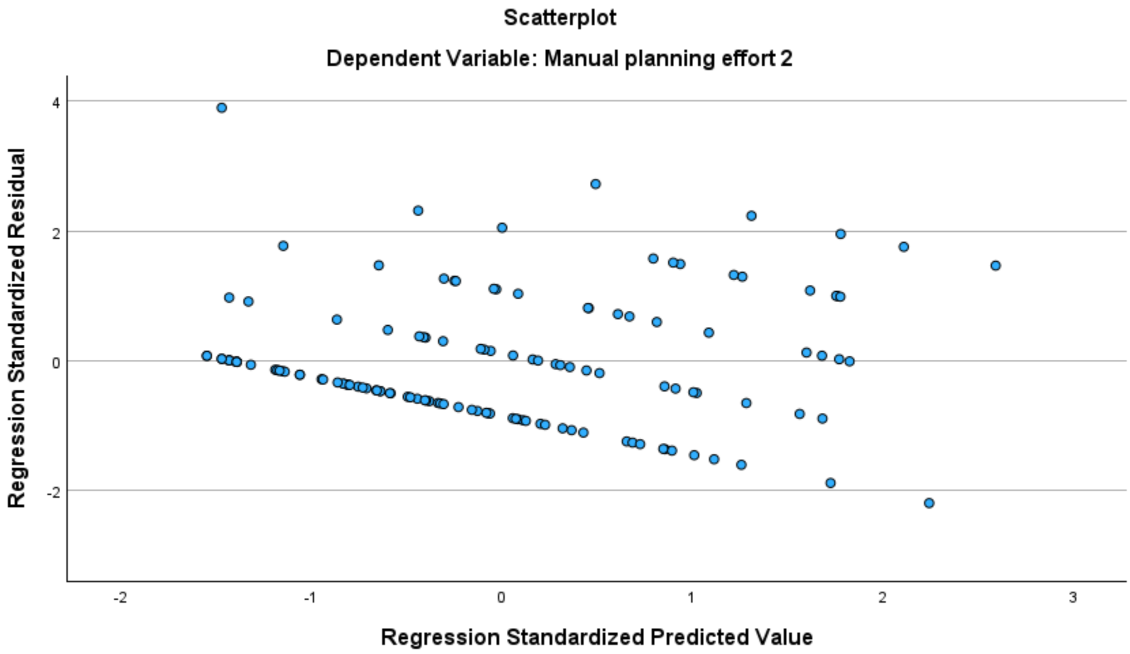

Figure C.8.8 Scatterplot (Homoscedasticity assumption)

C.8.5 Linear regression PV monitoring effort washing machine group

Table C.8.15 Model summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.612[a]	.374	.340	1.191
a. Predictors: (Constant), Household schedules, Energy awareness, Stress sensitivity, Hassle in life, Personal flexibility, Changing routines, Schedule own				
b. Dependent Variable: PV monitoring effort 2				

Table C.8.16 ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	107.803	7	15.400	10.856	<.001[b]
	Residual	180.167	127	1.419		
	Total	287.970	134			
a. Dependent Variable: PV monitoring effort 2						
b. Predictors: (Constant), Household schedules, Energy awareness, Stress sensitivity, Hassle in life, Personal flexibility, Changing routines, Schedule own						

Table C.8.17 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.376	.468		2.943	.004		
	Changing routines	.208	.124	.159	1.682	.095	.549	1.823
	Energy awareness	-.228	.090	-.184	-2.547	.012	.945	1.058
	Personal flexibility	.388	.109	.326	3.555	<.001	.587	1.702
	Stress sensitivity	-.209	.127	-.144	-1.650	.101	.646	1.549
	Hassle in life	.071	.096	.058	.744	.458	.813	1.230
	Schedule own	.069	.133	.063	.516	.607	.334	2.990
	Household schedules	.223	.122	.214	1.828	.070	.359	2.783
a. Dependent Variable: PV monitoring effort 2								

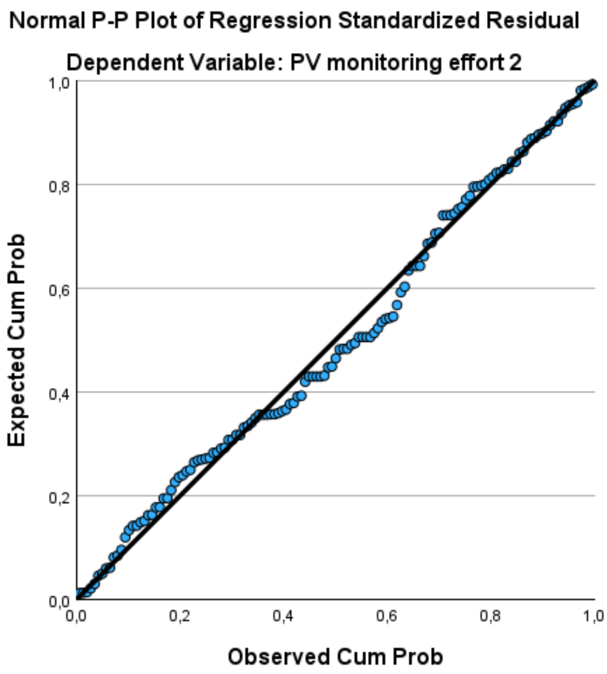

Figure C.8.9 Normal P-P plot (Normality assumption)

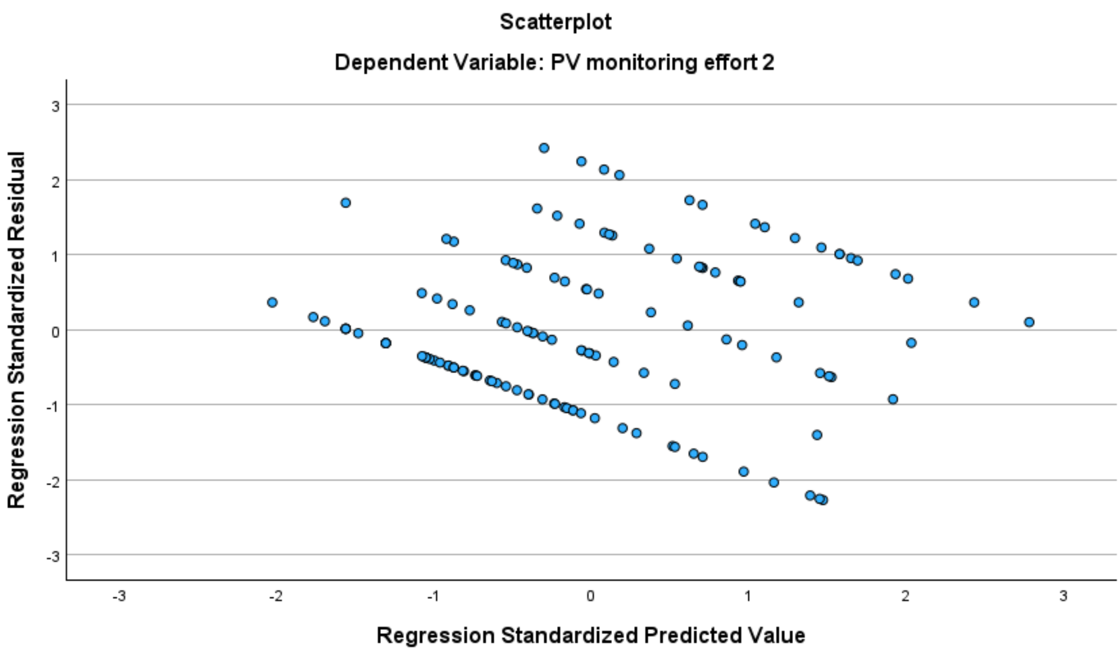

Figure C.8.10 Scatterplot (Homoscedasticity assumption)

Appendix D: Used Dutch quotes from open-ended questions

Answer in Dutch	Used translation
Q20: Motivation to load shift	
Zodanig dat ik zo min mogelijk gebruik maak van de stroom van het net	So that I use as little power from the grid as possible
Ik kijk of de zon schijnt zodat ik gratis stroom heb	I check if the sun is shining so I have free power
Dynamisch contract. Soms is de stroom bijna gratis	Sometimes power is almost free
Alvast wennen aan stopzetten salderen	To get used to the end of net metering scheme
Om bewust te proberen de eigen opgewekte energie te gebruiken aangezien de salderingsregeling zal gaan verdwijnen	To make a conscious effort to use your own generated energy since the scheme will disappear
Gewenning inbouwen zodat later dit een standaard gewoonte is	To develop the habit so it becomes a standard practice in the future
Verbruiken wanneer er opwek is; daarnaast om netcongestie tussen 17.00-21.00 te vermijden	Using when there is self-generation, but also by avoiding net congestion between 17:00-21:00
Voorkomen lawaai in de nacht van wasmachine	Prevent noise at night from washing machine
Q21: Motivation to not load shift	
Denk er niet aan	I don't think about it
Niet bewust mee bezig	Just not something I've been consciously working on
Daar zit voor mij geen voordeel in. Sterker nog, het veroorzaakt allerlei ongemak	There's no benefit in it for me. In fact, it causes all kinds of hassle
Uitstellen is vaak niet handig	Postponing use is often just impractical."
Niet mee bezig zolang salderingsregeling van kracht is	As long as net metering is in place, I don't worry about it
Ik wil graag de apparaten gebruiken als ik ze nodig heb. Ik heb een te druk leven en weinig flexibiliteit hierin	I want to use appliances when I need them. My life is already too busy and not flexible enough
Ik wil de druk op het elektriciteitsnet, om te innoveren, niet verlagen. Als het voor mij persoonlijk niet uitmaakt, ga ik ook niet mijn leven compliceren omdat het electriciteitsnetbeheer het nalaat om te innoveren.	I'm not going to complicate my life just because grid operators failed to innovate. If it doesn't benefit me personally, I won't change my behaviour."
Er valt niet veel te verschuiven. Alleen de wasmachine is een optie. Die zetten we 's ochtends om een uur of negen aan, ongeveer om de acht dagen een bonte was op 30 graden en ongeveer om de twee weken een witte was op veertig graden.	There's not much to shift. Only the washing machine, which we use only occasionally
We doen het al overdag (zon piek uren) dus verschuiven niet	We already use electricity during sun peak hours, so we don't shift
Q32: Barriers to load shifting using the dishwasher	
Vaatwasser nog niet vol	The dishwasher is not yet full
Dat de vaatwasser 's avonds al vol is. Dan wil ik niet wachten tot de volgende dag	Sometimes it's full after dinner. Then I don't want to wait until the next day

De machine gaat enorm stinken als er lang vieze vaat in zit die niet gewassen wordt.	The machine starts smelling extremely if there are long dirty dishes in it that are not washed
Dan koekt de vaat teveel aan, waardoor er een meer energieverbruikend programma gedraaid moet worden	When dishes stay dirty too long, we need to run a more energy-consuming program
Dat de broodtrommels van de kinderen de volgende dag weer naar school moeten, dus vaatwasser gaat aan buiten schooltijden	The lunchboxes need to be clean again for school the next day, so the dishwasher runs outside school hours
Dat er doordeweeks overdag vaak niemand thuis is	We're often not home during the day
Geen automatische inschakeling mogelijk. Zou het handigst zijn	No automatic start possible. That would be the most convenient
Huisgenoot gaat er niet in mee (vind het gedoe)	My partner doesn't join in, finds it too much hassle
De vaatwasser wordt door 3 van de 4 personen in ons huishouden bediend, en ik ben de enige die eenvoudig een nieuwe gewoonte kan aanleren.	The dishwasher is used by three out of four people at home. I'm the only one trying to change the habit
De meeste vaat ontstaat bij het avondeten. vandaar dat we jarenlang de gewoonte hadden om die na het avondeten aan te zetten.	The majority of dishes are created at dinner, so we've been running it at night for years
Het lawaai dat de vaatwasser maakt. Het is een ouwetje en mijn geluidsprikkelgevoelige man werkt thuis.	The dishwasher makes a lot of noise. My partner is sensitive to sound and works from home
Als de zon nou elke dag van 8 tot 17:00 zou schijnen zou dit zeker geen probleem zijn. Echter wij wonen in Nederland, daar is vaak bewolking, regen en in het najaar en in de winter is er amper opbrengst	If the sun was shining every day from 8 to 17 it wouldn't be a problem. But we live in the Netherlands, it's often cloudy or raining
Q32: Barriers to load shifting using the washing machine	
Dat ik niet thuis ben om de was dan op tijd op te hangen of te verplaatsen naar de droger. Dan ligt de natte was er een hele dag	If I'm not home, I can't take the laundry out or put it in the dryer. Then it sits there wet all day
Bij te lang in de machine laten zitten gaat de schone was stinken	If you leave it too long in the machine, the clean laundry smells bad.
Er zit geen timer op de wasmachine (wel op de vaatwasmachine). Ik zet vaak een wekker op m'n telefoon wanneer ik de wasmachine moet aanzetten	There's no timer on the washing machine, so I have to set an alarm on my phone when I want to start it manually
Ik kan de wasmachine wel later laten starten, maar alleen voorgeprogrammeerd op tijd. Dus niet op opwek	I can start the washing machine later, but only pre-programmed by time. So not on generation
Alles moet dan op zijn plek vallen, voldoende was, thuis zijn, tijd hebben, zon schijnen. Als een van deze factoren ontbreekt gaat het "feest" al niet door.	Everything has to align, enough laundry, being home, having time, sun shining. If one of these things is missing, it won't work
Er is niet voldoende was, een halve trommel laten draaien is zeker niet milieu vriendelijk, ook al schijnt de zon dan	There isn't enough laundry, and running a half-full machine isn't environmentally friendly—even if the sun is shining

Alleen soms onhandig als we bijvoorbeeld al het beddengoed willen wassen	Sometimes it's just inconvenient, for example when we want to wash all the bedding
te weinig uren in een dag (of te veel was, maar dat heb je met kinderen)	Not enough hours in the day, or too much laundry, especially with kids.
Ik moet zoveel wasjes draaien, dat ik niet kan wachten op de zon	I have to do so much laundry that I can't wait for the sun
Als de zon volop schijnt is het geen probleem. Als er in een week weinig zon is weet ik niet of het wel zin heeft rekening te houden met de zon.	If the sun doesn't shine much in a week, I don't know if it's worth planning around it
Bedenk me op laatste moment	I often think of it too late
Gedoe. Weet niet of het echt helpt	It's too much hassle, I don't even know if it helps.
Q41: Causes of hassle experience	
Werk en schooltijden maken het lastig om elke dag overdag bezig te zijn met elektriciteitsverbruik	Work and school times make it hard to deal with electricity use during the day
Door werk en kinderen kan ik niet wachten op de zon	With work and kids, I can't just wait for the sun
Past niet goed in de ritme van de dag	It doesn't fit in the rhythm of the day
Vraagt extra tijd en aandacht	Adds an extra layer of time and attention
Niet echt gedoe, gewoon nog niet routine	It's not really a hassle, we're just not used to shifting yet
De macht der gewoonte	The power of habit
Ik heb altijd tijd nodig om mijn routine te wijzigen. Zeker als het gaat om een jarenlange routine.	The only issue is that I would need to change my routine, especially when the routine has been there for years
Niet iedereen in het huishouden staat daar hetzelfde in. Ik kan dat wel willen maar dat wil niet zeggen dat anderen daar rekening mee houden.	Not everyone in the household thinks the same. I might want it, but that doesn't mean others do
Alleen vergt dat de nodige intelligentie van de apparaten, auto's en omvormers. En die is helaas niet op elkaar afgestemd. Ook zou het helpen om een smart-grid in de wijk te hebben, waardoor veel minder van 'buiten' gehaald hoeft te worden.	The equipment, cars, and inverters aren't aligned. A smart grid in the neighbourhood would really help
Het kost tijd en aandacht. Het zou fijn zijn als dit makkelijk te programmeren is	It takes time and attention. It would be nice if it was easier to program
Nog meer nadenken/ rekening houden met iets. Ik wil juist minder. Als het automatisch kan graag, maar heb me daar nog niet in verdiept.	I just want to think about fewer things. If it could be automated, I'd like that
De veroorzakers van het probleem wentelen de oplossing nu af op anderen	The causes of the problem are being pushed onto us