

The Impact of Friction on Customer Value Experience in E-Commerce Design

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ABSTRACT,

Digital service design often focuses on seamless and frictionless customer journeys. However, recent studies argue that not all forms of friction negatively impact customer experience by providing evidence that some thoughtfully designed friction can increase consumer value. This thesis examines how different levels of experiential friction affect the customer value experience in e-commerce environments. Based on customer experience, cognitive reflectivity, emotional valence, and the value co-creation and co-destruction framework, this study investigates the effects of low, moderate, and high friction levels in an e-commerce setting. An experiment exposed participants to three simulated checkout journeys, which were later evaluated with a questionnaire that assessed their experience in terms of perceived effort, type of reflection, and emotional response. According to the experiment findings, low friction creates a smooth but shallow customer value experience. In comparison, moderate friction stimulates meaningful cognitive engagement without emotionally overwhelming users, supporting value co-creation. Finally, high friction leads to frustration and emotional decline in customers. This research contributes to the customer experience approach by providing empirical evidence for reflectivity as a mechanism linking friction and value experience. Friction is a deliberate design tool that enhances customer value experience rather than being entirely eliminated.

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Keywords

Customer Value Experience, Friction, Cognitive Reflection, Emotional Valence, Value Co-Creation, Value Co-Destruction, E-Commerce Design, Experiential Design

During the preparation of this work, the author used Grammarly in order to refine grammar and spelling throughout the writing process. After using the tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the work.

1. INTRODUCTION

Customer experience has become a central concept in both marketing and service research. Customer experience is especially critical for understanding how individuals engage with businesses across digital touchpoints (El-Barkouky, 2024; Lemon & Verhoef, 2016; Verhoef et al., 2009). As consumer interactions increasingly occur in digital environments, the design of the online experience plays an important role in shaping perceived value (Verhoef, 2021; Jaakkola et al., 2022). In response to rising expectations for convenience and speed, many organisations have sought to reduce or eliminate friction in digital service journeys (Williams et al., 2020). Friction, commonly understood as any point of delay, interruption, or added effort for the customer, is often treated as a barrier to customer experience (Padigar et al., 2024).

Recently, more researchers have questioned the assumption of prioritising seamless interactions, suggesting that not all friction is negative. In some cases, thoughtfully implemented friction could lead to a better customer experience by encouraging engagement, reflection, and goal alignment (Sahhar & Loohuis, 2022). Padigar et al. (2024) have shown that minor, intentional interruptions can create a more conscious experience, like requiring customers to confirm decisions. This view on customer experience challenges the focus on seamlessness and offers the new idea that friction can contribute positively to customer value experience when used carefully.

There is increasing interest in this idea, however most of the existing research has been conceptual rather than based on real-world data. Some works have pointed out the positive effects of light friction, such as greater engagement and improved interactions. On the other hand, some studies have also examined the negative consequences of friction (Bai et al., 2020; Ngwe et al., 2019), as well as the potential benefits of thoughtfully designed friction (Padigar et al., 2024; Tomalin, 2022). However, these insights stay theoretical. Despite these contributions, little empirical research has explored how different friction levels, especially within the same type of service, influence customer value experience. This study seeks to fill that gap by investigating how varying amounts of friction affect how customers experience value.

This research also aims to investigate the relationship between friction levels and customer value experience. The study uses a simulated e-commerce checkout journey as a testing approach and focuses on understanding how friction influences digital experiences. The study interprets how friction can increase or decrease customer value using the lens of the theoretical framework of value co-creation and co-destruction. It also adds to the existing literature by operationalising and empirically testing the proposed U-shaped relationship between friction and perceived value.

Research Question: How do different levels of experiential design friction affect customer value experience in a digital service context?

This study empirically tests the relationship between friction intensity and value perception, adding to the current understanding of customer experience. While earlier research largely treated friction as a negative factor, recent works argue that some forms of friction may support customer engagement and meaning-making (Padigar et al., 2024; Sahhar & Loohuis, 2022). This research tests those assumptions in a controlled environment, thereby addressing a gap in empirical validation. It demonstrates how friction intensity influences customer value experience in digital service design and investigates whether moderate friction levels promote meaningful customer interaction while positively maintaining emotional outcomes.

The results indicate moderate friction stimulates cognitive reflection without overwhelming emotional engagement, making it especially effective in fostering value co-creation. In contrast, low and high friction limit value outcomes through insufficient engagement or emotional strain. These findings clarify how friction intensity influences customer value by increasing reflectivity while maintaining emotional balance, highlighting the critical role of cognitive reflection in value formation. These insights extend the theory on friction design and offer practical recommendations for optimising digital experiences by cautiously manipulating friction levels.

This thesis first introduces the theoretical framework and outlines the key concepts of customer experience, friction, and customer value experience. Based on these concepts, a conceptual framework illustrates the proposed constructs' relationships and supports the development of hypotheses. Next, the methodology chapter explains the experimental design, prototype development, data collection, and analysis approach. Further, the result section illustrates and interprets the findings, followed by a discussion chapter on the key results, theoretical implications, practical implications, limitations, and suggestions for future research.

2. THEORETICAL FRAMEWORK

This theoretical framework establishes a foundation for understanding how varying friction levels in digital service environments influence customer value experience. Specifically, it introduces the constructs of customer experience, friction, and customer value experience, together with the interpretive mechanisms of value co-creation and value co-destruction. This section first defines each of the main constructs, then links them theoretically, followed by the development of a conceptual framework that illustrates these relationships. Finally, the section formulates testable hypotheses to guide the empirical investigation.

2.1 Customer experience

Customer experience is framed as a multidimensional construct involving customers' cognitive, emotional, behavioral, sensorial, and social responses to interactions with the firm over the customer journey (Lemon & Verhoef, 2016). These reactions happen throughout the entire journey through pre-purchase, purchase, and post-purchase phases and are co-created and shaped by both direct and indirect touchpoints (Jaakkola et al., 2022). Direct touch points might be product use, website browsing, or a customer service call (Bilgihan et al., 2016). Indirect touchpoints involve noticing mentions on social media or interacting with third-party reviews or peer recommendations (Jaakkola et al., 2022). Therefore, customer experience is subjective and always changing. It is not only influenced by what companies design and offer but also by how customers interpret and connect their experiences across stages of the journey (Lemon & Verhoef, 2016; Verhoef, Kannan, & Inman, 2015). In today's multi-platform and digitally connected environment, companies have limited control over the full experience. It is also shaped by interactions with other users, technologies, and platforms outside the firm's reach (Jaakkola et al., 2022).

In online contexts, the extent and quality of the customer experience are closely tied to the digital environment. Demangeot and Broderick (2006) discuss how the online shopping experience is affected by the visual impact of the website, interactivity, and the presence of products. These factors affect how involved and engaged the customer feels in the online shopping experience. Bilgihan et al. (2016) propose a comprehensive online customer experience model that includes several factors: ease of navigation, personalization, and multi-

device accessibility, which all shape the positive digital experiences. Holz et al. (2023) focus on the negative side of customer experience by calculating experiential pain points in complex customer journeys, but also demonstrate how smart service technologies can address those pain points in a way to improve emotional outcomes. This is also aligned with Hoyer et al. (2020), who indicate that AI, AR/VR, chatbots, and other technologies can increase customer experiences by offering opportunities through access to more information, greater personalization, and improved emotional connections throughout the journey. Furthermore, functionality plays a crucial role. Saoula et al. (2023) show that the design of the website, reliability, and perceived ease-of-use directly influence customers' trust and loyalty in the online shopping experience. These elements also affect how positively users feel about the service provider in the long run.

To support meaningful experiences for the customer, Schmitt (1999) proposed five key dimensions: sensory, emotional, cognitive, behavioral, and social identity. This framework helps clarify how companies can influence different parts of the experience. Additionally, Sahhar et al. (2023) introduced the GraphEx model, which looks at how experiences differ in emotional depth and cognitive engagement. It describes experience in terms of valence (positive or negative), intensity (level of emotional involvement), and type (reflective or unreflective). This model helps explain why some interactions feel smooth and automatic, while others make users pause and reflect. GraphEx supports customer experience theory, assessing the effects of specific design features, such as friction, on how deeply customers engage. This thesis supports the idea that different levels of friction may encourage different types of engagement, and in turn, influence how customers experience value.

2.2 Friction in Customer Experience

In customer experience, friction is an element in service interaction that slows down the process, demands effort, or disrupts customers in goal achievement. It may be purposefully created or accidentally introduced by a discrepancy between the system's functionality and the user's expectations. It can be defined by cognitive, procedural, emotional, or physical forms (Tomalin, 2022; Padigar et al., 2024).

Friction has been traditionally regarded as a design issue. Past research in user experience and service design viewed friction as a barrier to efficiency and satisfaction, where the most optimal customer journeys are the quickest and most seamless (Bilgihan et al., 2016). But recent studies have shown a different view on this problem, highlighting that friction should be evaluated more critically. Following this, Padigar et al. (2024) present a framework that distinguishes friction according to how users experience it and how it aligns with their goals. They define four types: frustrating friction, which is perceived as a barrier and results from poor design; constructive friction, which elicits attention and thoughtful action; rewarding friction, in which effort produces a feeling of control or achievement; and preference-oriented friction, in which effort aligns with a user's values or principles, for example, sustainability or fairness. This model helps show that friction is not just a technical issue and is not inherently good or bad, but it depends on the situation and how the user experiences it. According to Tomalin (2022), certain kinds of frictions, such as preserving user privacy or reducing impulsive behaviour, benefit ethical and responsible digital design. He offers three basic criteria for evaluating friction: is it voluntary or forced? Is it hidden or visible? And does it aim to manipulate or assist the user? These elements help to explain why the same design element, such as extra steps in a

process or a pause, is seen as supporting in one context but as intrusive in another. Further, Bertini et al. (2023) pointed out that certain friction might benefit both firms and customers, especially when it comes to important decisions like payment in e-commerce settings. Slowing down a process could reduce regret, increase return rates, and enhance emotional attachment to the product or brand. Hence, they underline the fact that well-designed friction will move customers off autopilot and into more conscious decisions.

In addition to these theoretical perspectives, other studies examine the practical impacts of friction in the e-commerce experience. For instance, Ngwe et al. (2019) show that eliminating filters that only display discounted items might create more friction in online shopping. It can benefit retailers because less price-sensitive customers are less likely to find discounts and may be more likely to buy full-priced products. On the other hand, Bai et al. (2020) highlight the detrimental effects of unintentional and excessive friction. Their analysis of the AliExpress (online marketplace platform) revealed that when users struggled to find products or clear vendor information, it was more difficult for them to find reliable sellers. This led to poor purchase decisions and negative customer experiences.

Lastly, friction should not be considered as something that should be automatically eliminated. When properly understood and applied, it becomes a valuable tool for generating significant customer experiences, whether that means making things faster, more considerate, or more in line with consumers' values.

2.3 Customer Value Experience in Value Co-Creation and Co-Destruction

Customer value experience is the personal and evolving sense of worth that people form as they interact with products, services, or systems (Lemon & Verhoef, 2016; Grönroos & Voima, 2012; Jaakkola et al., 2022). Previous studies described consumer value as a trade-off between what is received and what is provided, typically in terms of price and quality (Zeithaml, 1988). That model has been criticised for oversimplifying value to functional or economic outcomes. Later research expanded on the concept, demonstrating that value is a holistic, multidimensional construct that includes hedonic, symbolic, emotional, and relational dimensions ("Consumer Value," 1999/2002; Mathwick, Malhotra, & Rigdon, 2001; Smith & Colgate, 2007; Zauner et al., 2015).

Researchers indicate that this expanded understanding of customer value is based on the idea that value is not simply assessed upon the end of a purchase process. It is constructed through a series of lived experiences across the customer journey. To study this, researchers have introduced the idea of customer value experience. This explains how, through their interactions with the company at its touchpoints, individuals make sense of value. These interactions create an ongoing, contextually sensitive experience where value is continually constructed and shaped fluidly over time (Lemon & Verhoef, 2016; Jaakkola et al., 2022; Sahhar & Loohuis, 2022). Helkkula et al. (2012) provide the insight that value in the experience is not merely concerning what happens in one service moment, but rather that it is in constant and evolving. Individually or collectively, people are constantly making sense of their interactions, combining their past, present, and future experiences in the context of their everyday life.

The experiential framing of value provides a foundation for understanding value co-creation and value co-destruction. Value co-creation occurs when customers, firms, and other actors engage in meaningful interaction that allows them to combine resources and to create value together

(Grönroos & Voima, 2012; Vargo et al., 2008). On the other hand, value co-destruction occurs when customers feel that the interaction is worthless and fails to produce value, leading to a negative experience. This often happens due to poor communication, a lack of shared understanding, or a mismatch between the service design and the customer's needs. As a result, customers may feel confused, frustrated, or emotionally drained, which prevents them from achieving their intended goals and diminishes the overall value of the experience (Echeverri & Skålén, 2011; Heidenreich et al., 2014; Bai et al., 2020). Furthermore, it is important to mention that value co-creation and value co-destruction are mutually exclusive. Both of them can occur at the same time within the same interaction, a phenomenon known as the value co-creation and co-destruction paradox (Echeverri and Skålén, 2011).

In summary, customer value in the experience depends on how the individual interprets and interacts with the service. This perspective is crucial for examining how friction, as a deliberate design feature, can shape the experiential process and lead to value co-creation, value co-destruction, or their simultaneous occurrence.

2.4 Linking Customer Experience, Friction, and Customer Value Experience

Customer value experience is shaped not just by the design of the service interaction, but by how customers reflect on and emotionally appraise it. To explain this, the study draws primarily on the work of Sahhar and Loohuis (2022), who show that changes in service flow, such as interruptions or increased effort, can shift customers between different modes of experience depending on their level of reflectivity.

They identify three distinct types of experience: unreflective, semi-reflective, and fully reflective. Unreflective experience emerges in fluent, uninterrupted interactions where value may be reinforced but is not consciously appraised. Semi-reflective experience occurs when minor interruptions cause the customer to pause and re-engage more meaningfully with the interaction. Fully reflective experience results from major disruptions, where the service feels misaligned, confusing, or frustrating, leading to disengagement and negative value judgments. To extend this view, the study incorporates two dimensions from the GraphEx model (Sahhar et al., 2023): reflectivity and valence. Reflectivity refers to the customer's level of cognitive engagement, while valence reflects the emotional tone of the experience. Together, these dimensions determine the value outcome.

In low-friction conditions, customers complete the service process easily and quickly, without much thinking or emotional involvement. This study describes such outcomes as transactional value. This means that customers achieve their goals in a functional and efficient way, but the experience feels routine and lacks deeper engagement (Siebert et al., 2020; Padigar et al., 2024). While transactional value meets service goals, it does not create meaningful or memorable experiences. Moderate friction is expected to stimulate semi-reflective engagement. Customers think more about the service, and if these evaluations remain positive, value co-creation emerges. High friction, however, may result in fully reflective experiences and cognitively overload customers, suppressing or diminishing perceived value, leading to value co-destruction.

To better understand how customers interpret friction, the framework incorporates the typology developed by Padigar et al. (2024). They distinguish between four types of friction: frustrating, constructive, rewarding, and preference-oriented. A design feature that slows the process slightly may be seen as helpful if it adds clarity or security, but may be frustrating if it

feels unnecessary. Tomalin (2022) further contributes by showing that digital friction can differ in visibility, voluntariness, and ethical perception. Some forms of friction are experienced as supportive and empowering, while others are perceived as manipulative or obstructive. Together, these perspectives highlight that friction acquires meaning through interpretation, not just through its presence or intensity.

To evaluate the value outcome of the experience, this study applies the concepts of value co-creation and value co-destruction. While originally developed to describe multi-actor resource integration in service systems (Echeverri & Skålén, 2011), these terms are used here to capture the customer's individual evaluation of value-in-use, consistent with the value-in-experience perspective (Sahhar, 2016). Value co-creation is interpreted as a positively appraised, goal-aligned, and emotionally resonant experience. Value co-destruction, by contrast, is perceived negatively, cognitively effortful, or emotionally dissonant experience. These outcomes can coexist within the same journey. A customer may appreciate one feature while feeling frustrated by another. As Sahhar and Loohuis (2022) emphasise, such contradictory appraisals reflect the dynamic nature of experiential value.

In summary, this framework proposes that friction influences customer value experience by influencing reflectivity and emotional valence. Low friction leads to transactional value, moderate friction enables value co-creation, and high friction results in value co-destruction. This logic is the foundation for the conceptual framework and hypotheses developed in the following section.

2.5 Conceptual Framework

Figure 1 shows a U-shaped relationship between friction level and value experience (H1).

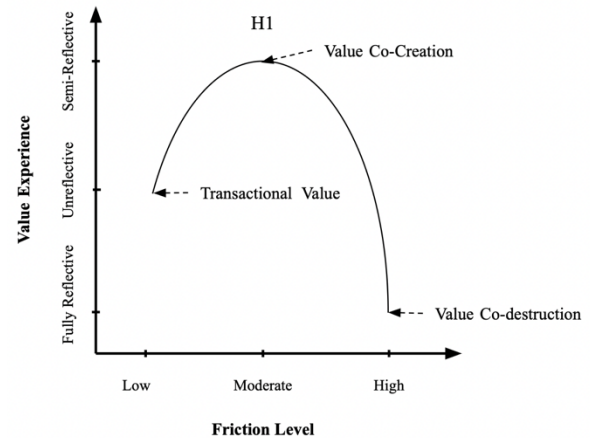


Figure 1. U-shaped relationship between friction level and value experience

Process logic of friction pathways and value outcomes was hypothesised in Figure 2 (H2a–H2c). According to the GraphEx model and the experiential modes proposed by Sahhar and Loohuis (2022), this diagram associates each friction level with a corresponding value experience.

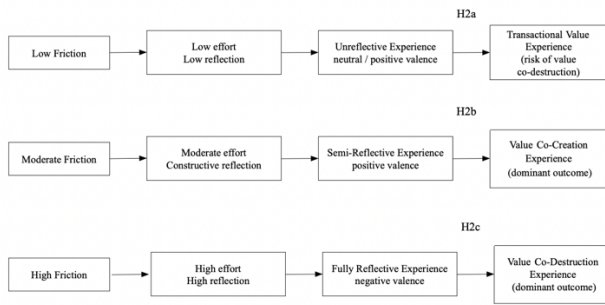


Figure 2. The relationship between friction levels and customer value experience

2.6 Hypotheses

Based on the conceptual framework and visual models, the following hypotheses are proposed:

H1: Customers exposed to moderate levels of friction will report a higher perceived value experience than those exposed to either low or high levels of friction.

This hypothesis reflects the model's U-shaped logic: moderate friction stimulates reflection and enhances perceived value, while too little or too much friction suppresses or undermines it. H2a: Low friction leads to unreflective experiences with neutral or mildly positive emotional tone, resulting in a transactional value outcome.

H2b: Moderate level of friction leads to a semi-reflective experience with a positive emotional tone, resulting in co-creation.

H2c: High level of friction leads to a fully reflective experience with a negative emotional tone, resulting in value co-destruction.

These hypotheses operationalise the theoretical argument that friction shapes customer experience through cognitive reflection and emotional interpretation, which together influence how value is ultimately constructed.

3. METHODOLOGY

3.1 Study Design

This study used a quantitative, experimental design to investigate how different levels of friction during the e-commerce checkout process affect customer value experience. This paper aims to answer the central question: How do different levels of experiential design friction affect customer value experience using e-commerce settings?

E-commerce platforms offer an excellent context for experimental studies because researchers can modify design elements such as navigation pathways, information display, or steps in the checkout process, while remaining familiar to users (Lorenzo et al., 2007; Ngwe et al., 2019). E-commerce has become an important aspect of the digital consumer journey, where checkout experiences influence how customers perceive value and decision-making (Lemon & Verhoef, 2016; Wang et al., 2022).

To test the proposed hypotheses (H1, H2a–H2c), the study developed three simulated checkout experiences, each representing a distinct level of friction: low, moderate, and high. After completing the assigned checkout journey, participants responded to the survey measuring emotional valence, cognitive reflection, and perceived effort. Survey responses were analysed

to evaluate differences across the experimental conditions and assess the relationship between friction and customer value experience.

3.2 Participants

A total of 30 participants completed the study, which involved interacting with a simulated checkout prototype and filling out a post-task questionnaire. Participants were gathered from both personal and academic networks.

With ten participants per group, participants were assigned randomly to one of three experimental conditions: Group A (low friction), Group B (moderate friction), or Group C (high friction). No data were excluded, and all participants completed the procedure as intended. The sample included 13 female participants (43.3%), 14 male participants (46.7%), non-binary/third gender participants (6.7%), and 1 participant (3.3%) who preferred not to disclose their gender. Ages ranged from 18 to 23 years old, with a mean age of 20.57 years (SD = 1.19).

All participants were informed about the study's purpose and provided digital consent. No personally identifiable information was collected. This study was conducted following the ethical guidelines of the University of Twente's Behavioural, Management and Social Sciences (BMS) faculty. Approval was obtained from the BMS Ethics Committee before data collection.

3.3 Materials

3.3.1 Prototype Design

Three interactive checkout prototypes were developed using Squarespace, each simulating the purchase of a black T-shirt. All participants began with the same product page. The versions differed only in the design of the checkout flow, based on the level of friction (Figure 3).

Prototype Design and Friction Visualisation



Figure 3. This diagram illustrates the experimental checkout flow across the three conditions: Group A = Low Friction, Group B = Moderate Friction, Group C = High Friction. A more detailed version of this figure is provided in APPENDIX A.

3.3.1.1 Group A - Low Level of Friction

Group A simulates a near-effortless checkout journey. All critical fields, like name, address, email, and payment, are pre-filled and visually verified with green checkmarks, reducing both cognitive and mechanical effort. Optional elements, such as a confirmation checkbox and expandable order summary, are included but do not obstruct progress. A single click on the “Place Order” completes the entire process in one action. Friction elements were limited and voluntary (Tomalin, 2022). In addition, visual green checkmarks were added as a form of visual

feedback to enhance perceived control without user action, grounded in Norman's (2013) principles of perceptual affordance and trust. The visual feedback enabled a functionally efficient journey, as the task was completed by the user with minimal effort and emotional breakdowns.

3.3.1.2 Group B - Moderate Level of Friction

Group B introduced moderate, constructive friction intended to stimulate reflection and facilitate meaningful engagement without producing frustration. Participants in this group were required to make several deliberate choices, including deciding whether to use saved data or re-enter their information, selecting between eco-friendly, express or standard delivery options, and manually choosing a payment method. These interactions represent constructive and preference-oriented friction, which support cognitive involvement, user agency, and a sense of personalisation (Padigar et al., 2024; Mathwick et al., 2001). In addition, the design included an optional two-factor authentication feature to reinforce trust and perceived service quality (Tomalin, 2022). A discrete upsell suggestion and an open field for delivery notes added hedonic and relational elements. A toggleable order confirmation allowed users to inspect their recent purchase details with minimal effort involved, along with a final confirmation checkbox as a small, but purposeful step to attempt to prevent faults. This element is consistent with ethical friction and at the same time prioritises voluntariness and transparency (Tomalin, 2022). It also strikes a balance between usability and reflection, in creating a semi-reflective experience, which improves perceived value and positive emotional connection to the task (Sahhar et al., 2023).

3.3.1.3 Group C – High Level of Friction

Group C was intended to simulate a high-friction, fully reflective experience. Immediately after clicking "Place Order," participants were tasked with creating an account. Along this route, participants experienced a password rejection on the first attempt, asking to make it stronger. This is a clear instance of opaque friction, as described by Tomalin (2022), where hidden or non-transparent rules disrupt the flow of interaction. According to Padigar et al. (2024), these elements are included in frustrating friction, which is involuntary, impersonal, and, in most cases, reduces perceived value.

Next, participants had to manually enter their payment details. This was rejected on the first attempt on purpose, again, due to formatting restrictions. At this moment, a warning message appeared stating, "You will be signed out in 60 seconds." This increased time pressure and emotional stress. After this, participants were asked to verify their email with a simulated two factor authentication step. This step imitated an extra step providing a secure service. The next features aimed at increasing effort included a CAPTCHA requirement and repeated session timeout warnings, leading to urgency and frustration. Users then had to scroll through an extensive Terms and Conditions message until the very bottom of the scroll, where a locked checkbox had to be clicked on. The checkbox prevented the user from deciding when to finish reading the message, and there were no obvious actions allowing to go back. Just before completion, a full-screen pop-up upsell appeared on screen, requiring the user to close it. The experience ended with a "session expired" message that wiped out everything the user had just done and further amplified users' feelings of wasted effort. Overall, these effort-increasing steps present a profoundly negative experience that induces emotional turmoil. This prototype combined mechanical and emotional layers of frustrating friction, leaving users with a fully contiguous experience that could only be described as having negative valence. All of the mentioned elements combined, the prototype

acts as an example of value co-destruction whereby excessive and involuntary friction has completely overrun the user, which leads to disengagement, frustration, and emotional collapse (Echeverri & Skålén, 2011)

3.3.2 Questioner Design

After completing the prototype interaction, participants were directed to a post-task questionnaire hosted on Qualtrics. The questionnaire consists of 13 items across three main sections: emotional valence, cognitive reflection, and perceived effort. Each statement in the questionnaire was rated on a 7-point Likert scale (from 1 = strongly disagree to 7 = strongly agree). This type of scale was chosen because it gives people enough range to express their opinions clearly and is commonly used in experience research (Klug, 2017). Some of the questions were adapted from existing research, and others were created by the researcher to match the specific design of this study (Table 1). The full questionnaire is included in Appendix B.

Operationalisation of Variables

Variable	Source	Number of Items
Emotional Valence	Laugwitz et al., 2008	4 (1 reverse-coded)
Cognitive Reflection	Sahhar & Loohuis 2022	4 (2 adapted; 2 developed)
Perceived Effort	Flavián et al. 2005	5 (3 items adapted; 2 developed)

Table 1.

3.4 Procedure

The experiment consisted of two parts: interacting with a checkout prototype and completing a follow-up questionnaire. Participants were randomly assigned to one of three groups (A, B, or C), each corresponding to a different friction condition. The task began with a generic product page for a black T-shirt that was the same for all groups. Then, participants proceeded through their assigned checkout flow. To ensure informed participation and ethical data handling, all participants were instructed not to enter real personal details. For Groups B and C, participants had to manually enter data, using a sheet with fake credentials to conceal their identity. After completing the checkout, participants immediately filled out a short questionnaire assessing their experience. Responses were recorded anonymously using Qualtrics.

3.5 Data Analysis

All survey data were analysed using *R-Studio*. The purpose of the analysis was to explore how low, moderate, and high friction levels shaped three outcome variables, emotional valence, cognitive reflection, and perceived effort. Together, these variables represent different elements of the customer value experience, each measured using multiple 7-point Likert-scale items (1 = Strongly disagree, 7 = Strongly Agree). Next, the data was cleaned to help create composite scores for each variable by averaging all items completed by each participant. Two negatively framed items (one in the valence scale and one in the effort scale) were reverse-coded to ensure that scale directionality was consistent. Internal consistency was evaluated using Cronbach's Alpha, and all three scales met the accepted threshold of $\alpha \geq 0.70$ (Nunnally, 1978). This indicates reliability

in the composites. The variables were then screened for normality using the Shapiro-Wilk test (Shapiro & Wilk, 1965). As the three outcome variables were found to be approximately normally distributed ($p > .05$), parametric tests were utilised.

Descriptive statistics were calculated to examine group means and the distribution of scores (see Table 2). To determine if there was a statistically significant difference in valence, reflection, and effort between friction conditions, a one-way ANOVA was conducted for each outcome. For measures that demonstrated significant group differences, a Welch's independent samples t-test was used to compare the moderate friction condition (Group B) against the low and high friction conditions (Groups A and C). A planned contrast using linear regression was carried out to determine if Group B was significantly different from the average of Groups A and C, as predicted by the U-shaped value model. In addition to group-based differences, a Pearson correlation was also calculated to assess relationships among all three variables across the entire sample. This test was conducted to investigate how perceived effort, cognitive reflection, and emotional valence may situate themselves outside the identification of group-related patterns. The alpha significance level to assess all statistical tests was $\alpha = .05$, indicating that the analysis has a statistically significant result if the p-value remains below 0.05. A 95% confidence interval was also applied to assess the potential range of true group differences. Key findings relating to these experiments were also depicted utilising bar charts with standard error bars, so readers can better understand the statistical or group differences.

4. RESULTS

This section presents the empirical findings and their interpretation from the experiment. It examined how different levels of friction (low, moderate, high) in a digital checkout flow influenced perceived effort, cognitive reflection, and emotional valence. These outcome variables represent the dimensions used to evaluate the customer value experience. Each subsection presents the results for one variable, supported by descriptive statistics (see Table 2), ANOVA tests, pairwise comparisons, and a Pearson correlation analysis assessing the relationships between the three outcome measures across the full sample.

Group Means and Standard Deviations per Outcome Variable

Outcome Variable	Group A		Group B		Group C	
	M	SD	M	SD	M	SD
Perceived Effort	2.24	0.73	2.98	0.96	4.86	1.20
Cognitive Reflection	3.15	0.52	4.03	0.68	4.90	0.91
Emotional Valence	6.53	0.34	6.20	1.03	3.18	1.99

Table 2.

Summary of One-Way ANOVA Results

Variable	F	df	p-value
Perceived Effort	16.24	2,27	<0.001
Cognitive Reflection	10.77	2,27	<0.001
Emotional Valence	19.91	2,27	<0.001

Table 3.

4.1 Perceived Effort

Perceived effort increased with the level of friction in the checkout process (Figure 4). A one-way ANOVA showed a significant effect of friction level on perceived effort, $F(2, 27) = 16.24$, $p < 0.001$ (Table 3), with a notable increase across conditions. Group A (low friction) reported the lowest effort ($M = 2.24$, $SD = 0.73$), Group B (moderate friction) reported a higher mean ($M = 2.98$, $SD = 0.96$), and Group C (high friction) reported the highest ($M = 4.86$, $SD = 1.20$). A Welch's t-test comparing Groups A and B indicated no statistically significant difference ($t(16.76) = -1.94$, $p = .070$), while the difference between Groups B and C was statistically significant ($t(17.22) = -3.87$, $p = 0.001$).

Perceived Effort across Friction Conditions

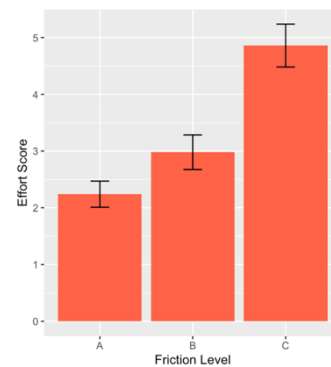


Figure 4. Bars represent group means (Group A = Low Friction, Group B = Moderate Friction, Group C = High Friction). Error bars represent ± 1 standard error of the mean.

4.2 Cognitive Reflection

Reflection levels progressively increase across the three conditions (Figure 5). Group A reported the lowest reflection ($M = 3.15$, $SD = 0.52$), Group B reported higher reflection ($M = 4.03$, $SD = 0.68$), and Group C the highest ($M = 4.90$, $SD = 0.91$). ANOVA results indicated significant group differences, $F(2, 27) = 10.77$, $p < 0.001$ (Table 3). Pairwise comparisons using Welch's t-test showed that Group B had significantly higher reflection than Group A ($t(16.77) = -3.24$, $p = 0.005$), and significantly lower reflection than Group C ($t(16.64) = -2.43$, $p = 0.027$).

Relationship Between Levels of Friction and Cognitive Reflection

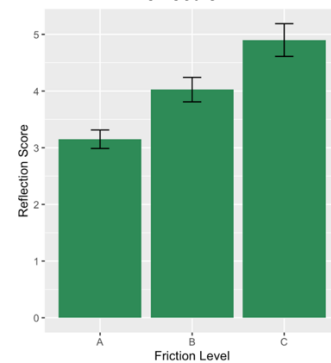


Figure 5. Bars represent group means (Group A = Low Friction, Group B = Moderate Friction, Group C = High Friction).

Friction). Error bars represent ± 1 standard error of the mean.

4.3 Emotional Valence

Emotional valence scores varied significantly between groups (Figure 6). Group A reported the highest average valence ($M = 6.53$, $SD = 0.34$), followed by Group B ($M = 6.20$, $SD = 1.03$), and Group C ($M = 3.18$, $SD = 1.99$). A one-way ANOVA confirmed a statistically significant main effect of friction level on valence, $F(2, 27) = 19.91$, $p < 0.001$ (Table 3). Welch's t-test showed that the difference between Groups A and B was not statistically significant ($t(10.96) = 0.94$, $p = 0.365$). In contrast, the difference between Groups B and C was statistically significant ($t(13.52) = 4.27$, $p < 0.001$).

Relationship Between Levels of Friction and Cognitive Reflection

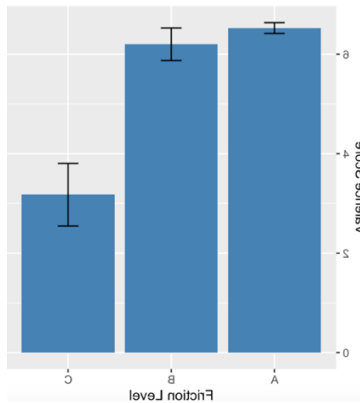


Figure 6. Bars represent group means (Group A = Low Friction, Group B = Moderate Friction, Group C = High Friction). Error bars represent ± 1 standard error of the mean.

4.4 Planned Contrast Testing (U-Shaped Hypothesis H1)

Planned contrast analysis tested whether Group B (moderate friction) differed significantly from the combined average of Groups A and C (low and high friction). The contrast was significant for cognitive reflection ($t = 3.12$, $p = 0.004$) and perceived effort ($t = 2.41$, $p = 0.023$), but not significant for emotional valence ($t = 1.58$, $p = 0.126$) (see Table 4).

Results Planned Contrast Results: Group B vs Average of Groups A and C

Variable	t-value	p-value
Perceived Effort	2.41	0.023
Cognitive Reflection	3.12	0.004
Emotional Valence	1.58	0.126

Table 4.

4.5 Correlation Between Outcome Variables

To further explore the relationship between outcome dimensions, a Pearson correlation analysis was used to examine the relationship between outcome dimensions (Table 5). The results indicated a strong positive correlation between cognitive reflection and perceived effort ($r = 0.81$), and strong negative correlations between effort and emotional valence ($r = -0.86$), as well as between reflection and emotional valence ($r = -0.65$).

These findings suggest that as reflection and effort increase, emotional valence tends to decrease.

Pearson Correlations

Variable	Correlation (r)
Perceived Effort	0.81
Cognitive Reflection	-0.86
Emotional Valence	-0.65

Table 5.

4.6 Findings Interpretation

Results demonstrated a clear increase in perceived effort from low-friction to high-friction conditions. These results support a theoretical notion that friction presents cognitive and mechanical demands on users. Participants in the high-friction condition evidenced procedural barriers that disrupted flow, whereas participants in the low-friction condition accomplished tasks with minimal effort. These findings align with Sahhar and Loohuis's (2022) typology of reflective experience. Cognitive reflection increased in proportion to friction levels. Participants in the low-friction condition reported minimal reflection, which supports unreflective engagement. Participants in the moderate-friction condition reported signs of semi-reflective engagement, and participants in the high-friction condition reported the most reflective engagement. In terms of emotional valence, scores declined with increasing friction. Group C showed significantly lower emotional tone, suggesting value co-destruction. Although there was no statistically significant difference between Groups A and B in valence, Group B was the only condition to combine reflection with maintained emotional positivity.

These patterns of effort, reflection, and emotional valence confirm Hypotheses 2a, 2b and 2c. Low friction resulted in minimal effort, unreflective experience and the highest emotional valence, corresponding to transactional value. In contrast, moderate friction creates medium effort, and semi-reflective engagement with a positive emotional tone supports value co-creation. High friction increases perceived effort, resulting in a fully reflective experience with declining emotional valence, representing value co-destruction. These patterns of effort, reflection, and emotional valence confirm Hypotheses 2a, 2b, and 2c. The results also address Hypothesis 1, which proposed a U-shaped relationship between friction level and customer value experience, with moderate friction leading to higher perceived value than both low and high friction.

5. DISCUSSION

This chapter interprets the experimental study's results, critically evaluating how different levels of friction in digital checkout design affect customer value experience. It connects empirical findings to the theoretical framework, reflects practical and theoretical contributions, and outlines limitations and future research directions.

5.1 Key Findings

Using a controlled experimental design, this study investigated the relationship between low, moderate, and high friction and customer value experience, specifically in terms of cognitive reflection and emotional valence. The findings indicate that moderate friction, while not significantly superior to low friction in terms of emotional valence, uniquely promotes cognitive engagement without overwhelming the user. This makes it especially effective in fostering conditions for value co-

creation. Low friction, although emotionally positive, may reduce opportunities for meaningful interaction. High friction, by contrast, increases both effort and reflection but significantly reduces emotional tone, supporting the interpretation of value co-destruction. These outcomes reinforce the theoretical argument that friction must be carefully designed. Value is not just produced by minimising discomfort or removing barriers, but also by allowing users to engage meaningfully and reflectively. This process must remain within an emotional threshold that avoids frustration. The findings of the study provide empirical evidence of a more complex understanding of friction, as a design element that can either enable or obstruct customer value, depending on its form and intensity.

5.2 Theoretical Implications

This research expands the theoretical perspective in three important ways. Firstly, the research extends Sahhar and Loohuis's (2022) framework of experiential value by demonstrating how design characteristics can lead to differences in engagement styles that cause users to move through unreflective, semi-reflective, and reflective engagement states. The findings suggest that moderate friction involves semi-reflective engagement, when minor interruptions slow down users, causing them to think and process the service experience in meaningful ways without interference. This process utilises and clarifies the GraphEx model (Sahhar et al., 2023) and demonstrates that value outcomes are affected by reflectivity and emotional valence. Secondly, the findings also extend knowledge on the implications of value co-creation and co-destruction outcomes related to the interaction between cognitive and emotional processes. Moderate friction increased the level of reflection while keeping emotional valence at a positive level to promote value co-creation. On the other hand, high friction produced fully reflective experiences and emotional deterioration, leading to value co-destruction. This finding further advances the conceptualisation of the value-in-use perspective and positions friction as one that enables or suppresses value. Third, this study compiles the existing friction theories (Padigar et al., 2024; Tomalin, 2022) into a unified process model to explain how friction impacts the customer journey. It reveals that different levels of friction engage different sequences of the customer experience: with capturing perceived effort followed by the reflection type, then by emotional valence type, culminating in relevant value outcomes. This structured framework offers a clear way to analyse how friction can be intentionally designed to enhance the customer value experience.

5.3 Practical Implications

This study suggests useful implications for managers and service designers who are involved in digital customer journeys. First, managers should not completely remove friction from the digital service journey. Although seamless experience may be efficient, it could also affect customers' potential for engagement and reflection around their decisions, limiting their value. Therefore, managers can implement friction in the user journey, nudging them to pause and think deliberately about their shopping decisions, such as confirmation during checkout, the personalisation process, or the selection of delivery options. Secondly, in order to foster thoughtful engagement, managers can introduce a deliberate amount of friction to encourage customer involvement. One method to introduce cognitive engagement without frustration is to offer multiple, differentiated choices, which would necessitate the user to develop trade-offs, including sustainability choices, delivery times, and additional features. Friction should be designed to remain clear, voluntary, and relevant to the customer's goals, aligning with the idea of

constructive friction (Padigar et al., 2024). Third, managers should be cautious when employing friction in the form of mandatory steps or additional verification steps. Features such as forced account creation, multiple security verifications, and several versions of the same form can be emotionally overwhelming, especially when these actions can be perceived as being unnecessary. However, when additional steps cannot be avoided for regulatory or security reasons, managers should focus on improving the transparency of the whole process. For example, offer clear explanations, progress indicators or support options to help users have a sense of control over the process. Overall, friction should be treated as a dynamic design lever rather than a problem to eliminate. By balancing ease of use with thought-through cognitive engagement, managers can design digital experiences that support customer reflection, increase emotional satisfaction, and enhance value co-creation.

5.4 Limitations

This research acknowledges several limitations, yet it significantly advances the understanding of friction in the customer value experience. The first limitation is that instead of testing in a truly dynamic or commercial e-commerce setting, static, simulated prototypes were used. Although the researcher could account for many potential intervening variables, this static simulation would probably result in less natural scenarios than people could encounter in real life. Participants were aware that they were not making a real purchase, which might have decreased their level of cognitive or emotional connection with the prototypes and influenced the overall depth of response and involvement with their customer value experience. The second limitation is the student network convenience sampling, which was highly familiar with digital technology and had a small sample size ($N = 30$). Compared to older, less technologically inclined, or sceptical of risk consumers, this demographic may respond to friction differently. The potential for generalising the findings across larger consumer groups is restricted. This sampling characteristic might also help explain why moderate friction resulted in slightly lower emotional ratings than low friction in this study. Third, as soon as participants finished the activity, they were asked to self-report and complete a survey on the emotional valence, cognitive reflection, and perceived effort variables used in this study. Although self-report measures are susceptible to biases in personal perception or response, they proved adequate for assessing subjective experience. Furthermore, they only record immediate emotional reactions and don't show how perceived value could evolve with time and introspection. Behavioural measures would strengthen the results. Click routes, time on task, or psychological assessments, for instance, might give a more reliable indication of the results of this investigation. Fourth, while the friction levels were carefully designed, it is possible that the moderate friction condition introduced only mild interruptions that were not strong enough to fully stimulate the expected reflective engagement. A moderate level of friction could have resulted in additional variations. The final limitation refers to the single and individualised perspective used to evaluate the value experience of potential customers. According to the theoretical framework, value co-creation and co-destruction are frequently impacted by multi-actor events. Using participants' personal experience, this study examined the effects of design-induced friction. Future studies could examine service experiences with various actors or value co-creation experiences within complex collaboration.

5.5 Future Research

Future studies should be conducted in real e-commerce settings where participants make actual purchases. This would help capture more natural emotional and cognitive responses.

Second, future research should examine how different customer segments respond to friction. For example, experienced online shoppers may prefer seamless journeys, while other customer groups, such as older consumers, less digitally experienced users, or risk-averse individuals, may appreciate certain forms of moderate friction that foster reassurance, trust, or perceived control. Studying how factors like age, digital literacy, shopping goals, or personality traits influence reactions to friction would help create more personalised and adaptive experience design. Third, longitudinal research could examine how reactions to friction evolve over time. Positive feelings from low friction may fade if lacking meaningful engagement. Moderate friction might build stronger value through deeper involvement. High friction may either remain frustrating or later be seen as beneficial in contexts like security. Fourth, further studies could refine and calibrate the intensity and type of constructive friction. Future experiments may test different types of purposeful interruptions to better balance cognitive stimulation with emotional comfort, providing clearer guidelines for optimal friction design. Lastly, new research could explore how friction affects value experience in multi-actor settings, such as social shopping or service collaborations, where value is co-constructed across users and platforms.

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Appendix A

Figure 3. Prototype design and friction visualisation

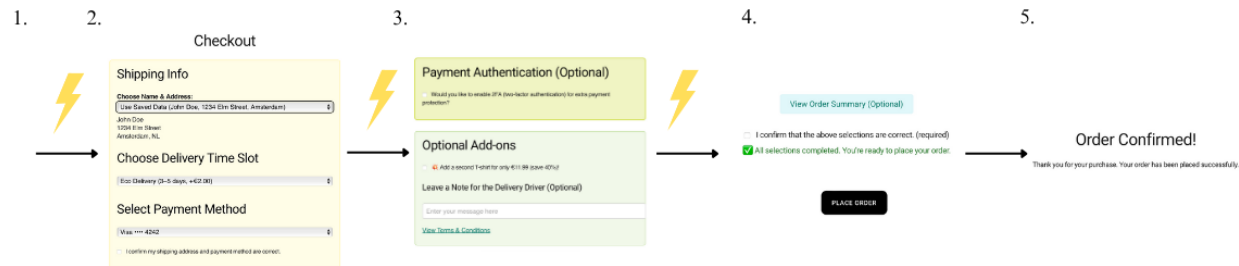
All Groups: 1.



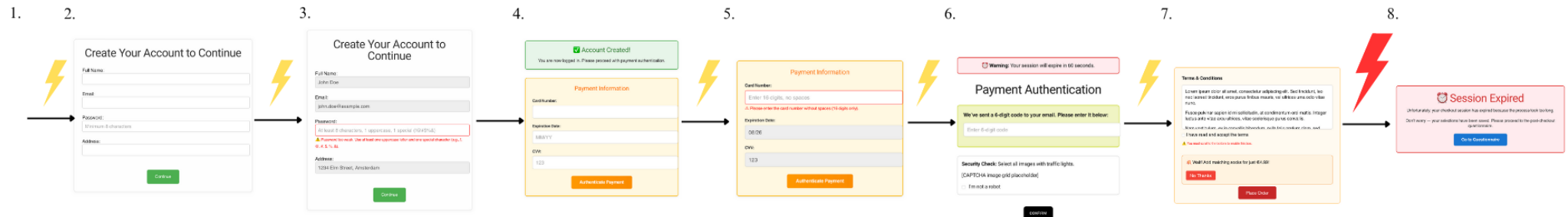
Group A:



Group B:



Group C:



Symbol	Description
1, 2, 3, 4, 5, 6, 7, 8	The numbered boxes indicate the sequence of checkout steps
	Mild intentional breakdown designed to slow the process and stimulate reflection
	Major breakdown that fully breaks flow

Appendix B

Survey

Please indicate how much you agree with the following statements about your overall checkout experience.

Use a scale from 1 (Strongly Disagree) to 7 (Strongly Agree).

[illegible]

Please indicate how much you agree with each of the following statements about what you were thinking or noticing during the checkout process.

Use a scale from 1 (Strongly Disagree) to 7 (Strongly Agree).

[illegible]

Please think about how much effort the checkout process required from you.

Indicate how much you agree with the following statements

Using a scale from 1 (Strongly Disagree) to 7 (Strongly Agree).

[illegible]