ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

USABILITY OF MOBILE APPLICATIONS: A CONCEPTUALIZATION AND INSTRUMENT DEVELOPMENT STUDY BASED ON APPLE HUMAN INTERFACE GUIDELINES

M.Sc. THESIS

Kübra ÇETİN YILDIZ

Department of Industrial Engineering

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(507191117)

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ

MOBİL UYGULAMALARIN KULLANILABİLİRLİĞİ: APPLE İNSAN ARAYÜZÜ YÖNERGELERİNE DAYALI BİR KAVRAMSALLAŞTIRMA VE ENSTRÜMAN GELİŞTİRME ÇALIŞMASI

YÜKSEK LİSANS TEZİ

Kübra ÇETİN YILDIZ

(507191117)

Endüstri Mühendisliği Anabilim Dalı

Endüstri Mühendisliği Programı

Tez Danışmanı: Doç. Dr. Çiğdem ALTIN GÜMÜŞSOY

NİSAN 2023

Kübra ÇETİN YILDIZ, a M.Sc. student of ITU Graduate School student ID 507191117, successfully defended the dissertation entitled “USABILITY OF MOBILE APPLICATIONS: A CONCEPTUALIZATION AND INSTRUMENT DEVELOPMENT STUDY BASED ON APPLE HUMAN INTERFACE GUIDELINES”, which she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

Thesis Advisor: **Assoc. Prof. Dr. Çiğdem ALTIN GÜMÜŞSOY** ....
Istanbul Technical University

Jury Members: **Asst.Prof. Dr. Ayşe Elvan BAYRAKTAROĞLU** ....
Istanbul Technical University

Prof. Dr. Selim ZAİM ....
Istanbul Sabahattin Zaim University

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To my family,

FOREWORD

The penetration of mobile applications is constantly increasing as a consequence of rapid technological development. Thanks to this rapid development, the capabilities of mobile applications are evolving continually. Although this recent growth has gained, it also has a drawback because it is challenging for mobile application developers to create user-centric interfaces. This study is a comprehensive conceptualization and survey instrument development study on mobile application usability. Thus, it aims to both guide mobile application developers in creating user-centered interfaces and contribute to the assessment of the usability of mobile applications.

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Kübra ÇETİN YILDIZ
Industrial Engineer

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ABBREVIATIONS

AVE : Average Variance Extracted
CFI : Comparative Fit Index
CR : Composite Reliability
CSV : Substantive Validity Coefficient
CVR : Content Validity Ratio
df : Degree of Freedom
ECM : Expectation-Confirmation Model
GQM : Goal Question Metric
HCI : Human-Computer Interaction
IFI : Incremental Fit Index
IS : Information Systems
ISO : International Organization for Standardization
UCD : User-Centered Design
UI : User Interface
KMO : Kaiser-Meyer-Olkin
MAUEM : Mobile Application Usability Evaluation Metrics
mGQM : Mobile Goal Question Metric
MSV : Maximum Squared Variance
NASA-TLX : National Aeronautics and Space Administration Task Load Index
PACMAD : People at the Center of Mobile Application Development
PSA : Proportion of Substantive Agreement
PSSUQ : Post Study System Usability Questionnaire
RMSEA : Root Mean Square Error of Approximation
SEQ : Single Ease Question
SLR : Systematic Literature Review

SMASH **:** SMArtphone's uSability Heuristics

SRMR **:** Standardized Root Mean Square Residual

TLI **:** Tucker Lewis Index

TMD **:** Touchscreen-based Mobile Devices

UAT **:** User Acceptance Test/Testing

SYMBOLS

α	**:** Alpha
n	**:** Number of participants
p	**:** Significance level
R^2	**:** Coefficient of determination
$\chi 2$	**:** Chi-square

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**USABILITY OF MOBILE APPLICATIONS:
CONCEPTUALIZATION & INSTRUMENT CONSTRUCTION BASED ON
APPLE HUMAN INTERFACE GUIDELINES**

SUMMARY

Smartphones and their services make people's lives much more accessible and enable them to use their limited resources more effectively. With the advancement in technology, the capabilities of smartphones have also increased, and several mobile applications have been developed. Through these mobile applications, people can perform and manage many activities, from making hospital appointments to financial transactions, communication, and educational activities. For instance, mobile e-government applications enable various public services to be performed with a single click with less physical effort. Being available at any time and from any location is one of the most important advantages of mobile applications. The portability of mobile devices and their suitability for a variety of user settings are important features for users. Users always expect to be able to seamlessly enjoy the service a mobile application promises to deliver. However, the use of mobile applications in a wide range of usage environments and some physical constraints, such as small screen sizes, are the factors that complicate usability studies for mobile applications. The ever-evolving nature of smartphones, in parallel with developed technology, also complicates the design of mobile application interfaces. All these difficulties and the continued widespread use of mobile applications have accelerated the studies related to mobile application usability. Initial studies on mobile application usability were derived from previous studies on website usability. However, the characteristics of websites differ from mobile applications in terms of the devices they are used and the usage environment. Therefore, the usability of mobile applications should be handled individually. In the literature, an essential part of the studies on mobile application usability focus on only one type of mobile application, such as mobile health, mobile commerce, and mobile learning. These studies are helpful in evaluating usability for a particular type of mobile application. On the other hand, this study provides a comprehensive usability model that may be used in the design and evaluation phases of any kind of mobile application by software developers. Furthermore, the developed survey instrument based on the mobile application usability concepts evolved may be used to understand the significant factors in the usability assessment of mobile applications from the users' perspective.

In this study, a three-step formal methodology was used to conceptualize and develop a survey instrument: conceptualizing the constructs, developing the scale, and evaluating the measurement properties. In the first stage, the first matrix of open codes was created by examining Apple's human interface guidelines line by line, which was taken as the main source of the open and axial coding procedure for the conceptualization of constructs. This open code matrix, consisting entirely of qualitative data, was then examined eight more times and open and axial coding procedures were applied. The finalized matrix consists of 16 axial codes, 29 subcategories, and 92 open codes. Sixteen constructs are conceptualized, namely

instant start, branding, orientation, collaboration, content, search, privacy, graphics & animations, realism, control obviousness & reliability, effort minimization, consistency & standardization, concise & user-driven language, feedback, navigation, and transition. In the second stage, an initial item pool consisting of 113 items measuring 16 constructs was created by making use of the open codes created in the previous section and the relevant literature. The initial version of the items was screened with a procedure. First, a face validity check was performed to eliminate vague items. Then the survey items were applied to real users with a pilot study, and a content validity check was performed to validate the items. As a result of analyses, 69 items representing 16 constructs were revealed to evaluate the measurement properties of the scale. At the final stage, the measurement properties of the developed survey instrument were evaluated with exploratory and confirmatory analyses. The factor structure was discovered with the first collected data (n_1=476), and the discovered factor structure was confirmed with the second data collected with different participants(n_2=583). The target audience of these survey studies is social media mobile application users, which is one of the most widely used mobile application types and appeals to a large part of society. In the exploratory analysis, two items with factor loadings lower than the threshold value were excluded from the item pool. Confirmatory analysis was performed with 67 items representing 16 constructs to validate the constructs and their corresponding items revealed with explanatory analysis. The internal reliability, convergent validity, discriminant validity and fit indices of the measurement model were examined, respectively. Finally, for the nomological validity of the developed scale, the fit indices of the structural model and the effects of constructs on satisfaction and continued intention to use were examined. The results show that the scale developed for mobile application usability explains a significant part of the variability in satisfaction and continued intention to use. In addition, the significant relationships between mobile application usability constructs and satisfaction and continued intention to use provide evidence for the applicability of the developed survey instrument.

MOBİL UYGULAMALARIN KULLANILABİLİRLİĞİ: APPLE İNSAN ARAYÜZÜ YÖNERGELERİNE DAYALI BİR KAVRAMSALLAŞTIRMA VE ENSTRÜMAN GELİŞTİRME ÇALIŞMASI

ÖZET

Gelişen teknoloji ile birlikte akıllı telefonlar da insanların hayatının vazgeçilmez bir parçası durumuna gelmiştir. Öyle ki akıllı telefon kullanıcı sayısı sürekli olarak artış göstermektedir. Akıllı telefonlarda sunulan ve insanların günlük hayatını önemli ölçüde kolaylaştıran mobil uygulamaların da bu hızlı gelişimdeki payı oldukça büyüktür. Akıllı telefonların ilk kullanılmaya başlandığı zamanlarda arama yapma, yazılı veya görsel ileti gibi kısıtlı kabiliyeti vardı. Fakat teknolojideki ilerleme ile birlikte akıllı telefonların kabiliyetleri de artmış, çok çeşitli mobil uygulamalar geliştirilmiştir. Bu mobil uygulamalar sayesinde insanlar birçok günlük hayat aktivitesini gerçekleştirebilmekte ve yönetebilmektedir. Mobil uygulamalar aracılığıyla akıllı telefonlar, hastane randevusu almaktan finansal işlemlere, iletişimden haberleşmeye, eğitim öğretim faaliyetlerinden müzik dinleme ve oyun oynama gibi hedonik faaliyetlere kadar çok geniş bir hizmet yelpazesi sunmaktadırlar. Mobil uygulamalar insanların hayatını kolaylaştırdığı gibi aynı zamanda kısıtlı kaynaklarını da daha verimli bir şekilde kullanabilmelerine yardımcı olur. Örneğin e-devlet mobil uygulamaları çalışan bir bireyin iş yerindeyken çeşitli kamu hizmetlerini daha az fiziksel çaba ve zaman harcayarak gerçekleştirebilmesine olanak sağlar.

Akıllı cihazların ve dolayısıyla mobil uygulamaların en önemli avantajlarından biri de bütün kullanım koşullarında ve sürekli olarak erişilebilir olmalarıdır. Böylelikle taşınabilir bir aygıt olan akıllı telefonların sunmuş olduğu mobil uygulamalara da kullanıcıların erişimi bilgisayar gibi cihazlar ve onların sunmuş olduğu hizmetlere ulaşmaktan daha kolaydır. Fakat mobil uygulamaların çok çeşitli kullanım ortamlarında kullanılması mobil uygulamalara yönelik kullanılabilirlik çalışmalarını zorlaştırabilmektedir. Kullanıcılar nerede ve ne zaman olursa olsun bir mobil uygulamanın sunmayı taahhüt ettiği hizmetten sorunsuz bir şekilde yararlanabilmeyi bekler. Eğer başarısız olurlarsa mobil uygulama kullanım deneyimine yönelik memnuniyet hissi ve hatta kullanıma devam etme niyeti olumsuz yönde etkilenebilir. Ayrıca mobil cihazların küçük ekran boyutuna sahip olması taşınabilir olması yönüyle avantajlı olsa da mobil uygulama arayüz tasarımcıları açısından zorlayıcı olabilmektedir. Kısacası mobil uygulamaların taşınabilir bir yapıya sahip olması ve çok çeşitli bağlamlarda kullanılabilmesi kullanıcılar açısından faydalı ve hatta kullanıcıları mobil uygulamalara bağlayan özelliklerdir. Fakat bu özellikler aynı zamanda mobil uygulama geliştiricilerini zorlayan ve mobil uygulama kullanılabilirliği açısından dikkatli bir şekilde üzerinden durulması gereken hususlardır. Mobil uygulamaların kullanımının giderek yaygınlaşması ve akıllı telefonların teknoloji ile paralel olarak sürekli gelişen yapısı da mobil uygulamaların tasarımını karmaşık hale getirmektedir. Tüm bu zorluklar ve mobil uygulamaların sunduğu hizmetlerin kullanıcılar tarafından verimli bir şekilde kullanılabilmesi kaygısı mobil uygulamaların kullanılabilirliğine yönelik çalışmaları hızlandırmıştır.

Başlangıçta, mobil uygulama kullanılabilirliği ile ilgili çalışmalar, web sitesi kullanılabilirliği ile ilgili önceki çalışmalardan evrilmiştir. Ancak web siteleri hem fiziksel olarak hem de kullanım bağlamı açısından mobil uygulamalardan oldukça farklı olduğu için mobil uygulamaların kullanılabilirliği ayrıca ele alınmalıdır. Mobil uygulama kullanılabilirliğine yönelik literatürdeki çalışmaların önemli bir kısmının da ya tek bir kullanılabilirlik kriterine ya da mobil sağlık, mobil ticaret, mobil öğrenme, mobil seyahat, mobil alışveriş, mobil bankacılık ve mobil reklamcılık gibi yalnızca tek bir mobil uygulama türüne yönelik çalışmalar olduğu görülmüştür. Bu çalışmalar belirli bir tür mobil uygulamaya yönelik kullanılabilirliğin değerlendirilmesinde faydalı olmasına rağmen tüm mobil uygulama geliştiricilerine hitap etmemektedir. Bu nedenle, mobil uygulamaların kullanılabilirliğini etkileyen öznitelikleri spesifik olarak araştıran ve ortaya koyan, tüm mobil uygulama türlerine uygulanabilecek kapsamlı çalışmalara ihtiyaç vardır. Kapsamlı bir kavramsallaştırma ve anket aracı geliştirmenin avantajı, mobil uygulamanın kullanılabilirliğine ilişkin bütüncül bir bakış açısı sağlamasıdır. Bu tez çalışması, pazara liderlik eden iki mobil uygulama sağlayıcısından biri olan Apple'ın insan arayüzü yönergelerine dayalı bir kavramsallaştırma ve anket aracı geliştirme çalışmasıdır.

Bu çalışmada, kavramsallaştırma ve anket aracı geliştirme için üç adımlı bir metodoloji takip edilmiştir: yapıların kavramsallaştırılması, ölçeğin geliştirilmesi ve geliştirilen ölçeğin ölçüm özelliklerini değerlendirmesi. İlk aşamada, yapıların kavramsallaştırılması için Apple'ın insan arayüzü yönergeleri açık ve eksenel kodlama prosedürünün temel kaynağı olarak alınmış ve satır satır incelenerek açık kodlardan oluşan ilk matris oluşturulmuştur. Tamamen nitel verilerden oluşan bu açık kod matrisi daha sonra sekiz kez daha incelenmiş ve açık ve eksenel kodlama prosedürleri uygulanmıştır. Açık kodlar benzerlik ve farklılıklarına göre gruplandırılmış böylece kategoriler ve alt kategoriler oluşturulmuş, oluşturulan kategoriler kendi alt kategorileri ile eksenel olarak ilişkilendirilmiş ve matris nihai halini almıştır. Son haline getirilen matris 16 eksenel kod, 29 alt kategori ve 92 açık koddan oluşmaktadır. Kavramsallaştırılan yapılar hızlı başlatma, markalaşma, yönlendirme, iş birliği, içerik, arama, gizlilik, grafikler ve animasyonlar, realizm, kontrollerin açıklığı ve güvenilirliği, efor minimizasyonu, tutarlılık ve standardizasyon, özlü ve kullanıcı merkezli dil, geri bildirim, navigasyon ve geçişler olmak üzere 16 adettir. Daha sonra kavramsallaştırılan yapıların literatür ile ilişkisi incelenmiştir.

Metodolojinin ikinci aşaması olan ölçeğin geliştirmesi aşaması kendi içerisinde alt bölümlere ayrılmaktadır. Öncelikle bir önceki bölümde oluşturulan açık kodlardan ve ilgili literatürden yararlanılarak 16 kavramsal yapıyı ölçen ve 113 kriterden oluşan bir başlangıç kriter havuzu oluşturulmuştur. Sonrasında oluşturulan bu ilk kriter havuzunun katılımcılar tarafından kolayca cevaplanabilir olması, belirsiz ve anlaşılması güç kriterlerin elimine edilebilmesi ve toplanan verideki hatanın en aza indirilebilmesi için sırasıyla görünüş geçerlilik kontrolü, pilot çalışma ve içerik geçerlilik analizleri gerçekleştirilmiştir. Görünüş geçerlilik kontrolüne 5 akademik personel ve 4 yüksek lisans/doktora öğrencisinden oluşan 9 kişi katılım göstermiştir. Bu aşamada katılımcılardan belirsiz buldukları, anket aracından çıkarılması gerektiğini düşündükleri veya yeniden ifade edilmesi gerektiğini düşündükleri kriterleri belirtmeleri istenmiştir. Ayrıca kriterlerin yeniden ifade edilmesi konusundaki önerileri de alınmıştır. Görünüş geçerlilik kontrolü aşamasından sonra güncellenen kriter havuzu kullanılarak hedef kitleyi temsil eden bir grup katılımcı ile pilot çalışmaya geçilmiştir. Pilot çalışma anket aracının bir ön değerlendirmesi olarak, ana popülasyonu temsil eden 39 katılımcı ile gerçekleştirilmiştir. Bu ön çalışma ile anket aracındaki kriterlerin tüm katılımcılar tarafından anlaşılabilmesi adına nasıl düzenlenmesi gerektiği ve anket aracının tasarımı konusunda faydalı geri bildirimler alınması hedeflenmiştir. Bu doğrultuda kullanıcılardan anketi doldururken kendilerine sunulan bazı sorulara cevap aramaları ve kriterler ve anket aracı ile ilgili geri bildirimlerde bulunmaları istenmiştir. Pilot çalışma aşamasında güncellenen kriter havuzu ile son aşama olan içerik geçerlilik kontrolüne geçilmiştir. Bu aşamada, görünüş geçerlilik kontrolünün aksine katılımcıların uzman olması gerekli değildir ve daha fazla katılımcı ile gerçekleştirilir. İçerik geçerliliği, ölçülmek istenen yapının kriterler ile ne derece iyi ölçüldüğünün istatistiksel olarak gösterilmesini sağlar. Son olarak içerik geçerlilik kontrolü için literatürde sıklıkla kullanılan ve her bir kriterin yalnızca bir kavramsal yapıya atanması ile gerçekleştirilen bir yöntem kullanılmıştır. Bunun için 40 katılımcıdan veri toplanmış ve toplanan veriler ile her bir kritere yönelik iki indeks hesaplanmıştır. Her bir kriterin indeks değerlerinin literatürde önerilen eşik değeri geçip geçmediği incelenmiş ve bu inceleme sonucunda eşik değerin altında olan kriterlerin anket aracında çıkarılması veya yeniden ifade edilmesi hususu titizlikle incelenmiştir. Tüm analizler sonucunda nihai kriter havuzunda16 kavramsal yapıyı temsil eden 69 kriter bulunmaktadır.

Metodolojinin son aşamasında geliştirilen anket aracının ölçüm özellikleri keşfedici ve doğrulayıcı analizler ile değerlendirilmiştir. Bunun için iki aşamalı bir veri toplama süreci olmuştur. İlk toplanan veri ile faktör yapısı keşfedilmiş, ikinci veri ile de keşfedilen faktör yapısı doğrulanmıştır. Anketler en yaygın kullanılan mobil uygulama türlerinden biri olan ve toplumun geniş bir bölümüne hitap eden sosyal medya kullanıcılarına yönelik toplanmıştır. Bu doğrultuda, Türkiye'de son yıllarda sıklıkla kullanılan sosyal medya uygulamalarından Facebook, Instagram, Twitter ve YouTube kullanıcılara seçenek olarak sunulmuş ve en çok kullandıkları sosyal medya uygulamasını seçmeleri istenmiştir. Anket soruları katılımcıların en çok kullandıkları sosyal medya uygulamasına göre revize edilerek katılımcıların önüne sunulmuştur. İlk aşamada 476 kullanılabilir anket verisi ile açıklayıcı faktör analizi gerçekleştirilmiş ve sonuçta metodolojinin ilk aşamasında kavramsallaştırıldığı gibi 16 faktör yapısı keşfedilmiştir. Ayrıca kavramsal yapıların iç güvenilirlikleri de test edilmiştir. Bu aşamada 2 kriter ait oldukları düşünülen faktöre atanmadıkları için anket aracından çıkarılmıştır ve doğrulayıcı analizlere 16 kavramsal yapıyı temsil eden 67 kriter ile geçilmiştir. Keşfedici analizde toplanan veriden farklı katılımcılarla gerçekleştirilen ikinci anket çalışması sonucu 583 kullanılabilir anket verisi elde edilmiştir ve doğrulayıcı analizlere geçilmiştir. Doğrulayıcı analizlerde öncelikle ilk aşamada keşfedilen faktör yapısı doğrulanmıştır. Sonrasında sırasıyla kavramsal yapıların iç güvenilirliği, tek boyutluluğu, ayırt edici geçerliliği ve ölçüm modelinin uyum indeksleri incelenmiştir. Ölçme aracında yer alan kavramsal yapıların geçerliğinin kanıtlanmasındaki son aşama nomolojik geçerlilik aşamasıdır. Bu aşamada geliştirilen araçla teorik olarak ilişkili olduğu düşünülen değişkenler ile ölçme aracındaki kavramsal yapılar arasında istatistiksel olarak anlamlı bir ilişki olup olmadığını incelenir. Bu doğrultuda, yapısal modelin uyum indeksleri ve ölçekteki kavramsal yapıların memnuniyet ve kullanıma devam etme niyeti üzerindeki etkileri incelenmiştir. Sonuçlar incelendiğinde mobil uygulamaların kullanılabilirliğine dair geliştirilen ölçeğin, memnuniyet yapısındaki değişkenliğin yönlendirme, iş birliği, içerik, arama, grafikler ve animasyonlar ne navigasyon kavramsal yapıları tarafından %49,3 açıklanabildiğini; kullanıma devam etme niyeti yapısındaki değişkenliğin de hızlı başlatma, markalaşma, kontrollerin açıklığı ve güvenilirliği, efor minimizasyonu, özlü ve kullanıcı merkezli dil, navigasyon ve geçişler kavramsal yapıları tarafından %57,7 açıklanabildiğini göstermektedir. Mobil uygulama kullanılabilirliği kavramsal yapıları ile memnuniyet ve kullanıma devam etme niyeti yapıları arasındaki anlamlı ilişkiler, geliştirilen anket aracının uygulanabilirliğine dair kanıt sağlamaktadır.

1. INTRODUCTION

Smartphones and the opportunities they offer have become a part of our everyday lives. In 2021, there are more than six billion smartphone users globally, according to statistics. This number has increased every year from past to present and is expected to increase in the coming years and it is estimated to reach six and a half billion in 2022 and 7 billion in 2023(Taylor, 2022). When they were first come into use, smartphones only had a limited number of features such as making calls and sending textual or visual messages, but today they have many different features from keeping a person's health data to giving directions to the connected car, and this is one of the most important factors that attract people to use these devices. Mobile applications, on the other hand, are one of the most important opportunities offered by mobile devices, where people can follow their work, shop, interact with each other and perform many other actions. The biggest characteristic and perhaps the biggest advantage that distinguishes mobile devices, therefore mobile applications from other devices/platforms, is that they can be accessed anytime, anywhere (Coursaris and Kim, 2006).

With the increasing interest in mobile applications and the rapid adoption of mobile devices in line with the increasing frequency of use, many features are integrated into mobile applications. This development complicates the design of mobile applications. While the capabilities of mobile devices are increasing, their sizes are getting smaller due to both ease of use and aesthetic concerns. Therefore, this situation makes mobile application design more complex. As a result of the design concerns that have arisen, efforts have also gained momentum to ensure that mobile applications are user-friendly and that the service offered can be used with maximum efficiency by users (Jokela et al., 2006). Focusing on usability is the key to produce high-quality and user-accepted mobile applications. Usability is defined as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" in the current version of ISO 9241-11 (2018). According to this definition, usability focuses on the results of the user's interaction with the system, product or service to achieve a specific purpose (ISO 9241, 2018). The research field that concentrates on the design of user centered products and carries out studies in this field is called usability engineering (Nielsen, 1993). Since each system, product or service mentioned in the usability definition has different features, the usability of each is affected by different features. Therefore, when it is desired to measure usability, first of all, the attributes that affect the usability of that system, product or service should be determined.

Some of the studies on mobile application usability have been carried out by using attributes that affect the usability of websites or by trying to adapt website usability characteristics to mobile applications (e.g., Venkatesh and Ramesh, 2006). However, the fact that the physical structure and usage environments of mobile applications are significantly different from websites means that the attributes that affect their usability may also be different. Another part of the studies on mobile application usability has focused on only one mobile application type and examines the usability attributes specific to that type (Tsang et al., 2004; Xu et al., 2008; Osman et al., 2010; Redondo et al., 2015; Abubakar et al., 2016; Kaur and Haghighi, 2016; Fang et al., 2017; Jung, 2017). However, it is not practical for mobile application developers to examine different guidelines and apply the principles to the specific system. In particular, the literature investigating the factors affecting mobile application usability and offering a holistic perspective on mobile application usability is limited (Venkatesh and Ramesh, 2006; Hoehle and Venkatesh, 2015; Hoehle et al., 2016). Therefore, there is a need for comprehensive studies that specifically investigate and present the features that affect the usability of mobile applications and that can be applied to all mobile application types.

In this study, a comprehensive guideline containing a set of usability attributes has been created that can both guide mobile developers to develop user-centered mobile applications and measure the usability of developed or currently used mobile applications. A systematic survey instrument development methodology was followed to develop a survey instrument to measure mobile application usability. Apple's human interface guidelines (Apple, 2022) were used as the primary source to conceptualize the mobile application constructs with the open codes and also the literature was examined in detail in the conceptualization stage. The initial version of the survey items was obtained by examining the open codes and the literature in detail. The survey instrument was screened by performing a face validity check, a pilot study and a content validity check, respectively, in order to understand whether there were any obscure, ambiguous or unnecessary items among the items created. Finally, the reliability and validity of this developed instrument have been verified with mobile application users.

2. LITERATURE REVIEW

2.1 Usability

One of the most accepted definitions of usability was made by Nielsen in 1993. In this definition, Nielsen discussed usability in five dimensions: learnability, efficiency, memorability, errors and satisfaction (Nielsen, 1993). ISO 9241-11 defines usability as "*the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*" (ISO 9241, 2018). This definition is both frequently used in the literature and appears as a standard definition of usability (Jokela et al., 2003). In the design of a successful and usable system, product or service; the user, task, tool and environment elements, which are also present in ISO's definition, cannot be considered independently from each other. These four elements are considered as essential in HCI (Shackel, 1991 as cited in Coursaris and Kim, 2006), are dynamic and interact with each other (Shackel, 2009). The use of this standard definition provides consistency between usability measurement studies in the literature (Brereton, 2005). Hence, the three most frequently encountered measures were found to be effectiveness, efficiency and satisfaction in the study of Coursasis and Kim's (2006) mobile usability literature review.

The usability theme has brought with it the notion of user-centered design (UCD), which focuses on the user in design, along with a series of design principles (Jokela et al., 2003). These principles are also the cornerstone of usability engineering (Nielsen, 1993). The ISO 13407 standard is an important internationally valid standard created to guide designers in the user-oriented design of interactive systems and the planning of these design processes (ISO 13407, 1999; Jokela et al., 2003). UCD aims to provide user satisfaction while providing an effective and efficient use by integrating human factors and ergonomics into the design (ISO 13407, 1999). The UCD approach provides a perspective based on the analysis of user needs and reciprocal development by performing repetitive tests with users instead of presenting a specific procedure for the design of a system, product or service (Baek et al., 2008).

2.1.1 Methods for evaluating usability

The number of studies evaluating mobile applications continuously increases (Zahra et al., 2017). Nielsen (1994) examined the evaluation methods followed reveal and detect usability problems in four main categories. These are respectively automatic methods (i.e., measurements made on the interface using some programs), empirical methods (i.e., tests performed by interacting users with the interface), formal methods (i.e., measurement of usability with specific models and formulas) and informal methods (i.e., evaluator's assessment with a set of predetermined practical rules).

User testing is one of the most basic evaluation methods as it provides a perspective of the user's interaction with the product, reveals the challenges that occur in this interaction, and is applicable throughout the life cycle of related product (Nielsen, 1993; Matera et al., 2006). Since usability is strongly tied to the user and the user's context, user testing is important in usability evaluation. However, performing user tests requires more time and budget compared to other methods. In such cases, using less costly informal techniques provides convenience to developers in terms of both time and budget (Nielsen, 1994). Informal methods, on the other hand, are based on the knowledge and skills of people who work in the field of usability and specialize in this field. These methods usually rely on experts examining the interface and identifying usability problems using a predetermined set of heuristics (i.e., usability principles (Nielsen, 1993; Tan et al., 2009). A heuristic evaluation study with a single expert participant has a limited ability for detecting usability problems. In studies with different expert participants, more usability problems can be detected than in studies with a single expert. Therefore, it would be useful for the researcher to conduct a cost-benefit analysis to determine the exact number of evaluators (Nielsen and Landauer, 1993).

Many studies in the literature compare user testing, heuristic evaluation and other evaluation methods (Jeffries et al., 1991; Nielsen, 1994; as cited in Tan et al., 2009; Doubleday et al., 1997; Liljegren and Osvalder, 2004). For example, Tan et al. (2009) conducted a study evaluating four websites with a scenario-based user testing methodology and a set of heuristics. According to the study results, two commonly used methods revealed different usability problems. Therefore, Tan et al. (2009) emphasized that these two methods cannot be used interchangeably and are needed in usability evaluations. As a result, there is no superiority among usability evaluation techniques. Different evaluation techniques can be used at different design stages and for different purposes (Tan et al., 2009). Moreover, combining different techniques produces the best results (Karat et al., 1992).

2.2 Mobile Application Usability

Many features are added into mobile applications as a result of the rising demand and frequency of usage. As a result, the design of mobile applications become more challenging by this growth. Due to the design challenges that have arisen, efforts have also accelerated to assure that mobile applications are user-friendly (Jokela et al., 2006). Due to the ever-changing characteristics of mobile devices, the field of evaluation study for mobile applications is likewise a field that is constantly evolving (Huang, 2019). Therefore, studies that can be used by mobile application developers during their initial design and creation stages, as well as to measure application usability, have gained momentum.

2.2.1 Evaluation of mobile application usability

Zhang and Adipat (2005) claimed that since mobile applications available on mobile devices differ from software available on desktop and other devices in terms of physical and usage environment, the same evaluation methodologies cannot be directly applied. As a result, they recommended that usability evaluation methodologies should be developed specifically for mobile applications. Similar to this, Bastien (2010) suggested that mobility should be considered in studies that assess the mobile application usability.

Comparatively speaking, each of the usability assessment techniques has benefits and drawbacks. Therefore, it is crucial that researchers and mobile application developers get informed with usability assessment techniques (Tan et al., 2009). The studies on mobile application usability that used these approaches will be mentioned in the following sections.

2.2.1.1 User testing for mobile applications

The user testing method, which is an empirical method, is basically carried out by users interacting with the mobile application interface (Nielsen, 1994). User testing can be carried out in a laboratory environment or remotely by assigning users predetermined tasks. As a result of the user interacting with the interface and carrying out certain tasks, some qualitative information about this interaction can be obtained, or the users' subjective opinions about the interaction can be gathered through methods like surveys and interviews.

Alturki and Gay (2017) claim that user testing conducted in a laboratory setting are more useful for identifying usability problems. Laboratory user testing produce more useful results with fewer participants. Moreover, laboratory settings are the only testing environments where data-gathering strategies like thinking aloud and observing are applicable. There is no other option except to rely on user opinions about the usability of the system evaluated when observation is not available (Sawhney and Schmandt, 2000). Alturki and Gay (2017) conducted a systematic experiment in laboratory settings to assess the usability of a mobile fitness application by considering all these advantages. The factors of "effectiveness, efficiency, satisfaction, memorability, errors, learnability, and cognitive load" were used to evaluate the application's usability (Alturki and Gay, 2017, pp. 111). They recorded the screens of the mobile devices throughout the tests for further analysis. Three times, at intervals of an hour and a week, participants interacted with the mobile application, completing fourteen tasks each time. The participants were expected to respond to the “single ease question (SEQ)” presented by Sauro (2010) to assess the satisfaction factor, and the “National Aeronautics and Space Administration Task Load Index (NASA-TLX)” questions presented by Hart and Staveland (1988, pp. 146) to assess the cognitive load factor after completing each session. Quantitative metrics, such as the number of errors and task completion time, were used to assess other usability factors. They concluded that the evaluated mobile application did not meet the expectations in terms of investigated usability factors. The authors noted the necessity for studies that gather qualitative data in this area in order to comprehend the user perspective. Therefore, it is recommended that studies based on quantitative measures produced in laboratory settings should be supported with qualitative user data. This viewpoint suggests that it would be advantageous to incorporate different usability evaluation methods.

In a similar way, Borys and Milosz (2015) set up a testing environment at a university laboratory and carried out user tests with eight participants over four scenarios. Throughout the experiments, a mobile eye-tracking device was used. This study allowed for the identification of several usability issues and assessment of metrics such as error rate and task completion time. Before and after the user tests, researchers also gathered qualitative data from participants to support the quantitative results. One of the most crucial outcomes of this study is the detection of significant usability issues in the mobile application under investigation. The developers of this application will be able to determine which aspects they should concentrate on to make the application more usable.

Haas et al. (2021) evaluated the usefulness of a mobile health application by assigning users a specified task and performing a semi-structured interview following user testing. The participants were directed to use a mobile application to share the results of their genetic tests with their family members. The purpose of these mobile applications is to warn at-risk family members and encourage them to take preventative action against genetic diseases. Following their interaction with the application, the users were requested to complete the “Post Study System Usability

Questionnaire (PSSUQ)” (Haas et al., pp. 2) for the purpose of assessing the usability of applications. Furthermore, 14 participants participated in an interview consisting of questions created in line with the study's goals by employing pilot studies. It was determined that the mobile application assisted the users in feeling more comfortable while carrying out the task given based on the test participants' comments. Moreover, improvements were made to the mobile application design to enhance usability taking into consideration all the data gathered. It has been concluded that the relevant mobile application is useful and beneficial in the research area, that is, in sharing the pathogenic test results with the family members of the application users.

As a result, user testing studies are extremely helpful since they enlighten the mobile application's usability from the user's perspective. Developers are capable of acquiring an understanding of the difficulty level of users' interaction with the mobile application by virtue of user testing (Zhang and Adipat, 2005). Additionally, this approach can connect users and mobile application developers, aiding in a better understanding of customer needs and leading to the development of applications that are more user-oriented (Borys and Milosz, 2015). However, there are also drawbacks to this approach. In spite of the fact that user tests usually need fewer volunteers, they require a considerable amount of time due to the length of the experiments (Borys and Milosz, 2015). In addition, the outcomes obtained from user tests are closely related to the user performing the test, the technology being utilized and the tasks assigned. However, they are not sufficient to provide a comprehensive perspective of the mobile application usability, even though they are helpful for understanding usability principles related to the tasks used in the user testing (Hoehle and Venkatesh, 2015).

2.2.1.2 Mobile Application Heuristics

Due to its simplicity and ability to detect a great number of usability issues quickly, heuristic evaluation is a common and efficient evaluation technique (Inostroza et al., 2012). Previous studies on mobile application usability have generally progressed through website usability heuristics and have ignored some physical characteristics of mobile devices, including their small screen size and some capabilities such as animated transitions.

Inostroza et al. (2016) presented 12 heuristics to fill this gap, which they called “SMArtphone's uSability Heuristics (SMASH)” (p. 41), for the usability of both mobile devices and mobile applications by using the 6-step heuristic development procedure proposed by Rusu et al. (2011). In fact, SMASH is a modification of the set of heuristics previously offered by Inostroza et al. (2012, p.665), known as “usability heuristics for Touchscreen-based Mobile Devices (TMD)”. As a result of the experiments, it was stated that SMASH is an effective tool that mobile application developers can benefit from. Dourado and Canedo (2018) conducted a SLR utilizing manual search and snowballing techniques, and they presented thirteen mobile-context-appropriate heuristics. They provided an explanation of the heuristics they proposed as well as their applicability to the mobile context. The most significant benefit that this study provides is the development of heuristics customized to the context of mobile applications. In addition, five metrics are proposed to assess the usability of mobile applications. A study was conducted using the developed heuristics and the findings showed that these heuristics are effective in detecting usability problems of mobile applications. Swaid and Suid (2018) focused on creating usability heuristics for a specific kind of mobile application, unlike prior studies. Based on the 10 heuristics developed by Nielsen and the usability guidelines presented by Google and Apple, 13 heuristics for the usability of mobile commerce applications are proposed in this study. In order to assess the performance of generated heuristics, a usability evaluation with four experts was conducted. Thus, this study is extremely useful for the mobile commerce application designers.

Huang (2019) conducted a systematic literature review (SLR) and presented seven heuristics regarding mobile application usability, namely "navigation, content, error handling, consistency, functionality, cognitive load and aesthetic design" (pp. 146-147). Usability features have also been created so that each heuristic can be better understood and internalized. Parente Da Costa et al. (2019) offered 13 heuristics and explained their benefits alongside the detailed definitions as a consequence of a SLR study. The primary goal of this study, which is a continuation of Dourado and Canedo's (2018) research, is to create mobile concept-specific heuristics. The study's main strength is the development of heuristics that emphasize the usability attributes in the model developed by Harrison et al. (2013) as well as the cognitive load that significantly affects the usability of mobile applications that is also emphasized in the study of Harrison et al. (2013).

The studies mentioned above have common benefits: they can both be used to assess the usability of existing mobile applications and provide suggestions to mobile developers on interface design. However, studies on usability evaluation utilizing the proposed heuristics can be conducted with individuals who have expertise in the field. In the current study, mobile application concepts with their open codes explain the significant factors in mobile application usability which also may show a way to the software developers during the development and evaluation phases of mobile application.

Table 2.1 summarizes above mentioned studies, their research techniques, and presented heuristics that were generated for mobile application usability.

Table 2.1: Heuristics previously proposed in the literature for mobile usability.

Study	**Methodology**	**Mobile Application/ Mobile Device**	**Heuristics**
Inostroza et al. (2012)	6-step procedure proposed by Rusu et al. (2011)	Touchscreen Based Mobile Devices	"Visibility of system status, Match between system and the real world, User control and freedom, Consistency and standards, Error prevention, Minimize the user's memory load, Customization and shortcuts, Aesthetic and minimalist design, Help users recognize, diagnose, and recover from errors, Help and documentation, Physical interaction and ergonomics" (pp. 664-665)
Inostroza et al. (2016)	6-step procedure proposed by Rusu et al. (2011)	Mobile Device&Mobile Application	"Visibility of system status, Match between system and the real world, User control and freedom, Consistency and standards, Error prevention, Minimize the user’s memory load, Customization and shortcuts, Efficiency of use and performance, Aesthetic and minimalist design, Help users recognize, diagnose, and recover from errors, Help and documentation, Physical interaction and ergonomics" (pp. 44-51)
Dourado and Canedo (2018)	SLR	Mobile Application	"Visibility of system status, Correspondence between the application and the real world, User control and freedom, Consistency and standards, Error prevention, Minimize user memory laod, Customization and shortcuts, Efficiency of use and performance, Aesthetic and minimalist design, Helping user recognize, diagnose and recover from errors, Help and documentation, Pleasant and respectful interaction with the user, Privacy" (pp. 489-492)
Swaid and Suid (2018)	An Integrated Approach	Mobile Application	"Visibility, Matching-Real-World, User-Control, Error-Prevention, Recognition, Flexibility-and-Efficient Use, Minimal Design, Diagnose-and-Recover, Help, Performance, Information–and-Visual-Hierarchy, Natural-Interaction, Dynamic-Engagement" (pp. 79)

Table 2.1 (cont.): Heuristics previously proposed in the literature for evaluating mobile usability.

Study	Methodology	Mobile Application/ Mobile Device	Heuristics
Parente Da Costa et al. (2019)	SLR	Mobile Application	"Visibility of system status, Correspondence between the application and the real world, User control and freedom, Consistency and standards, Error prevention, Minimize user's memory laod, Customization and shortcuts, Efficiency of use and performance, Aesthetic and minimalist design, Help users recognize, diagnose, and recover from errors, Help and documentation, Pleasant and respectful interaction with the user, Privacy " (pp. 116155-116159)
Huang (2019)	SLR	Mobile Application	"Navigation, Content provision, Error handling, Consistency, Functionality, Cognitive load, Aesthetics design" (pp. 146-147)

2.2.1.3 Models and Formulas for Mobile Application Usability

In the literature, specialized models have been created that consider the constraints of mobile applications and the characteristics of user interaction.

Condos et al. (2002) identified a variety of usability problems such as labelling and poor connectivity as a consequence of their survey and user testing on m-commerce applications. Then, they established ten usability principles that address most of these problems. Examples of real usability problems related to the principles are provided in the developed model, along with solution strategies of these problems. This is regarded as the model's most significant contribution to the literature and mobile application developers. Hussain (2012, pp. 57-58) created the "Mobile Goal Question Metric (mGQM)" model in a different study by specifically applying the "Goal Question Metric (GQM)" approach to mobile applications. After conducting a comprehensive literature review, the quantitative and qualitative usability metrics in this model were created by first defining the goals and then the usability metrics. Hussain (2012) assessed the usability of four mobile applications. The results indicated that the model was successful in evaluating mobile application usability. Additionally, as a result of this model's comprehensiveness, it is anticipated that it can be adapted to operate in contexts other than the mobile context. Coursaris and Kim (2011) identified 31 application usability attributes by carefully examining the experimental findings reported in the literature. The developed model is quite detailed and appears to cover the unique characteristics of various kinds of mobile applications. However, the developed model has not been validated on any mobile applications, and its usefulness has not been confirmed. Baharuddin et al. (2013) examined previous studies using the content analysis technique to create 25 usability attributes, rank them according to importance levels, and then propose the top 10 attributes for assessing the usability of mobile applications. This model differs from other studies since it considers user characteristics, the physical environment, the technology being used, and the tasks being performed. Although this model is comprehensive, it fails to provide developers with guidance on how to assess a specific mobile application type.

Harrison et al. (2013, pp. 1), on the other hand, carefully examined the prior models created for mobile usability and offered a new model known as "People at the Center of Mobile Application Development (PACMAD)" that answers the issues that existing models do not cover. In this model, the "cognitive load" (Harrison et al., pp. 3) attribute is included in addition to the six attributes identified in the studies of ISO 9241 (2018) and Nielsen (1994). As a consequence of their literature review, Harrison et al. (2013) concluded that this attribute should be added to the model because it is addressed in almost a quarter of the studies assessing the usability of mobile applications. This model, however, does not include usability metrics. Saleh et al. (2015) extended the PACMAD model using the GQM technique to generate the model's usability metrics. As a result, the PACMAD model's applicability has been enhanced. Which questions and metrics mobile application developers should focus on have been clearly stated. This study also provided evidence of how the GQM model generates usability metrics.

Another expanded version of the PACMAD model was introduced by Saleh et al. (2017, pp. 72). The authors included "interruptability and simplicity" attributes to the new model, which they termed "Mobile Application Usability Evaluation Metrics (MAUEM)" (Saleh et al., 2017, pp. 71). They used the GQM technique to determine the metrics of the usability attributes in this study, and they also offer suggestions regarding how to measure these metrics. For instance, they proposed that the total time a participant spent on the help page to complete the assigned task can be used to assess the time spent for help measure of cognitive load attribute. The model is useful since it instructs mobile application developers and researchers on how to measure usability attributes in detail.

The proposed models are extremely useful for evaluating the usability of mobile applications since they consider the characteristics of mobile devices. However, these models need to provide guidance for understanding how to apply them to certain mobile application categories. As a result, by recognizing the potential audience and the unique characteristics of various mobile application categories, usability assessments can be conducted more efficiently (Zahra et al., 2017).

2.2.2 Investigating factors affecting mobile application usability

Studies examining the factors affecting mobile application usability in the literature have either concentrated on only a single metric or only a single type of mobile application. A few research studies have provided thorough guidelines focusing at the factors that affect mobile application usability.

Studies examining the impact of a single criterion on the usability of mobile applications have been conducted and are available in the literature. For instance, Osman et al. (2010) investigated the effects of screen transition and animation on the learnability and thus usability of mobile applications. Although the aforementioned study investigates the effect of the use of animation on screen transitions, which have been integrated into mobile applications in recent years, it does not provide a general perspective on mobile application usability. Such studies are effective studies examining the effect of this new feature on mobile application usability when mobile devices support a new technology, and its positive benefit to the literature is undeniable. However, due to their focus on a single criterion, they lack a holistic study of mobile application usability. Unlike such studies in the literature, the aim of this study is to provide mobile application developers with a comprehensive guide to mobile application usability.

Many of the other studies on mobile application usability in the literature focus on a single mobile application type. For instance, Xu et al. (2008) investigated the factors affecting attitude, hence intention, towards mobile advertising applications, Fang et al. (2017) investigated which criteria are important in the design of mobile travel applications, Abubakar et al. (2016) presented an intuitive evaluation method for m-banking applications and similarly Kaur and Haghighi (2016) presented a framework that can be used in the development and design of mobile health applications. These studies are quite important in that they provide customized, specific information about the usability of the type of mobile application they are considering. However, as with studies focusing on a single usability criterion, these studies do not provide comprehensive information on general mobile application usability. In other words, a criterion that is considered very important only for the application that is the focus of the study may be less important for another mobile application.

2.2.2.4 Instrument Development Studies for Mobile Application Usability

There are few studies that develop a comprehensive guide to measure mobile application usability, which is the main purpose of this study. The guide created by Venkatesh and Ramesh (2006) based on Microsoft usability guidelines was not originally created specifically for mobile application usability, but has been proven to be valid on both websites and wireless sites, wireless handheld devices. This study is a continuation of the work of Agarwal and Venkatesh (2002). Factors that differ between the web and wireless site usability have been reviewed using an instrument previously designed for the usability of websites. However, mobile application usability is very different from the usability of websites, given the capabilities of mobile devices. Therefore, it is necessary to work from start to finish focused solely on mobile application usability. Unlike Venkatesh and Ramesh (2006), the instrument to be prepared in this study focuses on mobile application usability from the beginning. There are only two studies that develop instrument on mobile application usability and take a holistic look at mobile application usability. One of these instruments was developed by Hoehle and Venkatesh (2015) by examining Apple's user experience guidelines, while the other was developed by Hoehle et al. (2016) by examining Microsoft usability guidelines. Hoehle and Venkatesh (2015) conducted a survey development study following the methodology presented by MacKenzie et al. (2011) while Hoehle et al. (2016) conducted a survey development study by following the methodology presented by Lewis et al. (2005). However, both instrument development procedures are similar, starting with the identification of constructs using the open and axial coding procedure of Corbin and Strauss (1990), continuing with the development of the instrument and ending with a series of validity analyses. Survey instruments developed in both studies have been proven valid and have been able to be a guide to mobile application developers. When the operating system of mobile devices differs, the experiences that can be made in the mobile application also differ. Therefore, these published guidelines for mobile application usability also differ from each other and it is useful to examine each one separately. For this reason, Microsoft and iOS usability guidelines have been previously examined in separate studies in the literature. However, the research based on Apple's user experience guidelines was carried out in 2015. Furthermore, it is apparent from the study's references that the researchers' last access to Apple's user experience guidelines was in 2012. As a result, the constructs for assessing the usability of mobile applications were conceptualized more than ten years ago. Considering the developing technologies, the development of the iOS operating system and mobile devices in this process, and the changes in Apple's user experience guidelines in this direction, the necessity of doing this study has arisen.

Android operating system and iOS operating system are the two most widely used operating systems. Although the number of mobile application downloads via Google Play is higher than the number of downloads using the App Store, the App Store platform is more capable of generating revenue (Ceci, 2023a; Ceci, 2023b). Therefore, the market share of both mobile application providers is significant. Since iOS is one of the widely used operating systems and there is a recent guideline (Kazdaloglu,

2021) developed based on Google's material design principles, Apple's human interface guidelines are selected as the main resource in this study.

2.3 Social Media Applications

Social media is one of the most widely used internet services and it covers a significant part of daily internet usage. According to Statista data, there are more than 4.26 billion social media users worldwide in 2021. Moreover, users spend an average of 144 minutes a day on social media and messaging applications (Dixon, 2022). One of the most important factors in social media having such an important place among all application types is that it appeals to a large part of the society and its usage area is quite wide. Stakeholders benefit from the power of social media for purposes such as providing coordination and informing the masses in many areas, from disaster management (Luna and Pennock, 2018) to interaction in health services (Grajales et al., 2014), from aid collection campaigns of non-governmental organizations (Albanna et al., 2022) to providing educational opportunities (Almutairi et al., 2022). Therefore, social media applications are beyond being a means of having a good time and sharing for individuals today (Kaplan, 2015). They are also a means of obtaining information and interaction. Moreover, it is an indispensable communication tool for companies and institutions to reach their target audience.

Participants in recent research conducted by Al-Shamaileh and Sutcliffe (2023) were questioned about their top four mobile applications at the beginning of the survey study. As a consequence, around 3 out of 4 respondents stated that their first preference was well-known social media applications while there are several other mobile application options, including banking, e-commerce, and communication. Moreover, social media applications comprised almost 65% of the users' second preferences. The demographics of the participants may have had an impact on this statistic, but it still demonstrates the widespread use of social media applications.

In brief, social media applications have a wide user base and have been adopted by a large part of society with different demographic characteristics. In this study, the target audience was determined as social media application users in Turkey in order to bring the surveys to the participants more quickly and efficiently.

2.4 Contribution to the Existing Literature

It has been stated before that all mobile application usability evaluation studies have advantages and disadvantages compared to each other. For instance, although user testing studies, which are based on users' interaction with the interface with a set of predefined tasks, are very useful in terms of taking the perspectives of users based on the interaction with the interface and making observations (Zhang and Adipat, 2005), the length of the experiments makes these studies impractical (Borys and Milosz, 2015). In addition, the findings obtained in user tests are closely related to the tasks. Therefore, while they help to understand the usability principles for tasks, they are not sufficient to provide a comprehensive view of mobile application usability. This study, on the other hand, provides a task-free, comprehensive perspective to mobile application developers as a conceptualization and survey instrument development study on mobile application usability. Another group of studies related with mobile application usability is heuristics for mobile application usability. The heuristic evaluation method is useful for its simplicity and for allowing a large number of usability issues to be identified quickly. In recent years, useful heuristic development studies have been carried out that consider the unique features and physical characteristics of mobile devices (Inostroza et al., 2012; Inostroza et al., 2016; Dourado and Canedo, 2018; Swaid and Suid, 2018; Parente Da Costa et al., 2019; Huang, 2019). However, the common drawback of the studies that develop heuristics is that the usability evaluation can only be carried out by experts. In this study, mobile application developers will be able to design more user-centered applications thanks to proposed set of open codes that define the conceptualized constructs, and even non-experts will be able to assess the usability of a mobile application with real users, thanks to the developed survey instrument.

iOS, Google, and Microsoft provide detailed guidelines that contain data about usability for mobile application developers. Nevertheless, these guidelines are impractical since they fail to highlight the most important features. For this reason, conceptualizing the factors affecting mobile application usability by analysing the information provided in these comprehensive guidelines is extremely helpful for mobile developers. This study has provided information that mobile application designers can use while designing new applications. They will also be capable of understanding which aspect they should concentrate on to improve the usability of existing mobile applications. Furthermore, researchers will be able to efficiently and practically evaluate a mobile application's usability. In this direction, conceptualization and survey instrument development studies have been carried out in the literature. The first of these studies was conducted by Hoehle and Venkatesh (2015) by examining Apple's user experience guidelines, the other was conducted by Hoehle et al. (2016) by examining Microsoft usability guidelines, and the last one was conducted by Kazdaloğlu (2021) by examining Google's material design guidelines. Although there is a current study on the usability of mobile applications in the Android operating system, which is one of the two operating systems that dominate the mobile application market (Taylor, 2023), there is no current study on the iOS operating system. However, Hoehle and Venkatesh (2015) recommended that as mobile application providers publish updated guidelines, conceptualization and survey instrument development studies should be repeated. Thus, these studies must be updated and carefully follow technological improvements, as suggested by Hoehle and Venkatesh (2015). A conceptualization and survey instrument development study based on current Apple human interface guidelines will be introduced to the literature as an outcome of this research. In addition, it will be a comprehensive guide for mobile application developers that considers the latest characteristics of mobile devices.

3. METHODOLOGY

The methodology to be followed in this study is based on the 3-step construct development procedure of Lewis et al. (2005) and the 10-step construct measurement and validation procedure of MacKenzie et al. (2011). In the first stage of this comprehensive and hybrid methodology to be followed, the content in the human interface guidelines (Apple, 2022) presented for mobile developers on Apple's official website will be analysed line-by-line, using the open and axial coding procedure in Corbin and Strauss's (1990) Grounded Theory, and thus constructs will be conceptualized. Apple’s human interface guidelines to be used in this study consists of 9 categories and 83 sub-categories and provides detailed, comprehensive technical information about mobile application design principles, quality and functionality. In addition, this theoretical information presented was supported by visuals and a User Interface Kit (UIKit) was presented that developers can refer to at any stage of the design.

In the survey instrument development stage, which is the second stage of the study, items will be created by using the open codes obtained in the first stage and benefiting from the literature. Then the instrument will be developed by performing face validity check, pilot study and content validity check, respectively.

At the third stage, explanatory and confirmatory assessments will be carried out to prove the reliability and validity of this newly developed scale, and finally the survey instrument will take its final validated form.

3.1 Construct Domain Development

The first step in the scale development procedures presented by both MacKenzie et al. (2011) and Lewis et al. (2005) is the conceptualization of the constructs. At this stage, the sources to be taken as a basis are systematically examined by the researcher. These sources may be previous studies on the subject of interest in the literature, developed guides, or a wide variety of sources such as case studies and interviews (Lewis et al., 2005). Content analysis of these selected sources can be done using various methods. One of these methods is Corbin and Strauss's (1990) open and axial coding procedure, which will also be used in this study. According to this method, the researcher first codes the source by analyzing it line-by-line. The process of grouping these codes by examining the similarities and differences and creating categories and subcategories is called open coding (Corbin and Strauss 1990). Axial coding is the axial association of the created categories with their own sub-categories (Corbin and Strauss 1990). Open codes and associated categories, which are the output of this stage, are used as the basic input of the next stage, the survey instrument stage.

After the constructs are defined, if necessary, higher order constructs, namely multidimensional constructs, are conceptualized. Multidimensional higher-order constructs are created by combining several different but closely related constructs under one roof (Law et al., 1998). At this stage, researchers can benefit from previous studies in the literature as well as refer to the opinions of experts in the field of interest by card sorting method, as Hoehle and Venkatesh (2015) have done. The constructs created at each higher-order construct creation stage are questioned whether they represent a unique part of the underlying structure of interest, and if this is satisfied, the higher-order construct creation process ends (Hoehle and Venkatesh, 2015).

3.2 Survey Instrument Development

The second step in the scale development procedures presented by both MacKenzie et al. (2011) and Lewis et al. (2005) is the creation of survey items. The initial item pool is created by making use of the related literature and the open codes and extracted by content analysis in the previous stage. This initial item pool needs to be purified and validated by going through some steps. These steps to be followed in order to ensure the validity of the survey instrument are face validity check, pilot study and content validity check, respectively.

3.2.1 Face validity check

Before moving on to concepts such as face validity and content validity, it should be understood what validity is. Validity was defined by Kerlinger (1973) in a question: "Are we measuring what we think we are measuring?" (p.457).

In order for the prepared questionnaire to be easily answered by the participants, to reduce the error in the data collected through the questionnaire and to maintain the content validity of measure instrument, some pre-tests should be carried out. The first of these pre-tests is the face validity check, which is carried out with people who have knowledge about the subject studied (Lewis et al., 2005). The face validity check stands out with its practicality, so it is a method that can be used when one wants to see how well the measure instrument seems to measure what it is intended to measure because "it should not only be valid but it should also appear valid" (Mosier, 1947, p.192).

3.2.2 Pilot study

The pilot test is a trial study that should be done with the target user after the face validity check phase to clear of the items from the ambiguity (Lewis et al., 2005). This phase is very useful in getting the opinions and suggestions of the target user about the instrument and provides the researcher with important clues about how the item statements in the survey instrument should be arranged so that it can be understood by all the participants efficaciously.

The pilot study, which is frequently encountered as pre-test in the literature, is very important phase that allows the design features of the survey instrument such as response alternatives and skip patterns to be regulated, and thus minimizes the error of non-response of the participants (Bolton, 1993). Therefore, while measuring the intelligibility of the survey statements to the target user, missed details about the structural design of the survey instrument can also be caught and these errors can be corrected before data is collected with more users.

3.2.3 Content validity check (item screening)

The concept of validity was already defined in section 3.2.1. After looking at how well the measure instrument appears to measure what is intended to be measured in face validity check, statistical support for content validity is also required. This phase is done with more people than face validity check and there is no need for the participants to be experts.

Although there is no consensus in the literature on which method should be performed for content validity analysis, Strauss et al. (2004) argue that this analysis is not obligatory but highly suggested. One of the procedures frequently used in the literature for content validity check is suggested by Lawshe (1975). According to this procedure, participants are asked to evaluate the relationship of each item to each construct as "Essential", "Useful but not essential" or "Not necessary" and then the content validity ratio (CVR) of each item is calculated with the following equation (3.1):

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \tag{3.1}$$

where n_e is the number of participants indicating the item as “essential” and N is the total number of participants (Lawshe, 1975). Lawshe (1975) presented minimum threshold values with 95% confidence based on the number of participants. For example, if the number of participants is 10, the minimum value of the CVR must be 0.62 for an item to be accepted.

Another procedure frequently used for content validity check in the literature is the procedure proposed by Anderson and Gerbing (1991), which assumes that each item represents a single construct. They proposed two indices named p_{sa} and c_{sv} which you can see their formulations in equation (3.2) and equation (3.3), respectively.

$$p_{sa} = \frac{n_c}{N} \tag{3.2}$$

$$c_{sv} = \frac{n_c - n_0}{N} \tag{3.2}$$

where n_c nc is the number of participants who assigned the item to the relevant construct, n_0 is the highest number of assignments of the item to any other construct and N is the total number of participants. p_{sa} takes values between 0 and 1 and c_{sv} takes values between -1 and 1. Greater values indicates greater substantive validity. In addition, if the c_{sv} value is found to be a large negative value in absolute value, it is concluded that the item has substantive validity but belongs to another construct, not the construct that the researcher matched. In such a case, the construct definitions should be reconsidered (Anderson and Gerbing, 1991).

3.3 Evaluation of Measurement Properties

According to Lewis et al. (2005), explanatory and confirmatory factor analysis studies should be carried out, respectively, with different samples to be collected from the target audience using the developed survey instrument in order to evaluate the measurement properties. Finally, more evidence for the validity of the newly developed instrument is provided by performing the nomological validity analysis, which is also referred to as the related variable analysis in the literature (Lewis et al., 2005).

3.3.1 Exploratory assessment

Lewis et al. (2005) stated that for the first stage analysis, a representative sample of the main population should be collected using the instrument, which is revised and updated after the content validity analysis. In order to be able to argue that the collected sample is a qualified sample, it should be evaluated from the following aspects (Lewis et al., 2005): The response rate should be more than 20% (Malhotra and Grover, 1998), the subject-to-item ratio should be at least 5 to 1 (Hair et al., 2010), and the collected sample should sufficiently represent the main population (Lewis et al., 2005). If the data satisfies these requirements, appropriateness for factor analysis is examined. Accordingly, it is determined whether Barlett sphericity test is significant and Kaiser-Meyer-Olkin (KMO) test satisfies the threshold value of 0.5 (Hair et al., 2010). Afterwards, factor analysis is performed and factor structures are discovered. It is determined whether each item belongs to the intended factor by checking loading values. Items are eliminated from the item pool if their loading value is less than the threshold value.

Finally, internal consistency of each factor is examined. Reliability analysis can be performed by calculating Cronbach's (1951) internal consistency for each construct as suggested by MacKenzie et al. (2011).

3.3.2 Confirmatory assessment

A different random and qualified sample representing the main population should be collected for the second stage confirmatory analysis with the revised and updated instrument according to the first stage exploratory analysis results (Lewis et al., 2005). First of all, using the collected sample data, the multivariate normality assumption, which is one of the confirmatory factor analysis assumptions, should be questioned by examining the mean, skewness and kurtosis coefficients, which are univariate normality indicators for each variable (Hair et al., 2010; Lewis et al., 2005).

Subsequently, convergent and discriminant validity are checked, respectively, and the goodness-of-fit values of the measurement model created by considering the factor structure discovered in the first stage are checked. Then, it is determined whether the standardized factor loads are greater than the 0.7 threshold for convergent validity (Hair et al., 2010). The statistical significance of each standardized factor loading indicates that each item belongs to relevant construct (Bagozzi et al., 1991). The average variance extracted (AVE) values of the constructs are compared with 0.5, the threshold recommended by Fornell and Larcker (1981), and the composite reliability (CR) values are compared with 0.6, as suggested by Diamantopoulos and Siguaw (2020 as cited in Altin Gumussoy, 2016). Finally, for internal reliability, Cronbach's alpha values are compared with the threshold value of 0.7 suggested by Fornell and Larcker (1981). The discriminant validity of the constructs in the model can be tested with the Fornel-Larcker criterion. According to this method, all AVE values must be greater than the correlation values below it, that is, the correlation of the relevant construct with other constructs (Fornell and Larcker, 1981).

The nomological validity analysis is the last step in the validity assessment of conceptualized constructs. In this regard, structural model consisting of variables that are thought to be theoretically related to the developed instrument is established, and both the relationships between the variables and the significance of the model are tested (Lewis et al., 2005).

4. RESULTS

In this section, a conceptualization and scale development study for mobile application usability was carried out by following the comprehensive and hybrid scale development procedure presented in the methodology section. For this, first of all, constructs that represent mobile application usability are conceptualized. Afterwards, the survey instrument was constituted by following the survey instrument development steps. Finally, the measurement properties of the developed survey instrument were evaluated in two stages with explanatory and confirmatory analyses.

4.1 Construct Domain Development

The main resource that will be subjected to the Corbin and Strauss’s (1990) open and axial coding procedure and to be used as raw data in this study is the human interface guideline (Apple, 2022), which is a comprehensive guide for mobile application developers published on Apple's official website. In order to conceptualize the constructs, as stated in the methodology stage of the study, the guideline, which was taken as the main source, was examined line by line and open codes were derived. This matrix, consisting entirely of qualitative data, was prepared in line with Miles and Huberman's suggestion, and the information was summarized in a systematic way, so that the information could be handled as a whole, to facilitate the researcher while analyzing and to draw meaningful conclusions (Miles and Huberman, 1994). After the first open code matrix was created, it was re-examined eight more times and open codes and constructs were finalized by applying open and axial coding procedures. Accordingly, categories and sub-categories of these categories were created, and open codes were assigned to these sub-categories according to their similarity/difference using axial coding. At this stage, while the open codes were finalized and the constructs were created, the ideas of a total of 3 information systems (IS) researchers, an associate professor, an assistant professor, and a research assistant with a doctorate, were taken.

The finalized open code matrix is given in Table A.1. The first column of the table represents axial codes, the second column represents sub-categories, and the third column represents open codes. There are 16 axial codes, 29 sub-categories and 92 open codes in the finalized open code matrix. In the following sections, the 16 constructs created will be conceptually defined and their relations with the previous literature will be discussed. The intersection between the constructs conceptualized in this study and previous studies is demonstrated in Table B.1.

Instant start

It is very important for users that the launch experience, which is the initial engagement that users will have with the mobile application, takes place smoothly and quickly. In the past, excessive page loading time was largely due to slow internet and personal computers. However, nowadays, these problems have been overcome to a large extent, and even though the internet speed and the capabilities of personal computers have increased, loading times are still a trouble for websites and mobile applications that work with low performance (Whitenton, 2020; Galletta et al., 2006).

Whitenton (2020) argues that the ideal load time should be sub-second. To give a striking example on this issue, in a study conducted by Google, Global Product Lead An (2018) proved that if the page loading time is between 1-3 seconds, the rate of users leaving the mobile site increases by 32%. If it is in the range of 1-10 seconds, this rate has increased by 123%. This and similar studies prove that mobile applications should display the initial screen as soon as possible and allow the user to interact with the application quickly.

On the other hand, it is not enough to open the mobile application interface quickly. The application provides the user with a fast and smooth authentication experience, enabling the user to interact with the application interface as soon as possible. The fact that authentication methods give importance to usability as well as security is very important in the first interaction of the user with the mobile application (Allen and Komandur, 2019). Apple's human interface guidelines (Apple, 2022) recommend delaying authentication as much as possible unless the user's action explicitly requires authentication. Accordingly, the user should be able to navigate the application interface comfortably without being forced to authenticate. Guidelines state that mobile applications must support the Sign in with Apple option, which provides users with a simple and quick authentication when authentication is explicitly required. Support for this feature by mobile applications provides users with a single, consistent, basic and quick authentication experience. The mobile application should provide services that facilitate data entry, such as automatic password filling, displaying keyboards feasible for data type when the user chooses other authentication methods (Apple, 2022). Although more secure authentication options arise than the classical method, such as biometric authentication, these methods may be more difficult as users are familiar with logging in with the classical method (Allen and Komandur, 2019). Therefore, the increase in authentication options has brought the need for usability studies in this field. In this direction, the existence of studies on the relationship between authentication and usability is striking (Keith et al., 2007; Mihajlov et al., 2011; Schlöglhofer and Sametinger, 2012; Allen and Komandur, 2019; Wu et al., 2020; Mishra and Dutta, 2022; Marasco et al., 2022).

In summary, the instant start concept in this study advocates the necessity of both a fast and smooth launching experience and a fast and easy authentication. In this respect, the construct differs from other studies in the literature that discuss this conceptual structure (Hoehle and Venkatesh, 2015; Abubakar et al., 2016; Whitenton, 2020; Galletta et al., 2006).

Branding

The concept of branding, which is covered under the Visual Design heading in Apple's human interface guidelines, is basically that a mobile application provides its users with a smart and brand-reminiscent application design through brand-specific font, colors, icons, and other visual elements. In addition, it is argued that this branding approach should be integrated into the design in a simple and smart way, without going overboard.

Positive and negative thoughts that occur in the minds of users about the brand stay in their memories for a long time (Keller, 1993) and affect their trust in the brand (Lowry, et al., 2008). Therefore, it is essential for successful mobile application brands to create a positive brand image in the minds of their users. This brand image can be formed in the minds of users in two ways: Indirectly, through the transfer of other users' own experiences and thoughts, and directly through users' own one-to-one experiences (Dubberly, 2000 as cited in Rondeau, 2005). The concept of branding in this study includes the directly created brand perception described here. In other words, color, font, logos, glyphs and other visual elements in the mobile application interface can be used to both create brand awareness and increase usability (Rondeau, 2005). These visual elements and visual design, which are used wisely for branding, also affect the perceived usability (Kurosu and Kashimura, 1995). In this respect, it has been a frequently examined concept in usability studies.

In addition, it has been proven that mobile applications affect user attitude towards the brand itself (Bellman et al., 2011). In the study of Bellman et al. (2011), it has been shown that positive mobile application experiences increase users' desire for the brand and even positively affect the willingness to purchase the brand's products. Moreover, it is stated that this positive effect is even greater if the applications are user-oriented and a connection is established between the user and the brand during the user experience (Bellman et al., 2011). This can only be achieved by supporting the user's interaction with the mobile application by using components such as recallable colors and visual elements representing the brand through the mobile application interface. The concept of branded mobile application, which has been frequently used in the literature in recent years (Bellman et al., 2013; Kim et al., 2013; Peng et al., 2014; Wu, 2015; Zhao and Balagué, 2015; Alnawas and Aburub, 2016; Van Noort and Van Reijmersdal, 2019; Wang, 2020), has been defined by Bellman et al. (2011) as mobile applications that constantly present branding elements such as the brand logo and brand icons throughout the interface and thus reflect the brand identity. Branded mobile applications, which provide a strong bond between the user and the brand, also affect the attitude of the users towards the relevant brand and mobile applications and their preference for continuous usage (Peng et al., 2014; Wu, 2015).

In brief, branding aims to integrate the visual elements that are in the permanent memory of the users and remind the brand into the mobile application design wisely and without exaggeration, thus making a positive association with the brand in the minds of the users and making a positive contribution to the perception of usability and the preference of the mobile application.

Orientation

The notion of orientation, which is discussed under the heading of "adaptivity and layout" in the Apple human interface guidelines, arose from the desire of users to interact with the mobile application seamlessly regardless of the usage environment. Users should be able to clearly see the content on the screen and interact with the mobile application whether they hold the mobile device in portrait or landscape configuration (Apple, 2022).

The fact that mobile devices are easily carriable allows them to be used in all kinds of environments and conditions, even while traveling. Therefore, these various usage environments and conditions should be taken into consideration in the design of mobile applications offered for use with mobile devices (Wobbrock et al., 2008). Under all conditions, users should be able to engage with the mobile application and successfully take use of its potential without encountering any issues. Using horizontal orientation in addition to portrait mode enables for more information to fit on the screen, especially on mobile devices with small screens. In addition, the user doesn't have to scroll on the application screen to access more information (Sanchez and Branaghan, 2011). Scrolling on a screen is a circumstance that limits a user's performance on difficult activities and increases the time it takes to access information (Sanchez and Wiley, 2009). The resolution and content quality must meet the requirements for both landscape and portrait mode. Thus, the mobile application users have a better viewing and browsing experience (Gardner, 2011). The usability of mobile devices is also positively impacted by screen rotation, as has been previously mentioned (Cheng et al., 2013). Mobile applications should therefore be capable of fulfilling the demands of all users, given that grasping habits differ from person to person (Cheng et al., 2013).

Orientation is conceptualized as ‘the ability to access equally well the content in the mobile application, regardless of whether the user is holding it in landscape or portrait orientation’.

Collaboration

People generally tend to share with others what is important to them. For this reason, mobile applications should also allow users to share information with other social media accounts or other channels, thus allowing users to communicate with each other (Apple, 2022).

Mobile applications should be in active communication and interaction with their users, rather than a one-way communication, just like the marketing engagement strategies of other companies. In addition to the communication between company and the user, mobile applications should also attempt to strengthen the communication among the users. Thanks to this collaboration, mobile application companies can better analyze users' perceptions of the mobile application and the services it offers, and analyze the weaknesses that need to be developed (Gill et al., 2017). Furthermore, according to Swaid and Suid's (2018) interpretation of the "dynamic engagement" (pp. 83) heuristic, which is one of the 13 heuristics they have developed for mobile commerce applications, the user must be able to communicate with the application as well as with other users. The mobile application can therefore respond to the user's requests more efficiently.

As a consequence, collaboration is defined in this study as ‘the capacity of mobile application users to share information with other apps, to communicate with other users and the application itself’.

Content

It is particularly crucial for mobile apps that the material in the interface be appropriate, current and helpful for the target audience, since this has been shown to improve website usability (Agarwal and Venkatesh, 2002) and customer loyalty (Mithas et al., 2006). To avoid confusing the user when they navigate the mobile application interface, it is essential that all of the content on the page is appropriate for their expectations and the task they want to perform. In this study, personalization of mobile application content based on the user and the capability of the user to customize the content according to his/her preferences are also taken into consideration as sub-categories in addition to content relevance.

According to Venkatesh and Agarwal (2006), personalizing the content to the user enables them to obtain the content more quickly and easily. This concept is regarded as a sub-category of the content in this study and is included in many usability studies under the term of personalization in the literature (Baek and Yoo, 2018; Haghirian et al., 2005; Agarwal and Venkatesh, 2002). According to Apple's (2022) human interface guidelines, mobile applications should emphasize the content that users care about. The information and content presented should be up to date and beneficial to the user. Moreover, the user experience should be enhanced by using the user's past behavior and the personal details they permit. This feature makes the content that users might wish to revisit more visible and removes the need for users to keep track of how to access the content they are interested in (Fuller-Tyszkiewicz et al., 2018).
Lastly, mobile applications allow the user to customize the application as much as possible, letting them alter the app's features and content to fit their requirements and interests (Mirkovic et al., 2014). As a result, the content utilized in the mobile application needs to be appropriate for the context, up to date, beneficial to the user, and personalized for the user. In addition, the user should be able to customize the content that is given to him as far as the mobile application permits. In this study, the content is conceptualized as ‘providing the user with content compatible with the context, useful for the user, personalized according to the previous preferences of the users, and allowing the users to customize the content in the mobile application according to their own preferences as much as possible’.

Search

In order to help users in navigating the user interface, the search feature is crucial (Tung et al., 2009). One-third of users prefer the search function over using the menu while navigating, according to Cox and Dale (2002). This demonstrates the significance of the search function in navigation.

After interviews with twenty web designers, Tan et al. (2009) identified fourteen criteria that have to be considered while designing business to consumer websites. Usage of search engines and the evolution of search functionalities is one of the topics covered in navigation domain. It is emphasized how crucial it is for websites to have a good search function. It has been argued that this could possibly be accomplished by offering hints and keywords that will simplify the task for visitors to find the content they're looking for. Koufaris (2002) investigated whether value-added search mechanisms affect online consumers' perceptions of control, shopping pleasure, and concentration. The results demonstrated that using a practical tool like a search function enhances customers' online purchasing experiences. To facilitate the search, the results of the search might, for instance, be sorted by relevancy (Tung et al., 2009).

In addition, providing the user with effective search features is important in order to provide users more control when they try to find information in the interface (Jarvenpaa and Peter, 1997 as cited in Koufaris, 2002). In order to provide the user more control during the search, they should additionally be capable of terminating it at any point (Apple, 2022). In Apple (2022) human interface guidelines, the search bar is extensively covered, and helpful guidance is provided on how to use the search engine in the user interface design of mobile applications.

As a result, the search notion discussed in this study is conceptualized as ‘mobile applications should provide a standard search bar, provide features that will facilitate the search for the user’.

Privacy

Users' personal information may be required by mobile applications for a variety of valid purposes (Enck et al., 2014). For instance, a food ordering application could use the user's location to bring up a list of the nearby restaurants. However, users desire to feel confident that their personal data is utilized appropriately and is not given to outside parties (Enck et al., 2014). Mobile applications must get the user's permission before accessing personally identifiable information, but choosing the correct method to do so is crucial to avoid disturbing the user.

The application should not be prompted the first time the application is launched, unless it explicitly requires information that personally identifies users, such as location or health (Apple, 2022). In their study on Android mobile applications, Kelley et al. (2012) found that the displaying of the permission window immediately after installation, before the user interacts with the application, frustrates users. People might be concerned about engaging with a mobile platform if they have privacy concerns, making it difficult for them to perform out their targeted tasks (Chin et al., 2012). According to findings Chin et al. (2012) obtained through in-depth interviews with 60 smartphone users, people specifically avoid using their smartphones for sensitive tasks such as tasks involving identification numbers or financial transactions. However, they also stressed how effectively designed interfaces may considerably address this problem. With mobile shopping applications, for instance, customers' worry might be decreased by notifying them that their personal information is not stored. Mobile applications should politely and respectfully clarify to users why they should give personal details and request their approval. However, they shouldn't be forced to provide permission during this request so that they don't experience stress. In addition, allow choice shouldn't be highlighted (Apple, 2022).

The notion of privacy is defined in this study as ‘the mobile application asks personal data from the user in a pleasant and appropriate way when obviously needed, and notifies the user by clearly indicating the reason asking request’.

Graphics & animations

Aesthetic graphics, which appear as a hedonic component, not only improve the user's experience with mobile applications, but they have also been shown to have a beneficial impact on perceived usefulness and ease of use (Li and Yeh, 2010). In some studies, this notion covers all design components (Schultz, 2005 as cited in Cyr et al., 2006), such as color, imagery, and writing style, whereas in others, it solely refers to well created, aesthetically pleasing graphics and images (Hoehle and Venkatesh, 2015; Hoehle et al., 2016). According to Apple's (2022) human interface guidelines, mobile applications need to provide users graphics that are both high-quality and high-resolution. It is also highlighted the need for all visual components (such as images, glyphs, icons, etc.) presented in the interface must be distinguishable in various interface modes such as light mode, dark mode.

According to prior studies, using multimedia elements will enhance users' dynamism, attention, and decision-making skills (Hess et al., 2005; Kisielius and Sternthal, 1984; McGill and Anand, 1989). Nevertheless, Hong et al. (2004) suggested that the impact of animations engaged on websites to attract users' attention is not adequately understood. Hong et al. (2004) studied about how flash animation affects users' focus. According to the findings of the study, although users may find components that employ flash to draw their interest more quickly and readily, recalling of the relevant item component is not increased by this approach, and it may even decrease recalling of other components in the interface. Furthermore, the unfavorable impact of flash animation on website usage sentiments has been revealed. Many studies indicate that the usage of animation enriches the user experience, but it shouldn't be used excessively.

Graphics and animations in this study are conceptualized as ‘the balanced use of high-quality graphics and subtle animations throughout the interface’ in accordance with Apple's (2022) human interface guidelines and relevant literature.

Realism

Using icons makes it simple to comprehend what is intended to be communicated immediately instead of reading the text. From the past to the present, different icon design approaches have been evolved. Throughout its development, the skeuomorph design concept outlined by Norman (1999, as cited in Urbano et al., 2020) had immense popularity. This perspective was based on icons that imitated physical items.

However, Apple began utilizing a flat and simple design approach with the release of iOS 7 in 2013. Apple's flat design offers an advantage over complex design in that users can concentrate and perform tasks in the interface, despite some studies criticizing flat design for neglecting the three-dimensional nature of items. Google (2014, as cited in Urbano et al., 2020) proposed the skeuominimalism concept in material design principles when this discussion was taking place. This approach promotes minimalist design for icons, simply like Apple offers, but inserts three-dimensional details to call attention to interactive components, for instance. It is commonly believed that realism should be integrated into icon design, even if the overall effectiveness of these three design ideas compared to one another over many criteria are still under debate (Urbano et al., 2020).

Yu and Fang (2016) stressed the significance of icon design, particularly for elderly individuals because they have less eyesight than younger people. Although the application icon has been specifically the focus of this study, other interface icons have characteristics in common with the application icon. The icons' meanings should be simple to comprehend and simple for users to remember (Yu and Fang, 2016). The human interface guidelines published by Apple in 2022 give major weight to this concept, which has previously been mentioned in several studies (Kang, 2007; Hoehle and Venkatesh, 2015; Hoehle et al., 2016). According to guidelines, an interface element or control should be supported by a realistic and clearly recognizable icon or glyph so that users can understand their meaning more effectively. These icons or glyphs should be realistic and consistent with their stated meaning in order to avoid confusing users (Apple, 2022). Furthermore, it has been demonstrated that complicated icons are challenging for users to understand, which has a detrimental impact on usability. An icon is more likely to be understood correctly when common metaphors are used (Gatsou et al., 2012).

The concept of realism described in this study as ‘the usage of realistic, credible and consistent visual components (images, icons, glyphs, etc.) with their suggested meanings that would enhance the understanding of interface elements and commands’.

Control obviousness & reliability

The controls on the user interface that users can interact with should be straightforward and intuitive, according to Apple's (2022) human interface guidelines. It should be simple to determine if the interface elements are interactive or not by using visual clues. Users should be able to interact with controls rapidly and easily, and damaging actions should be emphasized to prevent users from potential mistakes (Apple, 2022). In their study, Ji et al. (2006) stated that a weak scroll bar design example is not apparent to users at first glance and they offered a suggestion to enhance visibility of this user control mechanism.

Furthermore, while interacting with a control, the user should be able to easily understand which tab they are being directed to or which task to accomplish. Thus, the controls don't lead users to the incorrect tabs and actions (Apple, 2022). In order to make the meanings of the items on a menu explicit, Huang et al. (2006) have provided various labeling suggestions. In this way, users will be prevented from being directed to the wrong pages and they will be able to better understand what they will see when they click on an item. In this study, this concept describes that 'user controls in the interface should be easily understandable and reliable'. The conceptualized construct in this study indicates that controls should be reliable and always lead to the users' expected outcomes, in comparison to the studies conducted by Hoehle and Venkatesh (2015), Hoehle et al. (2016).

Effort Minimization

Bevan and Macleod (1994 as cited in Seffah et al., 2006) characterized usability as the user's ability to accomplish their goals through interaction with the interface with the minimum possible mental effort. The interaction between the user and the mobile application interface should be as simple and intuitive as possible in order for mobile applications to minimize the mental effort required from the user.

According to Fitts' law, how fast a task is accomplished is affected by many factors such as task difficulty, human performance, distance from the center of the target, and width of the target (Fitts, 1954). Accordingly, as the width of a target increases, the time taken to reach the target decreases. Considering this law for the interface of mobile applications, it can be said that having a sufficiently large tactile area in the application shortens the time required for the user to reach that target. Due to the limited screen size of mobile devices, the size of the buttons should also have a limitation. In the literature, this size has been considered as the fingertip size in many studies (Hoehle and Venkatesh, 2015; Hoehle et al., 2016; Bhullar and Singh Gill, 2019). The mental effort construct created in this study states that gestures should also be presented to the users in order to perform a task in addition to the requirement that the controls in the interface should be fingertip-sized. This construct underlines the necessity of using not only fingertip-sized controls but also gestures in order to perform a task in a mobile application, unlike the fingertip size construct in the study of Hoehle and Venkatesh (2015) and Hoehle et al. (2016). Considering the changing features of mobile devices, it should be taken into consideration that a user can perform a task by using finger movements, that is, gestures, as well as using fingertip-sized buttons to perform a task. Therefore, it was deemed necessary to include gestures in mobile usability studies.

One of the most effective ways to reduce the effort spent in a mobile application is to reduce the mental effort on the user during data entry. One of the most effective ways to reduce the effort spent in a mobile application is to reduce the mental effort on the user during data entry. This can be achieved in ways such as providing reasonable values to the user during data entry and showing the parameters. Thus, the user can easily enter data without having to think about the type of data to be entered, and typing errors can be prevented (Doherty and Kelisky, 1979). Further, the mobile application is intended to regularly preserve interface changes in order to prevent data loss in the case of an interruption. Thus, users can continue their experience from where they left off when they return to the application interface, (Apple, 2022). This will considerably minimize the effort required for users to return to the mobile application interface after interruptions. Lastly, mobile apps should be designed to correspond to users' expectations and habits, as stated in Apple's human interface guidelines (Apple, 2022). The necessity for settings is reduced with this strategy. Thus, users are not required to make a lot of adjustments with in mobile application. According to Jokela et al. (2006), the usability of the user interface is significantly impacted by the excessive number of tasks the user must complete, including in-app settings.

In brief, the notion of effort minimization is conceptualized as 'designing a mobile application interface in a way that minimizes the user's mental load during data entry, interaction with a control, and in all other use cases' in this study.

Consistency and standardization

Nielsen (1994), Dix et al. (1998 as cited in Ji et al., 2006), and many other usability studies have examined the concept of consistency. According to Tan et al. (2009), the navigation menu, visual components, colors used in the interface, and location of the components on the screens need to be consistent.

Using standardized interface components is an effective practice for mobile application developers to ensure a consistent appearance across all screens (Swaid and Suid, 2018). According to Swaid and Suid (2018), mobile applications should use the standard iOS UI components as much as possible. Consequently, a standardized and consistent language can be established across applications developed for the iOS operating system. Swaid and Suid (2018) also emphasized the requirement for two components to behave the same if they have the same appearance, so as not to confuse users.

The consistency and standardization construct is defined as ‘presenting a consistent and familiar appearance throughout the application, using standard interface elements that users are accustomed to from other applications, and using user controls consistently’ in this study.

Concise & user-driven language

The language used in mobile applications is examined through two aspects in this study. The first is that all texts, messages, or warnings displayed in the interface, which is also addressed in the study of Hoehle and Venkatesh (2015), succinctly and clearly explain what is intended to be conveyed.

The language used in application needs to be user-centered, which is the other aspect. Mobile applications that communicate to their users from a user-centric perspective avoid using technical terms or expressions that are insulting or judgmental. Moreover, excessive humor should be utilized cautiously because it might disturb the user (Apple, 2022). McLean (2021) credited the concise and straightforward content of the interface with ensuring that health applications were used efficiently by all users. On the contrary, it was claimed that interface users might have difficulties communicating if they lack a strong understanding of health terminology. It is also emphasized in the research conducted by Broderick et al. (2014) on health mobile applications that users have inadequate health content knowledge, therefore mobile applications should employ straightforward and basic language.

Consequently, concise and user-driven language is conceptualized as ‘the mobile application's utilization of succinct and user-centered language across the interface, avoiding technical and unfamiliar terminology’ in this study.

Feedback

Mobile applications should always notify users to the situation by providing the appropriate feedback types, according to Swaid and Suid's (2018) visibility heuristic. In the study, it was underlined that the mobile application should notify the user in accordance with user actions and in the case of any status changes. According to Ji et al. (2006), the current state should be explicitly and understandably represented by the progress bar.

Feedback in the mobile application can be visual, auditory or tactile. As users interact with the user interface, haptic feedback offers the benefit of giving them physical sensations like pressure and vibration (Sobri et al., 2019). Brewster et al. (2007) revealed that haptic feedback strengthens the user's interaction with the interface. According to Akamatsu et al. (1995), users can find an interactive object more rapidly as a result of this sort of feedback. According to Brewster and King's (2005) study, users can follow haptic feedback while simultaneously performing a data entry.

Feedback is conceptualized as ‘providing the user with appropriate and intuitively understandable feedback (visual, audible or tactile-haptics) on status changes and giving the user waiting time information during interruptions’ in this study.

Navigation

Kang et al. (2014) emphasized that navigation is the most crucial component in user experience. According to Miranda González and Bañegil Palacios (2004), users should never feel lost when navigating the interface, and it should be simple to navigate through the interface and get to the main page from any page. Furthermore, according to Hoehle et al. (2016), users should be able to access to the mobile application from different locations. People expressed their dissatisfaction when they were unable to access to the application after downloading it. So that users can access the application easily and rapidly, the mobile application should offer a variety of options, such as connecting via another application or website, notifications, or widgets (Hoehle et al., 2016).

According to Larson and Czerwinski (1998), the objects provided at the top of the information hierarchy are more readily apparent, making them better targets. Adipat et al. (2011) agreed with this idea and recommended placing critical information at the top of the interface. By minimizing the user's effort to accomplish their goals, navigating will become simpler, especially for complex interfaces.

Taking advantage of these insights in the literature and Apple's (2022) human interface guidelines, navigation conceptualized as ‘navigating the interface is familiar, intuitive and does not need much guidance, the user always has a single and logical way to complete a task, and the user can easily access the desired content with a minimum number of steps’.

Transition

One of the fundamental components of navigating through a mobile application's graphical user interface is transitioning from one screen to another (Adipat et al., 2011). The mobile application interface requires the user to navigate between screens in order to finish a task. Thus, if the mobile application fails to provide a quick and seamless transition experience, users might be disappointed (Kang et al., 2014). Due to the limited screen size of mobile applications, it is not possible to fit too much knowledge on a single screen. As a result, in order to access information, users must either scroll the screen or switch between screen. According to Buchanan et al. (2001), users are more familiar with vertical scrolling than horizontal scrolling. They also claimed that excessive usage of scrolling made people dissatisfied and that screen transition is less monotonous. However, if graceful screen transitions are not provided, users may have more trouble trying to navigate between pages (Buchanan et al., 2001).

In this study, transition is conceptualized as ‘displaying placeholder texts and graphics to users during screen transitions of the mobile application until the content on the page is loaded, and maintaining visual continuity’ in accordance with Apple's (2022) human interface guidelines.

4.2 Instrument Development

4.2.1 Measure development

The second step of the methodology focuses on survey instrument development. In this section, an initial item pool was created by making use of the open codes created in the previous section and the relevant literature. Initially, a pool of 113 items measuring 16 constructs was created. This first item pool was purified by face validity check, pilot study and content validity control, respectively, and the final item pool was created.

4.2.2 Face validity check

113 items representing 16 constructs in the prepared instrument were subjected to face validity check. At this stage, a total of 9 people, including 1 professor, 1 associate professor, 1 assistant professor, 2 doctorate and 4 graduate students, who have done research on the subject studied or have an idea about the subject, participated. At the same time, it was confirmed that all participants were mobile smartphone users, so that they could easily understand and evaluate the items in the instrument. The participants were asked whether there is any ambiguity for each item and whether it needs to be deleted or modified in a previously prepared format. Participants were also asked to identify items that they thought needed to be added to the instrument or that needed to be modified, and to provide feedback and suggestions for other improvements. The collected answers were first evaluated by the researcher, then some issues were discussed with the participation of 2 experts, and as a result, necessary adjustments were made in the instrument. In accordance with these adjustments, 38 items were removed from the instrument and 9 items that were found to be meaningless or ambiguous were re-worded by the researcher. The next step, the pilot study, was passed with 75 items.

4.2.3 Pilot study

75 items representing 16 constructs in the prepared instrument were subjected to pilot study. At this stage, answers were collected from social media mobile application users, who are the target audience, in line with the suggestions. Since the target audience for the participants in this study is social media application users in Turkey, English-Turkish bilingual translation of the items was made before starting the survey. 39 participants were first asked to complete the instrument and at the same time to seek answers to the following questions recommended by Salant and Dillman (1994, as cited in Altunisik, 2008).

- Does the item measure what is intended to be measured?
- Does the item is related to mobile application usability? Which items do you think are unrelated?
- Are there any words that you do not know the meaning, and if so, what are they?
- Are there any items that you find difficult to understand, and if so, what are they?
- Are there any items or expressions in the instrument that will lead to prejudice or guidance, if any, what are they?

The participants look answers for these questions while completing the questionnaire, and they were allowed to convey their opinions in the feedback and suggestions field on each page of the questionnaire, which was prepared for the pilot study distinctively. In accordance with the answers of the participants, 1 item were removed from the instrument and 32 items were re-worded by the researcher. At this stage, the reason why 32 items were reworded was that when an incomprehensible word was changed, more than one item was affected. Therefore, all items containing incomprehensible words have been changed. The next step, the content validity check, was passed with 74 items.

4.2.4 Content validity check (item screening)

74 items representing 16 constructs in the prepared instrument were subjected to content validity analysis. 40 participants have contributed to study in this stage and the demographics of them presented in Table C.1. In the content validity check, Proportion of Substantive Agreement (PSA) and Substantive Validity Coefficients (CSV) indexes were used as explained in the study of Anderson and Gerbing (1991). According to the results, CSV value of 9 of 74 criteria is below 0.25, the proposed threshold value (Yao et al., 2008). It was noted that each construct is represented with at least 4 items and it was decided to remove 5 of these 9 items (COLL3, EFR6, EFR7, EFR8, FB5) from

the item pool and 4 items (BRND4, REAL4, NAV1, NAV3) were decided to re-express their statements. Table 4.1 shows PSA and CSV values of all items, the items that are removed from the item pool and whose expressions are changed are shown. After the changes, 69 items for constructs were confirmed by content validity check. The final item pool is given in Table D.1.

Table 4.1: Content validity check results: PSA and CSV values of items.

Construct	Code	Items	PSA	CSV
Instant Start	INST1	The mobile application displays initial screen as soon as possible.	0.88	0.83
	INST2	The mobile application is ready to use after launching.	0.78	0.68
	INST3	As the mobile application opens very quickly I can easily access the content.	0.80	0.68
	INST4	The mobile application doesn't force authentication to navigate within the application.	0.65	0.45
	INST5	The mobile application only asks for authentication when necessary and provides a simple way to do so.	0.60	0.43
Branding	BRND1	The mobile application integrates branding elements (brand colors, stylized icons etc.) into the interface without distractions.	0.85	0.75
	BRND2	The mobile application icon is artistically designed and clearly defines the purpose of the application.	0.58	0.38
	BRND3	The mobile application offers a recognizable and brand-reminiscent interface.	0.73	0.58
	BRND4*	The mobile application doesn't force me to watch advertisements. (original)	0.55	**0.23**
		The mobile application doesn't force me to watch brand-related advertisements. (modified)		
Orientation	ORIE1	The mobile application supports both portrait and landscape orientation.	0.83	0.70
	ORIE2	The mobile application works well whether I rotate the device left or right.	0.75	0.60
	ORIE3	The mobile application doesn't force me to change the orientation of the device.	0.88	0.75
	ORIE4	Content in the mobile application looks good in both portrait and landscape mode.	0.83	0.65
Collaboration	COLL1	The mobile application allows me to share information with social media accounts or other channels.	0.70	0.53
	COLL2	The mobile application allows me to interact with others through ratings, reviews and messages etc.	0.78	0.68
	COLL3**	The mobile application requests ratings and reviews only after interacting with the application.	0.50	**0.23**
	COLL4	The mobile application allows me to interact with others.	0.85	0.78
	COLL5	The mobile application makes it possible for me to communicate with others.	0.78	0.68
Content	CTNT1	The content of the mobile application is focused on a single purpose.	0.63	0.48
	CTNT2	The mobile application presents the content I am most interested in.	0.80	0.75
	CTNT3	The mobile application personalise the content according to my previous preferences.	0.73	0.58
	CTNT4	The mobile application allows me to customize the content according to my own preferences.	0.88	0.83
Search	SEAR1	The mobile application helps me to search the content faster.	0.75	0.63
	SEAR2	The mobile application provides a search bar for me to search easily.	0.88	0.80
	SEAR3	The mobile application narrows the list of results in relation to my search terms.	0.78	0.63
	SEAR4	The mobile application provides helpful shortcuts(bookmarks) under the search area.	0.75	0.60

*: Defines modified items.

**: Defines the items extracted from the item pool.

Table 4.1 (cont.): Content validity check results: PSA and CSV values of items.

Construct	Code	Items	PSA	CSV
Privacy	PRVC1	The mobile application clearly states why it needs personal data such as location, health and financial information.	0.80	0.65
	PRVC2	The mobile application asks for permission before using personal data and uses them according to my preferences.	0.88	0.83
	PRVC3	The mobile application allows browsing the application without access to personal data.	0.70	0.58
	PRVC4	The mobile application doesn't force me to share my personal data unless necessary.	0.88	0.85
Graphics & Animations	GRAN1	The mobile application uses beautiful, interesting and evocatory graphics.	0.85	0.78
	GRAN2	The mobile application makes use of high resolution and quality of images and artworks.	0.80	0.68
	GRAN3	The mobile application uses animations and motion effects, effectively.	0.78	0.68
	GRAN4	The animations and motion effects in the mobile application are optional.	0.88	0.83
	GRAN5	The mobile application makes use of animations to add vitality to the experience.	0.88	0.80
Realism	REAL1	The mobile application benefits from realistic icons.	0.83	0.75
	REAL2	The mobile application uses icons in accordance with their meaning and suggested usage.	0.70	0.48
	REAL3	Icons in the mobile application remind real-life objects.	0.80	0.68
	REAL4*	Icons in the mobile application don't have complex shapes and are easily understandable. (original)	0.58	**0.20**
		The meanings of the icons in the mobile application are easily understood. (modified)		
Control Obviousness &Reliability	COBV1	The mobile application provides intuitive controls that I can easily understand their function.	0.80	0.68
	COBV2	The controls in the mobile application always lead me the results I expect.	0.68	0.45
	COBV3	In the mobile application, controls are labelled correctly according to their functions.	0.75	0.65
	COBV4	The core function of the mobile application is clear and understandable at a single glance.	0.68	0.55
Effort Minimization	EFR1	The mobile application provides hints or reasonable default values in the data entry field.	0.78	0.65
	EFR2	The mobile application allows me to spend less effort by providing logical options.	0.80	0.68
	EFR3	The mobile application saves the current state and my data automatically so that I can continue from where I left off.	0.78	0.65
	EFR4	The mobile application doesn't force me to change the settings within the application.	0.78	0.60
	EFR5	The mobile application provides large-enough touchable area for each button.	0.68	0.53
	EFR6**	It's easy to interact with the mobile application, even in distracting environments.	0.40	**0.18**
	EFR7**	The mobile application allows me to control the interface with my fingertip.	0.55	**0.20**
	EFR8**	The mobile application uses touch gestures to make easier selections (For ex. swiping right to go back, double-click to add a product to favorites, etc.)	0.53	**0.18**
	EFR9	The mobile application allows me to interact with the application interface with finger gestures such as swiping, double-clicking on the touch screen.	0.63	0.50

*: Defines modified items.

**: Defines the items extracted from the item pool.

Table 4.1 (cont.): Content validity check results: PSA and CSV values of items.

Construct	Code	Items	PSA	CSV
Consistency & Standardization	CSTD1	The mobile application maintains a consistent and familiar appearance throughout the interface.	0.83	0.75
	CSTD2	The mobile application provides standard interface elements (icons etc.) and controls that are similar to other applications.	0.73	0.63
	CSTD3	In the mobile application, the controls are in the position I expected and can be found intuitively.	0.73	0.58
	CSTD4	The mobile application uses a consistent design, typography and color throughout the interface.	0.85	0.78
Concise&User-Driven Language	CUDL1	The mobile application uses concise language both texts and titles throughout the interface.	0.88	0.75
	CUDL2	The mobile application uses an easy-to-understand language.	0.78	0.68
	CUDL3	The mobile application uses a friendly tone and avoids judgmental and insulting expressions.	0.78	0.68
	CUDL4	The mobile application avoids technical jargon that seems complicated to me.	0.8	0.65
Feedback	FB1	The mobile application provides visual, auditory, tactile and other types of feedback appropriate to the actions I take.	0.88	0.80
	FB2	The mobile application notifies me for actions or any status changes.	0.53	0.38
	FB3	The mobile application keeps me informed of what happens during the waits and how long the situation will last.	0.68	0.55
	FB4	The mobile application immediately warns me when I make an incorrect data entry.	0.68	0.55
	FB5**	The mobile application always accurately conveys progress information.	0.53	**0.13**
Navigation	NAV1*	The mobile application can be accessed through notification, another application or the website of another application. (original)	0.50	**0.23**
		The mobile application can be accessed through another application or notifications. (modified)		
	NAV2	The mobile application provides a logical and predictable path.	0.65	0.58
	NAV3*	The mobile application makes navigating the interface and performing actions easy and predictable. (original)	0.58	**0.23**
		The mobile application interface is easy and predictable to navigate. (modified)		
	NAV4	The mobile application allows me to take the action I want to do in the shortest way.	0.78	0.63
	NAV5	The mobile application provides principal and the most frequently used information and actions on the top of the screen.	0.68	0.53
Transition	TRAN1	The mobile application seamlessly transitions from one screen to the next.	0.80	0.68
	TRAN2	The mobile application switches from one screen to another without any difficulty.	0.80	0.65
	TRAN3	The mobile application doesn't appear to be frozen when switching from one screen to another.	0.75	0.68
	TRAN4	The transition from one screen to another in the mobile application is fast enough.	0.88	0.80

*: Defines modified items.

**: Defines the items extracted from the item pool.

4.3 Evaluation of Measurement Properties

The developed scale is tested with the participants randomly selected from the target audience during the evaluation of the measurement properties stage. First, explanatory factor analysis is applied to examine the factor structure of the new scale, and then confirmatory factor analysis is applied to confirm this factor structure. The two random data to be used for exploratory factor analysis and confirmatory factor analysis, respectively, must be independent of each other (Lewis et al., 2005).

4.3.1 Exploratory assessment

Explanatory factor analysis was performed in order to examine the factor structure with the first sample collected using the developed survey instrument. Before starting the survey, the participants were asked the social media application they used most. The options offered to users are Facebook, Twitter, Instagram and YouTube, which are among the most preferred social media applications in Turkey in recent years (Statista Research Department, 2021). Adapting the questionnaire to a specific context and collecting data from a specific user group in this direction is an accepted practice in the literature (Venkatesh et al., 2003; Venkatesh and Ramesh, 2006). Then, the survey items were automatically adapted according to the social media application preferences most used by the social media users, the target group determined in this study. In this way, the items were shown to the participants during the survey, for example, ‘Facebook mobile application is ready to use after launching’ instead of ‘The mobile application is ready to use after launching’. In addition, all items in the survey instrument were measured using a 7-point Likert-agreement scale (e.g., 1-totally disagree; 7-totally agree). In order for the sample size to be statistically significant, attention was paid to ensure that the subject-to-item ratio was at least 5 to 1, as suggested by Hair et al. (2010). 508 responses were collected from the social media application users in Turkey through an online survey platform. In addition, the answers of 32 participants who marked the item ‘Please do not answer this question’, which was given as a trap in the survey were not included in the analysis. Finally, a total of 476 survey data were obtained for explanatory factor analysis. IBM SPSS Statistics 28 package program was used for this analysis. The demographic information of the respondents is given in Table C.1.

The suitability of the remaining 476 data for factor analysis was investigated by using the Bartlett sphericity test, which questions the existence of sufficient correlation between the variables, and the Kaiser-Meyer-Olkin (KMO) tests, also known as the Measure of Sampling Adequacy (e.g., MSA), respectively. It is expected that the Bartlett test of sphericity is statistically significant (e.g., p value <0.5) and the KMO values are higher than 0.5 for both the general test and each variable (Hair et al., 2010).

As a result of the analysis, the KMO value of the general test was 0.953 and the Bartlett sphericity test was also found to be statistically significant at the 0.001 significance level. In addition, the KMO values of each factor were found to be more than 0.5 threshold and Bartlett sphericity tests were significant at 0.05 significance level.

Factor analysis was performed by using the varimax method without specifying the number of factors beforehand. As a result, 16 factors with eigenvalues greater than 1 were obtained. Explanatory factor analysis results are given in Table 4.2. 69 items representing 16 constructs explain 71.7% of the total variance. Although there are different ideas for the threshold value of item loading in the literature such as 0.50 (Strauss, 1989), 0.45 (Lewis et al., 1995). The threshold value of item loading was determined as 0.50 in this study. 2 items (INST4 and EFR2) with loading below the threshold were privately evaluated and it was decided to remove these items from the item pool. At this stage, it was also checked whether an item was loaded more than 0.45 on more than one factor (Lewis et al., 1995). However, this situation has not been determined for any item.

For the reliability analysis, the Cronbach alpha values, internal consistency coefficients, of each construct were calculated and all values were above 0.79, so they were above 0.70 as suggested by Fornell and Larcker (1981).

Table 4.2: Explanatory factor analysis: Descriptive statistics and loadings of items, Cronbach alpha values and % variance explained of constructs.

Construct	Mean	Standard Deviation	Loading	% Variance Explained	Cronbach α
Instant Start (INST 1-5)	4.80	1.66	0.78	5.14	0.88
	4.76	1.61	0.77		
	4.75	1.59	0.76		
	4.04	1.73	0.44*		
	4.68	1.69	0.74		
Branding (BRND 1-4)	4.43	1.73	0.78	4.37	0.87
	4.34	1.63	0.77		
	4.46	1.54	0.77		
	4.11	1.80	0.64		
Orientation (ORIE 1-4)	4.18	1.64	0.84	4.82	0.89
	4.11	1.60	0.84		
	4.25	1.57	0.72		
	4.21	1.64	0.83		

*: Represents the extracted items from the item pool

Table 4.2 (cont.): Explanatory factor analysis: Descriptive statistics and loadings of items, Cronbach alpha values and % variance explained of constructs.

Construct	Mean	Standard Deviation	Loading	% Variance Explained	Cronbach α
Orientation (ORIE 1-4)	4.18	1.64	0.84	4.82	0.89
	4.11	1.60	0.84		
	4.25	1.57	0.72		
	4.21	1.64	0.83		
Collaboration (COLL 1-4)	4.50	1.40	0.66	3.94	0.79
	4.30	1.42	0.69		
	4.27	1.44	0.64		
	4.38	1.46	0.69		
Content (CTNT 1-4)	4.12	1.74	0.74	4.19	0.85
	4.16	1.62	0.73		
	4.29	1.56	0.70		
	4.23	1.58	0.73		
Search (SEAR 1-4)	4.63	1.45	0.67	4.35	0.85
	4.28	1.52	0.75		
	4.30	1.52	0.70		
	4.39	1.53	0.71		
Privacy (PRVC 1-4)	3.15	1.77	0.82	4.92	0.88
	3.17	1.66	0.77		
	3.19	1.73	0.77		
	3.35	1.76	0.82		
Graphics & Animations (GRAN 1-5)	4.44	1.44	0.59	4.66	0.86
	4.29	1.41	0.60		
	4.45	1.38	0.67		
	4.14	1.36	0.69		
	4.51	1.35	0.71		
Realism (REAL 1-4)	4.40	1.48	0.75	4.56	0.87
	4.20	1.48	0.77		
	4.20	1.48	0.65		
	4.44	1.48	0.78		
Control Obviousness & Reliability (COBV 1-4)	4.58	1.50	0.72	3.86	0.86
	4.37	1.45	0.64		
	4.48	1.47	0.64		
	4.56	1.58	0.66		
Effort Minimization (EFR 1-6)	4.80	1.63	0.73	5.38	0.85
	3.71	1.63	0.46*		
	4.19	1.53	0.62		
	4.67	1.64	0.68		
	4.72	1.68	0.64		
	4.84	1.61	0.66		

*: Represents the extracted items from the item pool

Table 4.2(cont.): Explanatory factor analysis: Descriptive statistics and loadings of items, Cronbach alpha values and % variance explained of constructs.

Construct	Mean	Standard Deviation	Loading	% Variance Explained	Cronbach α
Consistency & Standardization (CSTD 1-4)	4.84	1.61	0.655	4.06	0.86
	4.64	1.43	0.699		
	4.37	1.47	0.684		
	4.49	1.37	0.617		
	4.59	1.53	0.724		
Concise & User-Driven Language (CUDL 1-4)	4.75	1.33	0.685	3.91	0.87
	4.48	1.40	0.689		
	4.41	1.35	0.617		
	4.48	1.36	0.728		
Feedback (FB 1-4)	4.27	1.44	0.699	4.39	0.88
	4.08	1.45	0.693		
	4.01	1.56	0.726		
	4.36	1.42	0.699		
Navigation (NAV 1-5)	4.16	1.51	0.710	4.71	0.87
	4.20	1.46	0.657		
	4.28	1.48	0.691		
	4.51	1.46	0.72		
	4.50	1.49	0.52		
Transition (TRAN 1-4)	4.33	1.48	0.73	4.45	0.87
	4.09	1.51	0.70		
	4.05	1.53	0.75		
	4.41	1.42	0.71		

*: Represents the extracted items from the item pool

4.3.2 Confirmatory assessment

Lewis et al. (2005) stated that the measurement model, which consists of constructs and items representing these constructs, should be confirmed with a new random sample. In this direction, a confirmatory analysis was carried out with a new and different sample, consisting of a total of 637 participants and collected through a market research firm, in order to validate the measurement model created from the exploratory analysis and presented in Figure 4.1. All items in the survey instrument were measured using a 7-point Likert-agreement scale (e.g., 1-totally disagree; 7-totally agree). Participants are social media users, as in exploratory analysis. At the beginning of the survey, as in the previous stage, users were asked about the social media application they use most among Facebook, Twitter, Instagram and YouTube options, and then the survey questions were adapted according to this choice (Statista Research Department, 2021). 54 of the participants were excluded from the sample because they answered the trap question ‘Please do not answer this question’. As a result, 583 survey data were included in the confirmatory analysis. The demographic information of the respondents is given in Table C.1. IBM SPSS Amos 24 package program was used for the confirmatory analyses.

In the confirmatory analysis, the approach of Hair et al. (2010) was followed. Accordingly, the suitability of the data to the multivariate normality assumption was checked first. According to Lewis et al. (2005), this assumption can also be provided by examining the univariate normality of each of the variables. In this direction, the skewness and kurtosis coefficients of each variable in the model were examined. All skewness and kurtosis values were found between -2 and +2, which is the range suggested by George and Mallery (2019). This result indicates that the data meet the normality assumption. Another issue according to Hair et al. (2010) is the sample size. For the sample size, Hair et al. (2010) suggest that 5-10 samples should be collected per observed variable. In line with the proposal of Hair et al. (2010), approximately 8 samples were collected per observed variable for the confirmatory analysis.

The measurement model developed based on the factor structure discovered in the exploratory analysis is given in Figure 4.1. The model consists of 16 reflective latent variables and 67 indicators influenced by them (Freeze and Raschke, 2007). This developed measurement model is a reflective model as it includes ‘effects’ indicators and reflective latent variables. In addition, since measurement errors are added to the indicators in the reflective models, measurement errors are added to 67 indicators in Figure 4.1 (Freeze and Raschke, 2007).

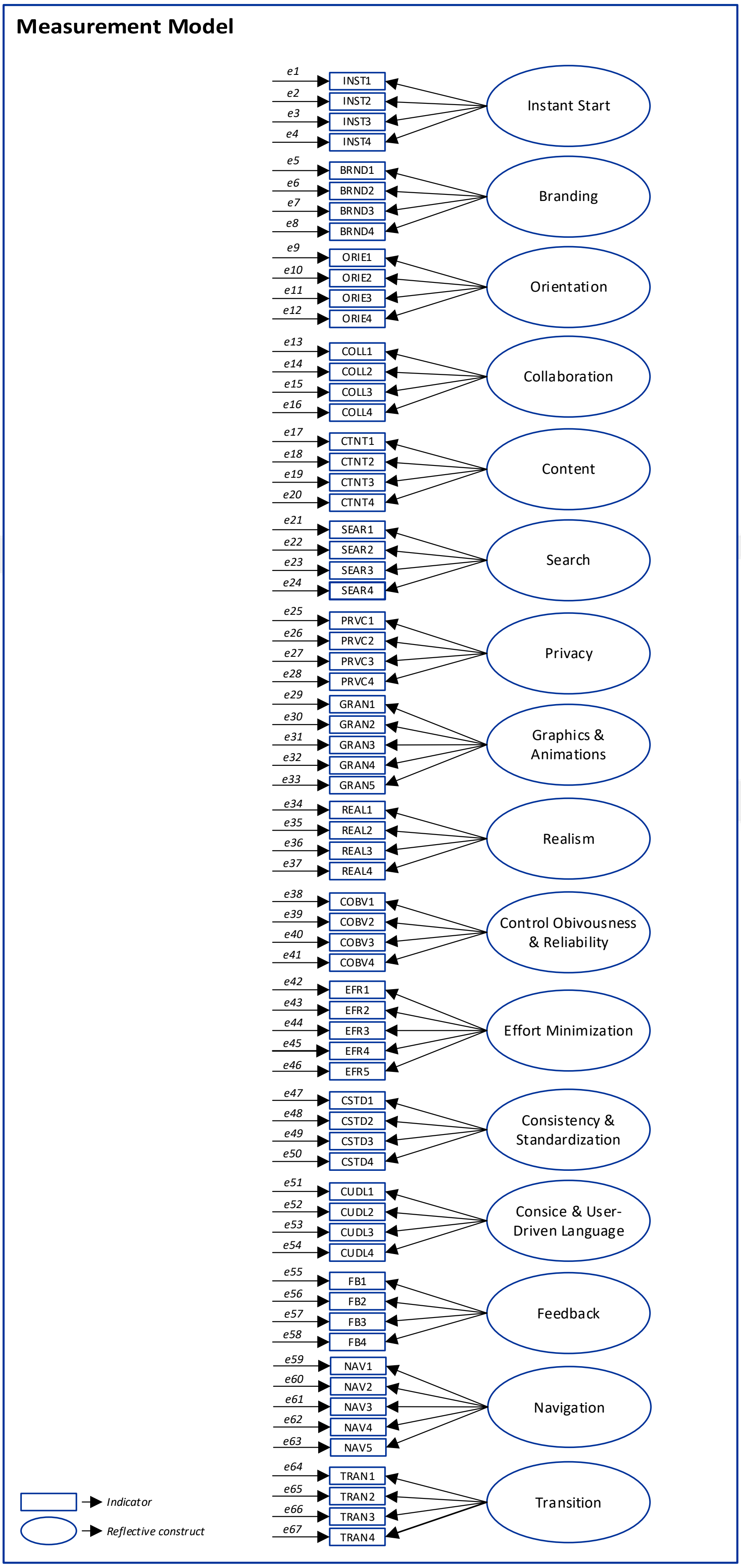

Figure 4.1: Measurement Model.

4.3.2.1 Convergent and discriminant validity

Anderson et al. (1987) defined convergent validity as "the existence of one latent trait or construct underlying a set of measures" (p. 432). This procedure, also known as the evaluation of uni-dimensionality, is important in terms of preventing excessive errors in the structural equation model (Segars and Grover, 1998; Lewis and Byrd, 2003).

In this study, standardized factor loadings were first examined for convergent validity. The standardized factor loadings of all items were found to be between 0.70 and 0.87, as can be seen from the Table 4.3. Therefore, all factor loadings are above the threshold of 0.70 suggested by Hair et al. (2010), which indicates that the items belong to the relevant construct. In addition, all standardized factor loadings were statistically significant (Bagozzi et al., 1991). Table 4.4 shows the average variance extracted (AVE) and composite reliability (CR) values of the constructs. As can be seen from the table, all AVE values are above 0.58, thus above the recommended value of 0.50 by Fornell and Larcker (1981). All CR values are above 0.85, thus above the value of 0.60 recommended by Diamantopoulos and Siguaw (2020 as cited in Altin Gumussoy, 2016). Finally, all Cronbach alpha values are above the recommended value of 0.70 (Fornell and Larcker, 1981). The results confirm the validity of the constructs.

Table 4.3: Confirmatory factor analysis: Descriptive statistics and loadings of items, t-values and Cronbach alpha's

Construct	Mean	Standard Deviation	Standardized Factor Loading	t-value	Cronbach α
Instant Start (INST 1-4)	4.29	1.57	0.82	19.89***	0.87
	4.26	1.47	0.79	19.11***	
	4.34	1.46	0.78	18.72***	
	4.21	1.52	0.77	18.72***	
Branding (BRND 1-4)	4.92	1.52	0.82	18.53***	0.87
	4.87	1.58	0.82	18.49***	
	5.02	1.51	0.83	18.65***	
	4.89	1.56	0.71	18.65***	
Orientation (ORIE 1-4)	4.51	1.99	0.86	24.67***	0.89
	4.50	1.92	0.83	23.75***	
	4.52	1.89	0.77	21.03***	
	4.50	1.88	0.84	24.64***	
Collaboration (COLL 1-4)	4.34	1.52	0.82	23.12***	0.88
	4.28	1.51	0.79	21.80***	
	4.31	1.52	0.78	21.48***	
	4.42	1.46	0.85	21.48***	

***p<0.001

Table 4.3 (cont.): Confirmatory factor analysis: Descriptive statistics and loadings of items, t-values and Cronbach alpha's

Construct	Mean	Standard Deviation	Standardized Factor Loading	t-value	Cronbach α
Content (CTNT 1-4)	4.69	1.74	0.75	20.20***	0.88
	4.88	1.63	0.83	23.49***	
	4.98	1.60	0.82	23.05***	
	4.92	1.57	0.84	20.20***	
Search (SEAR 1-4)	4.39	1.40	0.80	18.99***	0.86
	4.28	1.43	0.80	19.06***	
	4.21	1.39	0.78	18.50***	
	4.17	1.41	0.76	18.99***	
Privacy (PRVC 1-4)	3.67	1.44	0.78	18.44***	0.85
	3.70	1.47	0.78	18.35***	
	3.70	1.51	0.72	17.05***	
	3.78	1.46	0.78	18.44***	
Graphics & Animations (GRAN 1-5)	4.91	1.60	0.72	18.09***	0.87
	4.81	1.47	0.71	17.71***	
	4.91	1.59	0.85	22.06***	
	4.67	1.48	0.74	18.80***	
	4.87	1.53	0.79	22.06***	
Realism (REAL 1-4)	4.99	1.45	0.83	20.48***	0.86
	4.90	1.48	0.75	18.32***	
	4.87	1.49	0.78	19.13***	
	4.98	1.41	0.78	20.48***	
Control Obviousness & Reliability (COBV 1-4)	4.23	1.41	0.84	23.08***	0.88
	4.09	1.49	0.77	20.59***	
	4.14	1.40	0.78	20.99***	
	4.22	1.39	0.83	23.08***	
Effort Minimization (EFR 1-5)	4.39	1.47	0.84	22.33***	0.88
	4.14	1.43	0.71	18.09***	
	4.16	1.49	0.74	18.87***	
	4.22	1.50	0.80	22.33***	
	4.33	1.45	0.80	21.03***	
Consistency & Standardization (CSTD 1-4)	4.47	1.44	0.82	21.19***	0.86
	4.23	1.42	0.76	19.23***	
	4.30	1.41	0.74	18.61***	
	4.42	1.37	0.81	21.19***	
Concise & User-Driven Language (CUDL 1-4)	4.28	1.47	0.87	23.53***	0.89
	4.23	1.52	0.81	21.54***	
	4.10	1.47	0.78	20.39***	
	4.23	1.36	0.81	23.53***	

***p<0.001

Table 4.3 (cont.): Confirmatory factor analysis: Descriptive statistics and loadings of items, t-values and Cronbach alpha's

Construct	Mean	Standard Deviation	Standardized Factor Loading	t-value	Cronbach α
Feedback (FB 1-4)	4.86	1.63	0.84	23.09***	0.88
	4.71	1.66	0.79	21.21***	
	4.58	1.62	0.74	19.47***	
	4.97	1.66	0.83	23.09***	
Navigation (NAV 1-5)	4.74	1.66	0.80	23.30***	0.90
	4.81	1.70	0.82	24.56***	
	4.74	1.69	0.79	23.26***	
	4.97	1.67	0.87	23.26***	
	5.05	1.60	0.70	19.31***	
Transition (TRAN 1-4)	5.04	1.61	0.87	27.11***	0.90
	4.93	1.69	0.82	24.94***	
	4.87	1.69	0.79	23.25***	
	5.03	1.56	0.87	23.25***	

***p<0.001

The discriminant validity of the model was tested with the method known as the Fornell-Larcker criterion in the literature. According to this method, the diagonal values, namely the square roots of the AVE values, seen in Table 4.4, must be greater than the correlation values below it, that is, the correlation of the relevant construct with other constructs (Fornell and Larcker, 1981). In other words, it is the condition that the square of the correlation between two constructs is less than the AVE values of both constructs (Henseler et al., 2015). It is understood that each construct provides the relevant rule, namely discriminant validity from the Table 4.4.

Table 4.4: Composite Reliability (CR), Average Variance Extracted (AVE), Maximum Squared Variance (MSV) and Correlations.

	CR	AVE	MSV	CUDL	PRVC	REAL	GRAN	COBV	EFR	COLL	FB	ORIE	BRND	INST	NAV	TRAN	SEAR	CSTD	CNTN
CUDL	.89	.67	.33	**.82**															
PRVC	.85	.58	.28	.44**	**.76**														
REAL	.86	.61	.40	.42**	.46**	**.78**													
GRAN	.88	.58	.40	.43**	.47**	.63**	**.76**												
COBV	.88	.65	.27	.50**	.42**	.38**	.49**	**.81**											
EFR	.89	.61	.33	.46**	.48**	.51**	.54**	.40**	**.78**										
COLL	.88	.66	.29	.50**	.43**	.41**	.47**	.51**	.49**	**.81**									
FB	.88	.64	.33	.58**	.39**	.26**	.42**	.51**	.39**	.45**	**.80**								
ORIE	.90	.68	.20	.22**	.26**	.15*	.23**	.31**	.41**	.22**	.21**	**.83**							
BRND	.87	.63	.42	.55**	.53**	.54**	.57**	.52**	.54**	.51**	.47**	.44**	**.80**						
INST	.87	.62	.32	.49**	.38**	.34**	.38**	.50**	.50**	.43**	.38**	.39**	.56**	**.79**					
NAV	.90	.64	.32	.48**	.43**	.55**	.52**	.46**	.57**	.48**	.45**	.20**	.50**	.39**	**.80**				
TRAN	.91	.70	.24	.28**	.35**	.42**	.46**	.42**	.37**	.48**	.39**	.25**	.42**	.32**	.41**	**.84**			
SEAR	.87	.62	.38	.34**	.39**	.52**	.62**	.47**	.44**	.47**	.32**	.26**	.56**	.39**	.45**	.49**	**.78**		
CSTD	.86	.61	.31	.47**	.35**	.48**	.53**	.49**	.54**	.54**	.53**	.32**	.55**	.40**	.47**	.44**	.56**	**.78**	
CNTN	.88	.66	.42	.53**	.53**	.52**	.59**	.52**	.57**	.53**	.45**	.35**	.65**	.49**	.52**	.43**	.42**	.51*s*	**.81**

CUDL: Concise&user-driven language; PRVC: Privacy; REAL: Realism; GRAN: Graphics&animations; COBV: Control obviousness&reliability; EFR: Effort minimization; COLL: Collaboration; FB: Feedback; ORIE: Orientation; BRND: Branding; INST: Instant start; NAV: Navigation; TRAN: Transition; SEAR: Search; CSTD: Consistency&Standardization; CNTN: Content

*p<0.01, **p<0.001

4.3.2.2 Measurement model fit

In the confirmatory analysis, first of all, it was checked whether the model fit statistics met the expectations. Schermelleh-Engel et al. (2003) stated that the fit statistics indicate "the extent the specified model fits the empirical data" (p. 31). These measures are obtained by comparing the estimated and observed covariance matrices (Hair et al., 2010).

The most known and basic of these statistics is the chi-square statistic and it is obtained by taking the difference of two covariance matrices (Hair et al., 2010). However, Jöreskog and Sörbom (1993 as cited in Schermelleh-Engel et al., 2003) stated that the chi-square statistic should not be used as a test statistic. The reason for this is that the chi-square statistic may differ according to model complexity and sample size. Therefore, it is not possible to make a clear inference about the fit of the model by using only the chi-square statistics (Schermelleh-Engel et al., 2003). For this reason, Hair et al. (2010) stated that in addition to chi-square and degrees of freedom, at least one incremental index and one absolute index should be used. At least one of these fit indices should be a badness of fit index. They also said that three to four fit indices are sufficient to prove the model fit. Bollen and Long (1992) also supported this idea and stated that several different indices should be evaluated simultaneously.

Considering the recommendations, several different goodness of fit and badness of fit indices were determined in order to evaluate the fit of the data collected in this study with the developed measurement model. The indices to be checked for model fit in this study are determined as Chi-square statistic/degree of freedom ($\chi 2$/df), Comparative fit index (CFI), Incremental fit index (IFI), Tucker Lewis Index (TLI), Root mean square error of approximation (RMSEA) and Standardized root mean square residual (SRMR). Smaller values of the badness of fit indices are more acceptable, unlike goodness of fit indices (Hair et al., 2010). The observed values of these fit indices and the suggested threshold values in the literature are presented in Table 4.5. $\chi 2$/df (1.45), CFI (0.96), IFI (0.96), TLI (0.96), RMSEA (0.03) and SRMR (0.04) meet the values recommended in the literature, proving that the model provides an acceptable fit.

Table 4.5: Observed values of measurement model fit indeces.

Fit Index	Observed Value	Recommended Value	References
Chi-square statistic(χ^2)	2926.7	-	-
Degree of freedom(df)	2024	-	-
χ^2/df	1.45	between 1 and 3	Bagozzi et al. 1991
Comparative fit index (CFI)	0.96	>0.90	Hair et al. 2010
Comparative fit index (IFI)	0.96	>0.90	Hu and Bentler, 1999
Tucker Lewis Index (TLI)	0.96	>0.90	Hair et al. 2010
Root mean square error of approximation (RMSEA)	0.03	≤0.08	Hair et al. 2010
Standardized root mean residual (SRMR)	0.04	≤0.08	Hair et al. 2010

4.3.2.3 Nomological validity

In proving the validity of the constructs in the measurement instrument, the steps of convergent validity (uni-dimensionality), construct reliability and discriminant validity have been followed, respectively (MacKenzie et al., 2011; Lewis and Byrd, 2003; Sethi and King, 1994). The last step of construct validity is nomological validity, also known as predictive validity in the literature (Lewis and Byrd, 2003). Structural equation modelling is used to examine whether there is a statistically significant relationship between the variables thought to be theoretically related to the developed instrument and the constructs in the measurement instrument. Structural model is created and analyses are carried out by considering these theoretically related variables and causal relationships between these variables and the constructs of the developed measurement instrument (Lewis et al., 2005; MacKenzie et al., 2011).

Satisfaction

Satisfaction can be defined as the overall assessment made by users or customers based on their recent experience with the relevant product or service (Boulding et al., 1993). Hung (1977 as cited in Bhattacherjee, 2001) stated that even if the user's experience with the relevant product or service is positive, satisfaction may not occur if the users' expectations are not fully met. In other words, satisfaction is more likely to occur when users' experiences with the mobile application match their expectations. In addition, user satisfaction is crucial since it influences users' decisions to use the system repeatedly and their loyalty to the system (Alalwan, 2020; Kang and Lee, 2010). Users are more inclined to use different mobile applications if they are dissatisfied with their engagement with the current mobile application (Anderson and Srinivasan, 2003). In the study of Devaraj et al. (2002), in which they investigated the factors affecting user satisfaction, the effects of perceived usability and ease of use on satisfaction were found to be statistically significant. User satisfaction has been shown to be significantly impacted by website usability by Belanche et al. (2012). They recommended that website designers create usable platforms since usability has a major influence on users' behaviour. Based on these findings, mobile application developers will increase their satisfaction level if they design applications that can be used easily by all users rather than designing complex mobile applications with visual concerns.

The notion of satisfaction was utilized as an outcome variable in the nomological validity analysis of this study since it is commonly integrated into usability studies in the literature.

Continued intention to use

Continued intention to use is defined as the user's intention to continue using a system in the future persistently (Oghuma et al., 2016). Usability is a critical component for people to continue using mobile applications. There are both theoretical justifications and compelling proof for this claim (Venkatesh and Ramesh, 2006). Bhattacherjee (2001) likened the intention to repurchase a product expressed in the expectation-confirmation model (ECM) to the intention to continue using a system in the field of information systems. Accordingly, the decision of a consumer whether to purchase a product again after purchasing and using it can be compared to the decision of whether a user will continue to use a mobile application after downloading and interacting with it. According to a statistical research conducted with Android-based mobile applications, the percentage of users keeping the mobile application on their smartphones after one week of interaction was found to be only 6.5 percent (Ceci, 2022). One of the most fundamental goals of mobile application developers is to increase these retention rates. For this purpose, it is aimed that the interaction of the user with the mobile application is smooth and therefore the application interfaces are perceived usable. Usability is a user-subjective evaluation, according to previous studies in the literature (Hess et al., 2009; Wells et al., 2011). Oghuma et al. (2016) expressed perceived usability with three basic constructs: perceived usefulness, perceived enjoyment and user interface. They examined the effects of these constructs on satisfaction and continuance intention to use. The results revealed that all perceived usability constructs had a significant effect on satisfaction, and two of the three basic constructs had a significant effect on the continuance intention to use.

As it is frequently included in usability studies in the literature, the notion of continued intention to use was included as an outcome variable in the nomological validity analysis of this study.

Satisfaction and continued intention to use were used as output variables of the model as seen in Figure 4.2 and the nomological validity analyses were conducted. In order to measure the constructs of satisfaction and continued intention to use, items representing these constructs were adapted from studies in the literature (Wang et al., 2019; Venkatesh and Goyal, 2010). The items listed in Table 4.6 were included in the developed survey instrument while collecting the confirmatory assessment data. The nomological variables items were adapted according to the mobile application preferences of the participants, as in other survey items. For example, the expression ‘I'm satisfied with the Facebook mobile application’ appeared to the participant instead of the expression ‘I'm satisfied with the mobile application’. Then, the effects of constructs representing mobile application usability on satisfaction and continued intention to use were analyzed for nomological validation.

Table 4.6: Nomological variables and their indicators adapted from the previous literature.

Nomological Variables	Scale Items	Adapted from
Satisfaction	I'm satisfied with the (…) mobile application. The (…) mobile application has met my expectations. My experience with the (…) mobile application is very pleasing. The (…) mobile application does a satisfactory job of fulfilling my needs.	Wang et al. 2019
Continued Intention to Use	I intend to continue using the (…) mobile application. I predict I will continue using the (…) mobile application rather than other alternatives. I plan to continue using the (…) mobile application in the future.	Venkatesh and Goyal, 2010

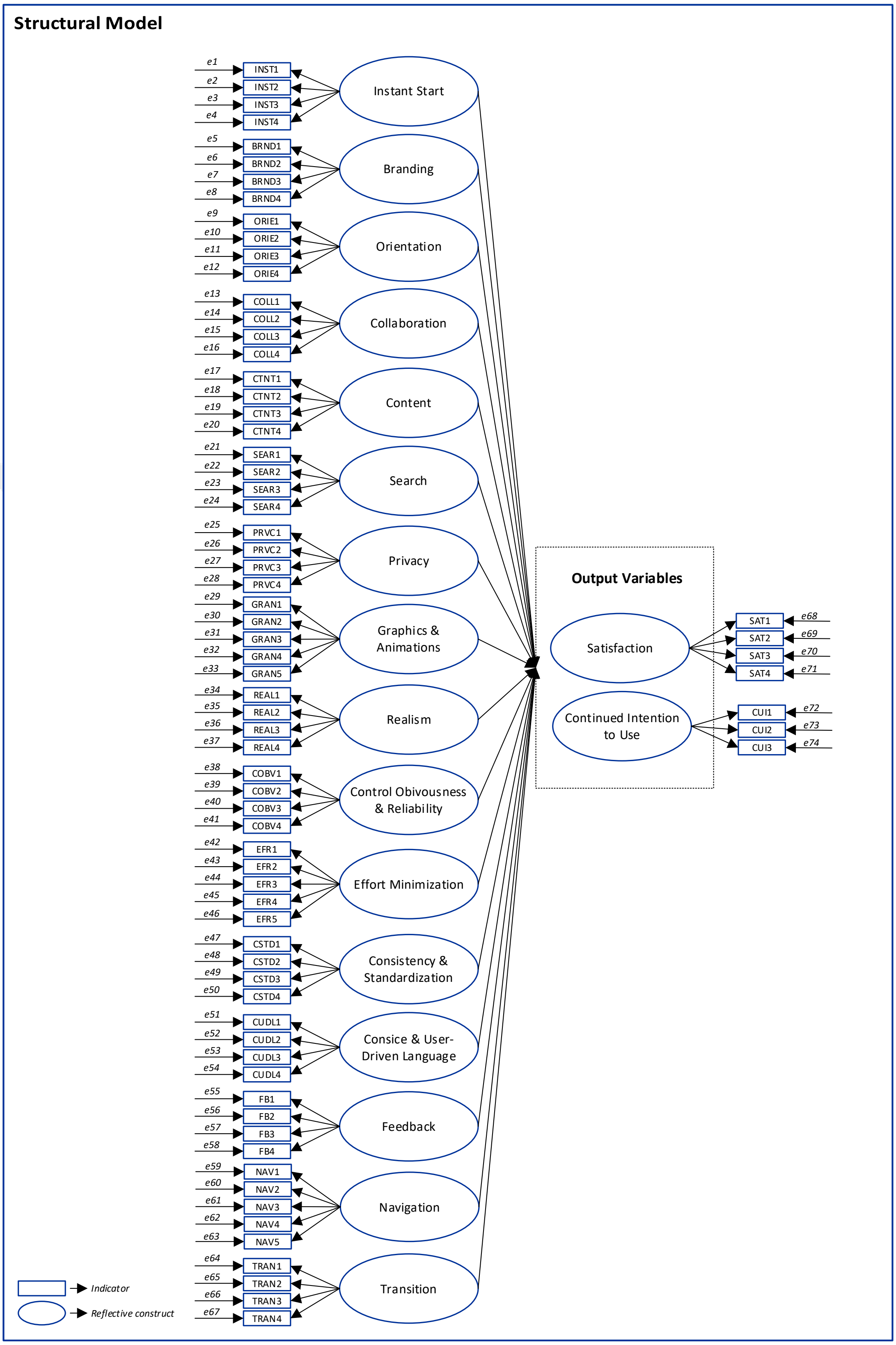

Figure 4.2: Structural Model.

Structural model was created using IBM SPSS Amos 24 package program and related analyzes were performed. First of all, it was evaluated whether the structural model fits with the data. The fit indices of the structural model are given in Table 4.7. In line with the recommendations of Hair et al. (2010), the ratio of chi-square to degrees of freedom, CFI, TLI, IFI, RMSEA, and SRMR values were used to check the model fit. According to the results, goodness of fit statistics (CFI=0.96, IFI = 0.97, TLI = 0.96), badness of fit statistics (RMSEA = 0.03, SRMR = 0.04) and the ratio of chi-square to degrees of freedom (1.39) provided a fairly good model fit.

Table 4.7: Observed values of structural model fit indices.

Fit Index	Observed Value	Recommended Value	References
Chi-square statistic(χ^2)	3432.1	-	-
Degree of freedom(df)	2475	-	-
χ^2/df	1.39	between 1 and 3	Bagozzi et al. 1991
Comparative fit index (CFI)	0.96	>0.90	Hair et al. 2010
Incremental fit index (IFI)	0.97	>0.90	Hu and Bentler, 1999
Tucker Lewis index (TLI)	0.96	>0.90	Hair et al. 2010
Root mean square error of approximation (RMSEA)	0.03	≤0.08	Hair et al. 2010
Standardized root mean residual (SRMR)	0.04	≤0.08	Hair et al. 2010

For the nomological validity of the model, the effects of mobile application usability constructs on satisfaction and continued intention to use variables were tested. In Table 4.8, statistically significant predictors of satisfaction and continued intention to use constructs are presented along with their significance levels and path coefficients. As can be seen from the Table 4.8, a total of 49.3% of the variance in satisfaction was explained by ‘orientation’, ‘collaboration’, ‘content’, ‘search’, ‘graphics and animations’ and ‘navigation’ usability constructs. 57.7% of the variance in continued intention to use was explained by ‘instant start’, ‘branding’, ‘control obviousness & reliability’, ‘effort minimization’, ‘concise and user-driven language’, ‘navigation’ and ‘transition’ usability constructs. Significant relationships between usability constructs and continued intention to use and satisfaction provide evidence for the validity of the developed survey instrument for mobile application usability.

Table 4.8: Structural model results.

	Satisfaction	Continued Intention to Use
R^2(%)	49.3	57.7
Instant Start	0.03	0.12**
Branding	-0.02	0.13**
Orientation	0.10**	-0.04
Collaboration	0.22***	0.08
Content	0.18***	0.09
Search	0.10*	-0.01
Privacy	-0.06	-0.03
Graphics & Animations	0.20***	-0.03
Realism	0.03	-0.05
Control Obviousness & Reliability	-0.07	0.10**
Effort Minimization	-0.04	0.14**
Consistency &Standardization	0.02	0.05
Concise & User-Driven Language	0.01	0.14***
Feedback	0.07	0.06
Navigation	0.15***	0.12**
Transition	0.04	0.13***

***p < 0.001; **p<0.05; p<0.1*

5. CONCLUSIONS AND RECOMMENDATIONS

The fact that the number of smartphone users nearly doubled from 2016 to 2021 (Taylor, 2022) has led to the rapid spread of mobile applications, a product offered by these devices. Mobile applications allow people to easily perform many activities in daily life. However, the constraints of mobile devices, such as having a small screen size and a wide variety of usage contexts, significantly limit the usability of mobile applications (Jung, 2017). These limitations and the increasing usage statistics of mobile applications have accelerated the studies on the usability of mobile applications. The limited number of studies in the literature that developed comprehensive guidelines for mobile application usability and the absence of an up-to-date scale for the iOS operating system are the most important motivations for carrying out this study. Current operating system providers, such as Apple, Google, and Microsoft, offer guidance to assist mobile application developers create effective applications for users. These guidelines are not practical for underlining crucial points and assessing mobile application usability. On the other hand, scales to be developed based on these guidelines, which are quite detailed and contain useful information, are very important in measuring usability and developing guides that will provide an overview for mobile application developers. Consequently, the in-depth guideline, namely Apple’s human interface guidelines, provided by one of the two widely used operating systems is regarded as the primary source in this study.

In this study, a systematic survey instrument development methodology consisting of three main phases was followed: conceptualizing the constructs, developing the scale, and evaluating the measurement properties. Apple's human interface guidelines were used as the main source of the open and axial coding procedure during the conceptualization of the constructs. 16 constructs are conceptualized, namely instant start, branding, orientation, collaboration, content, search, privacy, graphics & animations, realism, control obviousness & reliability, effort minimization, consistency & standardization, concise & user-driven language, feedback, navigation, and transition. Afterwards, an initial item pool was created by making use of open codes and related literature. Face validity check, pilot study and content validity check were carried out respectively in order to purify the survey instrument and to make the items easy to understand by all participants. Finally, measurement properties of the developed instrument were evaluated. Factor structures were discovered by exploratory analysis. Then, the discovered factor structures were confirmed, and convergent, discriminant, and nomological validity analyses were performed, respectively. As a result, a survey instrument with 67 items representing 16 constructs was developed, and the validity of this survey instrument was proven. Mobile usability constructs explain a significant part of the variability in satisfaction and continued intention to use. The significant relationships between mobile application usability constructs and satisfaction and continued intention to use provide evidence for the applicability of the developed survey instrument.

5.1 Theoretical Contribution

There are limited studies in the literature that develop survey instrument for mobile application usability. Although the usability guide created by Venkatesh and Ramesh (2006) based on Microsoft usability guidelines was not created specifically for mobile application usability, it has proven to be valid on both websites and wireless handsets. One of the other comprehensive scales was developed by Hoehle and Venkatesh (2015) examining Apple's user experience guidelines, and the other was developed by Hoehle et al. (2016) by examining Microsoft usability guidelines and the last one was developed by Kazdaloglu (2021) by examining Google's material design guidelines. Although there is a current study on the usability of mobile applications in the Android operating system, which is one of the two operating systems leading the market, there is no current study on the iOS operating system. However, considering the rapidly developing technology and the differentiating capabilities of smartphones, it is very important that these guidelines remain up-to-date. Since the scale development study of Hoehle and Venkatesh's (2015), a conceptualization and scale development study based on updated Apple's human interface guidelines and considering the changing capabilities of the iOS operating system has not been conducted. This thesis' major contribution is to conceptualize and develop a survey instrument based on the most recent Apple human interface guidelines.

The conceptualized mobile usability constructs in this study differ in many ways from the constructs those conceptualized by Hoehle and Venkatesh (2015). This study differs from the study of Hoehle and Venkatesh (2015) in that it includes many concepts such as easy authentication, customization, visual separation, reliable controls, gestures, privacy, feedback, and smooth transitions, which are frequently mentioned in Apple's current human interface guidelines (2022). For instance, the emergence of various options such as biometric authentication as an alternative to classical authentication methods in recent years (Allen and Komandur, 2019) has increased the number of studies examining the relationship between authentication and usability (Allen and Komandur, 2019; Wu et al., 2020; Mishra and Dutta, 2022; Marasco et al., 2022). The instant start conceptualized by Hoehle and Venkatesh (2015) as the application launches rapidly and the user can interact with the application quickly. However, quickly launching the mobile application interface is insufficient. A seamless authentication experience is essential the first time the user interacts with the application. Accordingly, in this study, instant start construct refers to a quick application launch and a seamless user authentication process. The content relevance construct of Hoehle and Venkatesh (2015) states that the content in the user interface should always focus on the main theme and also present the content that the user is interested in. This study makes contribution by advocating for the user's ability to customize the content to meet his or her own preferences and requirements. Users' satisfaction with their engagement with the mobile application may be supported by giving them the ability to customize the contents of the interface as much as the application permits. This is supported by the nomological validity findings of this study, which discovered a significant relationship between content construct and satisfaction. Therefore, the concept of customization included in usability studies (Mirkovic et al., 2014) is also considered as a sub-category of the content construct in this study. Similarly, visual separation (i.e. easily distinguishable visual components under all lighting and usage conditions) is also included in this study since it is a concept stressed in current Apple's human interface guidelines, in addition to the mobile application's use of eye-catching and high-quality graphics. The concept of control obviousness in the study of Hoehle and Venkatesh (2015) is conceptualized as the control obviousness and reliability in this study. According to Huang et al. (2006), providing reliable controls depends on the correct labeling of the controls. In addition, it is suggested in the current guidelines that all controls in the user interface direct the user to the correct pages (Apple, 2022). Therefore, this study indicates that the controls should not only clear and understandable, but also reliable. The mental effort construct developed in this study, which considers the evolving features of mobile devices, clearly states that gestures should also be presented to users in order to help them complete a task, in addition to the requirement that the controls in the interface should be fingertip-sized. This construct underlines the necessity of using not only fingertip-sized controls but also gestures in order to perform a task in a mobile application, unlike the fingertip size construct in the study of Hoehle and Venkatesh (2015) and Hoehle et al. (2016). Therefore, it was deemed necessary to include gestures in mobile usability studies.

In addition to these improvements, in this study, three different constructs that were previously discussed in usability studies in the literature were conceptualized. The notion of privacy is one of these constructs, and it describes how to request users for their personal information. Users' personal information may be required by mobile applications for a variety of valid purposes (Enck et al., 2014). Before accessing personally identifiable information, mobile applications must obtain the user's permission, but selecting the appropriate way is essential to prevent disturbing the user (Apple, 2022). If people are worried about their privacy, they could be unwilling to use a mobile platform, which would make it challenging for them to complete their intended tasks (Chin et al., 2012). It is also emphasized, though, how well-designed interfaces can help to significantly address this problem (Chin et al., 2012). In this direction, users should be respectfully informed of the reasons for requesting their personal information. Moreover, they should not be pressured for giving permission during this request. Consequently, this notion is conceptualized as privacy in this study. Another notion that is conceptualized in this study is feedback. This study emphasizes the need for the mobile application to notify users of any status changes. Ji et al. (2006) state, for instance, that the progress bar can give a clear and understandable representation of the current state. Feedback can be provided visually or audibly, as well as physical sensations such as pressure and vibration, i.e. tactile (Sobri et al., 2019). In particular, the benefits of tactile feedback such as quick finding of an interactive object have been previously mentioned in the literature (Brewster et al., 2007; Akamatsu et al., 1995; Brewster and King, 2005). Considering the literature and Apple's human interface guidelines, it was decided to emphasize the feedback construct in this study. Finally, transition construct refers to the mobile application's ability to provide a fast and smooth screen transition experience. According to Kang et al. (2014), users may be disappointed if the mobile application fails to provide a fast and seamless transition experience. Furthermore, it might make it harder for users to navigate between pages (Buchanan et al., 2001). Adipat et al. (2011) stated that screen transitions are one of the main elements of navigating the interface of the mobile application. Thus, it was decided to cover the seamless transitions in this study considering the literature and Apple's human interface guidelines.

As a result, in this study, constructs that are important for mobile application usability are conceptualized by examining Apple’s current guidelines and previous literature. The above-mentioned findings demonstrate that in an environment where technologies and the capabilities of smartphones change so rapidly, instrument development studies for mobile application usability should be repeated at regular intervals.

Another important contribution of this study is the presentation of open codes of conceptualized constructs that will guide mobile application developers to develop user-centered applications. Furthermore, everyone will be able to assess the usability of mobile applications thanks to the developed survey instrument.

5.2 Future Research

Usability may differ depending on cultural characteristics (Díaz et al., 2017). The survey data in this study were obtained from social media application users living in Turkey. The survey instrument developed for mobile application usability in this study can be adapted to different cultures in future studies and its nomological validity can be tested. In addition, since the validity of the developed survey instrument has been proven only in Turkish language, its application area is limited. For this reason, it is essential to prove the validity of the developed instrument in different languages and cultures in future studies.

In addition, one of the main starting points of this study was to develop an up-to-date survey instrument that considers changes in mobile application usability guidelines based on newly developed mobile technologies. In this respect, it is recommended to repeat this conceptualization and survey instrument development study whenever significant revisions are made in usability guidelines offered by the mobile application providers that lead the market. Furthermore, even though a usability evaluation for social media applications is conducted in this study, the developed survey instrument enables for the evaluation of the usability of other types of mobile applications. Therefore, the usability of different mobile application types can be assessed using the conceptualized constructs and survey instrument in this study.

Finally, the effects of demographic characteristics of survey participants on output variables were not examined in this study. In the future, the study can be repeated with participants with different demographic characteristics and it can be investigated how different demographic characteristics explain the variance in the output variables.

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APPENDICES

APPENDIX A: Finalized open code matrix.

APPENDIX B: Intersection between the constructs and prior studies

APPENDIX C: Demographics of participants.

APPENDIX D: Final item pool.

APPENDIX A: Finalized open code matrix

Table A. 1: Finalized open code matrix derived from Apple's Human Interface Guidelines.

Axial Codes	Sub-categories	Open codes
Instant Start	Instant start	The launch screen should gracefully switch to the first screen and the content should be displayed as soon as possible so that people can enjoy the application right away.
		Provide a simple, unobtrusive launch screen that looks like your first application screen.
	Authentication	People should have options to skip tutorials at the beginning of your application.
		Do not force the user to authenticate before navigating within the application and postpone sign-in as much as possible.
		Offer a simple in-app method to open a new account.
		The mobile application offers the user an alternative method to log in if the first method fails.
		Clearly indicate the authentication method, for example, "Login with Face ID".
Branding	Unique brand identity	Design a recallable application icon with a single focus point and identifies your application purpose in clear.
		Use complementary and non-distracting colors that compatible with your logo throughout your application.
		Give people enough brand awareness of your application through smart font, color and images.
	Do not overuse branding elements	Avoid displaying your application icon or other brand assets throughout the interface unless it's necessary for providing context.
		Don't try to provide branding by forcing users to watch ads.
Orientation	Orientation	If the application is suitable for both portrait and landscape orientation, it must be opened using the instant orientation of the device. If it is suitable for only one orientation, it should always open in that orientation.
		The application should allow both portrait and landscape orientation if possible.
		If the application only works in landscape orientation, it should work equally well when the user rotates the device left or right.
		Don't force users to change the orientation of the device while using the application.
Collaboration	Collaboration	Enable sharing information with social media accounts and other applications using sharing extensions.
		Let user rate and review your application after they try it, but only ask for a rating after the user interacts with your application.
		Provide functions to engage the user in two-way communication with application, other apps and users (Swaid and Suid, 2018).
Content	Content focus	Focus on content available in context changes. If content changes while users interact with the application, the change should be easy to follow.
		Enable a single, focused task in all views of the mobile application.
		Highlight content people care about.
	Personalization	The information transmitted to the user in mobile applications should be up-to-date and useful for the user.
		The user's experience should be personalized both by considering the past behavior of the user and by using the personal information that the user allows.
	Customization	Users should be allowed to customize content to their own preferences whenever possible.
Search	Refine the scope of the search	Unless there are clearly predefined categories for the search, prefer to improve search results instead of adding a scope bar.
		To facilitate the search, you should provide useful shortcuts (bookmarks) in the area below the search bar and show a list of results as the user types in the search field.
	Search bar	Provide a search bar to perform search function.
		If necessary, concise hints reminding the searched concept or simply the text 'Search' can be provided in the search bar.
		A Cancel button should be provided so that the user can end the search function immediately and a Clear button to easily clear the search field.

Table A.1 (cont.): Finalized open code matrix derived from Apple's Human Interface Guidelines.

Axial Codes	Sub-categories	Open codes
Privacy	Requesting access permission	Request personal information such as location, health, contact, and other personally identifiable information only when your application clearly needs it.
		When your application clearly needs personal information, provide a short permission text that politely explains to the user why that information is needed.
		Users should be able to browse your application without sharing personal information. Thus, don't ask for permission at launch if it's not necessary for your application to work.
		Don't encourage the user to give permission and don't use visual stimuli to draw the user's attention to the Allow button.
Graphics & Animations	High-quality artwork	Provide cleverly produced and dazzling graphics that attracts user's attention.
		Provide high resolution for all images on all devices supported by your application.
		Optimize graphics and images to find a balance between size and quality.
	Visual separation	Use the same asset (images, glyphs, icons etc.) if it looks good in both light and dark modes.
		Ensure sufficient color contrast and visual separation for all UI elements in all appearances and majority of use cases (variety of lighting conditions).
	Animation and motion effects	Use animation and motion effects wisely and sparingly, and make them optional for users.
		Visualize the results of users' actions using animation appropriately, thus add vitality to the user experience.
		Subtle animations such as smooth page transitions and smooth changes in orientation should be used consistently.
Realism	Strive for realism	If you need to clarify an item's or command's meaning, you can display a recognizable and realistic glyph or image right after its title.
		It's essential that each image, icon or glyph be used in accordance with its meaning and recommended usage so as not to confuse users.
		Offer realistic and reliable design elements so people don't get confused.
Control Obviousness	Easily understandable controls	The basic function of the mobile application should be clear and easily understandable at at first sight.
		Using visual cues, it should be easily understood whether the buttons are interactive or not.
		Interactions should be simple and intuitive, and should work well on most interfaces.
	Reliable controls	Destructive actions should be highlighted in red color and positioned at the top of the action page.
		All tabs must always be active for user controls to be reliable.
		Controls should be labelled correctly so that the user can clearly know what to expect when they click a button or interact with a control.
Mental Effort	Make data entry easy and intuitive	If possible, provide options such as a selector or a table instead of a text field, as it's easier to choose from a list of predefined options.
		Sort the value lists logically, for example alphabetically, so that users can quickly browse and easily select what they want.
		Show a hint in the text field or provide logical default values for simple and intuitive data entry.
		If possible, check the data values immediately after entry so that users can correct them quickly.
	Preserve data against interruptions	During the interruption, the application should be allowed to save the current state and continue where the user left off when they return.
		To avoid data loss, changes should be saved automatically at regular intervals rather than waiting for the user to save them.
	Minimize the need for in-app settings	The application should be designed in a way that many users expect, minimizing the need for settings and users should not be forced to make settings within the application.

Table A.1 (cont.): Finalized open code matrix derived from Apple's Human Interface Guidelines.

Axial Codes	Sub-categories	Open codes
Mental Effort	Finger-tip-size controls& Gestures	Avoid defining too many tap targets that make it difficult for people to interact with.
		A large space should be left around the Home Screen indicator so that users do not accidentally touch it when they trying to interact with another control.
		All controls in the application should be large enough to be possible and easy to touch, even in distracting environments.
		Use touch gestures to make it easier to perform actions and enhance the control experience.
Consistency and Standardization	Provide consistent and familiar appearance	Provide standard interface elements (icons, glyphs, etc.), controls, and gestures that other applications use, and use them according to their predefined meanings.
		Present an overall consistent and familiar look throughout the application.
		Multiple controls with the same functionality should not be used.
		The features offered in the application should be consistent, if they are available in one place, they should be provided in other places as well.
		Locate controls in convenient places that users are familiar with and use intuitively.
Concise& User-Driven Language	User-driven language	Use approachable and conversational terminology that most people will understand and feel comforted.
		Avoid using technical terms that users may find difficult to understand.
		Avoid judgmental or insulting expressions.
		Humor should be used with caution, as it may differ by culture and excessive use can make the user uncomfortable.
	Succinct language	Interface texts such as messages, alerts should be clear, concise and briefly express the situation.
		Titles should express the action or task in a concise manner.
		Punctuation and capitalization should be used appropriately.
		Core content should be clear and legible at its default size.
Feedback	Provide appropriate feedback	Visual, auditory(sounds), tactile(haptics) and other types of feedback should be used adequately and in moderation.
		A causal relationship must be established between each feedback and its trigger so that users can understand intuitively.
		Activity indicators should be used to convey to people that the application does not stop when it needs time to complete a task.
		If the duration of the task can be measured, the progress bar should be used to convey to people how long the task will take.
Navigation	Provide a clear and intuitive path	Users should have several options (connecting via another application, connecting via clicking on notification or widget) to choose from if aiming to access an application.
		Navigation should be natural, familiar and intuitive, not distract the user from the content and not require much guidance.
		A single, logical and predictable way should always be provided for users to reach a point within the application.
		A navigation bar must be provided to navigate a data hierarchy and a back button to go to the previous step.
		An intuitive way should be provided that allows the user to immediately end an operation or exits the application.
	Organize the hierarchy from top to bottom	The information hierarchy should be arranged in such a way that it requires minimum number of interactions when accessing the desired content.
		Basic and frequently used items should be located at the upper half of the screen.
		Important information and content should not be placed in the corners of the screen.
		Visual separators should be used so that users can browse the menu more easily.
		The most important actions should be on the main page, and menus should be used if additional actions are required.
Transition	Smooth transition	Provide a seamless transition to your application and ensure visual continuity during the transition.
		A blank and static screen should not be displayed while the content is loading so that the application does not appear to be frozen.
		Show people the screen they've been waiting for right away during screen transitions and make use of placeholder text or graphics until the content is fully loaded.

APPENDIX B: Intersection between the constructs and prior studies

Table B.1: Intersection between the constructs proposed in this study and previous studies in the literature.

Constructs	Open Codes Examples	Previous Literature
Instant Start	•The launch screen should gracefully switch to the first screen and the content should be displayed as soon as possible so that people can enjoy the application right away. •Do not force the user to authenticate before navigating within the application and postpone sign-in as much as possible.	Whitenton, 2020; Galletta et al., 2006; Hoehle and Venkatesh, 2015; Abubakar et al., 2016; Allen and Komandur, 2019; Keith et al., 2007; Mihajlov et al., 2011; Schlöglhofer and Sametinger, 2012; Wu et al., 2020; Mishra and Dutta, 2022; Marasco et al., 2022
Branding	•Give people enough brand awareness of your application through smart font, color and images. •Avoid displaying your application icon or other brand assets throughout the interface unless it's necessary for providing context.	Rondeau, 2005; Lowry et al., 2008; Dou et al., 2010; Bellman et al., 2011; Bellman et al., 2013; Hoehle and Venkatesh, 2015; Wu, 2015; Van Noort and Van Reijmersdal, 2019; Wang, 2020; Kazdaloglu, 2021
Orientation	•The application should allow both portrait and landscape orientation if possible. •Don't force users to change the orientation of the device while using the application.	Wobbrock et al., 2008; Gardner, 2011; Sanchez and Branaghan, 2011; Cheng et al., 2013; Hoehle and Venkatesh, 2015
Collaboration	•Enable sharing information with social media accounts and other applications using sharing extensions. •Provide functions to engage the user in two-way communication with application, other apps and users.	Oulasvirta et al., 2005; Oulasvirta et al., 2007; Hoehle and Venkatesh, 2015; Gill et al., 2017; Swaid and Suid, 2018; Kazdaloglu, 2021
Content	•Enable a single, focused task in all views of the mobile application. •The user's experience should be personalized both by considering the past behavior of the user and by using the personal information that the user allows. •Users should be allowed to customize content to their own preferences whenever possible.	Agarwal and Venkatesh, 2002; Blom and Monk, 2003; Kim and Stoel, 2004; Haghirian, 2005; Wells et al., 2005; Mithas et al., 2006; Agarwal and Venkatesh, 2006; Venkatesh and Ramesh, 2006; Tan et al., 2009; Tung et al., 2009; Mirkovic et al., 2014; Hoehle and Venkatesh, 2015; Inostroza et al., 2016; Dourado and Canedo, 2018; Baek and Yoo, 2018; Fuller-Tyszkiewicz et al., 2018; Parente Da Costa et al., 2019; Al-Shamaileh and Sutcliffe, 2023
Search	•To facilitate the search, you should provide useful shortcuts (bookmarks) in the area below the search bar and show a list of results as the user types in the search field. •Provide a search bar to perform search function.	Koufaris, 2002; Cox and Dale, 2002; Tan et al., 2009; Tung et al., 2009; Dou et al., 2010; Nah et al., 2010; Hoehle and Venkatesh, 2015; Huang, 2019; Kazdaloglu, 2021

Table B.1 (cont.): Intersection between the constructs proposed in this study and previous studies in the literature.

Constructs	**Open Codes Examples**	**Previous Literature**
Privacy	•When your application clearly needs personal information, provide a short permission text that politely explains to the user why that information is needed. •Don't encourage the user to give permission and don't use visual stimuli to draw the user's attention to the Allow button.	Chin et al., 2012; Kelley et al., 2012; Liu et al., 2014; Enck et al., 2014; Kazdaloglu, 2021
Graphics & Animations	•Provide high resolution for all images on all devices supported by your application. •Use the same asset (images, glyphs, icons etc.) if it looks good in both light and dark modes. •Use animation and motion effects wisely and sparingly, and make them optional for users.	Kisielius and Sternthal, 1984; McGill and Anand, 1989; Hong et al., 2004; Hess et al., 2005; Cyr et al., 2006; Li and Yeh, 2010; Hoehle and Venkatesh, 2015; Hoehle et al., 2016; Huang, 2019; Kazdaloglu, 2021
Realism	•If you need to clarify an item's or command's meaning, you can display a recognizable and realistic glyph or image right after its title. •Offer realistic and reliable design elements so people don't get confused.	Kang, 2007; Gatsou et al., 2012; Hoehle and Venkatesh, 2015; Hoehle et al., 2016; Yu and Fang, 2016; Urbano et al., 2020; Kazdaloglu, 2021
Control Obviousness & Reliability	•The basic function of the mobile application should be clear and easily understandable at at first sight. •Controls should be labeled correctly so that the user can clearly know what to expect when they click a button or interact with a control.	Seffah et al., 2006; Ji et al., 2006; Huang et al., 2006; Hoehle and Venkatesh, 2015; Hoehle et al., 2016; Jokela et al., 2006; Huang, 2019; Kazdaloglu, 2021
Effort Minimization	•Show a hint in the text field or provide logical default values for simple and intuitive data entry. •To avoid data loss, changes should be saved automatically at regular intervals rather than waiting for the user to save them. •Use touch gestures to make it easier to perform actions and enhance the control experience.	Doherty and Kelisky, 1979; Seffah et al., 2006; Park and Han, 2010; Hoehle and Venkatesh, 2015; Hoehle et al., 2016; Jokela et al., 2006; Bhullar and Singh Gill, 2019; Kazdaloglu, 2021
Consistency and Standardization	•Provide standard interface elements (icons, glyphs, etc.), controls, and gestures that other applications use, and use them according to their predefined meanings. •Present an overall consistent and familiar look throughout the application.	Ji et al., 2006; Tan et al., 2009; Tung et al., 2009; Adipat et al., 2011; Hoehle and Venkatesh, 2015; Swaid and Suid, 2018; Huang, 2019; Kazdaloglu, 2021

Table B.1 (cont.): Intersection between the constructs proposed in this study and previous studies in the literature.

Constructs	Open Codes Examples	Previous Literature
Succint&User-Driven Language	•Use approachable and conversational terminology that most people will understand and feel comforted. •Interface texts such as messages, alerts should be clear, concise and briefly express the situation.	Sørensen et al., 2012; Hoehle and Venkatesh, 2015; Kazdaloglu, 2021; McLean, 2021
Feedback	•Visual, auditory(sounds), tactile(haptics) and other types of feedback should be used adequately and in moderation. •A causal relationship must be established between each feedback and its trigger so that users can understand intuitively.	Akamatsu et al., 1995; Brewster and King, 2005; Ji et al., 2006; Brewster et al., 2007; Swaid and Suid, 2018; Sobri et al., 2019; Kazdaloglu, 2021
Navigation	•Navigation should be natural, familiar and intuitive, not distract the user from the content and not require much guidance. •Basic and frequently used items should be located at the upper half of the screen.	Larson and Czerwinski, 1998; Miranda González and Bañegil Palacios, 2004; Adipat et al., 2011; Kang et al., 2014; Hoehle and Venkatesh, 2015; Hoehle et al., 2016; Huang, 2019; Kazdaloglu, 2021
Transition	•Provide a seamless transition to your application and ensure visual continuity during the transition. •A blank and static screen should not be displayed while the content is loading so that the application does not appear to be frozen.	Buchanan et al., 2001; Adipat et al., 2011; Kang et al., 2014; Hoehle et al., 2016; Kazdaloglu, 2021

APPENDIX C: Demographics of participants.

Table C.1: Demographic information of the participants in the pilot test, content validity analysis, explanatory and confirmatory assessment stages.

		Pilot study		Content validity analysis		Explanatory assessment		Confirmatory assessment	
Demographic	**Category**	**N=39**	**%**	**N=40**	**%**	**N=476**	**%**	**N=583**	**%**
Gender	Women	22	56.4	19	47.5	210	44.1	278	47.7
	Men	17	43.6	21	52.5	266	55.9	305	52.3
Age	18-19	1	2.5	1	2.5	26	5.5	66	11.3
	20-29	29	74.3	26	65	228	48	231	39.6
	30-39	5	12.8	10	25	161	33.7	179	30.7
	40-49	2	5.2	0	0	45	9.5	89	15.3
	50 and above	2	5.2	3	7.5	16	3.3	18	3.1
Job	ICT	3	7.8	6	15	32	6.7	20	3.4
	Banking and Finance	1	2.5	2	5	19	4	23	4
	Insurance, Real Estate & Law	2	5.2	1	2.5	15	3.2	8	1.5
	Construction and Engineering	4	10.2	0	0	66	13.8	114	19.6
	Government Policy	2	5.2	4	10	144	30.3	48	8.2
	Health Services	4	10.2	5	12.5	37	7.8	57	9.8
	Trading and Self-Employed Areas	0	0	0	0	11	2.3	34	5.8
	Education	9	23.1	13	32.5	75	15.8	94	16.2
	Marketing, Advertising and Design	4	10.2	4	10	9	1.8	27	4.6
	Student	5	12.8	3	7.5	52	10.9	89	15.4
	Other	5	12.8	2	5	16	3.4	49	8.5
Social Media Preference	Facebook	2	5.2	5	12.5	45	9.5	93	15.9
	Twitter	8	20.5	9	22.5	71	14.8	102	17.4
	Instagram	17	43.6	17	42.5	204	42.9	226	38.7
	YouTube	12	30.7	9	22.5	156	32.8	164	28
Frequency of Using the Application (per week)	<1 day	N/A	N/A	N/A	N/A	53	11.1	58	10
	2-3 days	N/A	N/A	N/A	N/A	91	19.1	116	20
	4-5 days	N/A	N/A	N/A	N/A	138	29	225	38.6
	6-7 days	N/A	N/A	N/A	N/A	194	40.8	183	31.4
Average time consumed (per day)	<1 h	N/A	N/A	N/A	N/A	140	29.4	210	36
	1-3 h	N/A	N/A	N/A	N/A	263	55.3	246	42.2
	4-6 h	N/A	N/A	N/A	N/A	62	13	92	15.8
	>6 h	N/A	N/A	N/A	N/A	11	2.3	35	6

APPENDIX D: Final item pool.

Table D.1: Final item pool after content validity analysis.

Construct	Code	Items
Instant Start	INST1	The mobile application displays initial screen as soon as possible.
	INST2	The mobile application is ready to use after launching.
	INST3	As the mobile application opens very quickly I can easily access the content.
	INST4*	The mobile application doesn't force authentication to navigate within the application.
	INST5	The mobile application only asks for authentication when necessary and provides a simple way to do so.
Branding	BRND1	The mobile application integrates branding elements (brand colors, stylized icons etc.) into the interface without distractions.
	BRND2	The mobile application icon is artistically designed and clearly defines the purpose of the application.
	BRND3	The mobile application offers a recognizable and brand-reminiscent interface.
	BRND4	The mobile application doesn't force me to watch brand-related advertisements.
Orientation	ORIE1	The mobile application supports both portrait and landscape orientation.
	ORIE2	The mobile application works well whether I rotate the device left or right.
	ORIE3	The mobile application doesn't force me to change the orientation of the device.
	ORIE4	Content in the mobile application looks good in both portrait and landscape mode.
Collaboration	COLL1	The mobile application allows me to share information with social media accounts or other channels.
	COLL2	The mobile application allows me to interact with others through ratings, reviews and messages etc.
	COLL3	The mobile application allows me to interact with others.
	COLL4	The mobile application makes it possible for me to communicate with others.
Content	CTNT1	The content of the mobile application is focused on a single purpose.
	CTNT2	The mobile application presents the content I am most interested in.
	CTNT3	The mobile application personalize the content according to my previous preferences.
	CTNT4	The mobile application allows me to customize the content according to my own preferences.
Search	SEAR1	The mobile application helps me to search the content faster.
	SEAR2	The mobile application provides a search bar for me to search easily.
	SEAR3	The mobile application narrows the list of results in relation to my search terms.
	SEAR4	The mobile application provides helpful shortcuts(bookmarks) under the search area.
Privacy	PRVC1	The mobile application clearly states why it needs personal data such as location, health and financial information.
	PRVC2	The mobile application asks for permission before using personal data and uses them according to my preferences.
	PRVC3	The mobile application allows browsing the application without access to personal data.
	PRVC4	The mobile application doesn't force me to share my personal data unless necessary.
Graphics & Animations	GRAN1	The mobile application uses beautiful, interesting and evocatory graphics.
	GRAN2	The mobile application makes use of high resolution and quality of images and artworks.
	GRAN3	The mobile application uses animations and motion effects effectively.
	GRAN4	The animations and motion effects in the mobile application are optional.
	GRAN5	The mobile application makes use of animations to add vitality to the experience.
Realism	REAL1	The mobile application benefits from realistic icons.
	REAL2	The mobile application uses icons in accordance with their meaning and suggested usage.
	REAL3	Icons in the mobile application remind real-life objects.
	REAL4	The meanings of the icons in the mobile application are easily understood.

Table D.1 (cont.): Final item pool after content validity analysis.

Construct	Code	Items
Control Obviousness &Reliability	COBV1	The mobile application provides intuitive controls that I can easily understand their function.
	COBV2	The controls in the mobile application always lead me the results I expect.
	COBV3	In the mobile application, controls are labelled correctly according to their functions.
	COBV4	The core function of the mobile application is clear and understandable at a single glance.
Effort Minimization	EFR1	The mobile application provides hints or reasonable default values in the data entry field.
	EFR2*	The mobile application allows me to spend less effort by providing logical options instead of typing.
	EFR3	The mobile application saves the current state and my data automatically so that I can continue from where I left off.
	EFR4	The mobile application doesn't force me to change the settings within the application.
	EFR5	The mobile application provides large-enough touchable area for each button.
	EFR6	The mobile application allows me to interact with the application interface with finger gestures such as swiping, double-clicking on the touch screen.
Consistency and Standardization	CSTD1	The mobile application maintains a consistent and familiar appearance throughout the interface.
	CSTD2	The mobile application provides standard interface elements (icons etc.) and controls that are similar to other applications.
	CSTD3	In the mobile application, the controls are in the position I expected and can be found intuitively.
	CSTD4	The mobile application uses a consistent design, typography and color throughout the interface.
Concise & User-Driven Language	CUDL1	The mobile application uses concise language both texts and titles throughout the interface.
	CUDL2	The mobile application uses an easy-to-understand language.
	CUDL3	The mobile application uses a friendly tone and avoids judgmental and insulting expressions.
	CUDL4	The mobile application avoids technical jargon that seems complicated to me.
Feedback	FB1	The mobile application provides visual, auditory, tactile and other types of feedback appropriate to the actions I take.
	FB2	The mobile application notifies me for actions or any status changes.
	FB3	The mobile application keeps me informed of what happens during the waits and how long the situation will last.
	FB4	The mobile application immediately warns me when I make an incorrect data entry.
Navigation	NAV1	The mobile application can be accessed through another application or notifications.
	NAV2	The mobile application provides a logical and predictable path.
	NAV3	The mobile application interface is easy and predictable to navigate.
	NAV4	The mobile application allows me to take the action I want to do in the shortest way.
	NAV5	The mobile application provides principal and the most frequently used information and actions on the top of the screen.
Transition	TRAN1	The mobile application seamlessly transitions from one screen to the next.
	TRAN2	The mobile application switches from one screen to another without any difficulty.
	TRAN3	The mobile application doesn't appear to be frozen when switching from one screen to another.
	TRAN4	The transition from one screen to another in the mobile application is fast enough.

*: Defines the items extracted from the item pool after explanatory factor analysis.

CURRICULUM VITAE

Name Surname : Kübra ÇETİN YILDIZ

EDUCATION :

B.Sc. : 2019, Gazi University, Faculty of Engineering, Department of Industrial Engineering

PROFESSIONAL EXPERIENCE:

- January 2020-Present Research Assistant, Istanbul Technical University, Department of Industrial Engineering

PUBLICATIONS, PRESENTATIONS AND PATENTS:

- Gumussoy, C.A., Ay, N., Yildiz, K.C., Pekpazar, A. (2023). The Use of Gamification in Sales: The Technology Acceptance Model. In: Calisir, F. (eds) Industrial Engineering in the Age of Business Intelligence. GJCIE 2021. Springer, Cham. https://doi.org/10.1007/978-3-031-08782-0_6
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