Università
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Venezia

**Department
of Management**

Working Paper Series

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Adoption Stages and
Determinants**

**Working Paper n. 3/2017
March 2017**

ISSN: 2239-2734

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Consumer Innovation Adoption Stages and Determinants

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(February 2017)

Abstract:

Existing research on innovation adoption is divided into two main streams: organizational innovation adoption and individual (consumer) innovation adoption. Proponents of both perspectives approach the topic in a variety of ways. Contrary to the organizational adoption, research on the consumer adoption investigates the determinants of adoption/non-adoption without considering the innovation-decision as a process. Particularly, for high involvement innovations that require efforts in terms of cost, money, and resources to switch to a new routine and behavior, innovation adoption as a multi-stage process is most relevant. In line with Rogers' (2003) multi-stage individual adoption process, this study aims to first explore the existence of distinct stages of innovation adoption and then identify the different determinants of each stage of adoption. To address both research questions, an exploratory factor analysis (EFA) and a structural equation modeling (SEM) technique were used. Data was collected from individuals using two different online surveys on smartwatch and alternative engine cars (AECs). Data from the first survey was used to extract factors using EFA. The results confirmed the existence of five distinct stages: knowledge, persuasion, decision, implementation, and confirmation. Based on these results, data from the second online survey was used to identify the predictors of each stage. Different determinants in terms of perceived innovation characteristics of AECs were analyzed using a structural model. In line with temporal distance theories and loss aversion theory, the findings show that perceived benefits of an innovation explain variation in persuasion stage, while perceived losses impact implementation stage. Decision and confirmation stages on the other hand are less explained. The study contributes by confirming the existence of distinct stages of consumer adoption of high involvement innovations and developing a framework which not only determines the direction but also the strength of the relationships between different determinants and adoption stages.

Keywords: Consumer innovation adoption stages, alternative engine cars, perceived innovation characteristics, diffusion of innovation.

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1. Introduction

The diffusion of innovation (DOI) as a field of research has gained as much importance, if not more, as the innovation creation itself. Early studies on DOI highlight the importance of understanding the nature of this phenomenon, whose empirical manifestations show subsequent decisional stages (Rogers, 1962, 1983), in contrast with the discontinuous concurrence of events of the Schumpeterian perspective (Robertson, 1967).

Researchers from various disciplines adopt different perspectives. Economists tend to conceive innovation as an outcome while organizational sociologists mainly adopt a process perspective (Gopalakrishnan & Damanpour, 1997). Management studies consider both viewpoints with a focus on the adoption process conditions and emerging patterns, both in organization and in consumer behavior literature (Kimberly & Evanisko, 1981; Meyer & Goes, 1988; Van de Ven & Rogers, 1988).

Rogers' (1983, 1995, 2003) theory on DOI supports that innovation-decision is a multi-stage process through which a decision making unit passes through a number of selective steps. Such process occurs both in individuals and organizations adoption choices. Understanding the process perspective is relevant as the adoption of new technologies often requires resources and efforts to shift towards a new behavior. Different actors in a society e.g. policy makers, industry players, local authorities make and implement strategies to make the shift successful. Hence it is of paramount importance for such stakeholders to analyze how a decision making unit passes through the adoption process and which factors ensure smooth transition from one phase to another in the process. The dynamics that play role during each phase may be different due to a distinct nature of each phase and identification of success factors behind every step in the process can foster diffusion. Rogers' seminal contributions have deeply influenced the research in this field. He claims that the process nature of

innovation should be investigated through a research based on a type of data gathering and analysis that seeks to determine the ordered sequence of a set of events. In contrast, the majority of diffusion studies mainly focus on variance type investigation; innovation adoption as a process consisting of sequence of stages is, indeed, ignored (Frambach & Schillewaert, 2002; Rogers, 2003).

Empirical studies, on large bases, investigate determinants of adoption/non-adoption decision; ignoring other pre and post adoption phases in the decision process. For example, Frambach, Barkema, Nooteboom, & Wedel (1998) analyze determinants of adoption of an innovation by quantifying it as a binary variable (i.e., adoption or non-adoption decision). Very little is known about the factors that affect other phases (Frambach & Schillewaert, 2002; Arts, Frambach, & Bijmolt, 2011). There are few exceptions in consumer innovation adoption literature, however they either focus relatively on the broad categorization of phases or a subset of the whole process (e.g., Alexander, Lynch, & Wang, 2008; Arts et al., 2011; Manning, Bearden, & Madden, 2005; Wood & Moreau, 2006). On the other hand, relatively higher number of studies have empirically tested the phenomena in organizational innovation adoption with an interactive process perspective (e.g., Chong & Chan, 2012; Damanpour & Schneider, 2006; Kim & Garrison, 2010; Matta, Koonce, & Jeyaraj, 2012). Although the topic is considered relevant (Frambach & Schillewaert, 2002; Hameed, Counsell, & Swift, 2012), to the best of my knowledge the empirical validation of a multi-staged innovation-decision in consumer adoption process is still to be provided.

This article finds its motivation in this gap. Adoption is the premise for innovation diffusion and the research in this field commonly assumes that an individual evaluates a new idea and decides whether or not to incorporate the idea into an ongoing practice through an interrelated series of actions and choices. As highlighted above, presently this assumption do not relies on

empirical validation. What is more, adoption of the innovation which suffers from lock-in and is in early stages of diffusion curve requires more time, effort, and cost to switch to a new behavior compared to the adoption of the established alternative. Adoption of such innovations is likely to occur in distinct steps, hence provides a relevant setting to validate the assumption. This leads to two overarching research questions: whether distinct innovation adoption stages exist and whether different determinants affect different stages?

The study relies on the individual innovation adoption framework (Rogers, 2003) to test stage assumption and on temporal distance theories (Trope & Liberman, 2003; Wright & Weitz, 1977) to test varying effects of perceived innovation characteristics on each stage. Two surveys were conducted in order to collect the responses from (potential) adopters. The existence of stages is explored through principal factor analysis (PCA) using data collected from the first online survey on smartwatch technology ($N_1=110$) while the determinants of each stage are identified through a Structural Equation Modeling (SEM) approach using data gathered from the second survey on alternative engine cars (AECs) ($N_2= 246$). The peculiar kind of innovations has been chosen since both requires high consumer involvement and efforts and are in early phases of diffusion; thus the possible separation among stages is more evident with respect to a situation where the choices have assumed a routine connotation. The second survey, in particular, benefitted from a series of contributions (e.g., Jansson, 2011; Jansson, Marell, & Nordlund, 2010; Jansson, Marell, & Nordlund 2011; Ozaki & Sevastyanova, 2011; Petschnig, Heidenreich, & Spieth, 2014; Rezvani, Jansson, & Bodin; 2015) that also analyze high involvement consumer behaviors related to adoption of hybrid electric vehicles (HEVs) and electric vehicles (EVs).

The findings confirm the existence of five distinct stages –knowledge, persuasion, decision, implementation, and confirmation stage in both empirical settings in line with Rogers'

framework. The findings further reveal that each stage is explained by different set of perceived innovation characteristics- persuasion is affected by perceived benefits of an innovation, while implementation is explained by perceived costs and proximal factors. Decision and confirmation are explained by only few attributes.

The contribution to the present knowledge stands both in the proposed model and in the implications stemming from the results of the empirical research. First, the paper contributes by empirically validating and confirming the existence of five unique stages in case of high involvement innovations. Such contribution differs from prior studies in the field to the extent they look at adoption decision as a dichotomous variable (adoption or rejection i.e., 1 or 0) rather than focusing on each stage of the process. In addition, prior adoption literature utilizes 2-stage (e.g., Arts et al., 2011) or 3-stage models (e.g., Chong & Chan, 2012; Damanpour & Schneider, 2006; Kim & Garrison, 2010) while this study utilizes the five stages of adoption process as suggested by Rogers (2003). Secondly, the findings extend the results of earlier studies by identifying a clear dynamic role of antecedents of each of the five stages. Furthermore, the empirical analysis developed to test the model of determinants here suggested, identifies both the direction and the strength of the relationships between determinants and stages. Finally, to the best of author's knowledge, the existing literature provides weak operationalization of the five stages, with few exceptions from different fields (Celik, Sahin, & Aydin, 2014; Gilly & Zeithmal, 1985; Li & Lindner, 2007). The current study validates the stage questions partly adapted for both surveys.

The remainder of the paper is structured as follows: section two lays the foundation by introducing DOI theory and consumer innovation-decision process and presents hypotheses and framework of the study. The third section covers sample details, data collection, and

measures and operationalization of variables. Fourth section is devoted for factor analysis and SEM results. Finally, fifth section discusses the results, limitations and contributions.

2. Literature review and theoretical framework

Existing empirical work on consumer innovation adoption considers it as an outcome and determines it in terms of adoption or non-adoption (e.g. Jansson, 2011; Jansson et al., 2011; Lassar, Manolis, & Lassar, 2015). This perspective affects the way innovation adoption and related issues are interpreted. In particular, a crucial problem regards innovations that suffer from lock-in due to established/ dominant products available in the market are hard to diffuse quickly. This is because consumers using conventional products have to break their existing routines in order to switch to a new innovation. For example, the substitution of conventional brown products with green innovations requires a process of change in existing behavior. Roger's (2003) work on DOI clarifies this point by conceptualizing innovation adoption as a multi-stage process. However, existing literature did not investigate multi-step process of adoption empirically. This study fills the gap by first exploring consumer innovation adoption as a process based on different stages and secondly identifying different predictors of each stage further confirming the existence of stages for new products. Below, I review the existing literature after briefly shedding light on DOI and its emergence.

2.1. Background of the diffusion of innovation theory

Diffusion is a social process which is characterized by seven elements: *acceptance*, over *time*, of some specific *item*- an idea or practice, by *adopting units*, linked to specific *channels* of communication, to a *social structure*, and to a given system of values or *culture* (Katz, Levin, & Hamilton, 1963). The diffusion of innovation is generally acknowledged as the main mechanism of technical and social change; its importance emerged around the turn of twentieth century by the work of Gabriel Tarde, a French lawyer, judge, and sociologist, who

wrote the book, "The Laws of Imitation" in 1903. Although he did not use the word 'diffusion' directly in his work, he opened the way for further studies identifying the role of opinion leader and of social status in the diffusion process. He also postulated the S-shape curve of the rate of adoption (Tarde, 1903). Later, during the 1930s and the 1940s, sociologist and anthropologists started conducting empirical studies on diffusion of cultural traits, for example Pemberton (1936, 1937, 1938) analyzed postage stamps diffusion and Bowers (1937) studied diffusion of consumer innovations. Ryan & Gross (1943) studied the diffusion of hybrid corn seed. These contributions, as many others, commonly look at the diffusion as a cultural fact that follows successive, distinctive phases. Starting from these and other pioneering studies, the theory of diffusion was gradually modified and its principles were adopted by other social sciences. DOI then progressed overtime and Rogers' (1962) most widely cited theory played a vital role in popularizing and spreading the field. Presently the diffusion research is spread among various academic disciplines like anthropology, agriculture, sociology, economics, geography, political science, marketing, communication, management etc.; infact the diffusion paradigm has provided an interdisciplinary common ground.

This paper is grounded in the classical DOI theory introduced by Rogers (1962, 2003), whose seminal work lays the foundation of today's research on innovation adoption and diffusion. In his book "Diffusion of Innovations", Rogers (1983) defines innovation as "*an idea, practice, or object perceived as new by an individual or other unit of adoption*" (p. 35), and defines diffusion process as "*the process by which an innovation is communicated through certain channels over time among the members of a social system*" (p. 5). The diffusion process follows the S-shaped curve. The S-shaped slope of the curve represents the rate of adoption or diffusion. Some new innovations, which diffuse quickly, form a steeper S-shaped curve, while others form a gradual curve. The S-shaped curve is formed in relation with different

adopter categories: innovators, early adopters, early majority, late majority, and laggards (Rogers, 1995, 2003). Initially, the S-curve starts progressing slowly as the innovators start adopting the new innovation. Due to early adopters the curve then rises faster (reaches "take-off") and reaches at its steepest as early majority and late majority start adopting the innovation. Lastly, the curve moves slower and levels-offs at the top as laggards adopt the innovation slowly and the cumulative number of adopters are exhausted.

Although strictly related, innovation diffusion and innovation adoption are two different concepts. Innovation diffusion refers to the accumulated level of users of an innovation in the market; whereas, innovation adoption refers to the decision process in which a decision making entity- an individual or an organization makes use of an innovation (Rogers, 1995). The decision process reflects the existence of distinct stages ranging from the first knowledge of the innovation to the confirmation of innovation use. During 1960s and 1970s, a number of other studies of innovation adoption (e.g., Robertson, 1974; Ostlund, 1974) and diffusion (e.g., Bass, 1969; Mahajan, Muller, & Bass, 1991) were conducted, but the adoption process of a decision making unit and the way it is influenced lie at the heart of the diffusion paradigm.

2.2.Innovation adoption: A multi-stage perspective

The adoption of an innovation is a *process* that results in the introduction and use of a product, process, or practice that is new to the adopter (Kimberly & Evanisko, 1981). The adoption process is defined as the "mental and behavioral sequences through which the consumer progresses and which may result in acceptance and continued use of a product or brand" (Robertson, 1974, p. 271). Being a process, the innovation adoption occurs through a sequence of actions and choices. Rogers (2003) defines innovation-decision process as the process through which an individual passes from first knowledge to an innovation

(knowledge stage), to forming an attitude towards the innovation (persuasion stage), to a decision to adopt or reject (adoption decision stage), to implementation of the new idea (implementation stage), and to confirmation of this decision (confirmation stage). This behavior is based on dealing with the uncertainty which is inherent in deciding about a new alternative. Therefore, *perceived newness* of the innovation and the *uncertainty* attached with this newness are distinctive facets of innovation decision-making as compared to other types of decision-making (Rogers, 1983).

The evidence of the validity and existence of these stages comes initially from an Iowa study by Beal and Rogers (1960) and Beal, Rogers, and Bohlen (1957). The studies of agriculture innovations provide two important insights. First, most farmers recognized that they moved through the series of stages as they passed through knowledge-awareness and adoption decision of two agricultural innovations and were exposed to different communication channels at different functions. Secondly, none of the farmers adopted the innovation immediately after being aware of new ideas and they took different time period to pass through different stages. Hence, the channel and time differentiation at different functions of innovation decision confirmed that innovation adoption behavior is a process that has distinct phases which occurs over time. Similarly, other early studies also support the evidence of existence of innovation process stages like Copp, Sill, and Brown (1958), Coleman, Katz, and Menzel (1966), Kohl (1966), and Rahim (1961).

Besides individual innovation decision process, Rogers (2003) also contributes in organizational innovation literature by identifying similar five stages of innovation process in organizations. The stages are agenda setting, matching, redefining/ restructuring, clarifying, and routinizing. Organizational decision-making particularly focuses on collective or authority innovation decision. However, the main concern in this study is consumer or

individual decision-making that focuses on optional innovation decisions. Optional decision to adopt or reject is made by an individual who is independent of the decisions or choices of other members in the system.

Beside Rogers' innovation-decision process, others also provided stage-based process of innovation adoption. The summary of multi-stage models by prior studies is presented in table 1.1 below. Each stage in the process is characterized by a specific set of actions, events, and decisions. All the stages of individual or organizational adoption have been widely categorized into three phases: initiation, adoption-decision, and implementation (Damanpour & Schneider, 2006; Frambach & Schillewaert, 2002; Pierce & Delbecq, 1977; Tornatzky & Fleischer, 1990; Zmud, 1982). Initiation is based on information gathering, conceptualization, and planning to adopt an innovation while implementation refers to all actions, events, and decisions for putting an innovation into use. The actual decision to adopt the innovation falls in between initiation and implementation. These three phases are commonly referred as pre-adoption, adoption, and post-adoption. Later stages in adoption process depend on earlier stages and cannot be undertaken unless earlier stages have been settled (Rogers, 1983, 2003).

Table 1.1. Examples of multi-stage adoption models

Stages of Adoption		Studies
Intention, behavior	2-stage process	Ajzen (1991), Fishbein & Ajzen, (1975)
Evaluation, adoption, integration	3-stage process	Grover & Goslar (1993), Kim & Garrison (2010)
Awareness, selection, adoption, implementation, routinization	5-stage process	Hage & Aiken (1970)
Awareness, consideration, intention, adoption decision, continued use	5-stage process	Frambach & Schillewaert (2002)
Knowledge, persuasion, decision, implementation, confirmation	5-stage process	Rogers (2003)
Knowledge, awareness, attitudes formation, decision, initial implementation, sustained implementation	6-stage process	Zaltman, Duncan, & Holbek (1973)
Initiation, adoption, adaptation, acceptance, routinization, and infusion	6-stage process	Cooper & Zmud (1990)

2.3.Hypotheses development and the research model

Given the limited literature on antecedents of Rogers' five adoption stages namely knowledge, persuasion, decision, implementation, and confirmation stage; the theoretical framework and research hypotheses have been developed partially from available consumer adoption studies on relatively less number of stages (e.g. Alexander et al., 2008; Arts et al., 2011; Castaño, Sujan, Kacker, & Sujan, 2008; Meuter, Bitner, Ostrom, & Brown, 2005; Wood & Moreau, 2006) and organization innovation adoption literature (e.g. Chong & Chan, 2012; Damanpour & Schneider, 2006; Frambach & Schillewaert, 2002; Hameed et al., 2012; Kim & Garrison, 2010).

The literature highlights different categories of predictors of adoption. Given the overall framework and the exploratory nature of the present work, this study focuses on a subset of relationships referring to the most fundamental aspect- perceived characteristics of an innovation, which are found to be a major driver of innovation adoption (Arts et al., 2011; Frambach, 1993; Frambach et al., 1998; Frambach & Schillewaert, 2002; Gatigno &

Robertson, 1985; Rogers, 2003; Tornatzky & Klien, 1982; Vowles, Thirkell, & Sinha, 2011). Arts et al. (2011) conduct a meta-analysis of 77 studies from 1970 –2007 on consumer innovation adoption to identify how drivers of adoption differ across two broad stages: intention and behavior. The study confirms that different stages have different predictors in terms of innovation attributes. The research framework of this study hence is built on the assumption that perceived attributes of an innovation vary across distinct stages of innovation-decision. This assumption, if proven, will further confirm the stage existence hypothesis and it will provide the premise to the analysis of the relationships between different determinants and stages. The constructs describing the stages and perceived innovation characteristics are the following.

Knowledge Stage: A potential adopter learns about the existence of an innovation and gains some understanding of its way of functioning during the first stage. The knowledge stage is not included in the structural model of this study, since the awareness of the innovation's existence is a pre-requisite for the evaluation of determinants of subsequent stages.

Persuasion Stage: This stage helps form an attitude towards the innovation. During this stage, the potential consumer takes interest and actively seeks information about the innovation. The attitude is formed based on the knowledge they developed in the previous stage and on continued exposure. Whereas the mental activity at the knowledge stage was mainly cognitive (or knowing), the main type of thinking at the persuasion function is affective (or feeling).

Decision Stage: During this stage, the potential consumer takes the concept of change and is involved in certain activities e.g. trying out an innovation on a probationary basis, comparing its pros and cons etc. Such activities help a potential adopter to make the choice to adopt or

reject the innovation. The adoption decision in fact precedes the actual choice or acquisition of an innovation.

Implementation Stage: Until the implementation stage, the innovation-decision process has been strictly a mental exercise. But implementation involves overt behavior change, as the new idea is actually put into practice by employing the innovation to a varying degree. Rogers (1983) adds that this stage may continue for a long period but ends up when the innovation loses its distinction and becomes a routine.

Confirmation Stage: The consumer finalizes his decision to continue using the adopted innovation. Confirmation is the stage of reinforcement for the adoption decision which has already been taken. Consumers reconsider the innovation based on their level of satisfaction or dissatisfaction. He may reverse the decision to continue if received conflicting messages about the innovation. Hence, a consumer continuously seeks to avoid the state of cognitive dissonance.

Perceived Innovation Characteristics: Innovation characteristics refer to the *attributes* consumers use to evaluate an innovation (Arts et al., 2011). Innovation adoption literature generally utilizes six most common innovation characteristics. Rogers (2003) suggests five attributes namely relative advantage, compatibility, trialability, complexity, and observability to evaluate an innovation. Hoeffler (2003), Midgley and Dowling (1978), and Ostlund (1974) add perceived uncertainty or risk to the list. Moore and Benbasat (1991) developed an instrument to measure perceived characteristics of IT innovation. They identify eight characteristics useful to study diffusion of innovations namely voluntariness, image, relative advantage, compatibility, ease of use, trialability, result demonstrability, and visibility.

As explained above, different attributes are tested in this study to identify determinants of stages. These are perceived relative advantage, compatibility, complexity of use, trialability,

risk, ecology, and image. The definitions of each perceived characteristics are provided in table 1.2.

Table 1.2. Perceived innovation characteristics

Variable	Definition	Operationalization Source
Relative Advantage	The extent to which an innovation is perceived as being better than the existing product it supersedes.	Moore & Benbasat (1991), Jansson (2011), Petschnig et al. (2014)
Compatibility	The extent to which an innovation is perceived as consistent with the past experiences, existing values, life style, and needs.	Jansson (2011), Petschnig et al. (2014)
Complexity	The extent to which an innovation is perceived as relatively difficult to understand and use. Ease-of-use is taken as an alternative in different studies.	Moore & Benbasat, (1991), Jansson (2011), Petschnig et al. (2014)
Trialability	The degree to which an innovation is perceived to be easily experimented on a limited/ probationary basis.	Moore & Benbasat (1991), Jansson (2011)
Risk	The degree to which individuals perceive uncertainty about the functional, social, and/or financial consequences of purchasing and using an innovation.	Jansson (2011), Petschnig et al. (2014)
Ecology	The extent to which an innovation is perceived as environmental friendly and harmless to the environment.	Petschnig et al. (2014)
Image	The extent to which the use of an innovation is perceived by the individual to enhance his/her image or status in the social system or community.	Moore & Benbasat, (1991); Petschnig et al. (2014)

Existing studies usually do not distinguish between the impacts of innovation attributes on different stages of adoption (Arts et al., 2011). The innovation-decision process is essentially an information seeking and processing activity in which an individual is motivated to reduce uncertainty about an innovation (Rogers, 2003). This means that each stage in the process deals with a certain level of uncertainty. To reduce the uncertainty and deal with the perceived newness of the innovation, individuals consistently seek information and knowledge of innovation during each stage. This knowledge requirement is higher and different in the early stages due to relatively higher uncertainty and newness than in the later

stages. This represents that consumers may use different criteria to evaluate the innovation across various stages of decision-making (Alexander et al., 2008; Castaño et al., 2008). At different stages, use purposes and situations are perceived differently and therefore, consumers may weigh product attributes differently (Arts et al., 2011).

Similar argument is used by temporal distance theories (Trope & Liberman, 2003; Wright & Weitz, 1977). The theories explain how consumers adopt a new product and guide how innovation characteristics can impact temporally distinct decisions. They explain that adopters evaluate product characteristics differently, depending on whether the purchase behavior is closer or further in time. For example, construal level theory (CLT) suggests that the behaviors that are more distant in time, as reflected by *adoption intentions*, are more likely to be affected by relatively abstract or general attributes. Behaviors that are closer in time, as reflected by *adoption behavior*, are more likely to be affected by concrete, specific, and context-dependent attributes (Trope and Liberman, 2003). The above arguments clarify that different innovation attributes are relevant for different stages in the process. Hence, my first hypothesis is:

H_a: Different stages in the innovation adoption process are influenced by different perceived innovation characteristics.

Secondly, in order to evaluate which attributes are more relevant for each phase, innovation attributes are here categorized into perceived benefits, proximity, and costs. Relative advantage, compatibility, ecology, and image represent the direct benefits which make the innovation desirable for the potential adopter. Trialability provides close proximity to a product before purchase and helps to assess the direct benefits of an innovation. In contrast, risk and complexity represent the expected losses or costs which may decrease the adopter's motivation to adopt.

Potential adopters are likely to give high weights to perceived benefits of an innovation when they are farther from actual adoption (Arts et al., 2011, Wright & Weitz, 1977). This is because when potential adopters intend to buy an innovation, they form their attitude based on abstract or higher level features. In terms of innovation decision as a goal-directed process, this reflects relatively abstract '*why*' aspect of an innovation (Trope & Liberman, 2003; Vallacher & Wegner, 1987). The '*why*' aspect shows the desirability of a particular behavior. The desire increases when a potential buyer perceives the outcome of innovation as beneficial. Hence, the desirability in terms of improved performance and psychological gains are more important than the feasibility of choosing an option (Lynch & Zauberman, 2006). Based on this perspective, Castaño et al. (2008) suggest and find that managing uncertainties about potential outcomes like performance and symbolic benefits is important for distant future adoption decisions. The organization innovation adoption literature favors the same argument. In their study on CRM adoption; Ko, Kim, Kim, and Woo (2008) advocate that the decision makers perceive advantages of an innovation during persuasion phase and the benefits affect the decision phase positively. Findings of Chong and Chan (2012) study on RFID adoption confirm that perceived advantages are significantly relevant for pre-adoption and adoption stages. Hence this study hypothesizes:

H_b: Perceived relative advantage, compatibility, ecology, and image of an innovation significantly affect persuasion.

H_c: Perceived relative advantage, compatibility, ecology, and image of an innovation strongly affect decision.

In contrast, individuals are likely to assign high weights to the losses of an innovation when they are at behavior stage (Arts et al., 2011; Wright & Weitz, 1977). The notion is in line with loss aversion or prospect theory (Kahneman & Tversky, 1979), which proposes that an

individual focuses on potential losses than potential gains when faces a decision of behavioral change. In the present setting, implementation is the overt behavior in line with the construct conceptualized in theory of reasoned action (TRA, Fishbein & Ajzen, 1975). As individuals adopt the new behavior and put the new solution to practice, more concrete and lower level considerations explain their actions. In terms of innovation decision as a goal-directed process, this reflects relatively context-specific *'how'* details of an innovation (Trope & Liberman, 2003; Vallacher & Wegner, 1987). The *'how'* aspect shows the feasibility in terms of time, effort, and cost of conducting a new behavior or action. While analyzing time horizon effects on new product evaluation, Wright and Weitz (1977) find that negative aspects of choice options are weighted more by the individuals as the time to finally decide comes very close. Increasing time proximity shifts consumers attention from abstract to concrete mental models (Trope & Liberman, 2003), where costs matter more than benefits and feasibility matters more than desirability (Lynch & Zauberman, 2006). Based on this perspective, Castaño et al. (2008) find that managing uncertainties of potential switching costs like time, effort, affective, financial, and other risks is important for imminent future adoption decisions. This suggests that firm's promise to reduce perceived learning difficulty, time, and cost of using an innovation is effective during actual use rather than early stages where it only creates unrealistic expectations (Wood & Moreau, 2006). Similarly, organization adoption literature supports the argument for example, Chong and Chan (2012) find that perceived losses like complexity and cost of RFID effect on post-adoption is stronger than pre-adoption stages. Based on the above arguments and loss aversion and temporal distant perspectives, here I hypothesize that perceived losses of an innovation are more relevant for post adoption stages in the decision process.

H₄: Perceived risk and complexity of using an innovation significantly affect implementation.

H_e: Perceived risk and complexity of using an innovation significantly affect confirmation.

Trialability provides an opportunity to a potential adopter to closely observe the advantages and disadvantages of an innovation, enables him to see how it works within a limited time period, and helps him to analyze the required degree of change in existing behavior in order to switch to new behavior. Perceived trialability increases an individual's readiness to accept the change in such a way that he understands his role and feels confident to use a new innovation (Meuter et al. 2005). Hence, it is most relevant for overt behavior stage (Arts et al., 2011) which is closely associated with implementation. On the basis of this argument, the study hypothesizes that perceived ease of trialability is relevant for implementation stage.

H_f: Perceived trialability of an innovation strongly affects implementation.

The hypothesized relationships are shown in the research model in figure 1.1.

Figure 1.1. The research model

3. Methodology

3.1. Research design

The aim of this research is twofold: to identify and verify multi-stage process nature of high involvement innovation adoption and to identify various predictors of each identified stage. For this, I collected data about innovations which face lock-in and slowly diffuse due to the presence of alternative dominant technologies in the marketplace, hence makes existence of distinct stages more likely. The research questions were investigated through two different questionnaire-based online surveys. To identify distinct stages of adoption, data collected during the first survey were analyzed through exploratory factor analysis (EFA) technique while to identify different determinants of stages, data collected during the second survey were analyzed through structural equation modeling (SEM) approach. The first survey was administered for smartwatch innovation while the second survey was administered for alternative engine cars (AECs). The basic reason to select different innovations is to validate and confirm the existence of distinct stages for different innovations. Moreover, the two innovations share common issues. First, both are in early adoption stage of a diffusion curve and faces lock-in to cross the chasm and penetrate in the mass market. Second, though smartwatch and AECs are in early stage of diffusion still both are visible in the markets which means that products are known to the people, hence are possible to survey. Finally, use of both technologies require a shift to new behavior by breaking existing routines. It is highly likely for potential adopters of such products to invest their efforts before purchasing and during change of existing behavior. For example, substituting a conventional watch with a smartwatch or an existing conventional car with a green car requires building a new routine, hence requires efforts in terms of cost, time, and resources.

Since major focus of my work and the final survey is on sustainable vehicles, I reviewed empirical studies on their adoption to identify most suitable perceived characteristics of such

vehicles. The review of existing literature provides a list of functional, economical, and social attributes like range, acceleration, top speed, purchase price, fuel/ energy efficiency, maintenance/ operating cost, resale price, charging infrastructure availability, ease of driving/ use/ maintenance, charging time, environmental impact, safety, health risk, physical risk, financial risk, security, safety, comfort, design/ style, social image, visibility, policy incentives etc. (table 1.3). I categorize all such dimensions into broad characteristics. For this, I adopt Jansson (2011) and Petschnig et al. (2014) classification of innovation attributes because (1) their frameworks are based on Rogers' theory of adoption and (2) they study sustainable vehicles in general. Hence, the existing list of Roger's innovation characteristics was extended by adding new dimensions related to alternative cars. The attributes included in this study are perceived relative advantage, compatibility, complexity, trialability, risk, ecology, and image.

3.2.Measures and operationalization

I adapted the existing scales to measure perceived characteristics of AECs. The details are given in table 1.2 in previous section. The items were adapted from Jansson (2011), Moore and Benbasat (1991), and Petschnig et al. (2014). Similarly, I partly adapted existing scales to measure innovation adoption stages. Since the existing literature on individual adoption lack operational definitions and measurement scales of different stages; I adapted the existing scales from organizational and other literature which includes work by Celik et al. (2014), Chong and Chan (2012), Gilly and Zeithaml (1985), Kim and Garrison (2010), and Li and Lindner (2007). Few items were newly constructed and were validated before inclusion in the final survey. All the items were measured on five point Likert scale ranging from 1 = 'strongly disagree' to 5= 'strongly agree' to reflect respondents' degree of agreement or disagreement with a series of statements.

Table 1.3. Summary of perceived characteristics of sustainable vehicles

Studies	Ewing & Sarigollu (1998, 2000)	Brownstone et al. (2000)	Tzeng et al. (2005)	Lane & Potter (2007)	Eggers & Eggers (2011)	Hidruet et al. (2011)	Jansson (2011)	Egbue & Long (2012)	Ziegler (2012)	Schuittema et al. (2013)	Petschnig et al. (2014)	Peters & Düttschke (2014)
Vehicle Characteristics	Clean-Fuel vehicles	AFV	AFV	BEV	EV	EV	AFV	PHEV BEV	AFV	PHEV BEV	AFV	EV
Relative Advantage ¹	X	X	X	X	X	X	X	X	X	X	X	X
Ecology	X	X	X	X	X	X		X	X	X	X	X
Ease of use ²		X	X	X	X		X		X		X	
Compatibility							X			X	X	X
Risk ³				X			X	X			X	
Trialability							X				X	X
Observability							X			X	X	
Image				X						X	X	
Design/ style		X									X	

Note: AFV = Alternative Fuel Vehicle, BEV= Battery Electric Vehicle, EV= Electric Vehicle, PHEV= Plug-in Hybrid Electric Vehicle

¹ Relative advantage also includes profitability in terms of price, cost etc. and performance in terms of speed, acceleration, range, energy efficiency, range etc.

² Ease of use includes ease to drive, charging/ fueling, maintenance etc.

³ Risk includes all types of risks e.g. physical, financial, health, security, emotional, social, safety etc.

3.3.Content Validity

Since the scale items for adoption stages were partly adapted from the existing literature, I analyzed whether items were representative of the adapted construct. For this, content validity of the innovation adoption scale was performed employing a quantitative approach. In order to validate contents, the following steps were followed. Based on existing literature and existing scales, a total of 27 items for five stages were identified and selected for validation process. A content validity questionnaire was then generated that comprised definitions of the constructs and associated items on a three-point scale, where 1 = 'clearly representative of the construct', 2='somewhat representative of the construct', and 3= 'not representative of the construct'. The questionnaire along with a covering letter indicating the purpose and instructions were sent to academic experts via email. Responses from 6 experts were then gathered and item-level content validity index (I-CVI) was calculated. Based on experts' rating of each item's relevance to a particular construct, I deleted two irrelevant items: "I will adopt the innovation the next time I need it" and "I have been using the innovation for quite some time". The I-CVI for both items was less than the threshold value of 0.78 (Lynn, 1986). Few other items were refined and/or reworded as suggested by experts. Finally, 25 items were retained for inclusion in the first survey and for factor analysis which further confirmed convergent and discriminant validity.

3.4.First survey- sample and data collection

The unit of analysis is the individual level. Using Qualtrics software, an online survey was developed to have quantitative responses for the content validated 25 items. The questionnaire has two sections. The first part is based on socio-demographic questions while the second part has the whole set of validated questions of smartwatch innovation adoption. Smartwatch is a wearable smartphone technology. Compared to a regular watch, it has

additional features like game playing, portable media playing, physical fitness tracking, supporting mobile apps using mobile operating system etc. However, such technology is relatively less attractive among consumers of conventional watches and faces slow diffusion rate. For data collection, I used snowball non-probability sampling technique. I contacted acquaintances, colleagues, and friends with a request to fill the online survey and to send the survey link to their acquaintances. Moreover, the questionnaire was spread on social networks. Follow up strategies were adopted to get timely and maximum responses. This resulted in 138 responses. However, 110 usable set of responses were included in the analysis. It is not possible to know the exact response rate as the survey was conducted through the internet. In order to have variation in the variables of interest, I recruited a heterogeneous sample of respondents with different gender, age, income, and education. The sample statistics of final sample are shown in table 1.4. Majority of the respondents are non-owners of smartwatch, male, highly educated, and under age 35. Sample is partially based on European and Asian residents.

Table 1.4. Sample statistics (N1 = 110)

Socio-demographics		Frequency (%age)
Gender	Male	85 (77.3%)
	Female	25 (22.7%)
Education Groups	Primary	0 (0%)
	Intermediate	1 (0.9%)
	Secondary	3 (2.7%)
	University	106 (96.4%)
Continent of Residence	Europe	45 (40.9%)
	USA	3 (2.7%)
	Asia	59 (53.6%)
	Africa	1 (0.9%)
	Australia	2 (1.8%)
Age	25 and below	27 (24.5%)
	26-35	57 (51.8%)
	36-45	21 (19.1%)
	46 and above	5 (4.5%)
Smartwatch Owners	Owners	30 (27.3%)
	Non-owners	80 (72.7%)

3.5.Second survey- sample and data collection

To test the different determinants of adoption stages a survey instrument was developed based on existing literature. The data for the second online survey were collected from car users. A similar approach was used by Petschnig et al. (2014) and Jansson (2011) to analyze consumer adoption of alternative fuel vehicles. In this research the empirical setting has been defined as Alternative Engine Cars (AEC). AECs power their engines through additional sources of energy besides petroleum like CNG, electricity, hydrogen, ethanol etc. Typical examples of AECs are hybrid, electric, and hydrogen fuel cell cars. The alternative engine

innovation is selected for the analysis because such vehicles (1) are in the early phase of diffusion or S-shaped diffusion curve *and* (2) require high consumer involvement behavior and consumers are more likely to pass through distinct stages of adoption. Existing studies by Jansson (2011), Jansson et al. (2010), Jansson et al. (2011), Ozaki and Sevastyanova (2011), Petschnig et al. (2014), and Rezvani et al. (2015) also analyze high involvement consumer behaviors related to adoption of hybrid and electric vehicles. However, none addressed the adoption in terms of multi-stage process.

The survey questionnaire has 4 sections. The first section asks questions about five distinct stages of adoption process as identified during EFA discussed in the next results section. The second section asks questions about seven perceived characteristics of AECs as elaborated earlier. Finally, the third section is based on socio-demographic questions. Following Chong and Chan (2012), Jansson (2011), Kim and Garrison (2010), and Petschnig et al. (2014) the questions of independent and dependent variables were measured on 5-point likert scale. The 5-point Likert scale checks the level of agreement, ranging from 1 = ‘strongly disagree’ to 5 = ‘strongly agree’.

Using snowball sampling technique I received 263 online responses from traditional or alternative car users and 246 set of data were actually used for analysis. In order to have variation in the variables of interest, a heterogeneous sample of respondents was recruited. The sample statistics of final sample are shown in table 1.5. As in case of the previous survey respondents, individuals are majorly male, highly educated, and under 35 years age. Half of the respondents live in large towns having more than one million residents. More than half of individuals own traditional cars while only one tenth of the sample own AECs.

Table 1.5. Sample statistics (N2 = 246)

Socio-demographics		Frequency (%age)
Gender	Male	214 (86.99%)
	Female	32 (13.01%)
Education Groups	Primary	1 (0.41%)
	Intermediate	2 (0.81%)
	Secondary	6 (2.44%)
	University	230 (93.5%)
	Other	7 (2.84%)
Residence	Very large town	124 (50.41%)
	Large town	48 (19.51%)
	Middle town	49 (19.92%)
	Small town	17 (6.91%)
	Rural area/ country side	8 (3.25%)
Age		62 (25.2%)
	25 and below	128 (52.03%)
	26-35	42 (17.07%)
	36-45	14 (5.7%)
	46 and above	74 (30.1%)
Income	Less than \$15,001	38 (15.4%)
	\$15,001-\$35,000	23 (9.3%)
	\$35,001-\$55,000	12 (4.9%)
	\$55,001-\$80,000	9 (3.7%)
	More than \$80,000	90 (36.6%)
	No response	142 (57.7%)
Existing car type	Traditional	63 (25.6%)
	Bi-fuel	25 (10.2%)
	Alternative	16 (6.5%)
	Other	

4. Results

4.1. Analysis of adoption stages

To identify distinct adoption stages, I run factor analysis in SPSS using two extraction methods- Principal Component Analysis (PCA) and Principal Axis Factor (PAF). To confirm the validity and reliability, I further run confirmation factory analysis (CFA) and reliability analysis. The details of each analysis are given below.

Although PCA is the most popular, conventional, and default method to extract factors, PAF is often considered a preferable approach (Osborne & Costello, 2009). Osborne and Costello (2009) and Widaman (1990, 1993) suggest that PCA, though a popular and default extraction method, is not a reliable method of factor analysis. The aim of the factor analysis is to reveal latent constructs that allow manifest variables to covary. In order to reveal the underlying factor structure, the shared variance is separated from its unique variance and error variance during the analysis, and only shared variance is reflected in the solution. PCA disregards the underlying structure caused by latent variables and components are extracted using all the variance of manifest variables (Ford, MacCallum, & Tait, 1986). This means that PCA fails to partition shared and unique variance and analyze all the variance. Factor analysis only reveals shared variance and avoids the inflation of estimates of variance accounted for. On the other hand, proponents of PCA disagree that there is much difference between factor analysis and component analysis and preferred PCA (Arrindell & van der Ende, 1985; Schoenmann, 1990; Velicer & Jackson, 1990). Keeping in mind pros and cons of both approaches, this study considered results from both analyses. Following steps were performed to extract distinct factors using PCA and PAF.

1. To identify the number of distinct stages, the eigenvalues and scree plot were checked. The scree test examines the graph of eigenvalues and reveals a bend or break point

in the data where the curve flattens out. As expected, the eigenvalues (greater than 1.00) and scree plot (data points above the break) revealed 5 distinct constructs with different number of items loading on it. Further, 5 distinct constructs explained 59.2% cumulative variance⁴.

2. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy value of 0.804, greater than the threshold value 0.60, confirms that the sample ($N_1 = 110$) is adequate to run the factor analysis. Similarly, the significant p-value of Barlett's test of sphericity confirms that factor extraction is useful.

3. In the next step, I entered Direct Oblimin rotation method which simplifies and clarifies the data structure. The oblique rotation assumes that the factors are correlated as there is generally some correlation among the variables in real life, hence renders more accurate solutions (Osborne & Costello, 2009). This technique resulted in a pattern matrix which shows the items loadings (table 1.6 and 1.7). As suggested by Osborne and Costello (2005), I deleted the items with items loadings lesser than 0.30 and which cross load on more than one factor with loading greater than 0.30. This criterion resulted in the exclusion of 7 out of 25 content validated items. Once deleted, I calculated correlations between factors for each stage to confirm the distinctness of each factor or stage (table 1.8 and 1.9).

Comparing the analysis shown in table 1.6 and 1.7 confirms that both techniques PAF and PCA revealed similar findings with an exception. Both showed clear factor structure and extracted 5 different constructs. These factors are in line with the adoption stages conceptualized by Rogers (2003), hence referred as knowledge, persuasion, decision, implementation, and confirmation. This confirms the existence of stages of high involvement innovation adoption as hypothesized.

⁴ To confirm that five distinct factors (extracted) is not the result of over-extraction or under-extraction, I run multiple factor analyses by manually setting the number of factors to four, five, and six. However, the cleanest factor structure with item loadings greater than 0.25 and only few cross-loadings was achieved with 5 factor solution.

Table 1.6. Results of principal component analysis (N1 = 110)

Item codes and details	Extracted Factors				
	KNOW	PERS	DEC	IMP	CONF
KNOW1- I know about the innovation	.838	.141	-.018	-.084	.032
KNOW2- I am aware of the innovation	.786	-.121	.067	-.117	.142
KNOW3- I have seen the innovation	.727	-.051	-.086	.115	-.022
KNOW4- I have some knowledge of how it works	.724	-.014	.006	.281	-.084
KNOW5- I have heard about the innovation	.720	.285	.143	-.146	-.126
PERS1- I like to have further information about it	.022	.803	.148	.137	-.137
PERS2- I believe the innovation is appropriate *	.038	.706	-.071	.035	.343
PERS3- I think the innovation is beneficial *	.154	.641	-.066	.075	.322
PERS4- I have a positive impression of the innovation	.024	.631	-.022	-.099	.130
PERS5- I think it is better than the alternative	.245	.526	.151	-.170	.285
DEC1- Before buying, I would compare it with the alternative	-2.16E-005	-.051	.846	-.099	.058
DEC2- Before buying, I would try the innovation	.147	-.005	.733	.134	-.005
DEC3- Before buying, I would have sufficient knowledge about its advantages and disadvantages	-.064	-.093	.704	-.199	.149
DEC4- Before buying, I am going to evaluate the innovation	.015	.214	.703	.033	-.196
DEC5- I would make all the arrangements to buy it*	-.159	.370	.398	.494	-.020
IMP1-I am currently using the innovation	.023	.038	-.153	.850	.048
IMP2-I use the innovation on a regular basis	.066	.017	-.151	.741	.239
IMP3-I know how to maintain the innovation *	.251	-.161	-.064	.541	.391
IMP4-I know how to use the innovation *	.245	-.228	.028	.535	.482
CONF1-I find the innovation useful	.099	-.140	.128	.090	.825
CONF2-I receive positive feedback for using the innovation	.036	.163	-.013	-.029	.804
CONF3-I would suggest others to use the innovation*	-.010	.303	-.095	-.132	.754
CONF4-I am satisfied with the its performance*	-.124	-.016	.146	.359	.732
CONF5-I will continue its use	.029	.129	-.011	.024	.713
CONF6-I plan to continue its use in the future	-.046	.165	-.030	.294	.637

* Item deleted due to cross-loading

Note: KNOW= knowledge, PERS = persuasion, DEC= decision, IMP= implementation, CONF= confirmation

Table 1.7. Results of principal axis factoring (N1 = 110)

Item codes and details	Extracted Factors				
	KNOW	PERS	DEC	IMP	CONF
KNOW1- I know about the innovation	.833	.126	-.024	-.086	.018
KNOW2- I am aware of the innovation technology	.718	-.087	.045	-.080	.113
KNOW5- I have heard about the innovation	.671	.235	.147	-.141	-.107
KNOW4- I have some knowledge of how it works	.652	-.018	.012	.227	-.046
KNOW3- I have seen the innovation	.630	-.024	-.080	.113	-.014
PERS2- I believe the innovation is appropriate	.030	.742	-.084	.059	.257
PERS1- I like to have further information about it	.022	.718	.172	.108	-.132
PERS3- I think the innovation is beneficial for me	.146	.664	-.075	.095	.242
PERS5- I think it is better than the alternative	.233	.494	.140	-.136	.230
PERS4- I have a positive impression of the innovation	.038	.482	.035	-.089	.138
DEC1- Before buying, I would compare it with the alternative	-.004	-.078	.813	-.105	.065
DEC4- Before buying, I am going to evaluate the innovation	.016	.165	.653	.010	-.175
DEC2- Before buying, I would try the innovation	.131	-.020	.650	.079	.023
DEC3- Before buying, I would have sufficient knowledge about its advantages and disadvantages	-.051	-.010	.547	-.130	.054
DEC5- I would make all the arrangements to buy it*	-.126	.274	.371	.339	.058
IMP1-I am currently using the innovation	.016	.085	-.131	.854	-.016
IMP2-I use the innovation on a regular basis	.060	.033	-.123	.716	.210
IMP4-I know how to use the innovation *	.247	-.226	.040	.517	.466
IMP3-I know how to maintain the innovation *	.243	-.132	-.056	.515	.358
CONF1-I find the innovation useful	.105	-.125	.111	.080	.789
CONF2-I receive positive feedback for using the innovation	.039	.165	-.025	-.047	.779
CONF3-I would suggest others to use the innovation*	-.004	.289	-.100	-.148	.730
CONF4-I am satisfied with the its performance*	-.130	-.019	.156	.329	.724
CONF5-I will continue its use	.039	.152	-.018	.052	.620
CONF6-I plan to continue its use in the future	-.037	.176	-.026	.276	.585

* Item deleted due to cross-loading

Note: KNOW= knowledge, PERS = persuasion, DEC= decision, IMP= implementation, CONF= confirmation

The only exception in the analysis is that PCA suggested the deletion of seven items while

PAF suggested the deletion of five cross loaded items. All other items were converging to

different constructs with loadings greater than 0.30 reflecting convergent validity. Considering the theoretical and empirical perspective, seven items were deleted from further analysis in order to achieve uncorrelated factor structure as shown in table 1.8 and 1.9. The low correlation coefficients between different stages shown in both tables confirm the distinct nature of identified stages.⁵ However, PAF shows a relatively higher correlation between implementation and confirmation- which are subsequent post adoption stages, thus signaling a possibility of emergence of one unique stage instead of two in other settings.

Table 1.8. Factor correlation matrix based on PCA results⁶

Factors	KNOW	PERS	DEC	IMP	CONF
KNOW	1	-.160	-.087	-.098	-.253
PERS	-.160	1	.226	-.030	.214
DEC	-.087	.226	1	-.147	.042
IMP	-.098	-.030	-.147	1	.226
CONF	-.253	.214	.042	.226	1

Note: KNOW= knowledge, PERS = persuasion, DEC= decision, IMP= implementation, CONF= confirmation

Table 1.9. Factor correlation matrix based on PAF results

Factors	KNOW	PERS	DEC	IMP	CONF
KNOW	1	-.197	-.104	-.129	-.304
PERS	-.197	1	.342	-.053	.286
DEC	-.104	.342	1	-.189	.050
IMP	-.129	-.053	-.189	1	.336
CONF	-.304	.286	.05	.336	1

Note: KNOW= knowledge, PERS = persuasion, DEC= decision, IMP= implementation, CONF= confirmation

⁵ High correlation of a group of items within a single construct and low correlation among different constructs confirm construct validity. Discriminant validity is apparent by the examination of the cross-loadings, which are not substantial in magnitude compared to the loadings.

⁶ Table 1.8 and 1.9 are the results of SPSS while running PCA and PAF. The negative signs should be ignored and weights should be considered while interpreting the association between different factors.

In order to confirm the validity of constructs or stages identified during EFA and subsequently used in the second survey, confirmatory factor analysis (CFA) was applied⁷. The results are shown in figure 1.2. Findings show that all items except one item of persuasion "I like to have further information" exceed the stringent threshold value of 0.72 with $p\text{-value} < 0.05$. This shows that except one, all others were loading appropriately on relevant latent construct. Goodness of fit measures confirmed the uni-dimensionality in the factors. Goodness Of Fit Index (GFI), Adjusted Goodness Of Fit Index (AGFI), and Comparative Fit Index (CFI) are greater than the threshold value of 0.90 and Root Mean Square Error Of Approximation (RMSEA) is below 0.05 (Hair, Black, Babin, Anderson, & Tatham, 2006).

Additionally, to confirm the internal consistency among items, Cronbach's alpha values were calculated and results are reflected in table 1.10. A higher coefficient of reliability shows that all items of each latent construct measure the same content universe. As shown in the table below, all alpha coefficients exceed the cut-off value of 0.70 (Nunnally & Bernstein, 1978; 1994), thus confirms the internal consistency of group of items within a construct. The table also reflects the mean values of each variable. Mean of implementation stage is 1.93 which indicates that respondents on average do not use AECs. Similarly the mean values of confirmation, trialability, and risk are closer to 3.00 which indicates that the majority of respondents are neutral about using the innovation in future, the ability of the innovation to be experimented or tried, and the uncertainty related to the innovation adoption. Bivariate Pearson correlations (r) were calculated and included in table 1.10 to show early signs of

⁷ The data from the second survey was not used to replicate EFA due to several reasons: (i) majority of respondents are non-adopters (70% and 90% non-adopters of smartwatch and alternative engine cars respectively), which shows that they were not in the post implementation stages which may affect the association of last stages differently in different contextual settings, (ii) two innovations used in the surveys are at different stages of diffusion and the level of involvement and efforts required for the two innovations is different which reflects the likelihood of different degree of correlation and interaction between different stages, and (iii) items were adapted from already existing weak operationalization of constructs as mentioned earlier, which might have an effect on our results.

strong associations between the constructs. An unexpected result is a strong association between implementation and confirmation stage ($r = 0.73$, $p < 0.01$) corroborating the early signal provided by the factor correlation matrix (table 1.9). Very high correlation is also observed between relative advantage and compatibility ($r = 0.70$) and between complexity and risk ($r = 0.60$). The possible reason is that innovation attributes are interdependent to some extent (Holak & Lehman, 1990).

Figure 1.2. Results of CFA (N2=246)

Table 1.10. Cronbach's alpha, mean, and bivariate Pearson correlation matrix

Constructs	Cron α	Mean (SD)	<u>Bivariate correlations (r)</u>											
			KNOW	PERS	DEC	IMP	CONF	RA	COMP AT	COMP LEX	TRIAL	RISK	ECO	IMAG
KNOW	0.92	3.71(1.002)	1											
PERS	0.76	4.00 (0.796)	.50***	1										
DEC	0.84	4.29 (0.673)	.24***	.23***	1									
IMP	0.94	1.93 (1.349)	.17***	.13**	-.15**	1								
CONF	0.92	3.25 (0.666)	.26***	.22***	.01	.73***	1							
RA	0.83	3.60 (0.689)	.29***	.50***	.15**	.19***	.28***	1						
COMPAT	0.83	3.71 (0.679)	.41***	.53***	.16**	.28***	.42***	.70***	1					
COMPLEX	0.74	3.38 (0.729)	.16**	.001	.15**	-.05	.02	-.02	-.05	1				
TRIAL	0.84	2.93 (0.823)	.16**	.09	-.15**	.26***	.25***	.26***	.27***	.07	1			
RISK	0.75	2.88 (0.702)	.02	-.16**	-.08	.12*	.11*	-.09	-.12*	.60***	.21***	1		
ECO	0.81	3.87 (0.694)	.33***	.45***	.19***	.006	.21***	.40***	.42***	.04	.01	-.15**	1	
IMAG	0.84	3.42 (0.742)	.16**	.34***	.08	.19***	.23***	.40***	.46***	.01	.27***	.02	.23***	1

Note: *** = p-value significant at 0.01 level, **= p-value significant at 0.05 level, *= p-value significant at 0.10 level

Cron α = cronbach's alpha, SD= standard deviation, KNOW = knowledge, PERS= persuasion, DEC= decision, IMP = implementation, CONF= confirmation, RA= relative advantage, COMPAT= compatibility, COMPLEX= complexity, TRIAL= trialability, RISK= risk, ECO = ecology, IMAG= image

4.2. Results of the model

The structural equation modeling is applied to examine the hypotheses proposed in the second section as this method examines both the directions and strengths of the relationships of the latent variables. In addition it has the potential to analyze a larger number of constructs and their interrelations simultaneously and to control for measurement error (Mackenzie, 2001; Steenkamp & Baumgartner, 2000). For the estimation of the model, I used AMOS *ver* 18.0. Before running the SEM analysis, some of the basic assumptions were tested. There was no multicollinearity among variables as VIF was less than the stringent cut-off threshold of 3.00 and tolerance level > 0.01 . Similarly, the assumption of homoscedasticity was not violated. Power test showed that the required sample size to run SEM was 200 which is less than the study's sample size of 246 observations. Finally, scale reliability and validity were confirmed as discussed above. I assessed path coefficients and significance values using Maximum Likelihood estimation technique in SEM and the results are shown in table 1.11 and figure 1.3 below. The standardized regression weight shown in the table not only indicates the direction but also the magnitude of the proposed relationship while p-value confirms the significance of the relationship.

As hypothesized, findings show that persuasion stage is positively affected by all perceived benefits of AECs like relative advantage, compatibility, ecology, image as expected. Hence hypothesis H_b is supported. This is consistent with temporal distance theories (Trobe & Liberman, 2003; Wright & Weitz, 1977) suggesting that perceived performance benefits are important for distant future adoption decisions to encourage non-adopters to adopt (Castaño et al., 2008). Among all the significant AEC benefits, compatibility is the strongest predictor of persuasion ($\beta = 0.29$, $p < 0.01$). Ecology is the second critical factor explaining the second stage of AEC adoption ($\beta = 0.28$, $p < 0.01$). Image, on the other hand, is the weakest factor significant at 10% significance level ($\beta = 0.10$).

Table 1.11. Results of the structural model

Hypotheses		Standardized regression weights (β)	p-value	Decision
Relative advantage → Persuasion	H _b	0.21	.000	Accepted
Compatibility → Persuasion	H _b	0.29	.000	
Ecology → Persuasion	H _b	0.28	.000	
Image → Persuasion	H _b	0.10	.090	
Relative advantage → Decision	H _c	0.03	.635	Rejected
Compatibility → Decision	H _c	0.08	.183	
Ecology → Decision	H _c	0.15	.021	
Image → Decision	H _c	0.00	.991	
Complexity → Implementation	H _d	-0.18	.003	Accepted
Risk → Implementation	H _d	0.18	.003	
Complexity → Confirmation	H _e	-0.07	.242	Partially
Risk → Confirmation	H _e	0.15	.013	
Trialability → Implementation	H _f	0.23	.000	Accepted

Figure 1.3. Results of the structural model

On the other hand, none except perceived ecology of using an AEC significantly explains variation in decision stage ($\beta = 0.15$, $p < 0.05$). This leads to the rejection of hypothesis H_c which proposes that all perceived benefits predict decision phase.

As hypothesized, potential losses of using an AEC strongly affects implementation at 1% significance level. Perceived complexity of use and risk associated with AEC, both brings 18% change in individual's overt behavior of using a green car ($\beta = -0.18$ and 0.18 respectively), indicating equal importance of both predictors. These results confirm the assumptions of temporal distance theories and loss aversion theory (Kahneman & Tversky, 1979) that perceived costs, losses, and uncertainties of innovation's actual use are important for imminent future adoptions decision (Arts et al., 2011; Castaño et al., 2008). More specifically, the finding suggests that perceived learning difficulty, time, and cost are effective during actual use rather than early stages (Chong & Chan, 2012; Wood & Moreau, 2006). However, the results show a positive relation between risk and implementation. This is due to participants neutral response about the potential riskiness of using AECs in terms of financial, functional, health-related, and social uncertainty (mean score = 2.88, table 1.10) and their disagreement with AEC current use (mean score = 1.93, table 1.10). In terms of proximal benefits, perceived trialability also significantly predicts implementation stage ($\beta = 0.23$, $p < 0.01$). Both results confirm hypotheses H_d and H_f . In terms of degree of change, trialability of green cars is the strongest determinant of overt behavior compared to the other two.

Unexpectedly, complexity of using a sustainable car does not explain significant change in reaching to confirmation stage ($\beta = -0.07$, $p > 0.10$). However, low risk of using a sustainable car explains significant variation in confirming the adoption decision ($\beta = 0.15$, $p < 0.05$). This result facilitates partial acceptance of hypothesis H_e . Finally, the overall results support first hypothesis, H_a which suggests that different attributes of innovation affect different stages. The results shown in table 1.11

reveal that pre-adoption, adoption, and post-adoption stages have different predictors further confirming the existence of stages in case of AEC technology.

5. Discussion and conclusion

5.1. Discussion

The present paper addresses the first research question by exploring distinct nature of innovation adoption process. It empirically confirms the stage hypothesis by identifying 5 stages in case of high involvement innovations which require efforts to break existing routines and switch to new innovations which are in the early stage of diffusion. To do so, data on smartwatch innovation was collected from individuals. Exploratory factor analysis extracted solution of 5 different factors referred as knowledge, persuasion, decision, implementation and confirmation. The factors are unique and show little or no association with each other. However, the PCA and PAF used to extract factors show relatively highest association between the last two stages ($r = .25$ and $.30$ respectively, table 1.8 and 1.9). Such results provided an early signal that the two stages have a significant relation and are collinear. To further confirm the results and to validate the stage existence in another similar setting, data were collected on AEC adoption from car users. The data were analyzed through CFA, which also confirms the existence of stages. However, this time the results indicated that there is strong association between implementation and confirmation of sustainable cars (covariance = 0.77, figure 1.2 and $r = 0.73$, table 1.10). This leads to the conclusion that the two extracted post adoption stages may not be distinct and may be considered as a single stage. This is further confirmed by the goodness of fit indices of the SEM which did not exceed the threshold values (GFI and $AGFI < 0.90$ and $RMSEA > 0.05$)⁸. Though the study supports the existence of different stages of adoption in case of innovations which require

⁸ Modification indices shown by the SEM suggests to covary the last two stages, confirming that the two constructs are not unique. The model was retested after merging both constructs which showed goodness of fit ($\chi^2/df < 5.00$, p -value > 0.05 , GFI and $AGFI > 0.90$, $CFI > 0.95$, $RMSEA < 0.05$) between observed model and theoretical model.

efforts to switch to new behavior, the results should be used cautiously as the last two subsequent stages show high collinearity. However, the findings of the structural model reveal different predictors of both stages, signaling a separation.

The study also successfully addresses the second research question by identifying and confirming dynamic effects of innovation characteristics on consumer innovation adoption process further verifying the stage existence. Knowledge stage is taken away from the structural model as individuals at this stage know only about the innovation's existence and do not form a positive or negative impression hence are less likely to use various criteria for innovation's evaluation. The results suggest that individuals use different evaluative criterions during the multi-stage adoption process and different perceived attributes affect stages differently (Alexander et al., 2008; Arts et al., 2011; Castaño et al., 2008; Wood & Moreau, 2006). I found that perceived benefits of an innovation are relevant for persuasion in line with the CLT argument (Trope & Liberman, 2003). Similarly, perceived losses of an innovation are relevant for implementation stage in line with prospect theory (Kahneman & Tversky, 1979). However, the assumptions of both theories are not fully supported in case of decision and confirmation stage. Infact, the study is unable to find numerous determinants of both stages. This is in part inconsistent with the stage hypothesis confirmed from both surveys. Perceived ecology explains variation in buying decision of a sustainable car and risk explains variation in confirming the future use of an adopted car while all other expected relations could not be confirmed. A possible explanation is that many other predictors that were not included in the research model due to explorative nature of this study (for example observability, profitability, car cost, car design) could be additional possible candidates. In this respect, Moore and Benbasat (1991) classification of innovation characteristics can serve as a starting point. The present study combines financial, social, health/ safety, and functional risks under a single latent construct. Testing the impact of each separately (Petschnig et al., 2014) may affect stages in different ways (Castaño et al., 2008). Castaño and colleagues show that uncertainty

about potential benefits is more relevant for distant future decisions while uncertainty about switching and learning costs is more pertinent for near future decisions. Others add (potential) adopter characteristics and find relevance with adoption (Arts et al., 2011; Gatignon & Robertson, 1985; Manning et al., 1995; Tornatzky & Klein, 1982). The other possible explanation is that many relationships between exogenous and endogenous constructs were not hypothesized during the literature review which may reveal significant results, if added. For example, complexity-decision link, ecology-decision link, compatibility-confirmation link etc. show significant correlations ($r = 0.15, 0.19$, and 0.42 respectively, table 1.10). The present work is an exploratory study which confirms the basic assumption of stages' existence. Hence, it should be considered as a first step and used to extend the existing framework by including other relevant innovation attributes or relationships.

5.2.Conclusion

Existing literature on consumer innovation adoption does not provide empirical validation of distinct stages of innovation decision process neither typically differentiates between the impact of perceived innovation characteristics on distinct stages despite the evidence that individuals use different product evaluation criteria in different stages (see for example, Arts et al., 2011; Gardial, Clemons, Woodruff, Schumann, & Burns, 1994; Karahanna, Straub, & Chervany, 1999; Wilton & Pessemier, 1981). The results of this empirical research contribute to the existing knowledge which stands both in the theoretical framework and in the implications.

The present study contributes by exploring five distinct stages in line with Rogers' (2003) framework of innovation-decision process and identifying dynamic effects of perceived innovation attributes on each adoption stage. The SEM technique helped not only to test the model but also to explicate the strongest and weakest determinant of each stage by identifying the strengths of all relationships. This has implications as it helps practitioners to understand the most/least weighted abstract and/or concrete

benefits that encourage potential adopters in their smooth transition to the next stage. The existing literature on consumer adoption provides weak operationalization of the five stages, with few exceptions (Celik et al., 2014; Li & Lindner, 2007; Gilly and Zeithmal, 1985). The study also contributes by providing a valid and reliable scale for stages.

The findings of the study are also helpful for policy makers and practitioners to foster the diffusion of technologies which are locked-in due to the dominance of existing technologies in the mass markets. Since the information needs vary across stages, different messages and communication channels can be used at different stages to improve (potential) adopters' perception. For example, in distant future adoption case, managers should use communication strategies that engage individuals in an outcome simulation which reduces performance uncertainties and encourage positive feelings while in near future adoption case, managers should use strategies that engage them in a process simulation which reduces switching cost and assuage fatigue and anxiety (Castaño et al., 2008). In particular, ads and mass media messages which increase product awareness can help people at the knowledge stage pass to the next level, peer and subjective opinion can help people at the persuasion stage to form positive impression and pass to the next stage, while technical assistance by change agents or sales representatives can help people reduce operational complexity at the implementation stage to pass to the final stage (Rogers, 2003).

What's more, consumer's evaluation and adoption of a new product results in emotional responses that should be considered during the development of product launch strategies (Wood and Moreau, 2006). In this regards, designing a compelling value proposition (Anderson, Narus, & van Rossum, 2006) by combining required functional and/or hedonic attributes is a suitable strategy to encourage non-adopters pass through the adoption phases.

The main results of the study offer new insights for future research to enrich the much-studied consumer innovation adoption literature. The results of the study should be verified in other similar settings to address both the limitations discussed in the previous section. The findings show that persuasion and implementation have numerous predictors but decision and confirmation are relatively less explained. In this respect, correlation results provide opportunities to test more determinants. In the case of sustainable cars, the last two stages seem similar but are not explained by the same set of variables still favoring the distinction. Besides, another limitation of the present study is that majority of the respondents in both surveys were non-adopters as obvious from sample statistics. Participants in the two surveys were mainly in pre-adoption or adoption phases. Although the empirical setting was chosen for practical reasons, findings especially for post adoption phases may change in the study with sample of only adopters. The high association among several innovation attributes signals possible interdependencies and testing such interlinks can be another avenue for future research.

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