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Determinants of User Innovator Behavior in the Silver Market

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Abstract

The existing research on the behavior of user innovators has focused almost exclusively on younger users. In light of the demographic shift and the increasing importance of the "Silver Market" segment (customers 55 years plus), we analyzed whether important determinants of user innovator behavior (use experience, product knowledge, technical expertise, and the lead user components) exert the same influence among older users. We conducted a study in the camping and caravanning industry and included 333 respondents from 19 to 86 years of age. The innovator share among older users was slightly lower (43 % vs. 57 %). While use experience and product knowledge turned out less important for older users in our sample, technical expertise materialized as the most important determinant. Additionally, being ahead of trend is stronger related to dissatisfaction with existing products among older users. We found additional evidence that users with high use experience suffer from functional fixedness.

Keywords

User innovation; lead user; Silver Market; age; use experience; technical expertise; product knowledge; determinants.

1. Introduction

Many new products fail in the market because manufacturers do not sufficiently incorporate users in the development process and, as a result, develop what they think the market wants and not what it actually needs. Product innovation failure rates across industries are assessed to be between 40 % and 90 % (Griffin 1997); for fast-moving consumer goods even 70 % to 90 % (Gourville 2005). While some of the reasons are product-based by not offering a compelling advantage over existing products, other reasons reside in manufacturer's insufficient need knowledge and developer overconfidence (Rogers 2003; Gourville 2005). This problem is especially relevant for products which target elderly users because engineers are typically much younger and cannot necessarily relate to the specific needs and requirements. Integrating users in the innovation process can help to reduce these failure rates.

The existence of user innovators was first proposed by Eric von Hippel (Hippel 1976) and subsequently verified for industrial goods (Shaw 1985; Vanderwerf 1990; Urban and Hippel 1988; Herstatt and Hippel 1992; Franke and Hippel 2003) and consumer goods (Shah 2000; Franke and Shah 2003; Tietz et al. 2005; Lüthje 2004; Lüthje, Herstatt and Hippel 2002). Recent studies indicate that user innovators do not only exist in specific market niches but are actually a mass market phenomenon (Hippel, Ogawa and Jong 2011; Hippel, Jong and Flowers 2012).

The growing market segment of elderly customers is often called the Silver Market (Kohlbacher and Herstatt 2011; Kunisch, Boehm and Boppel 2011). The minimum age threshold to be considered a Silver Ager typically ranges from 50 to 65 years (Tongren 1988). For this research, the minimum age is defined at 55 years, which is in line with the definition of most researchers who do not use the entrance into the retirement age as a boundary but rather argue with changing needs and preferences at that age (Auken, Barry and Bagozzi

2006; Szmigin and Carrigan 2001). Additionally, based on a life expectancy of 82 years (which corresponds to the current life expectancy for most industrialized countries), 55 years mark the beginning of the last third of one's life span (World Health Organization 2013).

The Silver Market is becoming increasingly important due to the demographic change which is visible all over the world. Not only did the world's population grow from 3 billion people in 1960 to over 7 billion people nowadays (United States Census Bureau 2013), but also the population structure changed quickly. The median age of the world's population increased from 23 years in 1960 to 29 years today and is expected to grow to 36 years in 2050. This change is even stronger and faster in industrialized countries. Germany and Japan are currently among the oldest nations in the world. Their median age grew from 1960 until now from 35 years to 44 years (Germany), respectively 26 years to 45 years (Japan) (United Nations 2013). The population share of the Silver Market in Germany will grow from 33 % in 2010 to an expected 42 % in 2030 (Statistisches Bundesamt Deutschland 2009).

But which users should be incorporated in the development process of products for the Silver Market? From which users can a manufacturer learn best? The answer lies in users who are already developing their own products: user innovators! But whether user innovators also exist in the Silver Markets and how they are characterized is currently unknown. This is the first study which focuses explicitly on the relationship between age and user innovation. The key research objective is to evaluate to what extend user innovators also exist in the Silver Market and if so, how older user innovators differ from younger ones.

2. Literature review

2.1 Determinants of User Innovation Behavior

Based on von Hippel's observations in several industries, he demonstrated that the "functional source of innovation" (Hippel 1988) can reside with users, manufacturers, suppliers, and

others and varies depending on industries and product categories. Innovations are most likely to be created by users when their expected benefit from using an innovation is higher than the expected benefit by manufacturers from selling it (Hippel 1988; Shah 2000; Hippel 2005). The benefit for users is especially high when user needs are very heterogeneous, effectiveness of patents is low (Hippel 1988; Harhoff, Henkel and Hippel 2003), and transfer of need and solution knowledge is costly due to a high stickiness of information (Polanyi 1958; Hippel 1994, 2005).

With the importance of user innovators being established, researchers focused on the characteristics of user innovators and the antecedents of their behavior. Studies on the innovator share among users found it to be between 19 % and 54 % for industrial goods (Urban and Hippel 1988; Herstatt and Hippel 1992; Morrison, Roberts and Hippel 2000; Franke and Hippel 2003; Jong and Hippel 2009) and between 32 % and 41 % for consumer goods (Franke and Shah 2003; Franke, Hippel and Schreier 2006; Lüthje, Herstatt and Hippel 2002; Lüthje 2004; Tietz et al. 2005).

Compared to average citizens, innovative users are typically younger, highly educated, technically trained, male, and single (Hippel, Ogawa and Jong 2011; Steenkamp, Hofstede and Wedel 1999; Eisfeldt 2009; Midgley and Dowling 1993). Other studies could not confirm the correlation between demographics like age, income, and education, and the likelihood to become an innovator (Steenkamp, Hofstede and Wedel 1999; Im, Bayus and Mason 2003).

An especially interesting group among users are so called lead users. They represent a small group of users who "[…] face needs that will be general in a marketplace-but face them months or years before the bulk of that marketplace encounters them, and […] are positioned to benefit significantly by obtaining a solution to those needs" (Hippel 1986, p. 796). Lead users are typically highly qualified and very advanced in their field. They are often so far ahead of general market trends, that manufacturers have either not yet discovered their needs or it is not profitable to serve such a small and specific segment. Consequently, lead users

rarely have the option to buy a product for their needs and must rather innovate themselves (Franke, Hippel and Schreier 2006; Herstatt, Lüthje and Lettl 2001). The integration of lead users in the product development process can provide significant benefits for manufacturers. Product development with lead users can decrease development time and cost (Herstatt and Hippel 1992) and increase the resulting product's revenue potential up to eight times (Lilien et al. 2002). Since lead users also belong to the first adopters, they can additionally accelerate the diffusion and acceptance of new products.

The determinants of innovative behavior and lead userness have been intensely researched. The overview of the most relevant user innovation studies in table 1 shows that besides the two lead user components, ahead of trend and high expected benefits, especially use experience, product knowledge, and technical expertise exert a positive influence on innovative behavior. Additionally, the innovative behavior does not seem to be motivated by financial rewards, but rather by intrinsic motivators like reputation effects, helping others, and enjoyment of the innovation process itself (Hienerth 2006; Marchi, Giachetti and Gennaro 2011; Jeppesen and Frederiksen, 2006; Ogawa and Pongtanalert, 2013).

The existing studies on consumer goods focused almost exclusively on (extreme) sporting equipment and are therefore limited to rather young individuals. In contrast, most recent research indicates that user innovations do not only exist in specific small product niches but truly are a mass phenomenon (Hippel, Ogawa and Jong 2011; Hippel, Jong and Flowers 2012). With this study, we are also trying to counter a possible over-emphasis of younger users in lead user innovation studies.

Table 1 Studies Analyzing Determinants of Innovative Behavior and Lead User Components

		Correlated Variables									
Study	**Dependent Variable**	Ahead of Trend/ New needs	High Benefits/ Dissatisfaction	Use experience	Product knowledge	Technical expertise	Extrinsic motivator	Intrinsic motivator	Innovativeness index	Speed of adoption	Others
Shaw 1985	Commercial success of innovation										+
Voss 1985	Owner of innovation process				+	O					
Urban & Hippel 1988	Lead user components		+						+	+	
Vanderwerf 1990	Innovative behavior										+
Herstatt & Hippel 1992	Lead user components						O	+			
Slaughter 1993	Dominating process owner			+		+	+				
Riggs & Hippel 1994	Incentives for user innovators						O	+			
Lüthje 2000	Innovative behavior	+	+	+	+	+	O	–			
Morrison et al. 2000	Innovative behavior	+				+	O	+	+		
Shah 2000	Innovative behavior	+	+	+			+	+			
Lüthje et al. 2002	Innovative behavior		+	+		+					
Franke & Shah 2003	Innovative behavior	+	+	+			O	+			+
Lüthje 2004	Innovative behavior	+	+	+	+	+	O			+	
Morrison et al. 2004	Leading edge status	+	+								+
Tietz et al. 2005	Innovative behavior			+	+	+		+			+
Hienerth 2006	Driving factors of user innovators	+	+				+	+			
Franke et al. 2006	Innovative behavior	+	+			+					+
Schreier et al. 2007	Leading edge status[a)]								+		+
Schreier & Prügl 2008	Lead userness			+	+				+	+	+
Marchi et al. 2011	Level of innovativeness				+			+			+
Schuhmacher & Kuester 2012	Idea Quality	O	+	O	O		O	+			O

+ Positive relationship O No relationship – Negative relationship

a) LES was actually the independent variable. Relationships were estimated in very simple SEMs so that relationships can also be interpreted in the other way

2.2 Impact of Age on Creativity and Innovativeness

The impact of age on individuals' characteristics and capabilities is intensively but almost exclusively researched within the areas of medicine, psychology, and gerontology. The

marketing literature has focused on the changing preferences and buying behavior of older customers and is currently trying to divide the Silver Market into further sub-segments (Simcock, Sudbury and Wright 2006; Tempest, Barnatt and Coupland 2008). Older users as the source of new product ideas are not in the focus of these research fields.

The impact of age on innovative behavior is so far only of interest for human resource research with a focus on changing capabilities of an aging workforce and its impact on training and optimal team compositions. This naturally limits the focus on people below 65 years of age. Under this constraint, the inventive output of R&D employees shows an inverted u-shape with a climax in the early 30s and a sharp decline past the age of 40 (Hoisl 2007; Oberg 1960). (Eisfeldt 2009) estimated the likelihood to innovate to drop by 3 % per year. The main driver for the lower output is a decrease in creativity but depending on the context, individuals can compensate for it through higher experience and soft skills (Oberg 1960; Adenauer 2002). Similar patterns exist among academics, but the peak age depends on their discipline. Disciplines which require abstract thinking (e.g., mathematics, theoretical physics) observe an earlier peak in the late 20s and early 30s, while disciplines with a focus on experience and combination (e.g., history, philosophy) observe the peak in the late 40s (Simonton 1988). External impacts like switching career paths or early deaths are typically not incorporated in these studies. Nevertheless, the exemplary analysis of Thomas Edison's 1,093 patents show a similar pattern (see figure 1). After a peak output is reached between the age of 30 and 40, his output was relatively stable even up to a high age far beyond the typical retirement age of 65 years.

Since the described findings on intellectual peak performance indicate that, although there is a peak at a certain age, innovative output exists across all ages, one can assume that the same applies to user innovation.

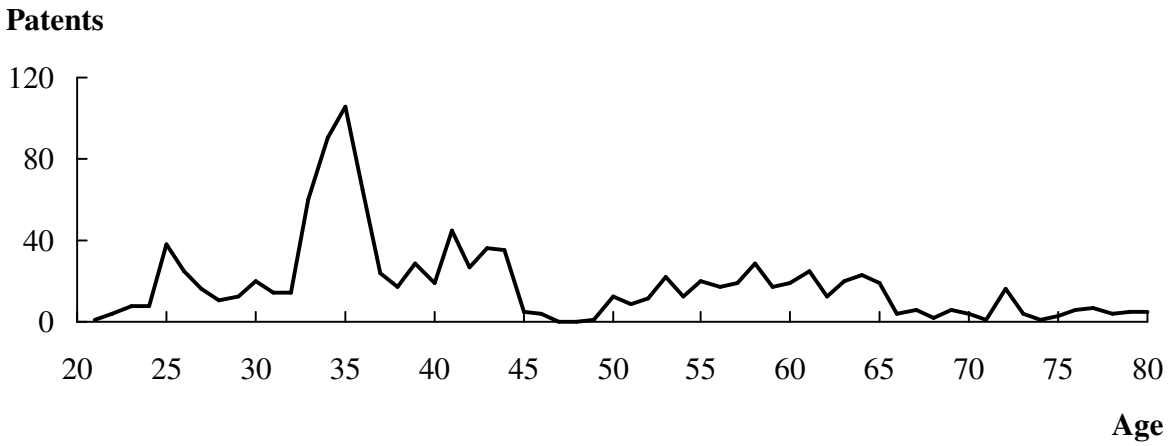

Figure 1 Number of Thomas Edison's U.S. Patents by Age, based on Execution Date. Source: http://edison.rutgers.edu/patents.htm, accessed on June 26, 2013.

3. Development of hypotheses

The purpose of this study is to test whether chronological age moderates the impact of the typical determinants of innovative behavior and lead userness. In order to do this, the most relevant determinants of innovative behavior from previous studies were identified and combined in a structural equation model (see figure 2). The selected determinants besides the two lead user components were use experience, product knowledge, and technical expertise (compare table 1).

Use experience is built up from using and interacting with a product during a certain activity (Schreier and Prügl 2008). During this interaction, personal wants and needs are formed and the user can better identify and describe existing problems (Bünstorf 2003). User innovators base their need information on their own personal experience rather than on information from others (Hippel 2005) and it has been found that high levels of experience are a prerequisite for a high level of lead userness (Schreier and Prügl 2008). Since use experience requires time to build up, it is typically correlated with age. The relative advantage of having much use experience therefore declines with age. Additionally, functional fixedness can become a problem. Functional fixedness occurs when a user is so familiar with a product, that he can hardly imagine any other creative way of using it or finding a substitute (Adamson 1952;

Fichter 2005). Since older users have a lower cognitive capacity and fluid intelligence, functional fixedness might present a larger barrier to become an innovator.

H1a: Age negatively moderates the impact of use experience on ahead of trend.

H1b: Age negatively moderates the impact of use experience on high expected benefits.

H1c: Age negatively moderates the impact of use experience on innovative behavior.

Product knowledge "[…] consists of know-how about the product architecture and the used materials and technologies of the existing products in the market" (Lüthje 2004, p. 686). It is required to identify options for improvement and innovation and to translate tacit knowledge into concrete product specification (Nonaka and Takeuchi 1995). Product knowledge is positively associated with innovative behavior (Marchi, Giachetti and Gennaro 2011; Tietz et al. 2005) and helps to assess expected benefits of an innovation. Since the product offering in any setting is continuously changing and improving, some product knowledge becomes obsolete over time and needs constant updating. Older consumers also tend to rely more on recommendations from family and friends and less on their own acquired product knowledge (Moschis 1992).

H2a: Age negatively moderates the impact of product knowledge on ahead of trend.

H2b: Age negatively moderates the impact of product knowledge on high expected benefits.

H2c: Age negatively moderates the impact of product knowledge on innovative behavior.

Technical expertise is the knowledge about product architecture and the required engineering techniques to build and modify them (Franke, Hippel and Schreier 2006). It is not domain-specific and users can apply it to different problems. Technical expertise is required to transform a simple idea into a working prototype (Lüthje, Herstatt and Hippel 2005; Lettl and

Gemünden 2005). High levels of technical expertise have been shown to be a prerequisite to being ahead of trend (Lüthje, Herstatt and Hippel 2005; Lüthje 2004), identifying and realizing potential benefits from innovations (Franke and Hippel 2003), and innovating successfully (Morrison, Roberts and Hippel 2000; Hippel, Ogawa and Jong 2011). Technical expertise belongs to the skills which are largely acquired during a formative period in the second quarter of one's life (Becker 2000). After that it remains relatively stable and changes only marginally. A potential lack of technical expertise can sometimes be overcome through motivation and endurance (Tietz et al. 2005; Voss 1985), which benefits older users who are already retired.

H3a: Age does not moderate the impact of technical expertise on being ahead of trend.

H3b: Age does not moderate the impact of technical expertise on high expected benefits.

H3c: Age does not moderate the impact of technical expertise on innovative behavior.

Both lead user components are associated with innovative behavior, independent of industry or product type. Lead users adopt new products earlier and in greater number (Urban and Hippel 1988; Schreier and Prügl 2008; Schreier, Oberhauser and Prügl 2007). They also create more novel innovations (Lilien et al. 2002; Olson and Bakke 2001; Urban and Hippel 1988; Morrison, Roberts and Hippel 2000; Lüthje 2004; Hienerth 2006), generate innovations faster (Schreier and Prügl 2008), and the results are more commercially attractive (Schreier and Prügl 2008; Franke, Hippel and Schreier 2006). Silver Market consumers have specific needs due to their decline in cognitive capacity and physical strength and therefore experience dissatisfaction with products earlier than younger users. They typically favor security and reliability (Sudbury and Simcock 2009; Simcock, Sudbury and Wright 2006). However, Silver Market consumers who are ahead of trend experience dissatisfaction even earlier and are highly motivated to find a solution that fits their specific requirements.

H4: Age positively moderates the impact of ahead of trend on high expected benefits.

H5: Age positively moderates the impact of ahead of trend on innovative behavior.

H6: Age positively moderates the impact of high expected benefits on innovative behavior.

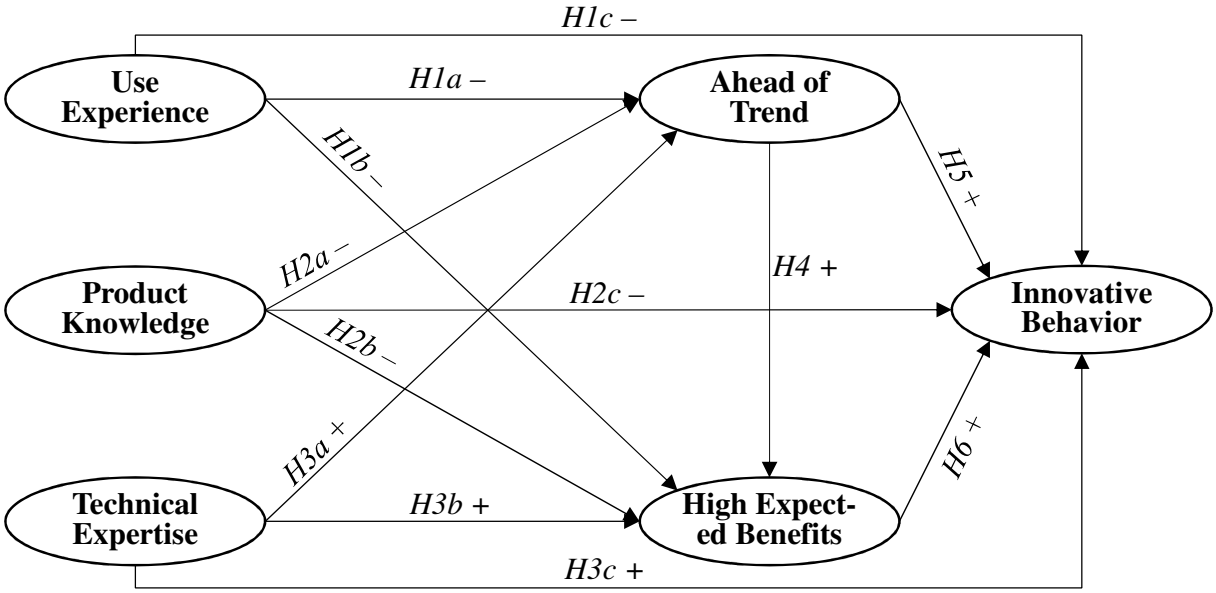

Figure 2 Structural Equation Model.

4. Study Methods

4.1 Research Field

The study was based on a survey among camping tourists across all age groups. The roots of camping can be traced back to the roots of modern mankind with nomadic tribes using temporarily set up shelters. Modern camping as a leisure activity was first developed in the late 19th century. Since the first *leisure trailer* was built by the Bristol Carriage Company for Dr. William Gordon Stables in 1885 (The Caravan Club Limited 2012), camping has developed into a wide-spread leisure activity with more than 4 million touring caravans and almost 1.4 million motor caravans registered in Europe (European Caravan Federation 2012a; European Caravan Federation 2012b). The economic impact of camping tourists is also significant. A study by the German Federal Ministry of Economics and Technology in 2010

estimated that camping tourists create a total of 11.6 billion Euros in net revenues per year in Germany (Bundesministerium für Wirtschaft und Technologie (BMWi) 2010).

The camping market is well suited to answer the research questions because all age groups are equally well represented. Additionally the broad range of equipment required for camping offers plenty of opportunities for modifications and innovations. Since camping is a leisure activity, which people usually undertake during their vacation, they are highly emotionally involved. It was expected that the high emotional and financial involvement leads to a high motivation of individuals to find optimal solutions regarding their needs.

4.2 Data Collection and Sample

The data was collected through an online survey in German online camping communities and through a paper-based survey which was conducted on German camping sites in 2012. Out of the twelve largest German online camping communities, the administrators of six agreed to support the survey and to distribute the link.[1] The paper-based survey was undertaken on nine, geographically distributed camping sites in Germany. Both surveys were identically worded and structured. Both collection modes were used to optimize the representation of all age groups in the final sample. Before the final sample was compiled, the data was tested for potential mode effects from the different data collection methods as well as for measurement invariance.

To test for mode effects, the suggested procedure of (Leeuw 2005) was applied by selecting sub-groups from each collection method which were matched "[…] on important variables, such as age and education, to see if the matched groups are much different" (Leeuw 2005, p. 249). To select appropriate subjects, the 25 % quartile cut-off values and 75 % quartile cut-off values for income, education, and age were computed and subjects were filtered based on

[1] The survey was posted in campen.de, camperboard.de, camperfreunde.com, ClassiCaravan, klappcaravanforum.de, and wohnwagen-forum.de. As of February 24, 2014, these online camping communities had an aggregated membership of 77,559.

these values. The resulting groups were then additionally split by the median age (50.2 years) to create two matching samples. The Mann-Whitney-U Test and the Kolmogorov-Smirnov test were used to test for differences in the groups. On a significance level of 5 %, differences were only indicated for items of technical expertise (items TE [1], TE [3], and TE [4]), innovative behavior, and FEEL age. Except for the differences in FEEL age, the differences do not indicate a direct mode effect on measurement and it can be assumed that the measurements of the online survey and the paper-based survey are equivalent. A higher self-evaluation of technical expertise by subjects from the online survey is not surprising, since they master at least one additional technology: the internet. Measurement invariance was confirmed by establishing indicator reliability, internal consistency reliability, convergent reliability, and discriminant validity separately for each group (Sarstedt, Henseler and Ringle 2011).

The final sample consisted of 333 usable responses. Respondents' age ranged from 19 to 86 years with an average age of 50.0 years. 33 % were at least 55 years old and therefore attributed to the Silver Age segment. Out of all respondents, 53 % had at least an innovative idea and 32 % had developed a working prototype.

4.3 Operationalization of Variables

All latent variables and their indicators have been applied in previous studies and proved to create reliable and valid results. Table 2 shows the wording of all items. Use experience was measured formatively with the two items frequency and length of experience (Lüthje 2004; Lüthje, Herstatt and Hippel 2005; Schweisfurth 2013; Schreier and Prügl 2008). Product knowledge and technical expertise were measured reflectively with three, respectively four items on a 5-point Likert scale from "strongly agree" to "strongly disagree" (Lüthje 2000; Franke, Hippel and Schreier 2006). The two lead user components are often measured using concrete actions or achievements. While this procedure is appropriate for sporting activities, it

is not very feasible for leisure activities like camping. Therefore, we used an adjusted lead userness questionnaire developed by (Franke and Shah 2003). It consisted of three items for being ahead of trend and two items for high expected benefits. The items were measured on a 7-point Likert scale from “strongly agree” to “strongly disagree”.

Finally, respondents were asked to classify their innovation in at least one of the following types: “comfort improvement”, “new functionality”, “better compatibility”, “time savings”, “cost reduction”, or “others”.

Table 2 Operationalization of Variables

Variable	Code	Item
Use Experience	UE [1]	How many days per year do you do camping?
	UE [2]	Since how many years have you been camping?
Product Knowledge	PK [1]	I use my equipment intensely.
	PK [2]	I have a good overview of the available equipment on the market.
	PK [3]	I am well versed in the materials of my equipment.
Technical Expertise	TE [1]	I can repair my own equipment.
	TE [2]	I can help other campers solve problems with their equipment.
	TE [3]	I am handy and enjoy tinkering.
	TE [4]	I can make technical changes to my camping equipment on my own.
Lead Userness	LU [1]	I usually find out about new camping products and solutions earlier than others.
	LU [2]	I have benefited significantly by the early adoption and use of new camping products.
	LU [3]	Among campers, I am regarded as being on the “cutting edge”.
	LU [4]	I have new needs which are not satisfied by existing camping products.
	LU [5]	I am dissatisfied with the existing camping equipment.
Innovative Behavior	IB [1]	Have you improved existing products or had ideas for new products that were not offered on the market before?
	IB [2]	How far have you developed your idea to date?

5. Findings

5.1 PLS-SEM Results

The analysis was conducted using the variance-based PLS-SEM approach (Wold 1982; Hair et al. 2013) through SmartPLS 2.0 (Ringle, Wende and Will 2005).[2] The measurement model fulfilled all required quality criteria concerning indicator reliability, internal consistency reliability, convergent validity, and construct validity (see tables 3 and 4).

The results show that user innovators exist across all age groups. 43 % of users of at least 55 years of age have had innovative ideas compared to 57 % of younger ones. Based on prototype development, the innovator shares drop to 25 % and 36 %. The Mann-Whitney U-Test was applied to test the significance of the differences. The age groups were not significantly different in idea development ($p = 0.193$) but the innovator share based on prototype development of the older age group was significantly lower ($p = 0.071$). The overall idea-to-prototype conversion rate was 61 % but dropped to 44 % for user innovators of at least 65 years. Apparently, older innovators experience more difficulty to overcome innovation barriers.

We decided to evaluate the impact of age by comparing the structural model for the two age groups above and below 55 years. To test for group differences, (Henseler, Ringle and Sinkovics 2009) suggested the PLS-MGA approach which considers the observed distribution of the bootstrapping results.

The evaluation of the general structural model showed that high expected benefits ($\gamma_{HEB,IB} = 0.357$; $p < 0.01$), technical expertise ($\gamma_{TE,IB} = 0.255$; $p < 0.01$), and use experience ($\gamma_{UE,IB} = 0.139$; $p < 0.05$) have an impact on innovative behavior. The influences of product knowledge ($\gamma_{PK,IB} = 0.078$; $p > 0.1$) and ahead of trend ($\gamma_{AoT,IB} = -0.072$; $p > 0.1$) on innovative behavior are not significant. Use experience does not have an impact on the lead

[2] PLS algorithm settings: mean centered path weighting scheme; maximum iterations: 3,000; abort criterion: 1.0×10^{-5}; initial weights: 1.0.
Bootstrapping settings: no sign changes; sample size: 5,000.

user components ($\gamma_{UE,AoT}$ = -0.022; p > 0.1; $\gamma_{UE,HEB}$ = 0.019; p > 0.1), product knowledge positively impacts being ahead of trend ($\gamma_{PK,AoT}$ = 0.271; p < 0.01; $\gamma_{PK,HEB}$ = 0.030; p > 0.1), and technical expertise exerts a positive impact on both lead user components ($\gamma_{TE,AoT}$ = 0.183; p < 0.01; $\gamma_{TE,HEB}$ = 0.119; p < 0.05).

The PLS-MGA shows that there exist several significant differences between the age groups (see Table 5). H1a and H1b cannot be confirmed because the expected impact of use experience on the lead user components does not exist in any of the age groups. The impact of use experience on innovative behavior is decreasing with age, as expected in H1c ($\gamma_{UE \times Age,IB}$ = -0.275, p < 0.05). Since the use experience indicators are correlated with age ($r_{Age,UE\,[1]}$ = 0.330, p < 0.01; $r_{Age,UE\,[2]}$ = 0.443, p < 0.01), we further tested for the existence of non-linear effects. The application of the two-stage approach (Henseler et al. 2012) shows that there exists a diminishing non-linear effect of use experience on innovative behavior. Although the effect is weak ($f^2_{UE^2,IB}$ = 0.020), it is nevertheless of a notable size and significant ($\gamma_{UE^2,IB}$ = -0.137, p < 0.05).

H2a and H2b are also confirmed. Age negatively moderates the impact of product knowledge on the lead user components, although only the effect on high expected benefits is significant ($\gamma_{PK \times Age,AoT}$ = -0.079, p > 0.1; $\gamma_{PK \times Age,HEB}$ = -0.298, p < 0.01). H2c cannot be confirmed, since product knowledge does not impact innovative behavior at all.

H4 is confirmed because the impact of ahead of trend on high expected benefits is stronger among older users ($\gamma_{AoT \times Age,HEB}$ = 0.194, p < 0.1). Therefore, being ahead of trend leads faster to dissatisfaction and the realization of high benefits from potential solutions among older users than younger ones. The negative impact of being ahead of trend on innovative behavior among young users, disappears completely in the older age group ($\gamma_{AoT \times Age,IB}$ = 0.138, p > 0.1), as expected in H5. Contrary to H6, the impact of high expected benefits is lower in the older age group ($\gamma_{HEB \times Age,IB}$ = -0.219, p < 0.05).

Table 3 Quality Criteria of Measurement Model

		Indicator Reliability		Internal Consistency Reliability	Convergent Reliability
Variable	**Item**	**Outer Weight/ Loading**	**T-Value**	**ρ**	**AVE**
Use Experience	UE [1]	-0.115	0.272	n/a	n/a
	UE [2]	1.022	3.102		
Product Knowledge	PK [1]	0.703	13.718	0.835	0.629
	PK [2]	0.867	40.865		
	PK [3]	0.801	21.990		
Technical Expertise	TE [1]	0.907	55.648	0.948	0.822
	TE [2]	0.889	59.946		
	TE [3]	0.890	49.635		
	TE [4]	0.939	145.312		
Ahead of Trend	LU [1]	0.801	22.365	0.844	0.644
	LU [2]	0.800	21.075		
	LU [3]	0.806	27.685		
High Exp. Benefits	LU [4]	0.920	66.200	0.878	0.783
	LU [5]	0.848	28.811		
Innovative Behavior	IB [1]	1.000	0.000	n/a	n/a

Table 4 Construct Validity of Reflective Variables

	Product Knowledge	**Technical Expertise**	**Ahead of Trend**	**High Expected Benefits**
PK [1]	**0.703**	0.217	0.164	0.043
PK [2]	**0.867**	0.283	0.358	0.189
PK [3]	**0.801**	0.468	0.248	0.159
TE [1]	0.374	**0.907**	0.215	0.190
TE [2]	0.421	**0.889**	0.319	0.187
TE [3]	0.357	**0.890**	0.217	0.160
TE [4]	0.351	**0.939**	0.292	0.237
LU [1]	0.220	0.207	**0.801**	0.271
LU [2]	0.281	0.215	**0.800**	0.168
LU [3]	0.308	0.269	**0.806**	0.325
LU [4]	0.204	0.216	0.342	**0.920**
LU [5]	0.102	0.161	0.227	**0.848**

Although the lead user components are stronger correlated among older users, the explained variance of innovative behavior is much higher for the younger age group ($R^2_{<55years} = 0.363$; $R^2_{\geq 55years} = 0.211$). Apparently, older user's decision to innovative is influenced by additional factors which have not yet been in the focus of traditional user innovation research.

Analysis of the innovation type revealed some slight differences between age groups. Older user innovators focused more on comfort improvements (78 % vs. 71 %) and better compatibility to their existing equipment (44 % vs. 34 %), and less on new functionalities (52 % vs. 59 %) or time-saving innovations (11 % vs. 18 %).

Table 5 Results of PLS-MGA

		≥55years	**<55years**	**Group Difference**	
Exogenous Variable	**Endogenous Variable**	γ^{55+}	γ^{55-}	$\gamma^{Moderator}$	**p-value**
Use Experience	Ahead of Trend	$0.057^{n.s.}$	$0.001^{n.s.}$	0.056	0.652
	High Expected Benefits	$-0.016^{n.s.}$	$0.041^{n.s.}$	-0.057	0.334
	Innovative Behavior	**$0.005^{n.s.}$**	**0.280*** **	**-0.275**	**0.015**
Product Knowledge	Ahead of Trend	0.233***	0.312***	-0.079	0.221
	High Expected Benefits	**-0.155****	**0.143***	**-0.298**	**0.003**
	Innovative Behavior	$0.058^{n.s.}$	$0.062^{n.s.}$	-0.004	0.489
Technical Expertise	Ahead of Trend	0.210**	0.129**	0.081	0.785
	High Expected Benefits	**0.161***	**$0.081^{n.s.}$**	**0.080**	**0.744**
	Innovative Behavior	0.332***	0.203***	0.129	0.897
Ahead of Trend	High Expected Benefits	**0.408*****	**0.211*****	**0.197**	**0.946**
	Innovative Behavior	**$0.030^{n.s.}$**	**-0.108***	**0.138**	**0.875**
High Expected Benefits	Innovative Behavior	**0.191****	**0.410*****	**-0.219**	**0.032**

* p < 0.10
** p < 0.05
*** p < 0.01

Cases: 110 Cases: 223
Samples: 5,000

6. Discussion

6.1 Contributions to Research

This study is the first quantitative study in the field of innovation management which focuses on the impact of age on the behavior of user innovators. The study was also not limited to an age cap of 65 years, which applies to almost all studies in organizational research, and provides first academic insights into the characteristics of age-related changes to innovative behavior that are not job-related. The findings add implications to two research streams within the innovation management community.

Firstly, there are implications for the Silver Market theory. Most importantly, in the area of low-tech consumer goods, older users are almost as innovative as younger ones, confirming first evidence by (Hippel, Ogawa and Jong 2011) and (Hippel, Jong and Flowers 2012) that user innovation is a mass phenomenon. The methods and tools developed to integrate innovating users in the product development process can therefore be applied for age-based innovations as well. The determinants of their behavior differ as well as the outcomes of their innovations because older innovators solve age-specific problems. They focus more on comfort and compatibility and less on time-saving innovations.

Secondly, there are implications for the lead user theory. The findings have shown that the prediction of innovative behavior through the lead user components works better for younger users. The degree of independence of the lead user components differs significantly between the age groups. Therefore, the correlation of the two components depends on the changing needs and preferences and not on the industry context nor is it a stable trait. The absolute and relative importance of the determinants of innovative behavior differs with age. The impact of use experience diminishes with increasing size so that it is not relevant anymore among older users, who typically have accumulated large amounts of use experience. Apparently, functional fixedness is a threat for user innovators. Expected benefits exert higher influence on innovative behavior among younger users. Since they have more time to capitalize on a

potential innovation, they are more motivated to invest into it (Lévesque and Minniti 2006). On the other hand, the negative impact of being ahead of trend disappears. The negative influence of being ahead of trend on idea quality has also appeared in other studies on lead user characteristics (Schuhmacher and Kuester 2012). Generally, the ahead of trend component gains importance among older users. Most probably, this is because the combination of both characteristics (high age and being ahead of trend) emphasizes the specific needs of older users and they experience the boundaries of non-age-based products faster. Because technical expertise is less prone to obsolescence (Becker 2000), it gains relative importance against all other determinants.

Additionally, our research has shown that the determinants of innovative behavior are not necessarily linear effects, as is typically assumed. As was shown through this study, use experience has a diminishing impact on innovative behavior. At first it is required for successful innovation but too much use experience seems to lead to functional fixedness (Adamson 1952). In that case "more" is not always "better" because users might have trouble coming up with creative solutions to problems or identifying problems in the first place because they have already adapted to it. The potential existence of non-linear effects should always be considered, especially in cases where a high degree of experience or knowledge is probable.

6.2 Recommendations for Managerial Practice

Manufacturers, who are thinking about developing new products or improving their existing products in the portfolio, can gain from the findings of this study. Silver Market camping tourists innovate despite all the required efforts. Although this industry historically has a relevant share of older customers, there are still needs which are not fulfilled by the current market offering. It is very probable that this situation is the same in other industries which have the same or less experience with the Silver Market segment.

The incorporation of users (and potential customers) improves the development process and its outcomes. But the identification of the best-suited users is often difficult. The findings of this study can help to identify the right users and provide recommendations when to incorporate them. When developing products for the Silver Market, manufacturers should look for older users with a high level of technical expertise, not too much use experience (to prevent functional fixedness) and who are comparably advanced in their field.

Older user innovators have more ideas than they can realize which shows in the low idea-to-prototype conversion rate. Therefore, manufacturers should carefully collect and evaluate ideas – and not only prototypes – of older users. Otherwise, they might miss promising product innovations.

Limitations and Suggestions for Further Research

Since this was the first study on the impact of age on the characteristics of innovating users, more studies in this area are required to confirm our findings. Our study was set in a low-tech consumer goods industry and should be interpreted in this area. In other industry settings, which require different sets of capabilities and knowledge, e.g., consumer electronics or application development, age might have a different impact on the overall innovative behavior and its determinants. Further studies are required to determine which findings are generalizable and which are industry-specific.

Although the sample included respondents from a wide range of ages, there are still some age groups missing; people under 19 and especially over 86. Like most other studies, our sample is male-dominated (Tietz et al. 2005; Franke, Hippel and Schreier 2006; Franke and Shah 2003). (Claßen 2012) has shown in her study on the technology acceptance of elderly users that the largest differences between age cohorts exist among women. A detailed analysis on the impact of age on the innovative behavior of women, therefore, seems promising. Also, we focused on healthy users who are autonomous and do not require support. It would be

interesting how significant physical or cognitive limitations, which are more likely to appear among the elderly, influence innovative capabilities.

The lower idea-to-prototype conversion rate among older user innovators indicates that they experience some innovation barriers which they are not able to overcome. The understanding of barriers to innovation (Braun and Herstatt 2009) and especially their mapping along the innovation process is still limited and should be elaborated to provide innovators with specific support.

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