

Article

# Boomers' Intention to Choose Healthy Housing Materials: An Application of the Health Belief Model

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Received: 13 August 2019; Accepted: 2 September 2019; Published: 6 September 2019



**Abstract:** This study aims to understand the decision-making process of healthy housing material selection of boomers who were born between 1946 and 1964 in the United States within the Health Belief Model (HBM) framework incorporating personal factors. The main constructs were three HBM components (perceived benefits, threats, and barriers), personal domains (knowledge, health concerns, and sensitivity to housing materials), and behavioral intention to choose healthy housing materials. With a nationwide random sample of boomers living in their homes (N = 306), path analysis was used to test the proposed research model. The findings indicate that behavioral intention to choose healthy housing materials is influenced by perceived benefits and threats. Of the personal factors, the knowledge component is directly and indirectly significantly associated with the behavioral intention. Insignificant association of perceived barriers and other personal components (health concerns and sensitivity) to the intention and the HBM components yield meaningful implications and discussions. The contribution of the HBM application to this study is to provide a foundation for understanding healthy housing material choosing behaviors for the general prevention of potential health issue purposes rather than actual maintenance. This paper discusses the significance of breadth and reliability of knowledge and the role of the relevant professionals to provide and communicate this knowledge.

**Keywords:** Health Belief Model; healthy housing materials; behavioral intention; knowledge; boomers

## 1. Introduction

With the increasing attention to sustainable and healthy living altogether, indoor environmental quality has received attention as one of the critical components that directly affect occupants' health and well-being. The World Health Organization [1] and the U.S. Environmental Protection Agency [2] have cautioned that interior materials containing harmful chemical substances can cause allergies, asthma, and cancer. For example, paints and carpets with Volatile Organic Compounds (VOCs) may raise sensory irritation in the eyes, nose, and throat, which more commonly occurs in asthmatic patients [3]. Most pollutants influencing indoor air quality originate from inside buildings rather than outdoor environments [4]. One recent study [5] reported that as of 2018, almost one-third of all households in the United States expressed concerns about their home environment. They were concerned that some aspect of their home might negatively impact their health, ranking indoor air quality as the leading concern.

Given this fact, it is assumed that consumers try to avoid using harmful interior materials and products for their home, especially if they recognize the possible harm of the materials or if they suspect interior air quality as a potential cause of health issues. However, this behavior might not be limited to those who are concerned about their indoor home environment where they currently live. The decision to choose healthy housing materials (i.e., interior materials that do not contain harmful

toxic chemicals or that meet certain performance requirements) could be made based on the intention to prevent possibly harmful conditions in the future. In other words, whether the motivation to choose healthy housing materials is due to their perceived benefits or the threats of not using it is uncertain. Which factor would be a stronger predictor for the healthy housing material selection behavior? How much does previous knowledge of the products influence the decision making? This current study began with these questions and explored a theoretical framework to answer them.

Various theoretical frameworks have been used to understand health-related behaviors. Among them, the Health Belief Model (HBM) has been demonstrated to be useful with a study that showed that individuals highly value their health, and stimuli for the health-related action are widely prevalent [6] (p. 44). According to the HBM, health-related decision making can be based on the intention of either prevention (preventive health behavior) or maintenance (sick-role behavior). Prevention behavior focuses on the prevention of a medical problem or disease, whereas sick-role behavior occurs to restore good health or prevent further disease progression after diagnosis of a medical problem [6]. These two main motivational components in the HBM are aligned with our focus in trying to understand the uncertain nature of healthy housing material selection, which could be more associated with either perceived benefits or threats.

This study focuses on the boomers' intentions and personal factors. As boomers are aging, it is expected that they will spend more time at home than they did while they were in the workforce. This means indoor environmental quality becomes more crucial not only to maintain boomers' current health but also to prevent any future indoor hazard-related symptoms. We argue that the significance of housing material selection focusing on health value has been increasing; however, its consequences have not been fully studied. This might be partly because this decision making occurs in limited circumstances and healthy housing materials were recently introduced to consumers. Unlike other health-related behaviors, such as vitamin taking or organic food consumption, healthy housing material decision making does not occur frequently in our daily lives. It occurs when individuals consider remodeling interiors or moving to a new place. Considering the nature of this decision making, a specific segment of individuals who are in this situation would provide more reliable data. According to recent remodeling research [7], boomers have led home remodeling expenditure for the past 20 years, although younger generations are more active for home remodeling projects. The study concluded that boomers' demand for home remodeling will increase, considering their strong desire to stay in their current home with independence and safety. Thus, this research focuses on boomers' intention to adopt healthy housing materials. We also understand that the housing material selection process involves not only consumers but also professionals, such as architects, interior designers, or contractors. Sometimes interior designers' intentions to choose particular interior materials can affect final material selection [8]. However, we believe the role of consumers should not be ignored.

In this paper, we used the term healthy housing materials by clearly focusing on the physiological health impacts of the material. Specifically, we defined healthy housing materials as interior materials that do not contain harmful toxic chemicals or that meet certain performance requirements. Examples of healthy housing materials include paints with low VOCs and non-toxic adhesives. However, healthy housing materials could be considered sustainable or environmentally responsible. Although these concepts are slightly different in focus, their strategies and principles share the value of providing physiologically and psychologically healthy indoor environments to occupants [9]. Healthy housing materials are not limited to personal health benefits at home but are environmentally responsible as well.

This study aims to understand healthy housing material selection behavior based on the HBM. A basic assumption for this study is that this behavior is influenced by HBM components and associated with an individual's prior knowledge, health concerns, and sensitivity to a certain material. In comparison with the interest in energy efficiency or sustainability, research about this health-focused topic has not been fully explored yet. Thus, the significance of this study is to fill this gap by proposing and testing the extended HBM, the which personal components (knowledge, health concerns, and sensitivity to housing materials) of which are incorporated with the original HBM components to understand boomers' behavior and attitudes about healthy housing materials.

## 2. Theoretical Framework

### 2.1. Theoretical Perspective

The HBM, originally created by psychologists in the public health research area [6], has been widely used to understand health-related behaviors to prevent disease [10] by stopping harmful behaviors (e.g., quitting smoking) [11] or adopting beneficial behaviors (e.g., cancer screening) [12,13]. While the HBM is highly relevant to environmentally-friendly behavior and healthy consumption behavior in a built environment, very few academic research fields [14,15] have tested the HBM. The original HBM contains four factors to predict health-related behavior: perceived benefits, threats, barriers, and susceptibility [6]. In this study, three factors (perceived benefits, threats, and barriers) were included in the research framework. *Perceived susceptibility*, or expected vulnerability such as risks for illness and disease, was excluded in the current study with two reasons. First, although it has been cautioned interior materials containing harmful chemical substances can cause allergies, asthma, and cancer, distinct particles that directly affect human health are yet clearly unknown [1,2]. Second, the relationship between this perception and (behavioral) intention has been reported almost always near zero [16]. *Perceived benefits* describe the positive outcomes one receives from a healthy behavior. *Perceived threats* pertain to potential negative consequences as a result of not adopting the healthy behavior. *Perceived barriers* are the factors such as time, effort, and price that make one unable to perform the healthy behavior.

### 2.2. Personal Factors

In this study, the HBM was extended. Besides the major constructs of the HBM, personal characteristics such as psychosocial factors and knowledge could affect one's perceived benefits, threats, barriers, and health behaviors [17–19]. Skinner et al. [17] asserted that the HBM does not specify how personal features interact with the HBM constructs, and this is a major gap of the model. In this study, we included three personal factors (knowledge, health concerns, and sensitivity to housing materials) in the extended HBM.

Knowledge has often been recognized as a significant predictor of healthy product and service consumption [20] as well as environmentally conscious behavior [14,21]. Knowledge of health benefits and threats is a precondition for behavioral change [22]. Several studies in health sciences have revealed the impact of knowledge on perceived susceptibility, benefits, threats, and barriers (e.g., [23–25]). For example, a study about osteoporosis prevention behavior evaluating the efficacy of education found that educational programming significantly influences the involvement in healthy behavior for osteoporosis prevention such as sun exposure and physical activity [26].

One of the personal reasons for health-related behavior in terms of health promotion and disease prevention is related to one's health concerns. Although little work to date has examined the relationship between health concerns and healthy housing material choosing behavior, the literature has emphasized the impact of health anxieties on other health promotion behaviors. One qualitative study [27] of pregnant women over age 35 showed that age-related health concerns resulted in engaging in multiple health promotion behaviors such as exercise and taking supplements. Several quantitative research studies about organic food purchasing behavior revealed that the most important reason for choosing organic food was health concerns [28–30].

Regardless of medical diagnosis by professionals, one's subjectively estimated physical reaction (i.e., sensitivity) may affect an individual's product choosing behavior. Toxic housing materials could cause eye irritation, coughing, headache, or mental fatigue, which is called sick building syndrome [31–33]. In the same manner as health concerns, few studies exist about the relationship between sensitivity to housing materials and healthy housing material consumption behavior. A study about sick building syndrome in office buildings found that subjectively estimated physical health significantly contributed to the sick building syndrome assessment [34]. Besides the building material studies, some other studies revealed that personal physical reactions influence particular product consumption. For example, a study about laundry detergent found that older people are more sensitive to skin irritation than younger people, and they seek environmentally-friendly laundry detergent [35].

### 2.3. Purpose of the Study

This study aims to understand the decision-making process of healthy housing material selection of boomers within the HBM framework incorporating personal factors. To this end, a conceptual model and related hypotheses were developed. Three personal factors (knowledge, health concerns, and sensitivity to housing materials) were included in the proposed conceptual model to examine their direct and indirect influence on behavioral intention to choose healthy housing materials. Figure 1 presents the proposed conceptual model.

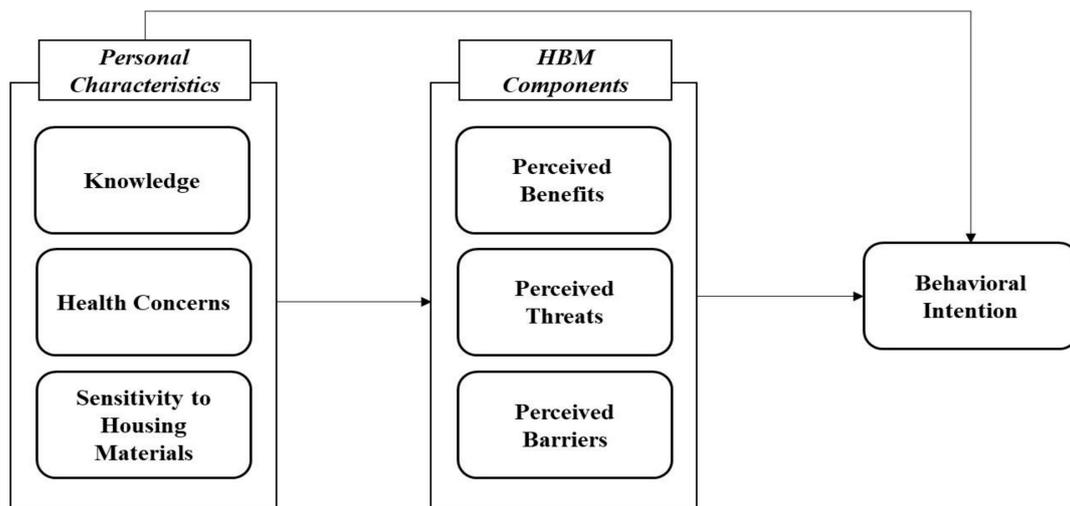


Figure 1. Conceptual model for behavioral intention to choose healthy housing materials.

### 2.4. Hypotheses

#### 2.4.1. Direct Effects of Personal Factors on HBM Components and Behavioral Intention

**Hypothesis 1a (H1a):** Knowledge directly affects perceived benefits.

**Hypothesis 1b (H1b):** Knowledge directly affects perceived threats.

**Hypothesis 1c (H1c):** Knowledge directly affects perceived barriers.

**Hypothesis 1d (H1d):** Knowledge directly affects behavioral intention.

**Hypothesis 2a (H2a):** Health concerns directly affect perceived benefits.

**Hypothesis 2b (H2b):** Health concerns directly affect perceived threats.

**Hypothesis 2c (H2c):** Health concerns directly affect perceived barriers.

**Hypothesis 2d (H2d):** Health concerns directly affect behavioral intention.

**Hypothesis 3a (H3a):** Sensitivity to housing materials directly affects perceived benefits.

**Hypothesis 3b (H3b):** Sensitivity to housing materials directly affects perceived threats.

**Hypothesis 3c (H3c):** Sensitivity to housing materials directly affects perceived barriers.

**Hypothesis 3d (H3d):** Sensitivity to housing materials directly affects behavioral intention.

#### 2.4.2. Indirect Effects of Personal Factors on Behavioral Intention

**Hypothesis 4 (H4):** *Knowledge indirectly affects behavioral intention, mediated by HBM components.*

**Hypothesis 5 (H5):** *Health concerns indirectly affect behavioral intention, mediated by HBM components.*

**Hypothesis 6 (H6):** *Sensitivity to housing materials indirectly affects behavioral intention, mediated by HBM components.*

### 3. Materials and Method

The target population was boomers who were born between 1946 and 1964, living in homes in the United States (N = 306). Data was collected in 2015 through an online survey with a random sample from a large nationwide pool of an online survey company, SurveyMonkey. The Institutional Review Board approval (IRB Protocol Number: 1311014229) was achieved before the online survey distribution. Screening questions filtered out non-qualifying participants (e.g., those who were not born between 1946 and 1964 or those living in rental housing or an institutional facility, such as nursing home and an assisted living facility). The concept of healthy housing materials was presented in the online survey screen with a sentence that “healthy housing materials are interior materials that do not contain harmful toxic chemicals or that meet certain performance requirements” and images of healthy interior materials certification labels such as green seal certified label and CRI green label.

The main constructs were (a) three personal domains, (b) three HBM components and (c) behavioral intention to choose healthy housing materials. The three personal domains were knowledge, health concerns, and sensitivity to housing materials. Knowledge was consumers’ subjectively measured general awareness of healthy housing materials and consisted of five items modified from previous research [14,20,21] (see Appendix A). Five *knowledge* items were “I have heard about healthy housing materials,” “I have heard about sick house syndrome,” “I have seen advertisements of healthy housing materials,” “I have read articles about healthy housing materials,” and “I have noticed that some products currently provide healthy housing materials information.” *Health concerns* measured general concern about one’s health and behavior due to health concerns and contained two items: “I am concerned about my health” and “I try to eat healthy food.” *Sensitivity to housing materials* asked about one’s sensory reaction to new housing materials [31,36]. It contained four items: “I am sensitive to indoor air quality,” “My nose is sensitive to new housing materials,” “My eyes are sensitive to new housing materials,” and “My throat is sensitive to new housing materials.” Each item was measured on a 7-point Likert scale.

All HBM components and behavioral intention were measured with items referred to in previous research [6,14,15]. *Perceived benefits* asked about positive perception when choosing healthy housing materials and contained three items: “I feel I am doing something good for my body when I choose healthy housing materials for my house,” “I feel my quality of life will be better if I choose healthy housing materials for my house,” and “I feel I can decrease medical expenses if I choose healthy housing materials for my house.” *Perceived threats* asked about the perception of negative results related to health when one does not choose healthy housing materials and was measured using three items: “I feel my chances of having serious health problems in the future are high if I install unhealthy housing materials in my house,” “If I get a disease/illness because of unhealthy housing materials, it will have a severe negative influence on my quality of life,” and “I will have higher medical expenses if I do not make healthy housing materials choices.” *Perceived barriers* referred to the perception of obstacles when choosing healthy housing materials and comprised four items: “I think healthy housing materials are too expensive compared to other general items,” “Healthy housing materials are not available in most building materials shops,” “Because of lack of information, it is hard to select healthy housing materials,” and “Even though there are numerous recommendations about healthy housing materials, it is hard to know what to believe.” Each item was measured on a 7-point Likert scale. *Behavioral*

intention was assessed with three items: “When I purchase my housing materials next time, I will try healthy housing materials,” “I will say positive things to other people about healthy housing materials,” and “I will recommend to my family and friends healthy housing materials.”

Descriptive statistics were employed to illustrate means and standard deviations of socio-demographic and housing characteristics, the personal factors, the HBM constructs, and behavioral intention. Path analysis was conducted to test the proposed research model and hypothesized causal relationships among constructs. The Statistical Package for the Social Sciences (SPSS) 20.0 and AMOS 18.0 were employed to describe and analyze data for this study. A significant level of  $p < 0.05$  was chosen.

## 4. Results

### 4.1. Overview of Respondents

The mean age of the participants was 60.78 years old ( $SD = 5.56$ ), and 54.2% were male and 45.8% were female. Almost 70% were married. In terms of education, 35% of them had a bachelor’s degree, 26.8% had technical school/some college education, 23.2% had a master’s degree or higher, and 15% had a high school diploma or less. Slightly more than 36% earned less than \$3000 per month, 27.8% made \$4000 to \$6999, 22.2% earned more than \$10,000, and 13.7% made \$7000 to \$9999 per month (i.e., US median income was \$56,516 in 2015 [37]).

In terms of housing characteristics, 92.2% lived in a single-family detached home, and 7.8% lived in a townhouse, condominium, or other housing. More than half of the participants lived in a city suburb, 22.2% lived in a rural area, 21.6% lived in a small town, and 5.9% lived in a city downtown area. In terms of housing size, 46%, of them had three bedrooms, 25.5% had four bedrooms, 17.3% had two bedrooms, 2% had one bedroom, and 9.1% had more than five bedrooms in their house.

### 4.2. Descriptive Statistics, Validity and Reliability of Measurements

A total of 24 items were subjected to confirmatory factor analysis to establish construct validity. The model fit indices (CFI (Comparative Fit Index) = 0.939; IFI (Increasing Fit Index) = 0.940; RMSEA (The root mean square error of approximation) = 0.068) suggested an acceptable fit [38]. The  $t$ -value of each item was significant at the 0.01 level [39], ranging from 4.82 to 35.76, which confirmed the satisfactory level of measurement validity. The reliability value of each multi-item measure was ranged from 0.75 to 0.95. Table 1 shows scale reliabilities and correlations between constructs. Appendix A illustrates means and standard deviations of the personal factors, the HBM constructs, and behavioral intention.

**Table 1.** Scale reliabilities, number of scale items, and correlations of observed variables.

|                    | KN       | HC       | SHM      | PB       | PT       | PBR   | INT  |
|--------------------|----------|----------|----------|----------|----------|-------|------|
| Cronbach Alpha     | 0.87     |          | 0.95     | 0.92     | 0.82     | 0.75  | 0.93 |
| # of items         | 5        | 1        | 4        | 3        | 4        | 3     | 3    |
| Mean               | 4.19     | 5.51     | 3.71     | 5.33     | 4.46     | 4.52  | 4.78 |
| Standard Deviation | 1.42     | 1.21     | 1.72     | 1.18     | 1.29     | 1.04  | 1.24 |
| KN                 | 1        |          |          |          |          |       |      |
| HC                 | 0.26 *** | 1        |          |          |          |       |      |
| SHM                | 0.35 *** | 0.28 *** | 1        |          |          |       |      |
| PB                 | 0.46 *** | 0.40 *** | 0.31 *** | 1        |          |       |      |
| PT                 | 0.34 *** | 0.34 *** | 0.29 *** | 0.57 *** | 1        |       |      |
| PBR                | −0.15 ** | 0.03     | 0.14 *   | 0.05     | 0.10     | 1     |      |
| BI                 | 0.54 *** | 0.36 *** | 0.28 *** | 0.72 *** | 0.67 *** | −0.02 | 1    |

Note. KN: Knowledge, HC: Health Concerns, SHM: Sensitivity to Housing Materials, PB: Perceived Benefits, PT: Perceived Threats, PBR: Perceived Barriers, and INT: Behavioral Intention. \*  $p < 0.05$ ; \*\*  $p < 0.01$ , and \*\*\*  $p < 0.001$ .

The multi-item measures for each construct were summed and averaged to ensure measurement validity and reliability. For the subsequent path model analyses, mean scores for each construct were

used as a single variable. As Table 1 shows, constructs with the highest mean value were health concerns (M = 5.51, SD = 1.21), perceived benefits (M = 5.33, SD = 1.18), and behavioral intention (M = 4.78, SD = 1.24). Constructs with the lowest mean values were sensitivity to housing materials (M = 3.71, SD = 1.72), knowledge (M = 4.19, SD = 1.42), perceived threats (M = 4.46, SD = 1.29), and perceived barriers (M = 4.52, SD = 1.04). Among the seven measures, sensitivity to housing materials was the only construct lower than a center value on a 7-point Likert scale.

4.3. Path Model Estimation and Results

The specified path model included three exogenous variables (knowledge, health concerns, and sensitivity to housing materials) and one endogenous variable (behavioral intention). Three other endogenous variables as mediators were perceived benefits, perceived threats, and perceived barriers. The model was showed an acceptable fit (CFI = 0.995; IFI = 0.995; GFI (Goodness of Fit Indices) = 0.995; RMSEA = 0.072) [38].

As summarized in Table 2 and illustrated in Figure 2, the path model provided support for eight of the 12 hypothesized direct relationships (from H1a to H3d). Significant direct effects between personal domain constructs and behavioral intention were found: from knowledge to perceived benefits (H1a), perceived threats (H1b), perceived barriers (H1c), behavioral intention (H1d), and health concerns to perceived benefits (H2a), perceived threats (H2b), sensitivity to housing materials to perceived threats (H3b), and perceived barriers (H3c). However, there were no significant effects between health concerns and perceived barriers (H2c), and health concerns and behavioral intention (H2d); and sensitivity to housing materials and perceived benefits (H3a), and behavioral intention (H3d).

Table 2. A summary of hypothesis testing results (direct relationships).

| Hypothesized Relationship | Standardized Effect Size | p    | H Testing Results |
|---------------------------|--------------------------|------|-------------------|
| H1a KN → PB               | 0.35                     | ***  | Accepted          |
| H1b KN → PT               | 0.23                     | ***  | Accepted          |
| H1c KN → PBR              | −0.23                    | ***  | Accepted          |
| H1d KN → INT              | 0.23                     | ***  | Accepted          |
| H2a HC → PB               | 0.28                     | ***  | Accepted          |
| H2b HC → PT               | 0.24                     | ***  | Accepted          |
| H2c HC → PBR              | 0.04                     | 0.55 | Rejected          |
| H2d HC → INT              | 0.02                     | 0.52 | Rejected          |
| H3a SHM → PB              | 0.10                     | 0.05 | Rejected          |
| H3b SHM → PT              | 0.14                     | *    | Accepted          |
| H3c SHM → PBR             | 0.21                     | **   | Accepted          |
| H3d SHM → INT             | −0.04                    | 0.34 | Rejected          |

Note. KN: Knowledge, HC: Health Concerns, SHM: Sensitivity to Housing Materials, PB: Perceived Benefits, PT: Perceived Threats, PBR: Perceived Barriers, and INT: Behavioral Intention. \* p < 0.05; \*\* p < 0.01, and \*\*\* p < 0.001.

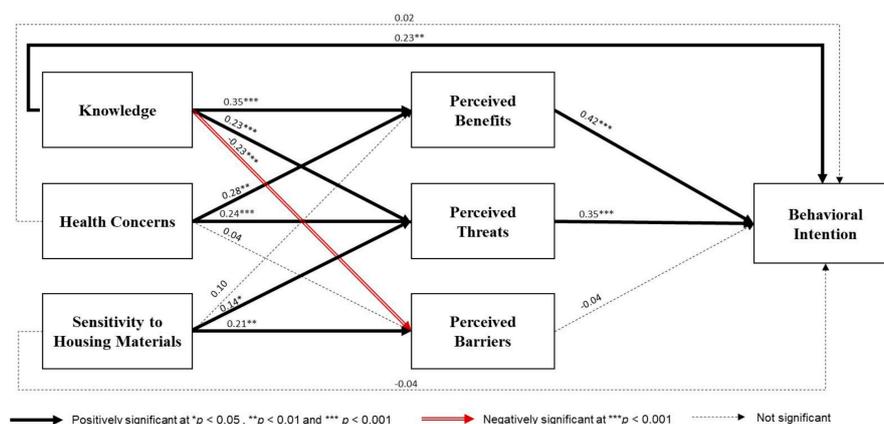


Figure 2. Modeling results.

Table 3 shows the results of decomposition tests for total, direct, and indirect effects. According to the bias-corrected percentile method, all the hypothesized indirect relationships were supported. The results confirmed the significant mediating role of HBM components (perceived benefits, threats, and barriers) in the path from personal domains (knowledge, health concerns, and sensitivity to housing materials) to behavioral intention.

**Table 3.** Indirect effect testing results.

| Hypothesis | Path      | Std. Total Effects | Std. Direct Effects | Std. Indirect Effects | H Testing Results |
|------------|-----------|--------------------|---------------------|-----------------------|-------------------|
| H4         | KN → INT  | 0.46 **            | 0.23 **             | 0.24 **               | Accepted          |
| H5         | HC → INT  | 0.22 **            | 0.02                | 0.20 **               | Accepted          |
| H6         | SHM → INT | 0.05               | −0.04               | 0.09 *                | Accepted          |

Note. KN: Knowledge, HC: Health Concerns, SHM: Sensitivity to Housing Materials, PB: Perceived Benefits, PT: Perceived Threats, PBR: Perceived Barriers, and INT: Behavioral Intention. \*  $p < 0.05$  and \*\*  $p < 0.01$ .

## 5. Discussion

Findings from the analysis indicate that making decisions about healthy housing materials is influenced by perceived benefits and threats. In the proposed model, the perceived benefits construct is revealed to be a stronger predictor than the threats construct. One noteworthy finding from our proposed model is the role of the knowledge component. This component is directly and indirectly significantly associated with the behavioral intention. The direct effects of knowledge on the HBM components have been revealed from several health science studies (e.g., [23,24]). Its direct association from this study also supports the results from a similar study that investigated housing consumers' knowledge and perceived benefits of green products [9]. In this study, housing consumers' knowledge was revealed to be related to their greater demand on purchasing such products.

In terms of the indirect relationships, knowledge is positively related to perceived benefits and threats, but negatively associated with perceived barriers. Boomers with greater knowledge of healthy housing materials were more likely to perceive benefits and threats of healthy housing materials. Also, this study found that perceived benefits and threats were the two strongest factors to positively influence the choice of healthy housing materials. The result parallels with preventive health-related behavior research (e.g., [40]). The negative relationship between knowledge and perceived barriers implies that individuals who have more knowledge are less likely to report their perceived barriers. This result agrees with an experimental study about diabetic patients in which perceived barriers were significantly reduced in an intervention group after patients attended diabetes seminars [23]. Thus, immediate interpretation from this relationship could be that some known barriers can be removed by providing appropriate knowledge. In this research, perceived barriers included higher costs, unavailability of the product, lack of information, and uncertainty about prevalent information.

The knowledge factor is worth our attention not only for consumers but also professionals such as architects, interior designers and contractors. It is an external component compared to health concerns or sensitivity to housing materials, which are innate to an individual's health condition. The result from this model indicates knowledge itself, which might or might not be related to the actual health condition, would work as a strong predictor for the behavioral intention. Considering there has been little research about the knowledge sources of healthy housing materials, further research on the accuracy or depth of the information is recommended. Recognition of the significant role of knowledge on behavioral intention inevitably leads to a discussion on who is currently educating consumers about healthy housing materials. Typically, generic or technical information about a new product or service is provided by the manufacturer. However, considering the process of choosing housing materials, the role of home builders or interior designers should not be ignored. Although this indirect influence on consumers has not been fully explored, one study about the interior designers' attitudes toward adopting sustainable flooring materials indicated that environmental beliefs are associated with the interior designer's attitudes but not with health beliefs [8].

Interestingly, sensitivity to housing materials shows limited associations with the HBM components, which have a positive relationship to perceived threats and perceived barriers but are not associated with perceived benefits. Considering that this personal component represents current actual health conditions and concerns, this result yields significant implications. Individuals with sensitivity to the housing materials were more likely to be concerned about the negative effects of not using healthy housing materials and the barriers in using them.

Meanwhile, boomers who had greater health concerns showed greater perceived benefits and threats about healthy housing materials; perceived benefits were a stronger predictor of health concerns than perceived threats. Individuals who have more health concerns were assumed to be more actively seeking relevant information and more opportunity to try products that are known to be healthy. In the same vein, we can assume that individuals who are more sensitive to housing materials are more likely to seek solutions from healthy housing materials. Thus, to promote healthy housing materials, targeting people who are sensitive to and/or have symptoms from housing materials containing harmful chemicals would be a promising marketing strategy. Boomers with health concerns who regularly exercise and eat organic foods would be the best group to target.

One of the HBM components, perceived barriers, was not a significant predictor of behavioral intention. Meanwhile, the mean value of the behavioral intention was fairly high. These results can be interpreted to show that behavioral intention to choose healthy housing materials can exist regardless of perceived barriers. In other words, perceived barriers such as cost, time, and information may be not critical factors in the choice of healthy housing materials. This relationship could cautiously be interpreted as showing that healthy housing material choice is more likely to be optional with a general prevention purpose. Although contradictory findings have resulted from other preventive health-related behavior research, the weak influence of perceived barriers on healthy housing material selection parallels the findings from preventive health-related behavior research. For example, condom use for AIDS (Acquired Immune Deficiency Syndrome) prevention [41] shows no significant association between perceived barriers and behavior, and barriers were reported as the weakest predictor among the HBM perception components for exercise among adults [36] and smoking in adolescents [42].

Another possible interpretation regarding this weak relationship found in the current study would be related to the perceived severity of the barriers. Subjectivity of the perception on the barrier could produce varied influence. Especially if these barriers are related to financial situations, perception would vary according to financial status associated with other demographic factors as well.

## 6. Implications

The significance of this study was to propose and test the extended HBM model including personal factors, knowledge, health concerns, and sensitivity to housing materials. The analysis results indicated the significance of the knowledge component, which was revealed as the strongest factor and both directly and indirectly associated with behavioral intention. The model test results also indicated that the benefits from using healthy housing materials were not strongly perceived by the individuals who may have been sensitive to housing materials. This loose relationship could result from consumers' lack of accurate knowledge on the product or a product's lower performance compared to other solutions, such as medicine or behavioral remedies.

The significance of the knowledge component in our model can be extended to the importance of education. Consumers can have varied perceptions of the product according to its main values and focus developed by manufacturers or markets. For example, non-toxic floor materials can be considered as both healthy housing materials and environmentally responsible materials. Both are true; however, potential beneficiaries should not be excluded by only focusing on sustainable aspects that represent more global benefits.

The results from the current study indicated similar relational results among the HBM components and selected personal factors by implying that healthy housing material choosing behaviors seem to be based on more general prevention purposes than actual maintenance. We believe either purpose, prevention, or maintenance could play a significant role in improving an individual's well-being

through better indoor environmental quality. Although we have not had significantly accumulated data to prove the benefits of healthy housing materials, currently available and scientifically reliable knowledge needs to be provided to consumers.

Along with the breadth of the knowledge, the role of the agent to provide and communicate the knowledge should be emphasized in education. As mentioned earlier, the occasion for adopting housing materials is very rare, such as moving to a new home or home remodeling. For this situation, professionals' involvement in this decision is common. We do not know how much consumers rely on the professionals' recommendations. We also do not know how much these professionals are educated regarding healthy housing materials. Several research studies have focused on professionals' attitudes toward sustainability [8,9]; however, no research focusing on the health benefits has been conducted. We expect to see a transition of focus from global benefits to personal benefits, considering the emerging trend of wellness in various professions, such as WELL building standards, which focus on indoor environmental quality and individual well-being.

## 7. Limitations and Future Research Directions

This study provides meaningful insights into understanding boomers' intention to choose healthy housing materials; however, it has some limitations. First, although the sample for this study was randomly selected by an online survey company, considering the socio-economic status (i.e., higher income and education level) of those who can access the online survey, the results from this study cannot be generalized to all boomers in the United States. Second, other personal factors excluded to our model, such as an individual's medical history or pro-environmental traits, could provide different perspectives on the healthy housing material decision making. And finally, because we focused on developing and testing the extended HBM model, this study did not include an analysis of the relationship between socio-demographic variables and behavioral intention.

Our research findings and implications developed through discussion provide future research directions. First, including another layer of external dimension, such as trust in professionals such as architects, interior designers, or contractors, to the current model is recommended. Second, more specific variables related to knowledge, including previous/recent experience in home renovation and construction, sources for knowledge or cues for action, to focus on are recommended. Lastly, investigating other demographic segments including younger generations or low-income households would provide meaningful perspectives in developing educational strategies. A comparative path analysis for different population groups may highlight the differences among education, income, and generation groups.

**Author Contributions:** Both authors contributed equally to the development of this article, specifically in its conceptualization, conceptual framing and hypotheses construction, methodology design, data analysis, and writing, reviewing and editing.

**Funding:** This research received no external funding.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

**Table A1.** Descriptive Statistics of personal factors, the Health Belief Model (HBM) constructs, and behavioral intention.

| Items  | Mean | Standard Deviation |
|--|------|--------------------|
| <b>Knowledge</b>   |      |                    |
| I have heard about healthy housing materials.  | 4.71 | 1.67               |
| I have heard about sick house syndrome.  | 4.79 | 1.79               |
| I have seen advertisements of healthy housing materials.                                   | 3.66 | 1.76               |
| I have read articles about healthy housing materials.                                      | 3.81 | 1.83               |
| I have noticed that some products currently provide healthy housing materials information. | 3.99 | 1.66               |

Table A1. Cont.

| Items  | Mean | Standard Deviation |
|--|------|--------------------|
| <b>Health Concerns</b>   |      |                    |
| I am concerned about my health.  | 5.36 | 1.51               |
| I try to eat healthy food.   | 5.68 | 1.46               |
| <b>Sensitivity to Housing Materials</b>  |      |                    |
| I am sensitive to indoor air quality.  | 3.74 | 1.8                |
| My nose is sensitive to new housing materials.   | 3.89 | 1.93               |
| My eyes are sensitive to new housing materials.  | 3.67 | 1.86               |
| My throat is sensitive to new housing materials.   | 3.56 | 1.83               |
| <b>Perceived Benefits</b>  |      |                    |
| I feel I am doing something good for my body when I choose healthy housing materials for my house.                                 | 5.47 | 1.24               |
| I feel my quality of life will be better if I choose healthy housing materials for my house.                                       | 5.48 | 1.23               |
| I feel I can decrease medical expenses if I choose healthy housing materials for my house.   | 5.05 | 1.37               |
| <b>Perceived Threats</b>   |      |                    |
| I feel my chances of having serious health problems in the future are high if I install unhealthy housing materials in my house.   | 4.21 | 1.52               |
| If I get a disease/illness because of unhealthy housing materials, it will have a severe negative influence on my quality of life. | 4.99 | 1.41               |
| I will have higher medical expenses if I do not make healthy housing materials choices.  | 4.21 | 1.45               |
| <b>Perceived Barriers</b>  |      |                    |
| I think healthy housing materials are too expensive compared to other general items.   | 4.69 | 1.25               |
| Healthy housing materials are not available in most building materials shops.  | 4.26 | 1.32               |
| Because of lack of information, it is hard to select healthy housing materials.  | 4.57 | 1.5                |
| Even though there are numerous recommendations about healthy housing materials, it is hard to know what to believe.                | 4.58 | 1.42               |
| <b>Behavioral Intention</b>  |      |                    |
| When I purchase my housing materials next time, I will try healthy housing materials.  | 4.89 | 1.22               |
| I will say positive things to other people about healthy housing materials.  | 4.75 | 1.38               |
| I will recommend to my family and friends healthy housing materials.   | 4.71 | 1.38               |

Note. 7-point Likert scale (1 = strongly disagree and 7 = strongly agree).

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