Risk Perceptions of Common Technologies

Rachel E. Stuck[1] & Bruce N. Walker[1]
[1]School of Psychology, Georgia Institute of Technology, Atlanta, GA

Perceived risk is an important component of technology acceptance and adoption. Research has explored perceived risk, and its relation to technology acceptance. However, only limited work has considered common technologies, or assessed different types of risk. This study explored perceptions of risk within 5 types (financial, performance, physical, psychological, social) and overall perceived risk, for 23 common technologies. 178 participants rated the technologies across all the types of risk. In general, the technologies were rated as mildly risky for all categories of risk, but ratings were even lower for psychological, physical, and social risk. However, individual technologies varied in their rankings. This study emphasizes the need to understand not just overall perceived risk, but also type of perceived risk. This insight can assist developers and others (e.g., marketers) to understand what types of risk must be mitigated through redesign, training, or other means to promote technology acceptance.

INTRODUCTION

Technology acceptance has been an area of interest for several decades, as it is key to understand what impacts peoples' adoption and use of technology. A foundational model for technology acceptance was developed by Davis in 1985. In recent years, many researchers have found support for perceived risk as a key influencer of technology acceptance. However, perceived risk is a complicated construct with various types, which have not been investigated in relation to common or everyday technologies.

Technology Acceptance Model (TAM)

Davis's original TAM model (1985) identified both perceived usefulness and perceived ease of use as key contributors towards a user's attitude toward using a system. These in turn impact the user's actual use of the system. Fifteen years after the original model, Venkatesh and Davis developed TAM2 (Venkatesh & Davis, 2000). This updated model incorporated influencers of perceived usefulness (i.e., image, job relevance, subjective norm, output quality, result demonstrability), as well as how subjective norms could also directly impact intention to use.

Researchers both prior to and after the TAM2 model continued to explore potential additional components and influencers of technology acceptance. Just a few of these items include complexity, self-efficacy, social presence, and computer anxiety (Lee et al., 2003). One component identified in recent years as a potential influencer is an individual's perceived risk of the system or technology.

Perceived Risk

Perceived risk is "…a subjective feeling about an objective risk surrounding the circumstances based on the knowledge, past experiences, and/or intuitive judgment of the individual" (or technology) (Lu, Xie, & Xiong, 2015 p. 200). Foundational research in this area was conducted by Slovic. An early paper titled "Why Study Risk Perception" (Slovic, Fischhoff, & Lichtenstein, 1982) highlighted how understanding risk perception could help predict people's responses to hazards, and this could be used to mitigate various issues for the government (this is still a large focus of perceived risk research today). Slovic et al. identified two main factors for how people perceived risk: dread and unknown. However, this work was just the beginning, and many technologies have been developed or become more commonplace since that original research.

Perceived Risk and Technology Acceptance

While research exploring perceived risk has primarily focused on hazards that require government involvement (e.g., floods), perceived risk is also being explored as a predictor of technology acceptance (Cocosila, Archer, & Yuan, 2009; Curran & Meuter, 2005; M. Featherman & Featherman, 2001; M. S. Featherman & Pavlou, 2003; Horst, Kuttschreuter, & Gutteling, 2007; Im, Kim, & Han, 2007; Martins, Oliveira, & Popovič, 2014; Pavlou, 2003).

Many of those studies explored a general perceived risk (Curran & Meuter, 2005; M. Featherman & Featherman, 2001; Horst et al., 2007; Im et al., 2007; Pavlou, 2003). Overall, general perceived risk had a significant impact on technology adoption. However, mitigating general perceived risk to increase technology adoption is difficult without considering specific risk types.

There have been a few studies that explored specific types of risk (Cocosila et al., 2009; M. S. Featherman & Pavlou, 2003; Martins et al., 2014). The type of risk can have varying impacts on overall perceived risk or intention to use. Featherman et al. (2003) found that *performance* risk was the most impactful for the adoption of e-services. In information technology, perceived *psychological* risk impacted intention to use, and was also impacted significantly by *financial*, *social*, and *privacy* risk (though perceived privacy risk had the greatest impact). In Internet banking, *privacy*, *financial*, and *performance* were the risk types that had the greatest impact on technology acceptance (Martins et al, 2014).

Therefore, it is essential to understand risk perception in relation to technology acceptance, especially within various types of risk, and not just overall risk perception. It is also important to note that research has primarily only explored types of risk within specific and limited domains (e.g., electronic banking, commerce, services, and communication).

The goal of this study was to explore various types of perceived risk, as well as overall perceived risk in a variety of

technologies. In addition, our goal was to build on the original work exploring general risk perceptions of technologies to update knowledge of individuals' risk perceptions of various common technologies. This was part of a larger study that explored technology categorization of various technologies and trust in these technologies.

METHOD

Participants

Overall, there were 193 participants. Fifteen of these participants were excluded because of at least one failure on an attention check question, leaving a total of 178 participants. They had a mean age of 33 years (SD=14.36, range: 18-72). There were 84 males and 94 females. Participants were primarily white or Caucasian 76%, 12%-Asian, 9% black or African American, and 2% reported Other or more than one race. Participants were diverse in educational background (1%-less than high school graduate; 18%-high school graduate/GED; 4%-vocational training; 45%-some or in-progress college/Associate's degree; 28% Bachelors degree; 4% Master's degree; 1% Doctoral degree).

Materials

The measure of perceived risk was developed by Jacoby and Kaplan (1972). The measure identified *financial*, *performance*, *physical*, *psychological*, *social*, and *overall* perceived risk. The rating was a nine-point scale with 1=Low Risk and 9=High Risk. For operational definitions of these various types see Table 1.

Table 1. Operational Definitions of Risk Types

Perceived Risk Type	Operational Definition
Financial Risk	What are the chances that you stand to lose money if you try an unfamiliar brand of ____(either because it won't work at all, or because it costs more than it should to keep it in good shape)?
Performance Risk	What is the likelihood that there will be something wrong with an unfamiliar brand of ____or that it will not work properly
Physical Risk	What are the chances that an unfamiliar brand of ____ may not be safe; i.e., may be (or become) harmful or injurious to your health?
Psychological Risk	What are the chances that an unfamiliar brand of ____will not fit in well with your self-image or self-concept (i.e., the way you think about yourself)?
Social Risk	What are the chances that an unfamiliar brand of ____ will affect the way others think of you?
Overall Perceived Risk	On the whole, considering all sorts of factors combined, about how risk would you say it was to buy an unfamiliar brand of ____?

Item Preselection

Twenty-three technologies were selected from an original list of 307 for this study. To select a random, but diverse group of recognizable technologies, 35 undergraduates rated the items on how representative they were of various technology categories (e.g., high tech, low tech, medical device) in a completely separate pilot survey. Individuals who participated in the ranking survey could not participate in the main risk assessment survey. If a technology had anyone respond, "Unsure what this is," the item was removed from the list. This was to create a list of technologies that everyone was familiar with. To be included in the final list, items had to be rated on the pilot test as being highly *representative* for 2 categories, and also highly *unrepresentative* for 2 categories,. This was to ensure that a wide variety of known technologies would be included. The final list of technologies were: apps; autonomous robotic vacuum cleaner (e.g., Roomba); camera; dishwasher; e-book reader (e.g., Kindle); electric can opener; electric razor; electric toothbrush; external prosthetic device (e.g., prosthetic leg); global positioning system (GPS); heart rate monitor; inhaler (e.g., for asthma); intelligent personal assistants (e.g., Alexa); laptop computer; motorized wheelchair; safety glasses; smart phone; smart speaker (e.g., Google Home); smart watch; smart/connected television; washing machine; wheelchair; and wireless-enabled wearable technology (e.g., Fitbit).

Main Survey

Participants were recruited through SONA (2 hours of credit) at Georgia Institute of Technology or Mechanical Turk ($5.00 compensation) to be a part of an online survey administered via Qualtrics. First, participants gave informed consent. The survey began with general demographics, then participants were asked to rate their risk perceptions of 23 technologies. The order of the technologies was randomized. The types of risk perception questions were asked in the following order: financial, performance, physical, psychologic, social, and overall perceived risk. Throughout the survey, attention check questions were randomly dispersed to eliminate participants not paying attention to the survey.

RESULTS

Overall Perceived Risk

In general, technologies were rated as mildly risky overall (M=4.37, SD=2.25). The technologies rated as the most risky were all health related: external prosthetic device (M=5.68, SD=2.46), heart rate monitor (M=5.48, SD=2.48), and inhaler (M=5.29, SD=2.14). The least risky of the technologies was an electric can opener (M=2.93, SD=1.86). See Figure 1 for the overall perceived risk averages for each technology. To conserve space, for all figures the scale runs from 1-6 instead of 1-9 since none of the averages exceeded 6.

Financial Risk

For financial risk, on average the technologies were considered mildly risky (M=4.67, SD=2.36). For financial risk, smart/connected television (M=5.63, SD=2.28), external prosthetic device (M=5.62, SD=2.54), and smart phone (M=5.48, SD=2.15) were rated as having the most risk. Electric can opener was also rated as the least risky for financial risk (M=2.98, SD=2.02). See Figure 2.

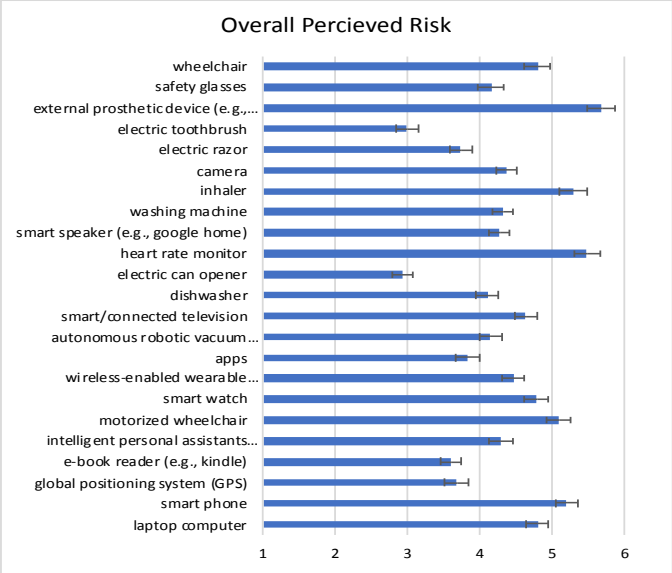

Figure 1. Overall Perceived Risk

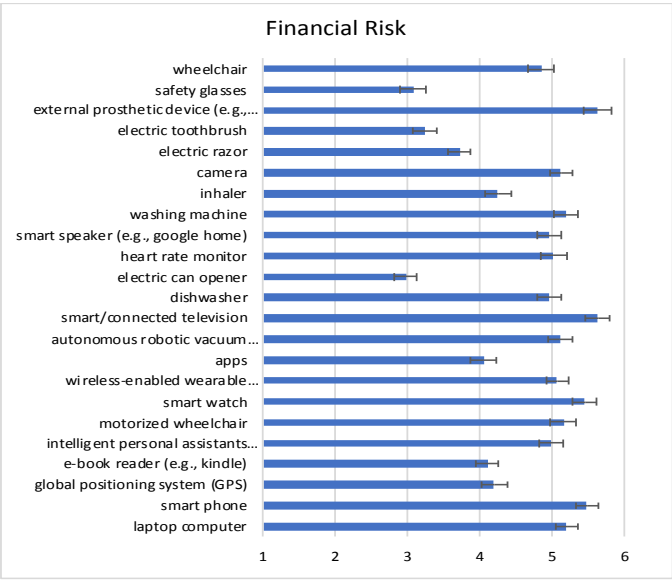

Figure 2. Financial Risk

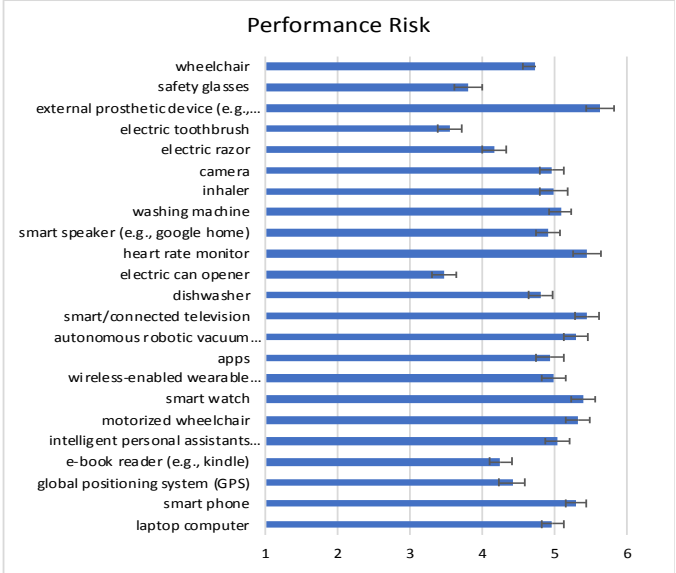

Figure 3. Performance Risk

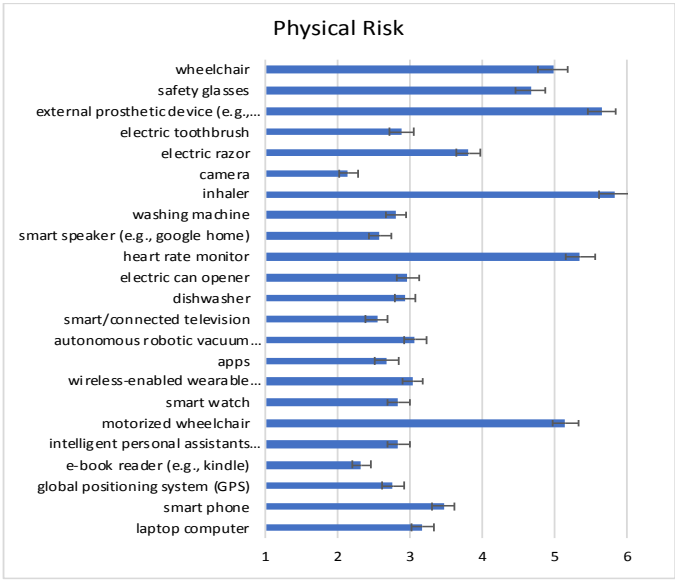

Figure 4. Physical Risk

Performance Risk

On average, the technologies were rated as mildly risky for performance risk (M=4.82, SD=2.37). External prosthetic device (M=5.63, SD=2.56), smart/connected television (M=5.45, SD=2.22), and heart rate monitor (M=4.67, SD=2.36) were on average rated as the riskiest in relation to performance. Electric can opener was again rated as the least risky for performance risk (M=3.47, SD=2.13). See Figure 3.

Physical Risk

For physical risk, in general the technologies were rated as mildly risky (M=3.50, SD=2.46). The health-related technologies were again rated as the most risky for physical risk: inhaler (M=5.82, SD=2.67), external prosthetic device (M=5.65, SD=2.63), and heart rate monitor (M=5.35, SD=2.72). For physical risk, camera was rated as the least risky (M=2.15, SD=1.76). See Figure 4.

Psychological Risk

The technologies were rated in general as being mildly psychologically risky (M=2.69, SD=2.17). The top three psychologically risky technologies were a smart phone (M=3.87, SD=2.49), smart watch (M=3.84, SD=2.56), and external prosthetic device (M=3.52, SD=2.66). Electric can opener was again the least risky for all the technologies in relation to psychological risk (M=1.85, SD=1.61).

Social Risk

Similar to psychological risk, technologies were also rated as only mildly socially risky (M=2.55, SD=2.08). The top three socially risky technologies were the same as well: a smart phone (M=3.92, SD=2.45), smart watch (M=3.80, SD=2.38), and external prosthetic device (M=3.21, SD=2.38). The lowest on social risk of the technologies was again electric can opener (M=1.77, SD=1.57). See Figure 6.

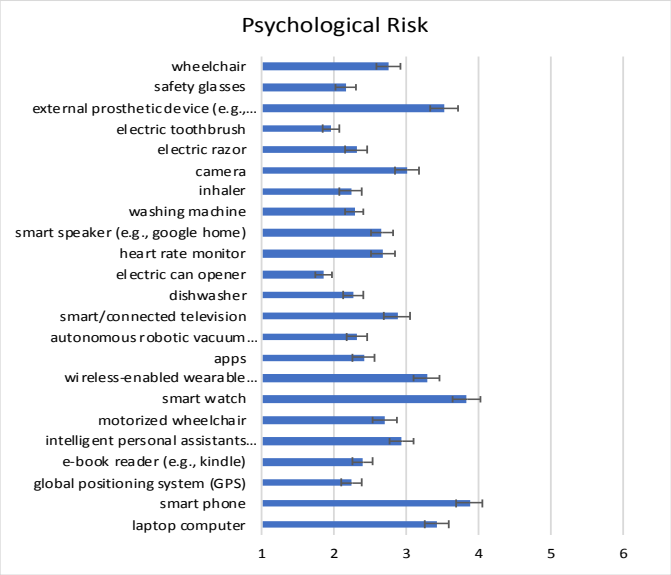

Figure 5. Psychological Risk

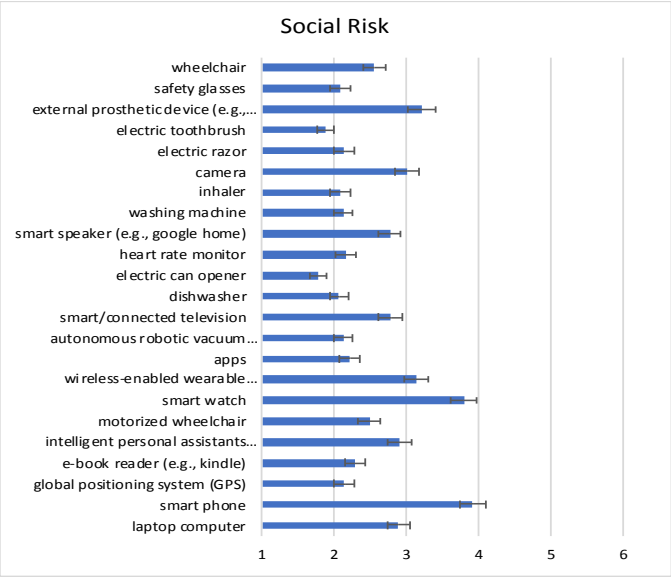

Figure 6. Social Risk

Composite Risk Score

To understand how each of the five risks associated with the reported overall risk, we created a *composite risk score* by adding all the types of risks (financial, performance, physical, psychological, social) and correlated that score with overall risk. See Table 2 for these detailed results.

These results demonstrate that there is a moderate to strong relationship (ranging from r=0.682 to r=0.87) between the composite score and overall perceived risk. Despite this strong relationship, there is on average 30-40% of unaccounted variance in the overall perceived risk.

DISCUSSION

Understanding type of perceived risk gives more insight into what components of risk will have the most impact on technology acceptance. This study demonstrated that even among common technologies the types of risk vary greatly for each technology and in relation to overall perceived risk.

Table 2. Correlation between Composite Risk Score and Overall Perceived Risk

Technology Type	r	r^2
wheelchair	.829**	0.687
safety glasses	.831**	0.691
external prosthetic device (e.g., prosthetic leg)	.870**	0.757
electric toothbrush	.860**	0.740
electric razor	.855**	0.731
camera	.777**	0.604
inhaler	.803**	0.645
washing machine	.788**	0.621
smart speaker (e.g., google home)	.786**	0.618
heart rate monitor	.826**	0.682
electric can opener	.857**	0.734
dishwasher	.798**	0.637
smart/connected television	.784**	0.615
autonomous robotic vacuum cleaner (e.g., Roomba)	.733**	0.537
apps	.803**	0.645
wireless-enabled wearable technology (e.g., fitbit)	.793**	0.629
smart watch	.774**	0.599
motorized wheelchair	.754**	0.569
intelligent personal assistants (e.g., Alexa)	.782**	0.612
e-book reader (e.g., kindle)	.814**	0.663
global positioning system (GPS)	.808**	0.653
smart phone	.785**	0.616
laptop computer	.684**	0.468

None of the technologies was rated as highly risky for any of the types of risk or overall risk. This is not surprising, since these are common everyday technologies (and would unlikely be common if they were extremely risky). The ratings for each technology also varied, based on type of perceived risks. For example, inhaler was in the bottom five technologies for psychological and social risk, but was the highest-rated technology for physical risk. As one of the top 3 riskiest technologies from the list in general, the variability within the types of risk show how important it is to understand types of risk, and not just overall risk.

Smart phones were in the top 5 of the overall risk. For psychological and social risk, smart phones were rated the riskiest out of all the technologies, though the scores were only mildly risky. For financial risk, smart phone was the third highest rated for financial risk among all the technologies. This again demonstrates how the categories of risk vary.

Financial, performance, physical, psychological, and social perceived risks are all distinct components that require unique ways of mitigating the risk. For example, with smart phones, physical risk is not a primary concern, but social risk is. Thus, if a developer (mis-)interpreted overall risk as being synonymous with physical harm and developed a phone that had no physical risk, but was now large, bulky, pricier, and "uncool" the change would actually negatively impact technology acceptance (via social risk). Clearly, the specific types of perceived risk that are likely to actually impact acceptance is what must be addressed. This example makes it

clear how a nuanced view of perceived risk is essential for the successful design of technologies.

In addition, the moderate to strong correlations between the composite risk scores and overall perceived risk suggests that after rating all the five types of risks, and then being asked about overall risk, participants are creating some mental composite of these risks when deciding on general overall risk for each technology. However, the ratings of overall risk fail to account for about a third of variance; that also suggests that even these 5 types of perceived risk may not be all of the components of overall perceptions of risk.

Beyond insights into how types of risk are essential to understand, this study adds to what is generally known about perceptions of risk within technologies. It is clear that even household technologies vary in risk, as the electronic can opener was consistently the lowest rated on many of the risks, but a smart/connected television was rated as one of the riskiest (due to financial and performance risk).

Future Directions

Future research is underway to explore risk perceptions with other technologies that may have more extreme perceptions of risk than these everyday technologies. In addition, future research is planned to explore how these risk perceptions impact trust in each technology, as well as how this interacts with technology adoption.

Conclusion

Perceptions of risk are essential to understand when trying to gain insight into people's behavior, whether it is responses to hazards or technology acceptance. This study is the first to explore risk perception within various types of technologies, and highlights how crucial it is to include type of risk when exploring perceived risk. All these common technologies had various ratings for each of the types of perceived risk, but even these ratings were not completely predictive of overall risk. This suggest that there are additional types of risk that may be identified and explored. The results of how these technologies vary by risk, can allow practitioners (e.g., developers, marketers) and researchers to have a deeper insight into what types of risk are most likely to impact technology acceptance and explain reasons for non-use of a system. By building on this information, we can continue to improve technology acceptance by mitigating the specific types of risk that are rated most problematic for that technology through improved design and training.

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