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The Validity of an Extended Technology Acceptance Model (TAM) for Assessing the Acceptability of Autonomous Ships

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Abstract

The study explored an extended Acceptance Technology Acceptance Model (TAM) for the purpose of developing a reliable tool for measuring potential user's acceptance of autonomous ships. Correlation analysis was conducted to see if the 8 variables of the extended TAM model co vary, and regression analysis to further explain the nature of the relationships. The study reinforced the notion of strong relationships between the original constructs in TAM. Results also showed that trust was a major construct in the extended TAM model. The relationship between values and attitudes towards using autonomous ships were insignificant, contradicting existing theories describing their relationship.

Keywords: Technology Acceptance Model, Autonomous ships, Innovativeness, Values, Trust

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Introduction

Background

Why are innovations adopted earlier by some individuals, and later by others? The rate at which we innovate peaked during the last century, capturing the attention and interest of many (Gary, 1993). The increased interest led to numerous studies on the diffusion of innovations, mainly by disciplines such as social sciences, management, engineering, and marketing (Smith, Langlois, & Lazau, 2011; Tidd & Bessant, 2013). Two highly influential researchers in the latter, Everett M. Rogers (1962) and Frank Bass (1969), pioneered analytical theories on the diffusion of innovations. Rogers' theory attempts to identify, and explain factors that influence the adoption rate and direction of innovations, and how these innovations gain momentum and diffuse through a specific demography (Boston University School of Public Health, 2013). His work emphasized specific characteristics of innovations that influenced the adoption rate. These characteristics include relative advantage, complexity, compatibility, testability, and observability (Rogers, 1962, 1983, 2003).

The literature on diffusion of innovations pays most attention to validating the factors that relate to the innovation itself. However, some attention has also been given to the characterization of the individuals that adopt innovations. In a psycho-sociological approach, Rogers (1962) suggested that the individual, or adopter as he called it, should also be the unit of analysis. He proposed that the individuals of a social system rarely adopt an innovation at the same time. Instead, innovations are adopted in an over-time sequence, which makes it possible to divide individuals into adopter categories based on when they first start using a new idea (i.e. innovativeness). Hence, each adopter category can be characterized by individuals with the same level of innovativeness (Rogers, 2003).

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Based on Roger's (1962) propositions, several researchers within marketing began to look into the link between the behaviors of adopters and their individual variables, primarily being of a socio-demographic nature. The studies that were presented showed large disparities, only revealing significant links between income, education level, age, professional status, and ethnicity. Different characteristics that are unique to each product being analyzed may explain the differences found. The significant links between the studies showed that young men with high income, education, and professional status where generally found to have a stronger predisposition to adopt innovations (Kavak & Demirsoy, 2009; Naoufel, John, & Frank, 1999).

The large scale investigation of individual variables of adopters can be said to have been a step in the right direction. However, it is argued that profiling adopters on the basis of demographic and socio-economic variables is insufficient, only presenting a hollow classification of consumers (Naoufel et al., 1999). Vyncke (2002) suggested that psychographic variables better explain adopter behavior and their innovativeness. This idea is echoed by Agarwal and Prasad (1998) who studied the effect of psychological factors on individuals in order to determine their innovativeness towards information technology (IT).

One specific facet of the psychological impact on innovativeness that has received little attention in explaining individual reactions towards innovations is human values (Rogers, 2003). Previous studies dealing with the impact of values on consumption have mainly been focused on the behaviors of consumers, such as food consumption (P. Y. Lee, Lusk, Mirosa, & Oey, 2014), the use of mass media (Becker & Connor, 1981; McCarty & Shrum, 1993; Schiffman, Sherman, Long, & Rosenbloom, 2003), cigarette smoking (Kristiansen, 1985; Sheth, Newman, & Gross, 1991), travel decisions (Madrigal, 1995; Pitts, 1986), and mall shopping behavior (Cai & Shannon, 2012; Shim & Eastlick, 1998; Swinyard, 1998). The importance of values in predicting

and explaining consumer behavior is eloquently explained by Kamakura and Novak (1992, p. 119):

> "A value refers to a single belief that transcends any particular object, in contrast to an attitude, which refers to beliefs regarding a specific object or situation. Values are more stable and occupy a more central position than attitudes within a person's cognitive system. Therefore, they are determinants of attitudes and behavior and hence provide a more stable and inner-oriented understanding of consumers."

The Study

With respect to previous research on the relation between values and consumer behavior, there are reasons to believe that values can shape adopter innovativeness. In this study, the relationship of values and acceptance of autonomous ships are examined for the purpose of developing a reliable tool for measuring acceptance of autonomous ships. Since autonomous ships are in an early development phase and not yet in use, one cannot directly measure the behaviors of consumers. One can, however, measure the potential adopters' behavioral *intention to use* autonomous ships, which in turn can be used to predict actual use.

A conceptual model has been developed for the purpose of exploring the validity of an extended Technology Acceptance Model (TAM). The original TAM model, developed by Davis, measures a potential adopters' behavioral intention to use a technology through the perceived ease of use and usefulness of a technology, as well as the users' attitude towards using it. In this study, the model have been extended with values obtained from Schwartz (1992) Theory of Basic

Human Values (STBV), the value-attitude-behavior hierarchy (VAB) proposed by Homer, Kahle, and Sarason (1988), and the concepts of trust and perceived risk.

The importance of studying innovativeness and adopter categorization can be justified by its validated usefulness in identifying individuals who are more likely to adopt new technology. These individuals can serve as opinion-leaders and key change agents, further facilitating the diffusion of new technology (Agarwal & Prasad, 1998; Rogers, 2003). Moreover, measuring innovativeness will allow for more efficient use of resources if implementation resources are scarce.

The Aim of the Study

The contribution and overall aim of this study is two-folded. The study will first establish a theoretical link between the innovativeness of potential adopters, based on their values, and their intention to use autonomous ships. Secondly, the study empirically tests the relationship between specific variables, such as values and attitudes, in an extended Technology acceptance model (TAM). The goal of the extended TAM model is that it can be used for measuring the level of acceptability of autonomous ships among Norwegian seafarers.

Research Questions

The underlying research problem that this study tries to answer is: “What motivates an individual to take shorter time in adopting an innovation, such as autonomous ships?” In order to explore this problem, a set of research questions have been formulated and specified to include the concept of autonomous ships: *1) Are Norwegian seafarers positive or negative towards autonomous ships? 2) Is the Technology Acceptance Model (TAM) a reliable tool for measuring*

acceptance of Autonomous Ships? 3) Are trust an important concept when measuring the acceptance of autonomous ships? 4) Do the values of openness to change and conservation affect attitudes towards using autonomous ships?

Outline of the Thesis

The thesis is organized in seven chapters, including the introduction. The second chapter presents a literature review on the most important concept of the thesis, providing a theoretical foundation that are further developed and used in upcoming chapters. Chapter three presents the conceptual framework of the thesis, along with the hypotheses to be tested in the next two chapters. Chapter four presents the research strategy and design, as well as the method used for data collection and analysis. In chapter five, analysis and essential findings are presented. Chapter six includes an objective discussion of the results and what's been presented in the previous chapters, as well as limitations of the thesis. Finally, the last chapter presents a conclusion and suggestions for further study. The relationships between the chapters are presented in figure 1.

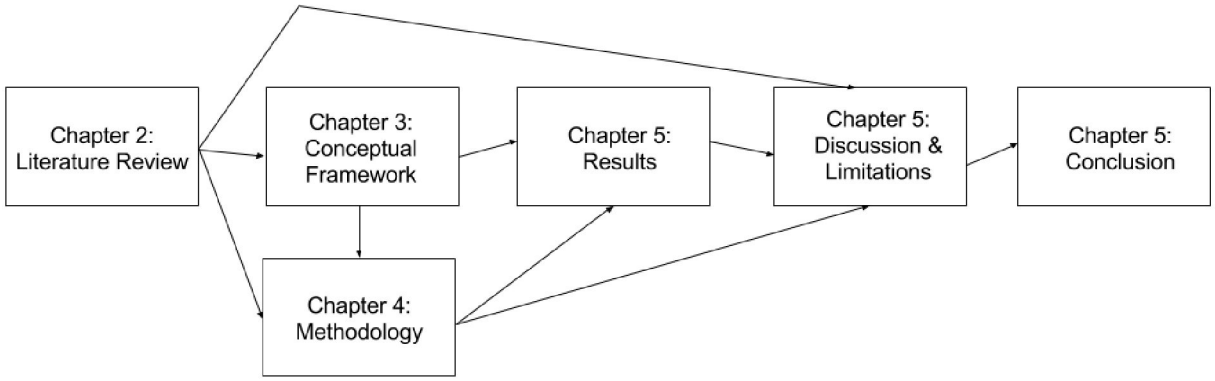

Figure 1: Structure of the thesis

Literature review

The development of a conceptual framework requires a thorough review of existing literature (De Cuyper et al., 2008). Consequently, this chapter presents the most essential theoretical models in which this study is based upon. A review of the work by accredited researchers will be presented in order to convey to the reader an overview of the literature on the concepts of automation, autonomous ships, technology acceptance, innovativeness, and values.

Automation

With today's rapid development of technology, the relationship between humans and technology plays an increasingly important role in our daily lives. In many cases, technology may drastically change how we perform our jobs, making the performance of automated systems ever more dependent on the integrity of this relationship. Automated Teller Machines (ATMs), aircraft cockpits, traffic light control systems, warning and control systems for cars, and sharing data through computer networks are just a few examples of how we encounter automation on a daily basis (Ghazizadeh, Lee, & Boyle, 2012).

According to Parasuraman and Riley (1997), automation can be explained as technology that executes a function that was previously carried out by a human, implying that our perception of automation will change with time. Despite this, humans are rarely completely replaced by automated systems. Instead, automation may result in restructuring of the task that was previously done by a human, such as coordinating activities and monitoring automated systems (Ghazizadeh, Lee, et al., 2012). Examples like this are extensively prevalent in the freight industry where new technologies give rise to automated systems, with the aim of enhancing efficiency, increase safety, and reducing the environmental footprint (Levinson & Zou, 2006).

Automation and freight transportation. The high cost of manual labor in industrialized countries produces a strong economic incentive to introduce new automated systems that can either replace or complement manual labor. Consequently, we have seen the adoption of many automated systems, perhaps most widely seen in industrial sites. An example of this is the automated guided vehicle (AGV) which is commonly used in factories in moving everything from raw material to finished products. These vehicles typically move at very low speeds, following either markers and wires, or using vision or laser to navigate in a carefully structured environment (Slack, 2008).

The development of automated systems in product and cargo handling, exemplified by the AGV, has led to the rapid increase of innovations in various cargo transport modes. The automobile industry, for example, has over the past few decades made significant leaps forward in terms of providing highly automated systems. One of these systems is the self-driving car, a car that is already driving on our roads (Fagnant & Kockelman, 2015). The world has also seen a growing use of Unmanned Aerial Vehicles (UAVs), primarily for military purposes. However, similar aerial vehicles are currently being considered and discussed for the purpose of cargo transport (Macsween-George, 2003). Highly automated and driverless subway trains are also becoming more and more widespread, providing transport for passengers in many cities across the world.

As autonomous systems are becoming popular concepts in both land based and aerial transport modes, autonomy is also seen as a possible solution for solving future challenges for maritime transport. Consequently, an increasing interest in the development of autonomous ships can be seen in various maritime domains (MUNIN, n.d).

Autonomous Ships. The shipping industry, especially within the EU, faces significant challenges with increased transport volumes, environmental regulations and a growing shortage of shipping crew and officers that has reached serious proportions. In order to maintain and strengthen the global position that Europe holds in various maritime domains, the European Waterborne Technology Platform (Waterborne TP) was established. Waterborne TP, which is a cluster of leading stakeholders within the European maritime industry, has created a vision for 2020. The vision bases itself on three pillars that focuses on the safe, sustainable, efficient, and competitive European waterborne industry, as well as the growth in transport volumes and changes in trade patterns (Rødseth & Burmeister, 2012).

Twelve "exploration outcomes" has been prioritized on the basis of these visions. One of these outcomes, which can be said to be important for all of these pillars, is the "Autonomous Ship" (Rødseth & Burmeister, 2012). The autonomous ship can be defined as a vessel with "next generation modular control systems and communications technology that will enable wireless monitoring and control functions both on and off board. These will include advanced decision support systems to provide a capability to operate ships remotely under semi or fully autonomous control" (Waterborne TP, 2011).

The Maritime Unmanned Navigation through Intelligence in Networks (MUNIN), a European backed research project, emphasizes three dimensions in which autonomous ships can provide a sustainable and attractive idea for ship-owners and seafarers:

1. Economic sustainability: As manning expenses can be partially removed, operational expenses goes down. On average, crew costs account for more than 30 % of the total cost of ship operation. By removing the space in which the crew resides, such as the crew quarters and bridge, the ship becomes lighter and can carry more cargo. This will enhance the fuel

efficiency of the ship (Rødseth & Burmeister, 2012; Wahlström, Hakulinen, Karvonen, & Lindborg, 2015)

2. Ecologic sustainability: By removing costs related to the crew, ships can reduce their speed (i.e. slow steaming). This measure will save fuel and carbon dioxide emissions will go down (Rødseth & Burmeister, 2012).
3. Social sustainability: The labor market for seafarers here in Europe faces a major problem. It is perceived as unattractive by youngsters and suffers from the lack of friendliness towards family and social life. The isolation from family and friends during a deep-sea transit is something that has been widely discussed by experts and institutions. Another important factor that should be mentioned is that although deep-sea shipping represents tasks that are routinized and relatively undemanding, fatigue may arise and cause human errors. As of 2005, human error accounted for 80 to 85 % of all maritime accidents (Baker & McCafferty, 2005). Autonomous ships would therefore reduce this risk by minimizing the routine tasks carried out by officers, allowing them to focus on tasks that are more cognitive demanding and challenging in an onshore operations center (Rødseth & Burmeister, 2012).

The possible advantages that autonomous shipping represents can be said to be the rationale behind the development of these ships. Despite the obvious advantages, autonomous ships are arguable far away from being commercially realized. According to Rødseth and Burmeister (2012), there are some issues regarding sensor and decision technology, but technological issues are just a small bump in the road towards the development of autonomous ships. The main barrier, they said, lie with the successful integration of these ships into the already existing maritime transport system, as well as developing a legal and contractual framework.

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Another possible issue regarding the implementation of autonomous ships is if whether we, as a society, are ready to hand over the control to these automated systems. Research investigating acceptance of the commercial use of Unmanned Aerial Vehicles (UAVs) and self-driving cars shows that the public is generally positive towards their use. Nonetheless, human operators are still perceived as safer than their automated counterparts (Casley, Jardim, & Quartulli, 2013; Tam, 2011).

As autonomous ships represent a potentially disruptive, yet beneficial, change to the maritime shipping system, the perception that potential users hold can greatly affect the rate at which it is diffused. Autonomous ships are yet to be commercialized and examining the acceptance level of potential users can help predict the degree to which they will actually use these ships (Morris & Dillon, 1997). In 1989, Fred D. Davis developed a model soon to become one of the most influential tools for measuring user acceptance of new technology. His model is better known as the Technology Acceptance Model (TAM) (Priyanka & Kumar, 2013) (Chau, Hu, Liu Sheng, & Tam, 1999).

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) by Davis (1989) was initially developed to explain the behaviors of individuals who used information technology (IT) (Chau et al., 1999). TAM has since proven itself to be a reliable and cost-effective tool in explaining the behaviors of users of a broad variety of technologies (Park, 2009). Bertrand and Bouchard (2008) used TAM to predict the use of Virtual Reality (VR) in clinical settings. Pavlou (2003) used the tool to predict the acceptance of electronic commerce. Payre, Cestac, and Delhomme (2014) applied it in their study on acceptability of automated driving.

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Davis' (1989) model uses two primary factors in predicting user acceptance:

1. Perceived usefulness (PU): The degree to which a user actually believes that using the technology will enhance the performance of his or her job (Davis, 1989).
2. Perceived ease of use (PEOU): Can be explained as the degree to which the user finds the technology easy to use and that the benefits of using this technology will outweigh the effort of using it (Davis, 1989).

As shown in figure 1, the model suggests that the two factors determine the users' attitude towards using the technology, which in turn will affect the users' intention to use it. Perceived usefulness is also believed to have a direct effect on the users' intention to use the technology. "Behavioral intention to use" is illustrated as the strongest indication of the actual use of the technology (Morris & Dillon, 1997).

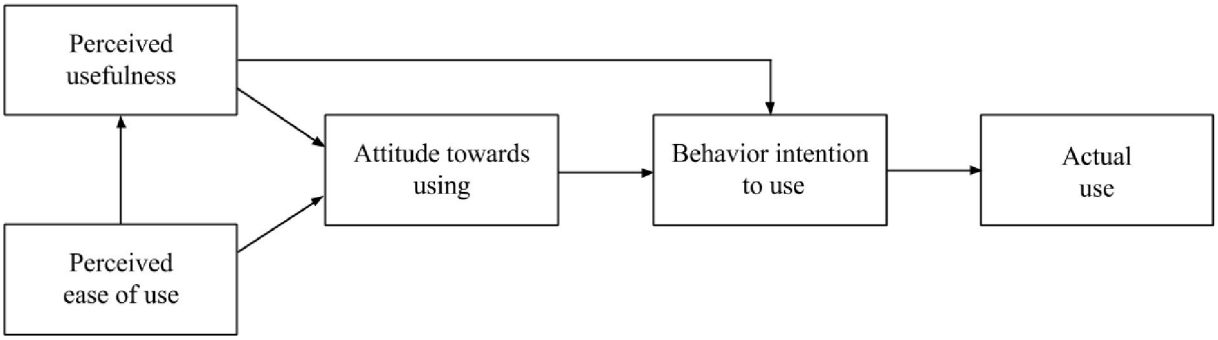

Figure 2: The Technology Acceptance Model (Davis, 1989)

According to Davis, perceived ease of use has a direct influence on usefulness as users who find a technology easier to use also finds it to be more useful. Studies of the relationship between the two have also found that perceived usefulness could be mediating some of the effect that perceived ease of use has on attitude. To elaborate, there could be an indirect effect of perceived

ease of use on attitudes towards using through perceived usefulness (Davis, 1993; Henderson & Divett, 2003).

TAM, like so many other prominent theories, is subjected to criticism. Bagozzi (2007) argued that TAM has gained popularity due to it being so easy to use, only introducing a manageable number of variables. However, simplicity might be its biggest weakness. This belief is also shared by other researchers (see Y. Lee, Kozar, and Larsen (2003)).

Acceptance of Automation. Previous research on the relationships between automated systems and humans shows that trust is particularly important in understanding this relationship. Just like human relationships, people have a tendency to rely more on automated systems that they trust (Sheridan & Hennessy, 1984). According to literature, trust serves as an important factor in determining people's acceptance of automation as it is situated between the users' attitude towards an automated system and their intention to use it. It can therefore be argued that trust should be incorporated into TAM in cases where the technology is highly automated (Carter & Bélanger, 2005; Parasuraman, Sheridan, & Wickens, 2008).

Adding to that, another important concept that has been proven to be highly influential in most technology adoption situations is the concept of innovativeness (Godoe & Johansen, 2012; Mudd, 1990).

Innovativeness

Who adopts? It can be a difficult task getting new products adopted. Even products with obvious advantages may take several years to become widely adopted. As a result, individuals and organizations alike spend a substantial amount of time trying to speed up the rate at which

innovations are diffused. Research has showed that adopters do not adopt new products at the same time. Hence, individuals can be classified into adopter categories based on their predisposition to adopt new products, relative to others in the same social system. This predisposition, and criterion for adopter categorization, is known as “innovativeness”. It may be argued that innovativeness is a relative dimension, meaning that individuals possess more or less of this trait. Innovativeness is also perceived to be a continuous variable that can be divided into discrete categories, similar to dividing the continuum of social class into lower, middle, and upper class (Rogers, 2003).

The distribution of individuals in categories, despite its apparent simplification, is important for understanding human behavior and may assist in targeting potential adopters and allocating resources in an efficient way (i.e. identifying potential innovators and laggards). It is also important for penetrating adopter categories based on carefully planned market strategies and predicting a products continued acceptance (Mahajan, Muller, & Srivastava, 1990; Rogers, 2003).

The method for adopter categorization that is most recognized and used, is that presented by Rogers (1962). He used two statistical parameters to obtain and explain five adopter categories, the first being the mean ($\bar{x}$), or average, of the individuals in the social system. The second parameter that he used was the standard deviation (σ), which is a measure of the variation about the mean. The five adopter categories, based on their innovativeness, are listed in the first column of table 1.

Table 1.

Categories of adopters

Adopter category	Percentage of adopters (%)	Area covered under the normal curve
Innovators	2.5	Beyond $\bar{x} - 2\sigma$
Early adopters	13.5	Between $\bar{x} - \sigma$ and $\bar{x} - 2\sigma$
Early majority	34	Between $\bar{x}$ and $\bar{x} - \sigma$
Late majority	34	Between $\bar{x}$ and $\bar{x} + \sigma$
Laggards	16	Beyond $\bar{x} + \sigma$

Source. (Mahajan et al., 1990; Rogers, 2003)

The normal distribution model of the five adopter categories has become very popular, mainly because it is easy to use. Because the model is exhaustive and mutually exclusive, results can be compared, generalized and replicated. Also, because the model is normally distributed, one can predict the continued acceptance of the product (Mahajan et al., 1990).

However, the model does not escape criticism. Peterson (1973) argues that it may be appropriate to use another size and number of adopter categories than the five identified by Rogers (1962). He emphasized that the size and number is dictated by the sample size or by theoretical considerations. Robertson and Kennedy (1968), Uhl, Andrus, and Poulsen (1970) underpins this notion. Peterson (1973) also questions the claim that new products always follow the normal-distribution pattern. Truly new (generic) innovations, he said, such as the television or food freezers follow a non-normal distribution. Despite the criticism, Rogers work remains widely accepted and his book, Diffusion of Innovations, is the second most cited book in social sciences (Singhal, Rogers, & Quinlan, 2009).

Adopter categories and their characteristics. The five adopter categories that Rogers set forth, where derived from observations of reality, designed to make comparisons possible. His set of categories are *ideal types*, meaning that exceptions can be found (Rogers, 2003). The five categories are presented below, together with their main characteristics and values:

1. Innovators: The first 2.5 % of adopters have venturesomeness as an obsession. They are well educated, have complex technical knowledge and understanding, and have great control of economic resources in case of unexpected losses from failed innovations. Risk taking, as well as living a rash and daring life, is salient characteristics of innovators (Fletcher-Knight, 2008; Rogers, 2003).
2. Early adopters: The next 13.5 % of adopters has the highest degree of opinion leadership, individuals with a lot of influence over other individuals' attitudes and behaviors. Consequently, early adopters are frequently sought out by change agents who want to speed up the diffusion process. Representing successful and discrete implementation of innovations, early adopters help trigger the critical mass and are highly respected by their peers (Fletcher-Knight, 2008; Rogers, 2003).
3. Early majority: The next category constitutes 34 % of the total adopter population and is characterized by being deliberate in their decision to adopt. The early majority holds a position that is situated between the very early and the late, meaning that they tend to adopt an innovation just before the average individual of a social system. Hence, their innovation-decision process is considerably longer than the one before them (Fletcher-Knight, 2008; Rogers, 2003).
4. Late majority: Adopters belonging to the late majority are usually cautious and skeptical, adopting innovations just after the average member of a system. Growing pressure by their

peers or economic necessity is often the underlying reasons for adoption. Uncertainty about the innovation has to be removed for the late majority to adopt, mainly due to relatively scarce resources (Fletcher-Knight, 2008; Rogers, 2003).

5. Laggards: The remaining 16 % of adopters belong to the laggards, a category that is very traditional, possessing virtually no opinion leadership. Laggards often look to the past, resulting in decisions that are based on what has been done previously. They tend to be skeptical of innovations and change agents, and most comfortable in the presence of likeminded people with the same traditional values. Laggards are also in an economic position that forces them to be extremely certain that the innovation will not fail before they adopt (Fletcher-Knight, 2008; Rogers, 2003).

The five categories mentioned above, together with their personality traits and the concept of innovativeness, has been widely studied and investigated. Research indicate that the dominant characteristic of each adopter category, apart from demographic variables, is personal values (Lam, Lim, Ho, & Sia, 2003; Rogers, 2003).

Human Values

Human values cover a broad multidisciplinary terrain and have been a central concept in sociology and psychology since their inception (Schwartz, 2012). Initially, values were thought of as philosophical concepts, but were eventually given a more concrete meaning by linking them to ordinary activities, such as voting and reading newspapers (Debats & Bartelds, 2005).

In an attempt to prove the relation between values and ordinary activities, Homer et al. (1988) developed a model that integrates the interrelationship between values, attitudes and behaviors. They postulated that abstract cognitions (i.e. values) only influence specific behaviors

through the mediating role of mid-range cognitions (i.e. attitudes). The causal sequence hierarchy that they proposed was tested on a specific activity, that is, natural food shopping. By performing a structural equation analysis, they revealed that values only indirectly influenced the shopping behavior of natural food consumers through attitudes. Their model have since been validated by many (i.e. Jerry J. Vaske (1999); Milfont, Duckitt, and Wagner (2010); Shim and Eastlick (1998)) and is visually depicted in figure 3 (Milfont et al., 2010).

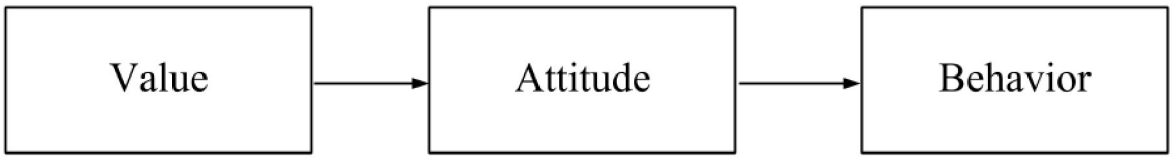

Figure 3: The Value-Attitude-Behavior hierarchy (Homer et al., 1988)

The work of Homer et al. (1988), as well as other researchers of human values (i.e. Williams, Schwartz, Kluckhohn, etc.), have contributed greatly towards the way we view values (Schwartz, 1992). The effort to explain and investigate human values have led to them being conceived as deeply rooted principles that may change over time, guiding, justifying, and explaining attitudes, behaviors, norms, opinions, and actions. (Davidov, Schmidt, & Schwartz, 2008; Debats & Bartelds, 2005). However, one cannot discuss the construct of values without mentioning one of the most influential researchers within the field, namely Rokeach (1973).

The Nature of Human Values by Rokeach. The major shift in how we view values can be credited to Rokeach (1973) (Debats & Bartelds, 2005; Lam et al., 2003). In his publication, "The Nature of Human Values", Rokeach defines a value as "an enduring belief that a specific mode of

conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence" (Rokeach, 1973, p. 5). His definition highlights the competitive and comparative nature of values (Alwin & Krosnick, 1985; Lam et al., 2003; McCarty & Shrum, 2000).

Rokeach pointed out that values are inherently positive constructs that, once learned, are organized in a hierarchical system in which they are prioritized (Kamakura & Novak, 1992). Individuals may, for instance, value both ambition and loyalty as important principles, but when asked, he or she is likely to report that one of the two is more important than the other. In order to measure the relative importance of values, Rokeach instrumentalised his value system into the "Rokeach Value Survey", (Lam et al., 2003; Rokeach, 1973).

Schwartz Theory of Basic Human Values (STBV). In an extension of the previous work of Rokeach and his concept of values, Schwartz (1992, 1994, 1995; 1987; 1990) examined human values by their psychological content and structure. His contributions to the research on values is recognized and considered to be especially important for distinguishing individual and cultural values.

By reviewing relevant literature, Schwartz (1987) generated a conceptual definition of values, specifying six main features:

1. Values are beliefs, meaning that they are infused with feelings when activated. Individuals that hold personal freedom as a life-guiding principle become agitated when they feel that their freedom is taken away from them. Feelings of despair and happiness may arise if they feel helpless to protect it or if they are able to enjoy it (Schwartz, 2012; Schwartz & Bilsky, 1987).

2. Values refer to preferable end states or behaviors. For instance, individuals that hold a specific set of values in high regard are motivated to pursue these in order to achieve specific goals (Schwartz, 2012; Schwartz & Bilsky, 1987).
3. Values exceed specific situations or actions. Obedience, for example, may be important in work related situations, in the classroom, in politics, with friends, family and strangers. Values can therefore be distinguished from two other concepts, namely attitudes and norms, which refer to specific situations, actions, and objects (Schwartz, 2012; Schwartz & Bilsky, 1987).
4. Values functions as standards that guides the evaluation or selection of behaviors, actions, events, policies, and people. Based on their own value system and possible consequences for these values, individuals decide what is good or bad, illegitimate or justified. However, decisions that happen on an everyday basis are rarely conscious. Awareness of values only occurs when we are considering actions or judgments that have conflicting implications for the values which we consider important (Schwartz, 2012; Schwartz & Bilsky, 1987).
5. Values are ordered and prioritized in a hierarchy relative to one another (Schwartz, 2012).
6. Actions are guided by the relative importance of many values. Attitudes and behaviors are guided by the constant trade-off between competing values. Religious affiliation, for example, may promote conformity and tradition at the expense of other values, such as hedonism (Schwartz, 1992, 2012).

Schwartz argued that the six features above were features for all values, only to be distinguished from each other by the type of motivation or goal that the values express. His theory on human values identified ten value types that he derived from three universal requirements. These being: the needs of individuals as biological organisms; prerequisites for

socializing and interacting with others; and the survival and welfare of groups (Schwartz, 1994). The ten value types that he identified are listed in the second column of table 2, together with their definition in terms of motivation (column 3). The first column in table 2 lists four higher-order value domains, in which the value types fall under. The codes in brackets are references for table 6 and should not be given too much attention at this point in time.

Table 2

The ten motivationally distinct value types.

Domains	Value types	Definitions
Openness to change	Self-direction (OPEN1)	Independence, control, autonomy, freedom
	Stimulation (OPEN2)	Novelty seeking, Variety seeking, Excitement, Risk taking
Conservation	Conformity (CONS1)	Obedience, Restraint of actions, inclinations and impulses
	Tradition (CONS2)	Acceptance of others' ideas, Follow norms of behavior
	Security (CONS3)	Safety, Harmony, Stability
Self-transcendence	Universalism	Understanding, appreciation, tolerance and protection for the welfare of all people and for nature
	Benevolence	Understanding, appreciation and protection for the welfare of people with whom on is in frequent personal contact
Self-enhancement	Power	Social status and prestige, control or dominance over resources or people

	Achievement	Personal success and competence
	Hedonism	Pleasure or sensuous gratification for oneself

Source. (Lam et al., 2003; Schwartz, 1994, 2012)

Schwartz theory does not merely list the ten motivationally distinct value types, but also explicates the relationships and structure among them. Schwartz argued that the actions that one takes in the pursuit of any of the ten values will induce conflicts with some other values. Pursuing stimulation values, for example, usually conflicts with the values of conservation and tradition. Enhancing one's own success and social status tends to hinder actions that are motivated by the goal of enhancing the welfare of others (Schwartz, 2012)

The circular structure that can be seen in Figure 4 visually depicts the congruity and relationship of conflicts between the ten values. The values of conformity and tradition are located next to each other as they share the same broad motivational goal. Schwartz put conformity closer to the center and tradition further out as he claimed that tradition are in a stronger conflict with the opposing values. Hedonism is located in a stipulated area as it shares elements of both openness to change and self-enhancement (Schwartz, 2012).

Schwartz' visual depiction of the relationship between the ten values shows that they are encompassed by two bipolar dimensions. The first bipolar dimension is that of "openness to change" and "conservation". The figure shows the conflicting nature of the values that emphasize independence, freedom, readiness for change, novelty seeking (i.e. stimulation and self-direction) and the values emphasizing safety, stability, and resistance to change (i.e. conformity, safety, and tradition). The second bipolar dimension encompasses the "self-enhancement" and "self-transcendence" values. Here, we see that the dimension captures the conflict of the values that

promotes the welfare of people and nature (i.e. benevolence and universalism) and the values that seeks to enhance one's own success and dominance over people and resources (i.e. achievement and power.

The circular arrangement of Schwartz' ten values form a continuum of related motivations. The closer any two values are in the circular arrangement, the more similar they are in terms of their underlying motivations. If the distance increases, their motivational similarity decreases (Schwartz, 2012).

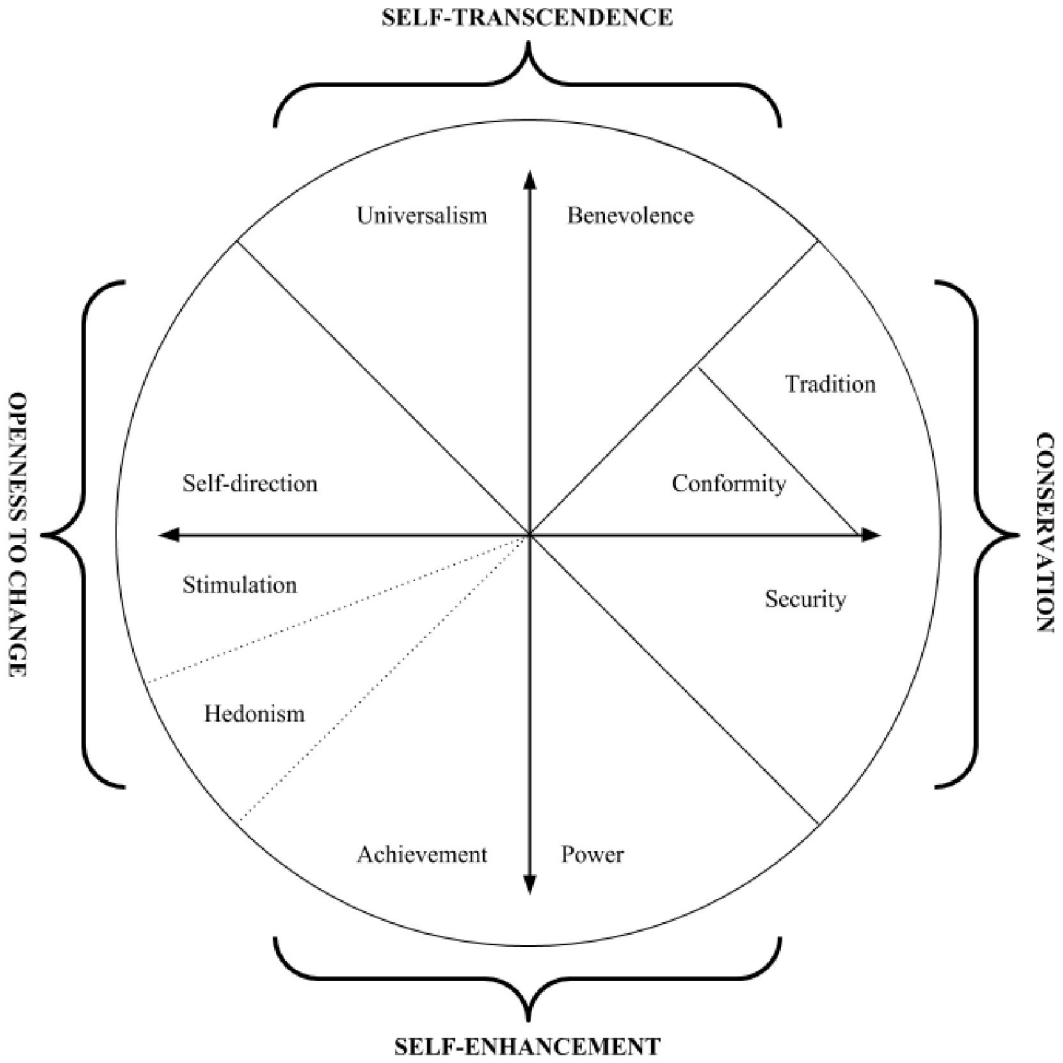

Figure 4: The bipolar dimensions that encompass the relationship between the ten values.

The Validity of an Extended Technology Acceptance Model

Summary and key points

1. Automation plays an increasingly important role in our daily lives and is extensively prevalent in the freight industry where new technologies give rise to automated systems.
2. There is an increasing interest in the development of autonomous ships. These ships may have the ability of providing a sustainable and attractive solution to the challenges of the European shipping industry.
3. As autonomous ships represent a potentially disruptive, yet beneficial, change to the industry, the perception that potential users hold can greatly affect the rate at which it is diffused.
4. TAM measures user acceptance of new technology. According to the model, perceived usefulness and ease of use affects attitudes towards using a technology, which in turn affects the behavioral intention to use it. Perceived usefulness could also be a mediator.
5. Previous research has shown that trust is a major component of user acceptance of automated systems. It can therefore be argued that trust should be incorporated into TAM.
6. Innovativeness has also proven itself to be a highly influential concept in most technology adoption situations. Innovativeness can be defined as de degree to which a potential user is predisposed to adopt an innovation. Adopters can therefore be divided into adopter categories, based on their innovativeness. Research indicates that the dominant characteristic of each adopter category, apart from demographic variables, is personal values.
7. According to Homer et al. (1988), values influence specific behavior through the mediating role of attitudes. Schwartz, one of the most influential researchers of values underpins this notion. His ten motivationally distinct values types, and the relationship between them, is recognized and considered to be especially important for distinguishing individual and cultural values.

Conceptual framework

To examine potential users' acceptability of autonomous ships, the Technology Acceptance Model (TAM) needs to be extended. While the TAM model measures important variables, it fails to investigate personal traits, such as innovativeness. As discussed earlier, innovativeness could further help the process of technology acceptance and use. Therefore, this study investigates the effect of personal values, as a measure of innovativeness, on potential users' attitudes towards using autonomous ships. Synthesizing previous work on values, technology acceptance, and automation has led to the development of a conceptual model. The extended Technology Acceptance Model (TAM) have been incorporated with external factors, and the conceptual model consists of 8 variables: Trust, perceived risk, perceived usefulness, perceived ease of use, openness to change, conservation, attitude towards using, and behavioral intention to use. On the basis of the literature review in the previous chapter, 13 hypotheses are proposed, in which are divided into primary and secondary hypotheses.

Primary Hypotheses: Correlation

The Technology Acceptance Model (TAM) and its hypotheses. As discussed in the previous chapter, TAM introduces two factors, perceived ease of use and usefulness, each of which influences attitudes towards using and behavioral intention to use a technology. Their relationship has been tested and their significance level has been demonstrated in many studies, proving the model to be robust and valid (King & He, 2006; Taylor & Todd, 1995; J. H. Wu & Wang, 2005). It thus seems reasonable that the following 5 hypotheses can be proposed (figure 5):

The Validity of an Extended Technology Acceptance Model

H1: Perceived ease of use is positively correlated with attitudes towards using autonomous ships.

H2: Perceived ease of use is positively correlated with perceived usefulness of autonomous ships.

H3: Perceived usefulness is positively correlated with attitudes towards using autonomous ships.

H4: Perceived usefulness is positively correlated with behavioral intention to use autonomous ships.

H5: Attitudes towards autonomous ships is positively correlated with behavioral intention to use autonomous ships.

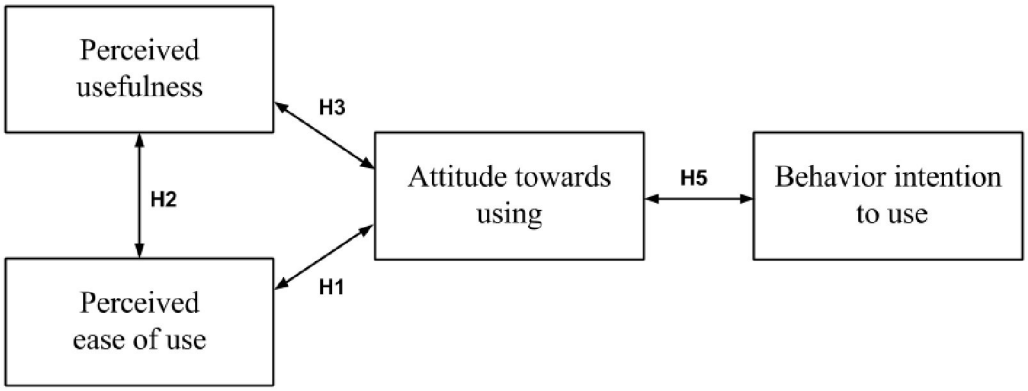

Figure 5: The TAM model and the first five hypotheses

Augmenting TAM with Trust and Perceived Risk. Previous studies on automated systems, such as e-commerce (Pavlou, 2003), e-government (Carter & Bélanger, 2005), mobile banking (Lin, 2011), and automated vehicles (Choi & Ji, 2015), reveals that trust is a major determinant of acceptance and adoption of automation. Choi and Ji (2015) hypothesized that trust functions as a direct determinant of a users' intention to use an automated vehicle, but also as an indirect determinant through the constructs of perceived usefulness and perceived risk.

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According to literature, perceived risk is a key component of trust in which trust has negative impact on (Choi & Ji, 2015). On the basis of previous research on trust and acceptance of automation, the following four hypotheses are proposed (figure 6):

H6: Trust is positively correlated with behavioral intention to use autonomous ships.

H7: Trust is positively correlated with perceived usefulness of autonomous ships.

H8: Trust is negatively correlated with perceived risk of autonomous ships.

H9: Perceived risk is negatively correlated with the behavioral intention to use autonomous ships.

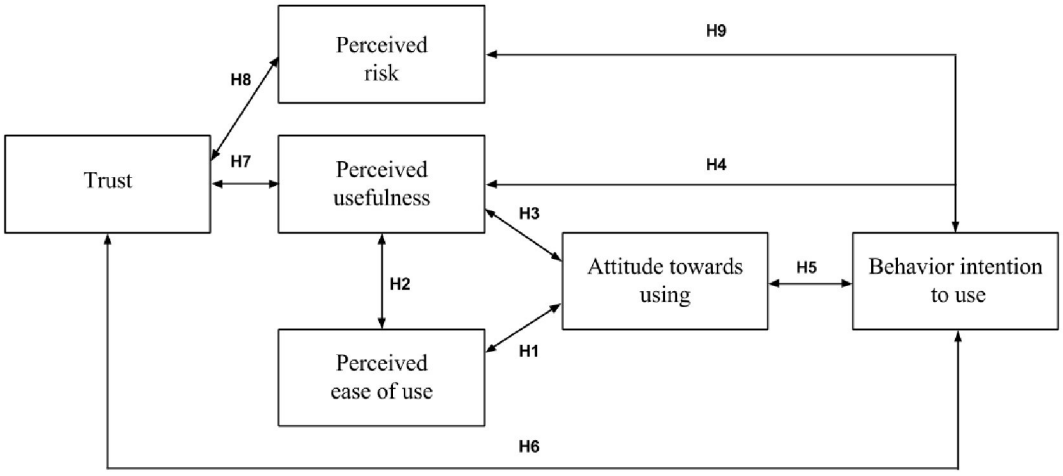

Figure 6: The TAM model augmented with trust and perceived risk

Augmenting TAM with STBV & VAB. The bipolar value dimension of openness to change and conservation are in constant conflict. Stimulation and self-direction, the underlying values of the openness to change domain, represents the motivational goals of independence, control, autonomy, freedom, risk taking, excitement, variety seeking, and novelty seeking (Schwartz, 1992). According to Rogers (2003), each of the five adopter categories carries some

kind of dominant characteristics and values. A comparison of dominant characteristics of adopter categories and motivational goals of openness to change reveals high correspondence between the two. Rogers (2003) argued that innovators, the first 2.5 % of adopters, are characterized by being venturesome. Salient characteristics of being venturesome are novelty seeking and risk taking, both important motivational goals of the stimulation value. Similarly, the motivational goals of conformity, tradition, and security (i.e. the conservation domain) are comparable to the dominant characteristics of less innovative individuals. Security, stability, resistance to change, restraint of actions, inclinations and impulses, for example, are prominent characteristics of the late majority and laggards (Rogers, 2003).

Many research studies investigating innovativeness have shown a positive correlation between innovativeness and personal characteristics. Hirschman (1980) argues that innovativeness is associated with creativity, independence, seeking new information and variety, and stimulus variation. This is supported by Venkatraman and Price (1990). Steenkamp and Baumgartner (1992) reported that a high optimum stimulation level (OSL), the satisfactory level of stimulation among individuals, cause people to engage in exploratory behaviors more frequently than people with low OSL. They also proposed that a high OSL is positively related to variety seeking and risk taking, and that individuals with low OSL would exhibit less of the same traits. A literature review conducted by Dobre, Dragomir, and Preda (2009) showed that innovativeness is positively related to flexibility, creativity, positive attitudes towards change, and risk taking. The same review found that innovativeness is negatively related to dogmatism, the need for structure, and reliability.

The literature presented above portrays a positive correlation between innovativeness and personal characteristics, underpinning the notion of a positive relation between values and

innovativeness. A thorough review of existing literature has led the author to believe that the values of openness to change (i.e. stimulation and self-direction) are positively correlated to innovativeness. Consequently, the values of conservation (i.e. security, tradition, and conformity), located opposite to openness to change in the motivational continuum presented in figure 4, are believed to have a negative impact on individual innovativeness. The sequential relationship of values, attitudes, and behaviors, presented by Homer et al. (1988), which can also be identified in TAM, are used to postulate the following two hypotheses (figure 7):

H10: The values of openness to change (i.e. stimulation and self-direction) are positively correlated with attitudes towards using autonomous ships.

H11: The values of conservation (i.e. tradition, security, and conformity) are negatively correlated with attitudes towards using autonomous ships.

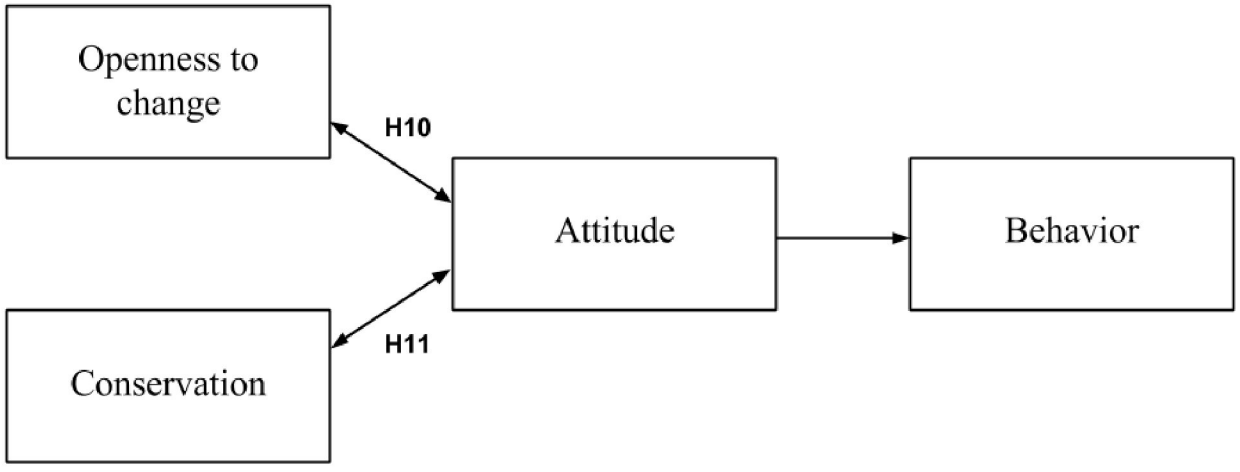

Figure 7: The value-attitude-behavior (VAB) hierarchy augmented with Schwartz theory of basic human values (STBV)

Secondary Hypotheses: Mediation

As discussed in the literature review on the Technology Acceptance Model, perceived usefulness could be mediating some of the effect that perceived ease of use has on attitudes towards using. In the previous subchapter, discussing primary hypotheses, it was argued that trust could have an indirect effect on behavioral intention to use autonomous ships through perceived risk and perceived usefulness.

As a result, the following two hypotheses are postulated. The two are highly dependent on significant relationships in the previous hypotheses, and will therefore only be analyzed if hypotheses 1 through 9 are supported.

H12: The positive effect of Perceived ease of use is mediated through perceived usefulness.

H13: The positive effect of trust on behavioral intention to use autonomous ships is mediated through perceived risk and perceived usefulness.

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Conceptual model

The conceptual model is presented in Figure 8, visually depicting the composition of concepts that are used for postulating the hypotheses in the thesis. The model captures the thought process of the author, and provides a visual representation of the theories in use. The model consists of the original Technology Acceptance Model (TAM), augmented with trust, perceived risk, and Schwartz' Theory of Basic Human Values (STBV), combined with the VAB hierarchy of Homer et al. (1988).

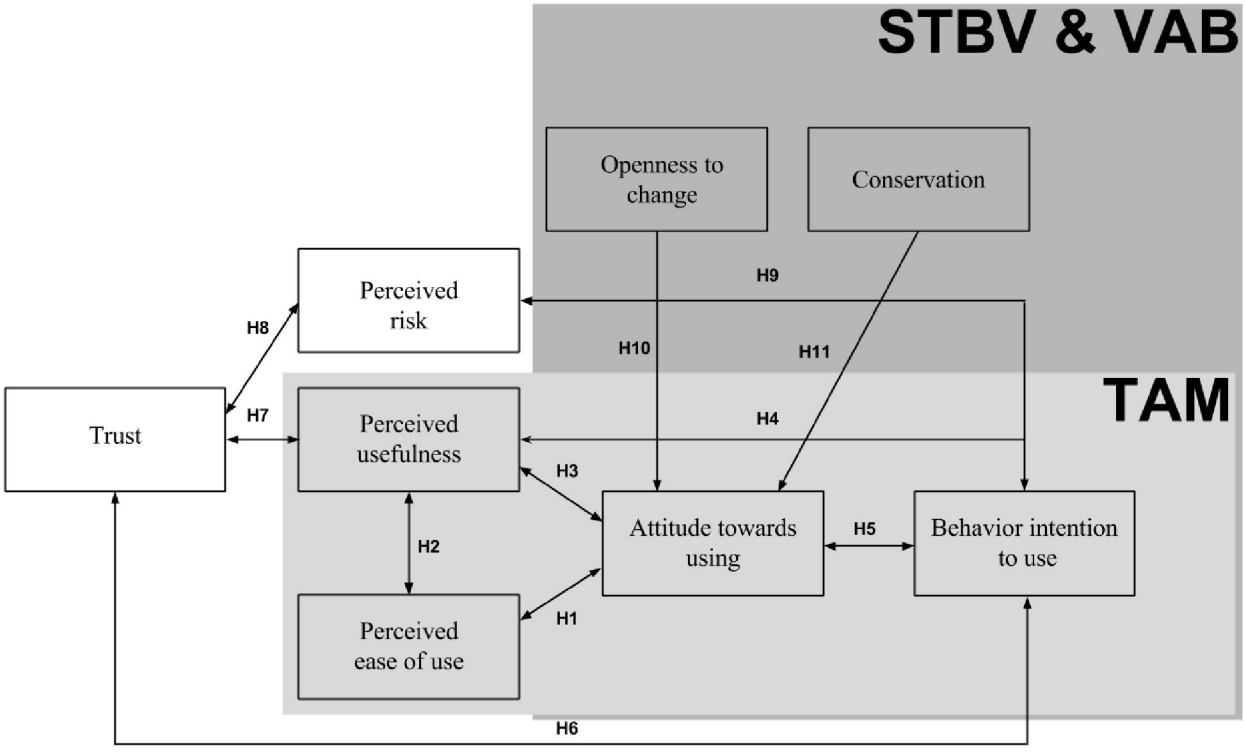

Figure 8: Conceptual model showing the relationship between the different constructs and hypotheses.

Methodology

According to Jupp (2006, p. 175), a scientific method can be defined as "a philosophical stance or worldview that underlies and informs a style of research". Frankfort-Nachmias and Nachmias (2008) compare a methodology to a system containing a set of rules and procedures. A process of gathering knowledge and empirical evidence used to support or contradict a theory. Hence, the following chapter will describe how the research will be conducted and why certain methods were used instead of other available options.

Research Strategy

There are two main strategies available when conducting a social research study: qualitative and quantitative methods (Bryman & Bell, 2011; Greener, 2008). The first strategy that one can choose is the qualitative research method, a method that is usually concerned with words, rather than numbers. Research of this nature has an inductive view of how theory and research are related, meaning that the former is usually a result of the latter. It is interpretivist and constructionist; it tries to understand social reality by interacting with others and examining their interpretation of the world (Bryman, 2004; Bryman & Bell, 2011; Frankfort-Nachmias & Nachmias, 2008).

In contrast to qualitative research we find quantitative research, which emphasize the need for numbers and quantification in the collection and analysis of data. Instead of being inductive, it takes a deductive approach to the relationship of theory and research, meaning that the latter is usually a result of the former. This implies that the method deals with the testing of theories. Because of this, it can be said that quantitative research follows the norms of positivism, where objective methods of natural sciences are advocated (Bryman, 2004; Bryman & Bell, 2011).

The Validity of an Extended Technology Acceptance Model

This study aims at measuring the level of acceptance among potential users by first investigating relationships between the concepts of trust, perceived risk, perceived usefulness, perceived ease of use, as well as values, attitudes towards using autonomous ships, and their behavioral intention to use these ships. The conceptual model presented in chapter 3, is based on the technology acceptance model (TAM). The original TAM model originated from a quantitative survey, and consequently, a quantitative method is commonly used for research projects that apply the model. In a recent review, all but 3 of a total of 101 studies adopting TAM used quantitative methods (P. F. Wu, 2012). Usually, TAM focuses on a contemporary event where the purpose of the study is to form a picture of a current situation at a specific point in time. It seeks to answer a "What" question. When a research study contains all of these three characteristics, it is highly appropriate to apply a quantitative method to the research, in particular a survey (Mojtahed & Peng, 2012).

Adding to this, Frankfort-Nachmias and Nachmias (2008) argues that attitudes may incline a person to react in a certain way, or to put it in another way, initiate a behavior. Attitudes, they say, is a concept that is often measured through the use of surveys. The relationship between attitudes and behaviors that Frankfort-Nachmias and Nachmias (2008) mentions, is the same relationship that can be seen in TAM, underpinning the suggestion that quantitative methods should be applied to TAM studies.

Traditionally, values have been measured through the use of value scales. The concept of personal values has over the years gained an import role in both marketing and psychology in determining consumer behavior. As a result, many measurement methodologies have been developed, most of which are of a quantitative nature (Alwin & Krosnick, 1985; Clawson & Vinson, 1978). Several methods are available, and popular measurement methodologies that have

been tested and validated are; Rokeach Value Survey, List of Values, and Schwartz Value Survey (Sirgy, Rahtz, & Dias, 2014).

With respect to the literature stated above and the proposed hypotheses, whose purpose is to test a developed theory, the study heads in a direction of a measurement methodology that is quantitative.

Research Design

In this sub-chapter, the possible research designs available will be discussed, together with an explanation to why the specific design was chosen. A research design can be defined as a framework on how empirical data will be collected and analyzed. It is therefore closely related to the research strategy, as the choice of one affects the other (Bryman, 2004).

When conducting research, five designs are available: experimental design; longitudinal design; case study design; comparative design; and cross-sectional design (survey design). The first design available is the experimental design. This design use manipulation and controlled testing to understand and control for changes in other variables. Longitudinal design represents another distinct form of research design. It is arguably the least used design as it is very costly and time consuming due to the measuring of a sample on at least two occasions. The third available option is a case study design. Here, the case in question is subjected to a detailed and intensive analysis. The case can be anything from an organization, a family, a single community, a person, and so on. The fourth research design, comparative design, entails a study of two contrasting cases. By using a more or less identical method for each case, the design compares the two. An example of this could be the comparison of some phenomena in two or more countries (Bryman, 2004).

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The final research design available, cross-sectional research design, or survey design as it is also called, collects data on more than one case at a single point in time. The design is associated with surveys as it collects a body of quantitative data, measuring the relationships between multiple variables. Researchers who use this type of design are usually interested in variation, which is only established when examining more than one case. In order to obtain this variation, a standardized method for systematic gathering of quantifiable data is needed, most often through the use of surveys or structured interviews (Bryman, 2004).

As mentioned in the research strategy, the purpose of this study is to measure the validity and the relationship between the different variables in the extended TAM model. In the same section, it was argued that a quantitative method was best suited for this type of research. The conceptual model that has been developed aims at exploring the different relationships between different variables. In order to do this, the study is highly dependent on gathering quantitative data. As the research is performed in a relatively short period of time, with limited resources, it is reasonable to expect that the data will be gathered more or less simultaneously. The reasoning above suggests that the study is to be performed using a cross-sectional design, or to be more specific, a survey. Reviewing other studies using either original or extended versions of the TAM model, shows that cross-sectional design are commonly used for this type of research (i.e. Chen, Yang, Tang, Huang, and Yu (2008), Gefen and Straub (1997), van der Heijden (2004)).

Data Collection

Based on the literature presented in the previous section, the study used a cross-sectional design for the purpose of gathering quantitative data. The data was collected using a survey, designed on the theoretical references of previous works that was discussed in the literature review. The survey was first written in English, and then translated to Norwegian. Norwegians generally rank very high in the English Proficiency Index (EPI), which is a yearly report delivered by Education First (EF) (Education First, 2015). Nonetheless, the source language in the survey contains words that may be too advanced for the average Norwegian. Hence, the survey was translated to the target language, that is, Norwegian. The procedure of translating surveys are seen as important for avoiding misunderstandings (Ervin & Bower, 1952; Harkness & Schoua-Glusberg, 1998).

The survey measured data in three parts and can be found in Appendix A. The first part of the survey gathered socio-economic data, such as gender, age, education, job status, income, and affiliation to the sectors of the maritime industry. The maritime industry was divided into five sectors in accordance with the overview presented in “Maritime Economics”, by Stopford (2009). The purpose of the first part of the survey was to identify the characteristics of the participants, and perhaps most importantly, weeding out participants who did not meet the criteria of the sample.

Sampling. A sample is defined as a set of elements that are selected, in one way or another, from the population of interest (Frankfort-Nachmias & Nachmias, 2008; Sapsford & Jupp, 2006). Methodologically speaking, a population, not to be confused with the everyday usage of the term, is the total number of elements that are being investigated. These elements can be persons, cities,

or events, students, patients: pretty much anything at all that are of interest (Sapsford & Jupp, 2006).

The conceptual model that was developed in chapter 3 aims at being a reliable tool in measuring the level of acceptability among the potential users of autonomous ships, by first establishing a correlation between the variables comprising the model. Consequently, the study targeted the people who are most likely to interact with these types of ships: crew on board ships. The inclusion criteria for the participants were that they had to be Norwegians who were either full-time employed, part-time employed, self-employed, or student's/cadets, who worked as crew on board a ship. The criteria can be seen in table 3.

Table 3

Inclusion criteria for participants

Criteria	Criteria Items
Ethnicity	• Norwegian
Status of employment	• Full-time • Part-time • Self-employed • Student/cadet
Connection to the maritime industry	• Vessel operations • Shipbuilding • Marine Resources • Marine fisheries • Other marine related activities
Crew on board ship	• Deck officer • Engineering officer • Petty officer (Boatswain's Mate, Carpenter's Mate, Electrician etc.) • Engine crew • Deck crew • Chief steward and steward crew • Other crew not mentioned

In order to weed out participants who did not meet the criteria, three questions was used. The first question asked about their current level of employment. The second question asked about their connection to the maritime industry, and the third question asked if they worked on board a ship. Compliance between the three had to be established before the participants were included in the final sample.

The study relied on a non-probability sampling strategy, as probability sampling was deemed unrealistic due to time and resource constraints. There are approximately 15 000 Norwegian seafarers which makes the procedure of ensuring a random selection of all subjects extremely demanding (Maritim Trainee, n.d). In order to obtain a satisfactory number of data, convenience sampling was used. Convenience sampling is a type of non-probability sampling that draws a sample on the basis of accessibility and convenience (Frankfort-Nachmias & Nachmias, 2008).

A link to the survey was posted on various websites where it was considered likely to gather data from members of the population. Such websites included discussion boards of maritime related topics, as well as social media outlets.

Data Collection of Values. As mentioned earlier, the survey consisted of three parts, where the first collected information on the respondents. The second part was designed to measure the values of the respondents. This part of the survey adopted the work of Schwartz (1992) and his instrument for measuring values, the Schwartz Value Survey (SVS). The original SVS, a common and validated instrument for measuring values, contains 57 items which express an aspect of the motivational goal of one of the ten values presented earlier (Lindeman & Verkasalo, 2005; Schwartz, 2012).

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Since the study was designed to collect data in three parts, it was considered whether a scale with 57 items were too time-consuming, resulting in a low completion rate of the survey. Therefore, the study adopted a short version of the Schwartz Value Survey (SVS), called the Short Schwartz Value Survey (SSVS). This shortened instrument gives insight to the ten broad values presented by Schwartz, and not in the 57 specific value items that are measured using the original survey. In other words, instead of using several value indicators, it directly measures the motivational goals of each value. The shortened instrument, despite its condensed nature, has proven itself to be a reliable tool (Karppinen & Korhonen, 2013; Lindeman & Verkasalo, 2005).

Respondents were asked to rate the importance of each value on a 9-point scale with the labels 8 (of supreme importance), 7 (unlabeled), 6 (unlabeled), 5 (unlabeled), 4 (important), 3 (unlabeled), 2 (unlabeled), 1 (not important), 0 (opposed to my principles). The order of the values was randomized for each responder in order to minimize order bias. The nonsymmetrical scale is adopted from the scale applied in the original SVS. Just like the original scale, the one used in SSVS is stretched at the upper end. The reason for this is the inherent positive nature of values. When given the chance to evaluate a set of values, respondents tend to not differentiate substantially between the different values, resulting in high ratings and end-piling of responses. This significant drawback of using a rating-scale when evaluating values has been proven to severely limit the usefulness of the data (McCarty & Shrum, 2000).

One of the countermeasures for end-piling of data has already been mentioned, but one alternative or supplementary approach has also showed to be effective in reducing end-piling. McCarty and Shrum (2000) proposed that values should first be ranked, then rated. The rank-then-rate procedure, they said, force respondents to first rank each value in terms of their relative importance. However, the procedure does not force the respondent to rank every value that are

presented to them as it would be too cognitively demanding and time consuming. Instead, the respondents are asked to first look through the complete list of values and then choose the value that is most important to them. The respondents are then asked to look over the same list again and choose the least important value. Similarly to the rate-then-rank procedure, the most-least rating procedure force respondents to compare and contrast the set of values. McCarty and Shrum (2000) argued that a procedure like this would be appropriate in surveys, such as mail and internet questionnaires, as it requires far less time than a full ranking procedure followed by a rating of each value.

This study adopted the most-least procedure of McCarty and Shrum (2000), as shown in question 8 and 9 in Appendix A. Question 10 constitutes the Short Schwartz Value Survey (SVSS).

Data Collection of Acceptance. The third and last part of the survey was designed to test the relationship between the different variables in the original TAM model, augmented with the constructs of trust and perceived risk. This could in turn be used to measure the acceptance of autonomous ships among Norwegian seafarers. The survey adopted a standardized instrument for measuring perceived usefulness and ease of use, developed by Davis (1989).

The original instrument contained 10 items for each of the two constructs, but was shortened down to three items per construct for the purpose of measuring acceptance of autonomous ships. According to a literature review by Shih-Chih, Shing-Han, and Chien-Yi (2011), a minimum of three items per construct is recommended when measuring acceptance with the use of TAM. A review of previous research studies applying extended versions of TAM showed that the number of items varies greatly (i.e. Porter and Donthu (2006), Pavlou (2003),

Gardner and Amoroso (2004)). Choi and Ji (2015), for example, used three items per construct for measuring acceptability of autonomous cars.

Due to the apparent similarity to the work of Choi and Ji (2015), the study adopted the same number of items per constructs used for exploring the acceptance of autonomous cars. Therefore, similar wording of each item was also adopted. Not only were the two studies alike in some areas, making it convenient to adopt certain parts of the items, but it was also considered if shortening the number of items would reduce the overall length of the survey, increasing the completion rate by participants. Hence, each construct was assigned three items. The 8 constructs, together with their 18 items are listed in table 4.

The different constructs in the original TAM model is measured using a 7-point Likert scale. Because of this, the study adopted the same scale for measuring the constructs in the extended TAM. The Likert scale is designed to examine the degree to which the respondents agree or disagree with the 18 statement-items in table 4. The continuum of possible responses used in the survey went from “strongly disagree” (1), “somewhat disagree” (2), “disagree” (3), “neither agree nor disagree” (4), “agree” (5), “somewhat agree” (6), to “strongly agree” (7).

It is also worth mentioning that the first 15 items, encompassing the first 7 variables, are positively worded. A high number assigned to a statement means that the responder have a positive attitude towards the statement. Examining the items of perceived risk, we see that the wording is negative, meaning that a low number indicates a positive attitude. If this had not been accounted for in the hypothesis, the three items would have had to be reverse coded when analyzing the data.

Table 4

List of constructs and their associated items

Survey Item (3-items per construct)		Construct
Using autonomous ships will increase my productivity.	PU1	Perceived Usefulness (PU)
Using autonomous ships will increase my performance.	PU2	
Using autonomous ships would enhance my effectiveness.	PU3	
Learning to operate autonomous ships would be easy.	PEOU1	Perceived Ease of Use (PEOU)
Getting autonomous ships to do what I want would be easy.	PEOU2	
Interacting with autonomous ships would not require a lot of mental effort.	PEOU3	
Using autonomous ships is a good idea.	ATT1	Attitude towards using (ATT)
Using autonomous ships is a wise idea.	ATT2	
I am positive towards autonomous ships.	ATT3	
I intend to use Autonomous ships in the future.	BI1	Behavioral Intention to use (BI)
I expect that I would use autonomous ships in the future.	BI2	
I plan to use autonomous ships in the future.	BI3	
Autonomous ship is dependable.	TRU1	Trust (TRU)
Autonomous ship is reliable.	TRU2	
Overall, I can trust autonomous ships.	TRU3	
Autonomous ship would lead to financial loss for me.	PR1	Perceived Risk (PR)
Autonomous ship might not perform well and create problems.	PR2	
Using autonomous ship would be risky.	PR3	

Data Analysis

The first 11 hypotheses presented in chapter 3 explore the relationship between pairs of variables, or to put it differently, if two variables correlate. Analysis of correlation, also known as bivariate analysis, search for the evidence that a variation in one variable coincide with the variation in another. Because of the examination of two variables, bivariate analysis can be distinguished from univariate analysis, in which only one variable is analyzed. According to Bryman and Cramer (2005), the investigation of whether variables are related or not is an important step in exploring, and consequently explaining the nature of the phenomena that we are interested in.

Bivariate analysis involves a wide range of techniques for examining relationships between variables, and the appropriate technique one should use is dependent on the nature of the variables (Bryman & Bell, 2011). The 18 items in the extended TAM model are measured using Likert response alternatives. Each variable has three associated items, meaning that the items are combined into a single composite score/variable during the data analysis process. Traditionally, Likert responses generate "ordinal" (categorical) data, meaning that it is a set of ordered categories (i.e. strongly agree, strongly disagree). However, there is an ongoing debate among researchers whether it should be treated as ordinal (categorical variable), or as interval/ratio (continuous variable). In an attempt to clear up the misconceptions concerning the analysis of Likert data, Boone and Boone (2012) discussed the difference between "Likert-type items" and "Likert scales". Likert-type items, they said, are characterized by being single questions that use a certain aspect of the original Likert response alternatives. A Likert scale, on the other hand, is characterized by being a variable that is composed by a series of Likert-type items during the data processing. To elaborate, Likert scale items are created by computing the composite score (mean)

of a number of Likert-type items. Therefore, the composite score should be a treated as an interval/ratio scale, and not as an ordinal measurement scale.

Since the extended TAM model combines eighteen items into six variables, the variables should be analyzed as intervals. The same can be said for the measurement of values, which measures higher order value domains by combining the scores of the ten value types. When all variables are interval/ratio variables, the appropriate bivariate method for measuring correlation is "Pearson's r" (Bryman & Bell, 2011).

Pearson's r. This is a widely used method for examining the correlation between pairs of interval/ratio variables. When measuring the correlation of variables, the Pearson's r coefficient will lie somewhere between -1 and 1. The closer the coefficient is to 1, the stronger the relationship is between the two. If it approaches 0, the correlation is weak. The sign of the coefficient only indicates the direction of the relationship (Bryman & Bell, 2011).

When conducting a bivariate analysis, such as Pearson's r, it is important to understand that a correlation between two variables uncovers nothing more than just that, the relationship between them. This implies that it is not possible to infer if one variable causes the other. When measuring correlation, it does not matter which of the two variables you call X and Y as the result will be the same. If the value of X increases, the value of Y increases. If X decreases, Y decreases, and vice versa (Bryman & Bell, 2011).

However, if results show that variables are related, it must mean that it is possible to explain the nature of the relationship itself. A change in one variable by a certain amount means that the other variable changes on an average by a certain amount. By investigating the relationships between a dependent variable and an independent variable one can ascertain a causal effect of the

independent variable on the dependent. The method for analyzing the dependence of one variable upon another, is called regression analysis (Swinscow & Campbell, 2002).

Regression analysis. The method is one of the most used tools for analyzing data and is closely connected to Pearson's r. As previously stated, if there is a relationship between two variables, a causal effect may be established. If y represents a dependent variable and x an independent, the relationship can be described as the regression of y on x. To explain in another manner, the relationship between the two variables can be explained by a simple equation called the regression equation. The word "regression" means that the average value of the dependent variable y can be explained as a function of the independent variable x (Bryman & Cramer, 2005; Swinscow & Campbell, 2002).

There are two types of regression analysis, the first being "simple linear regression analysis". For the purpose of illustration, let's imagine that a study wishes to identify the factors that shape political attitudes. A quick reflection uncovers a number of factors that can be associated with attitudes towards politics, such as family, age, gender, education, religion, race and ethnicity. Regression analysis characterized as simple linear regression focuses on just one of these exploratory variables, such as education. The second type of regression analysis is "multiple linear regression". The method allows for more than one variable affecting the dependent variable. The analysis is highly valuable as it quantifies the impact of a number of variables simultaneously affecting a dependent variable (Sykes, 1993).

This study explores the relationship between eight variables, and it is therefore appropriate to apply both of the analytical methods discussed above. Both Pearson's r and Regression analysis will be analyzed in IBM SPSS Statistics 23.

Ethical Consideration (NSD)

The research study was approved by the Norwegian Centre for Research Data (NSD), see Appendix B. The gathering of data through the use of an online questionnaire meant that sensitive personal information would be stored on the authors' computer during the processing of the data. NSD required that all sensitive information were to be deleted as soon as possible, which was followed up by the deletion of personal IP-addresses momentarily after the data was imported to the personal computer used for data processing. A cover letter was added to the questionnaire informing the participants of anonymity.

Results

This chapter presents the results of the study. First, the chapter presents the demography of the participants. The reader will then be presented with the descriptive statistics and the internal reliability of the eight scales. Lastly, Pearson's r and regression analysis will be conducted, analyzing and testing each of the 13 hypotheses postulated in chapter 3.

Participants

The online survey was administered on various websites and received 199 responses. Participants who did not fulfill the inclusion criteria were removed from the sample, leaving 140 usable responses. Out of the 140 participants, only 2 (1.44 %) respondents had primary and secondary school as the highest level of education. 64 (45.71 %) reported that they had vocational education, 68 (48.57 %) reported that they had higher education of four years or less. Only 6 (4.29 %) respondents have four years or more at a University or College.

Concerning average yearly income, only 1 (0.71 %) respondent reported an income less than 200 000 kr. 9 respondents earned 200-400 000 kr. 20 (14.29 %) respondents earned 400-600 000 kr. Respondents reporting a salary between 600 – 800 000 kr, amounted to 53 (37.86 %). 38 (27.14 %) respondents earned somewhere between 800 000 and 1 000 000. 16 (11.43 %) reported more than 1 000 000, and 2 (1.44 %) respondents did not want to answer the question concerning average income. 1 respondent did not complete the question.

123 (87.86 %) out the 140 respondents were full-time workers. 4 (2.86 %) were part-time employed, and the same number said they were self-employed. 7 (5.00 %) responders said they were students/cadets. Participants were also asked to report the maritime sector that they were affiliated with. 98 (70 %) reported that they worked in the vessel operation sector. 4 (2.86 %) said they were connected to the shipbuilding sector. The marine resources sector accounted for 20 (14.29 %) of the 140 responses. 15 (10.71 %) respondents belonged to the marine fisheries sector, and 3 (2.14 %) respondents said that they belonged to other marine related activities. The most important demographics are detailed in table 5.

Table 5

Demographics of participants

Characteristic	n	%
Gender		
Male	135	96.43
Female	5	3.57
Age		
29 or younger	35	25.18
30-39	46	33.09
40-49	36	25.90
50-59	18	12.95
60-69	4	2.88
70 or older	0	0.00

Categories of crew		
Deck officer	74	52.86
Engineering officer	34	24.29
Petty officer	0	0.00
Engine crew	2	1.43
Deck crew	17	12.14
Chief steward/steward crew	6	4.29
Other type of crew	7	5.00

Descriptive statistics

As the survey use rating scales to measure the eight variables, it was deemed beneficial to present some descriptive statistics. Table 6 presents the basic features of the data. We see that the participants on average have an attitude towards autonomous ships that are negative. The means for all scales in the extended TAM model lies somewhere between 2 and 3. The five first scales in the table was, as discussed earlier, positively worded. This means that the respondents on average disagreed or somewhat disagreed with all of the items. The same is true for the perceived risk scale, in which was reversecoded in SPSS due to it being negatively worded. The two value scales have means that are above 4, underpinning the notion that people tend to rate all values high due to their inherent positive nature.

Table 6

Descriptive statistics of the eight scales

	N Statistics	Mean Statistics	Std. Error	Std. Deviation
PU	104	2,4968	0,12655	1,29057
PEOU	103	2,9676	0,11640	1,18129
ATT	105	2,6444	0,16705	1,71174
BI	106	2,4969	0,15122	1,55686
TRU	103	2,3042	0,12671	1,28601
PR	103	2,8252	0,12245	1,24271
OPEN	111	5,7793	0,14852	1,56479
CONS	112	5,5595	0,16167	1,71095
Valid N (listwise)	95			

Reliability: Cronbach's Alpha

The analysis of the instrument used to gather data on values and the extended TAM model began by first assessing the reliability of the eight scales used in the survey. Cronbach's alpha is an index of reliability, evaluating if the instrument in use will elicit consistent and reliable data every time it is in use, even if the items were replaced with other similar items. When a set of items generate a variable that returns a stable response, the variable can be said to be reliable (Santos, 1999). The Cronbach's alpha coefficients are presented in table 7.

Table 7

Cronbach's alpha of the eight scales

Construct	Item	α
PU	PU1	0.84
	PU2	
	PU3	
PEOU	PEOU1	0.61
	PEOU2	
	PEOU3	
ATT	ATT1	0.93
	ATT2	
	ATT3	
BI	BI1	0.92
	BI2	
	BI3	
TRU	TRU1	0.86
	TRU2	
	TRU3	
PR	PR1	0.60
	PR2	
	PR3	
OPEN	OPEN1	0.72
	OPEN2	
CONS	CONS1	0.86
	CONS2	
	CONS3	

The alpha coefficient ranges from 0 to 1, in which a high score indicates a reliable scale. Normally, a Cronbach's alpha of 0.7 is considered to be an acceptable reliability coefficient, but lower thresholds are often considered acceptable (Santos, 1999). Nunnally (1978) is often cited when it comes to the rule of 0.7. However, he never claimed that 0.7 should be a reliability standard that should be applied universally. Instead, he argued that the satisfactory level of reliability is dependent on how, and for what purpose the instrument is being used. According to Lance, Butts, and Michels (2006), the notion of a 0.7 value is one of the most commonly cited "urban myths" in social sciences.

Table 7 presents the Cronbach's alpha values for each of the eight scales used in the survey. Analysis of the alpha coefficient if items were deleted was also performed. No significant increase could be seen and all items were therefore included. The instrument was designed to measure personal values of respondents, as well as their attitudes towards 18 statements. For the purpose of gathering quantitative data using an online survey, the length and number of items was shortened to a minimum. The reliability could therefore be expected to be lower than if the original SVS instrument, together with the original TAM instrument, was used. Looking at the eight alpha coefficients in table 7, we see that the internal consistencies of the eight scales are generally high. Six, out of the eight scales, shows good internal consistency with alpha coefficients > .70. Only two scales, PEOU and PR, shows consistency that are questionable. However, the purpose of this study has been clearly stated. Taking this into consideration, the overall consistencies of the scales are high, proving the instrument to be a reliable tool for measuring the variables in the study.

Proving a reliable measurement instrument, the analysis could continue to measure Pearson's r coefficients.

Correlation Analysis

The purpose of measuring the relationship between pairs of variables was to see if they co vary, testing the validity of the first 11 hypotheses postulated in chapter 3. Each of the 11 hypotheses expresses some kind of relationship between two variables, and it was therefore seen as appropriate to use this type of analytical method. Pearson's r coefficients are detailed in table 7.

Table 7

Correlation matrix: Pearson's r coefficients

Construct	PU	PEOU	ATT	BI	TRU	PR	OPEN	CONS
PU	1							
PEOU	0,456**	1						
ATT	0,731**	0,452**	1					
BI	0,744**	0,507**	0,801**	1				
TRU	0,655**	0,439**	0,786**	0,725**	1			
PR	-0,385**	-0,429**	-0,489**	-0,473**	-0,487**	1		
OPEN	0,058	0,116	0,115	0,083	-0,056	0,041	1	
CONS	0,016	0,053	0,074	-0,044	-0,047	0,044	0,537**	1

The Pearson's r coefficients measure the correlations between the different variables in each of the first 11 hypotheses. The resulting coefficients, together with evaluations of each hypothesis are presented in table 8. Results show that all but two hypotheses, H10 and H11, can be supported. H10 produced a correlation coefficient of r = 0,115, and a significance p>.05. The same result can be seen for H11, where the correlation coefficient of CONS only reached r = 0,074, p>.05. Therefore, both hypotheses can be rejected.

Table 8

Testing the hypotheses based on r coefficients

Hypothesis	Relationship	r	Significance	Supported or not
H1	PEOU↔ATT	0,452	**	Supported
H2	PEOU↔PU	0,456	**	Supported
H3	PU↔ATT	0,731	**	Supported
H4	PU↔BI	0,744	**	Supported
H5	ATT↔BI	0,801	**	Supported
H6	TRU↔BI	0,725	**	Supported
H7	TRU↔PU	0,655	**	Supported
H8	TRU↔PR	-0,487	**	Supported
H9	PR↔BI	-0,473	**	Supported
H10	OPEN↔ATT	0,115	0,245	Not supported
H11	CONS↔ATT	0,074	0,452	Not supported

Regression Analysis

The purpose of the correlation analysis above was to see whether there was a significant relationship between two variables. Regression analysis, on the other hand, expresses the relationship as an equation (Sykes, 1993).

The idea of regression is to produce a line which fits the data of the relationship between two or more variables. The relationship can usually be depicted as a scatter diagram, and the line, called the “line of best fit”, will minimize the deviations of all the dots in the diagram. As it is nearly impossible to draw this line visually, regression analysis allows us to produce an equation: $y = b_0 + b_1x$, where y is the dependent variable, and x the independent. The two elements, a and b, simply refers to the point of interception and the slope of the line, respectively (Bryman & Cramer, 2005). The regression analysis, both simple linear and multiple linear, is presented below.

Simple linear regression. This form of analysis has one dependent variable, and only one independent variable in which the dependent is predicted from. The regression analysis can be seen in table 9, followed by the calculated regression equations for the hypotheses in which there is only one independent variable. Studying the conceptual model we see that only H8 qualifies for the simple linear regression analysis. A scatter plot, as well as the regression equation (best fitted line) for the hypothesis is attached in Appendix C.

Table 9

Simple regression analysis of one independent variable.

Summary					Coefficients			
Hypothesis	DV	IV	R	R Square		B	Beta	Sig.
H8	PR	TRU	0,487	0,238	(Constant)	6,265		
					TRU	-0,472	-0,487	0,000

Note. DV = dependent variable; IV = independent variable; R = correlation coefficient; R square = percentage of variation in DV, explained by IV; B = unstandardized coefficient used to predict Y; Constant = intercept (a); Beta = standardized coefficient and the relative size of the influence of a variable; Sig. = indicates if null hypothesis can be rejected or not.

The first number in the following regression equation represents the point where the line intercepts the y-axis (b_0). The rest of the equation determines the slope of the line (b_1x). For every unit-change in x, y will change by b-units (Bryman & Cramer, 2005). Simple linear regression analyses of the effect of TRU on PR resulted in regression equation 1:

$Y = 6,265 – 0,472x$, where y = PR and x = TRU (Equation 1)

Multiple linear regression. This type of regression analysis is similar to the one above, but examines the relationship of more than one independent variable (predictor) on a single

dependent variable (criterion) (Aiken, West, & Pitts, 2003). Out of the 11 primary hypotheses being tested, only one qualified for the simple regression analysis. Again, if we study the conceptual model, we see that:

1. PU, PEOU, OPEN, and CONS are all hypothesized to influence ATT. This means that H1, H3, H10 and H11 can be analyzed using multiple regression.
2. TRU, PU, PR, and ATT are hypothesized to influence BI. Multiple regression analysis can therefore be used for H4, H5, H6 and H9.
3. PEOU is hypothesized to affect PU (H2). We also see that the same is postulated for TRU (H7). PEOU and TRU can therefore be analyzed as being predictors of PU. The multiple regression analysis is detailed in table 10, containing H1/3/10/11, H4/5/6/9, and H2/7.

Table 10

Multiple regression analysis of two predictors and a criterion.

		Summary			Coefficients			
Hypothesis	DV	IV	R	R Square		b	Beta	Sig.
H1/3/10/11	ATT	PEOU, PU, OPEN, CONS	0,758	0,574	(Constant)	-0,793		
					PEOU	0,220	0,151	0,046
					PU	0,900	0,672	0,000
					OPEN	0,025	0,023	0,770
					CONS	0,080	0,077	0,325
H4/5/6/9	BI	TRU PU, PR, ATT	0,841	0,707	(Constant)	1,029		
					TRU	0,253	0,221	0,023
					PU	0,320	0,271	0,001
					PR	-0,153	-0,129	0,050
					ATT	0,312	0,354	0,001
H2/7	PU	PEOU, TRU	0,675	0,456	(Constant)	0,557		
					PEOU	0,203	0,187	0,028
					TRU	0,562	0,572	0,000

Note. DV = dependent variable; IV = independent variable; M = Mediator; R = correlation coefficient; R square = percentage of variation in DV, explained by IV; B = unstandardized coefficient; Constant = intercept (a); Beta = standardized coefficient; Sig. = indicates if null hypothesis can be rejected or not.

Results showed that the only significant variables in explaining the change in ATT are PEOU and PU. As suspected from the correlation analysis, H10 and H11 are insignificant in determining ATT. Hence, they were removed from equation 2. Multiple regression analysis of TRU, PU, PR, and ATT, as determinants of BI, showed that they all where significant in explaining the variance in BI. Their relationship is presented in equation 3. The last multiple regression analysis showed that PEOU and TRU are significant predictors of PU (equation 4).

$Y = -0{,}793 + 0{,}220x_1 + 0{,}900x_2$, where y = ATT and x_1 = PU, x_2 = PEOU (Equation 2)

$Y = 1{,}029 + 0{,}253x_1 + 0{,}320x_2 - 0{,}153x_3 + 0{,}312\ x_4$,

where y = BI, x_1 = TRU, x_2 =PU, x_3 =PR, x_4 = ATT (Equation 3)

$Y = 0{,}557 + 0{,}203x_1 + 0{,}562x_2$, where y = PU and x_1 = PEOU, x_2 = TRU (Equation 4)

Summary of Correlation and Regression analysis

Correlation analysis showed that the relationships between the pairs of variables in the first 9 hypotheses where significant. Only H10 and H11 were rejected. Consequently, the same results were found in the regression analysis. Simple regression analysis supported the hypothesis that only had one predictive variable. Multiple regression analysis supported the hypotheses that had multiple variables, predicting the same dependent variable. However, as in the correlation analysis, H10 and H11 had to be rejected and were therefore removed from regression equation 2.The resulting correlation coefficients are illustrated in figure 9, and predictive b-coefficients are illustrated in figure 10, 11, 12, and 13

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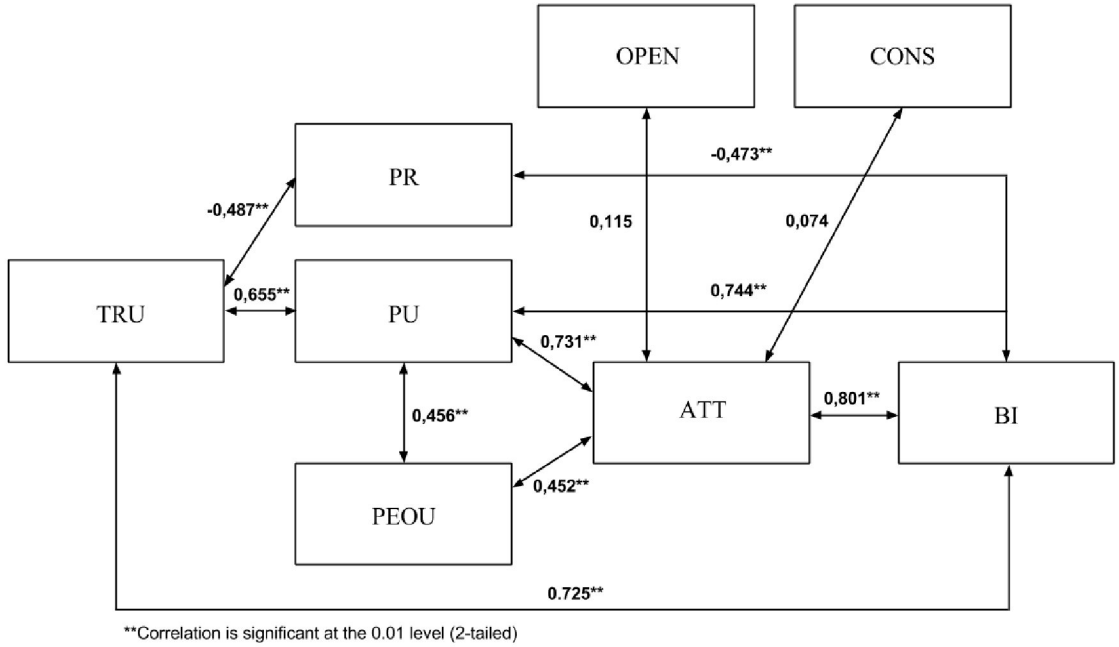

Figure 9: The Conceptual model together with Pearson's r coefficients.

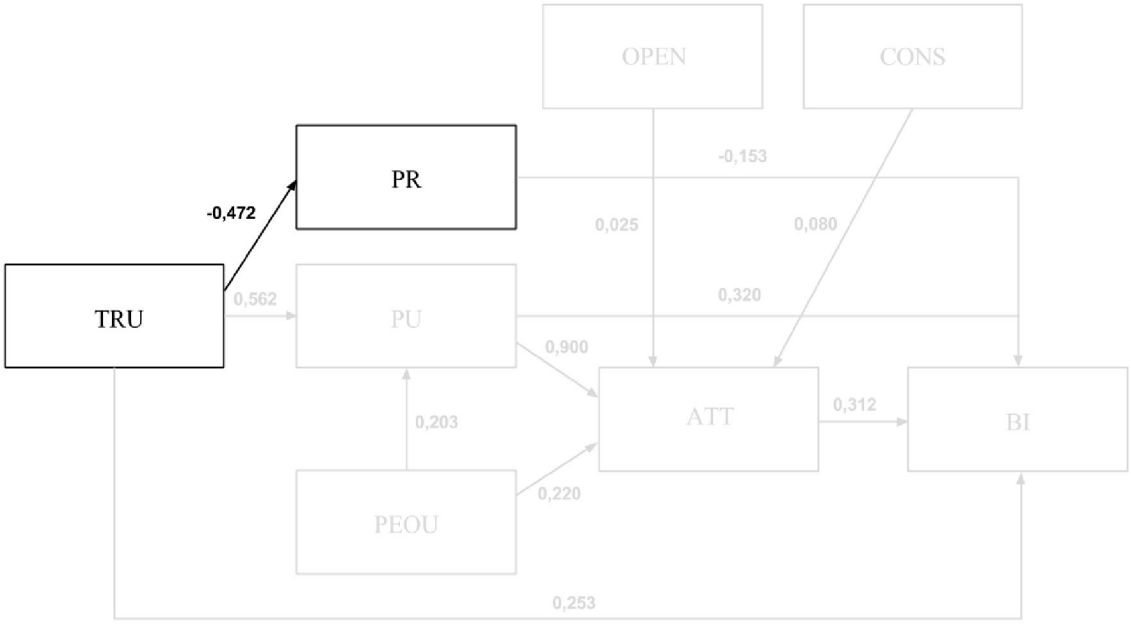

Figure 10: Predictive b-coefficient of the simple regression analysis.

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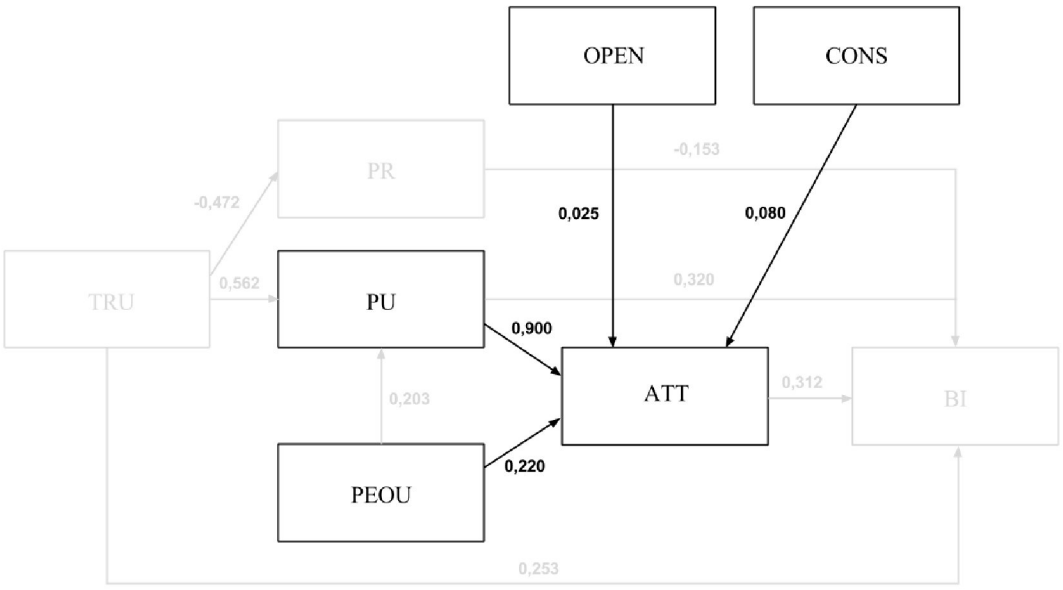

Figure 11: Predictive b-coefficient of the multiple regression analysis of H1/3/10/11.

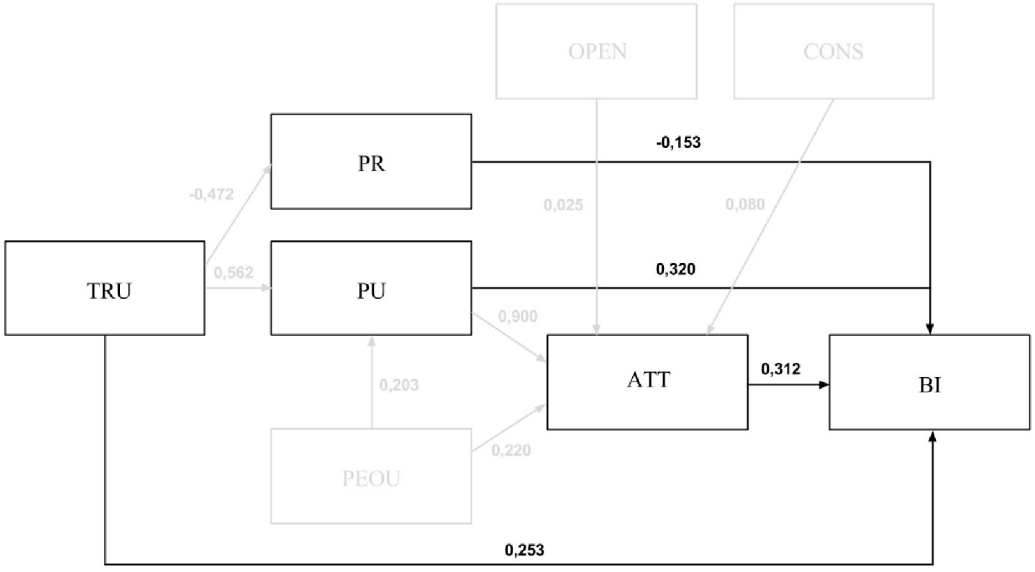

Figure 12: Predictive b-coefficient of the multiple regression analysis of H4/5/6/9.

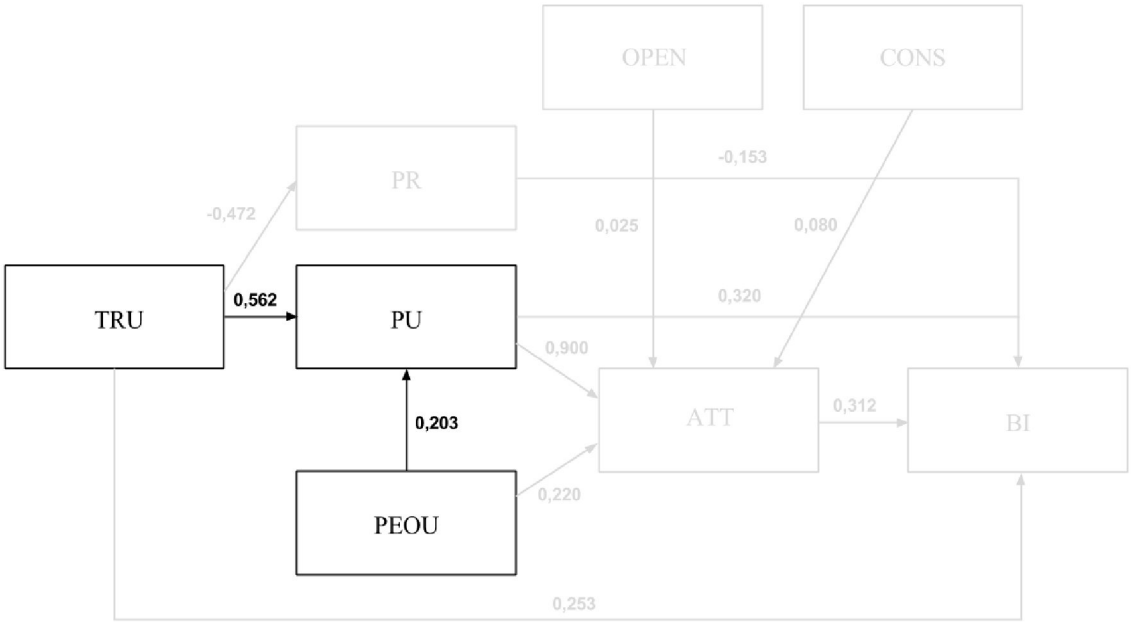

Figure 13: Predictive b-coefficient of the multiple regression analysis of H2/7.

Mediation. As the regression analysis above supported hypothesis 1 through 9, the analysis could continue to analyze the mediating effects stated in the remaining two hypotheses. H1 postulates that PEOU is positively correlated with ATT. Looking at the model; we see that PEOU also affect PU, which in turn affect ATT. This means that PU could be "mediating" some of the effect that PEOU has on ATT. The mediating effect of PU is postulated in H12. The remaining hypothesis, H13, postulates an indirect effect of TRU on BI, through the mediators, perceived risk and perceived usefulness.

As the hypotheses propose possible effects of mediators, it is appropriate to use Baron and Kenny's procedure for measuring mediation. Baron and Kenny (1986) proposed a four-step approach to analyzing the effect of the mediator, in which multiple regression analysis is conducted. The statistical method of analyzing mediators helps us answer the question as to how a predictor variable X transmits its effect on to the criterion variable Y. The most basic mediation

model is depicted in figure 14. Here, we see that X, the independent variable, influence Y through the mediator M. The direct effect of X on Y, when the mediator is included, is shown as c'(Hayes & Little, 2013). The four-step process of Baron and Kenny (1986) is listed below:

1. Simple regression: See if the independent variable X can be used to predict the criterion variable Y for the path c (without mediator M): $y = b_0 + bx$
2. Simple regression: Conduct a regression analysis to see if X can predict M through the path a: $m = b_0 + bx$
3. Simple regression: See if M can predict Y trough the path b: $y = b_0 + bm$
4. Multiple regression: Perform analysis to see if X and M can predict Y: $y = b_0 + b_1x + b_2m$. The X variable should no longer predict Y, or be seriously lessened in predicting Y.

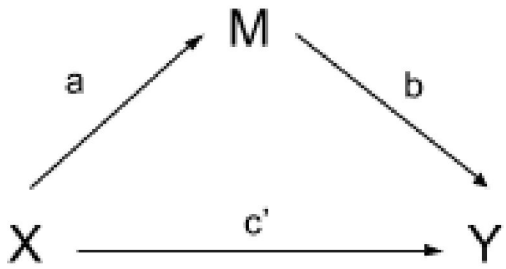

Figure 14: Simple mediation model (Baron & Kenny, 1986).

After conducting simple regression analyses, as well as multiple regression analysis with two independent variables and no mediators, there are only two hypotheses left to be tested. H12 postulates the effect of PEOU on ATT. But as discussed earlier, the effect could be mediated trough PU. The relationship is shown in figure 15. The last hypotheses H13, postulates the effect

of TRU on BI (figure 16). Here, we have the possible role of not only one, but two mediators. In order to analyze the effect of PEOU and PU on ATT, as well as TRU, PR, and PU on BI, SPSS was extended with the "Process" script developed by K. Preacher and Hayes (2008).

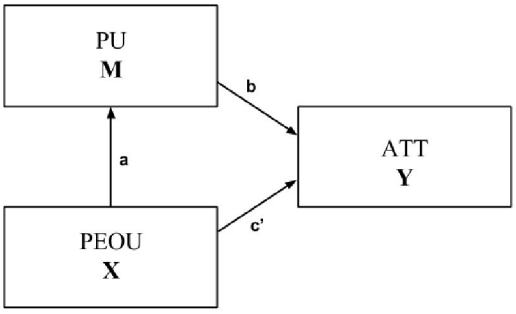

Figure 15: The possible effect of the mediator PU (model 1).

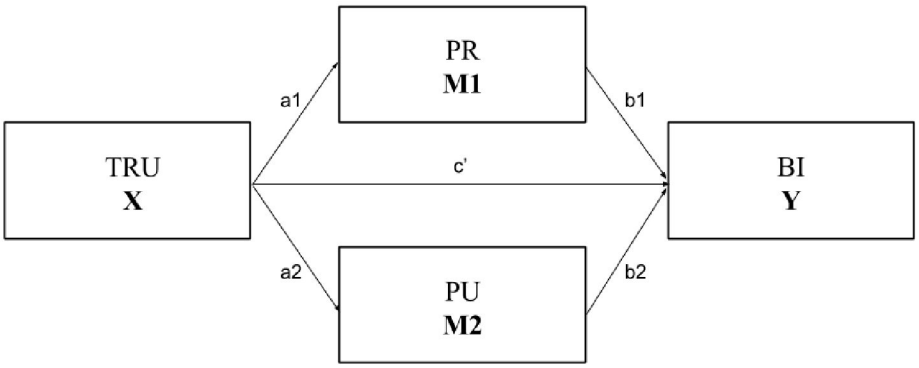

Figure 16: The possible mediating effect of PR and (model 2).

The results from the mediation analyses are presented in the following tables and figures. Table 11 and figure 17 addresses H12, with the mediator PU. Table 12 and figure 18 addresses H13, with mediators PR and PU:

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Table 11

Mediation model 1(H12)

Step	Purpose	Results	True or not
1	X predicts Y- path c	a. $F(1,100) = 25.70$, $P<..001$, $R^2=0.20$ b. $b = 0.66$, $t(100) = 5.07$, $P<.001$	TRUE
2	X predicts M - path a	a. $F(1,100) = 25.92$, $P<..001$, $R^2=0.21$ b. $b = 0.50$, $t(100) = 5.09$, $P<.001$	TRUE
3	M predicts Y- path b	a. $b = 0.88$, $t(99) = 8.71$, $P<.001$	TRUE
4	X and M predicts Y - X prediction of Y is lessened - path c'	a. $F(2,99) = 60.44$, $P<.001$, $R^2=0.55$ b. $b = 0.22$, $t(99) = 2.02$, $P<.05$	TRUE

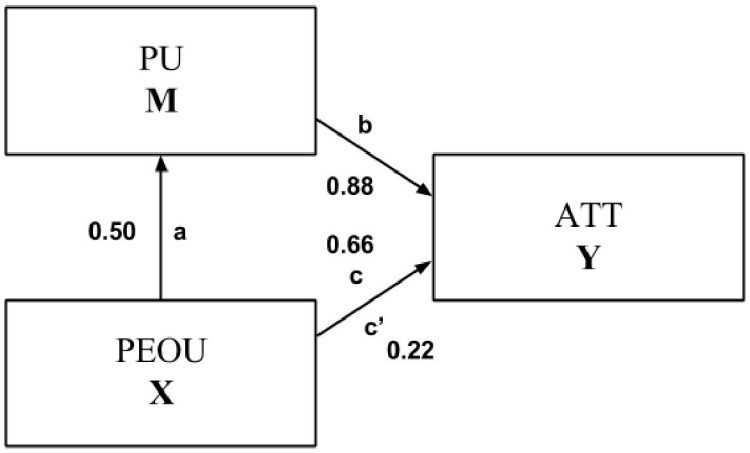

Figure 17: The mediating relationships, b coefficients, of model 1

See figure 17 for the visual representation of the mediated relationship detailed in table 11. By first predicting Y from X (path c), a significance relationship was established. Analysis showed that X alone accounts for 20 % of the changes in Y. Secondly, X was used to predict the mediator M (path a), which showed that X was positively related to the mediator variable. M was

then analyzed as a predictor of Y, proving that M accounted for 54 % of the change in Y. Lastly, X, together with M, was examined as a predictor of Y. Results showed that the significance of X dropped substantially. According to Baron and Kenny (1986), if step 1 to 3 proves significant relationships, and if step 4 shows that X is less significant, the findings support "partial mediation".

Next, the Sobel test was used to test the significance of the relationship between the mediator and the dependent variable (K. J. Preacher & Leonardelli, 2001). The Sobel test statistics ($z = 4.55$, $p<.001$) confirmed that the mediating effect of PU was significant. In other words, if autonomous ships are perceived as easy to use, we can predict that the attitude towards using them are positive, but only if the ships are perceived to be useful.

As the Sobel test is somewhat criticized, analysis of the Bootstrap confidence interval was performed to strengthen the perception of a significant mediator (Kenny, 2015) . The interval of the indirect effect of X on Y ranged from 0.2509 to 0.6835. The indirect effect is obtained by subtracting the total effect of X on Y (c), with the direct effect of X on Y (c'). If 0 is included in the interval there is no differences between the two. Analysis of H12 passed both the Sobel test and the Bootstrap test (proving significance of the mediation); hence, regression equation 5 was constructed and is presented below:

$Y = -0{,}176 + 0{,}222x_1 + 0{,}877m_1$, where y = ATT, x_1 = PEOU, m_1 =PU (Equation 5)

Table 12

Mediation model 2(H13)

Step	Purpose	Results	True or not
1	X predicts Y- path c	a. $F(1,96) = 116.48$, $P<..001$, $R^2=0.55$ b. $b = 0.86$, $t(96) = 10.79$, $P<.001$	TRUE
2	X predicts M1 - path a1	a. $F(1,96) = 32.30$, $P<..001$, $R^2=0.25$ b. $b = -0.48$, $t(96) = -5.68$, $P<.001$	TRUE
	X predicts M2 - path a2	a. $F(1,96) = 73.43$, $P<..001$, $R^2=0.43$ b. $b = 0.64$, $t(96) = 8.56$, $P<.001$	TRUE
3	M1 predicts Y- path b1	a. $b = -0.20$, $t(94) = -2.36$, $P<.05$	TRUE
	M2 predicts Y- path b2	a. $b = 0.47$, $t(94) = 5.01$, $P<.001$	TRUE
4	X, M1 and M2 predicts Y	a. $F(3,94) = 62.80$, $P<.001$, $R^2=0.67$	TRUE
	- X prediction of Y is lessened - path c'	b. $b = 0.45$, $t(94) = 4.470$, $P<.001$	TRUE

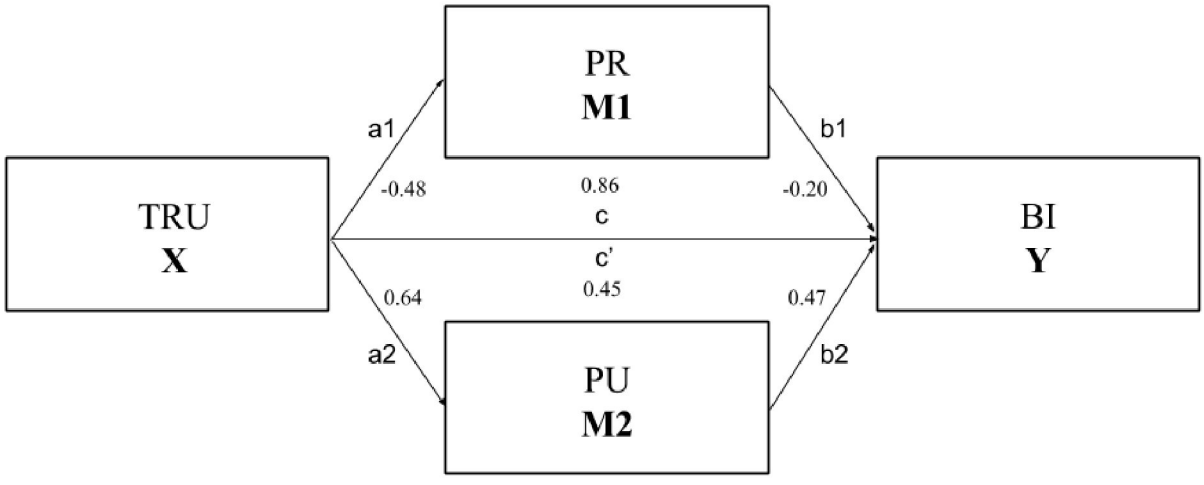

Figure 18: The mediating relationships, b coefficients, of model 2

See figure 18 for the visual representation of the mediated relationship detailed in table 12. The four-step approach by Baron and Kenny (1986), as was done in the previous mediation analysis, was conducted to test if PR and PU mediates some of the effect of TRU on BI. We see that the b-coefficient of TRU drops when mediators are added in the analysis. However, the effect of TRU on BI is still significant, implying a "partial mediation" of the mediators. The Sobel test statistics for the mediators PR ($Z=2.16$, $p<.05$) and PU ($z = 4.30$, $p<0.001$) showed that the mediation of both were significant. However, we see that PU is the larger mediator of the two. Analysis of the Bootstrap confidence interval (PR: 0.0213 to 0.2006 and PU: 0.1537 to 0.5291) showed that neither of the two intervals included 0, proving a significant difference between path c and path c'.

Analysis of H13 showed that PR and PU partially mediated the effect of TRU on BI, and regression equation 6 is therefore presented below:

$Y = 1{,}22 + 0{,}45x_1 - 0{,}20m_1 + 0{,}20m_2$, where y=ATT, x_1=TRU, m_1=PR, m_2=PU (Equation 6)

Discussion & Limitations

According to Evans, Gruba, and Zobel (2011, p. 12), the purpose of a discussion chapter is to "…critically examine your own results in the light of the previous state of the subject as outlined in the background, and make judgments as to what has been learnt in your work". Therefore, the following chapter will present discussions of each of the four research questions, and consequently each of the 13 hypotheses on the basis of the literature review and results. The chapter is divided into five subchapters, the first three discussing the research questions and

hypotheses, the fourth presents a revised conceptual model, and the last discussing potential limitations of the study.

Attitudes towards Autonomous Ships among Norwegian Seafarers

The descriptive statistics presented at the beginning of the previous chapter depicted a view of autonomous ships that can be interpreted as negative. Average scores for each of the six scales used to analyze the relationships between the six variables in the extended TAM, ranged from 2.30 to 2.97. These values corresponds to the responses of “somewhat disagree” and “disagree”.

As TAM requires quantitative data collection on potential users, it was considered appropriate to purposefully seek out those who most likely will interact with these types of ships, namely crew onboard ships. However, gathering attitudes of crewmembers towards the one thing that might replace their job may seem like a waste of time, much like asking taxi drivers if they are positive or negative towards the rise of the sharing economy, i.e. Uber. Off course they are going to have attitudes that are negatively directed. Nonetheless, as previously mentioned in chapter 1, the selection of the sample can be justified by identifying individuals who are more likely to adopt an innovation, even if the average attitudes are negative. These individuals may serve as opinion-leaders, having huge influence over the opinions and actions of others. Hence, they can more easily be targeted by change agents who wish to further facilitate the diffusion of the innovation.

The results do seem to indicate that Norwegian seafarers are negative towards autonomous ships, answering the first research question. However, this part of the thesis was not analyzed in depth due to it not being the main focus of the study. A more thorough analysis of potential adopters and adopter categories would contribute to a more nuanced discussion.

Correlation Analysis of the extended Technology Acceptance Model (TAM)

The original TAM model. In order to investigate if the original TAM model could be applied to measure acceptance of autonomous ships among Norwegian seafarers, proof of the relationships between the four original variables had to be established. Therefore, five hypotheses were postulated in order to test the relationship between them. Correlation analysis showed that all relationships were significant. Both PEOU (r = 0,452) and PU (r = 0,731) correlates strongly with the users ATT towards autonomous ships. Analysis of the relationship between PU and BI also showed a high correlation coefficient of r = 0,744. The correlation coefficient of Attitudes towards using and Behavioral intention, where r = 0,801, showing a very strong correlation between the two. Perceived ease of use was also postulated to be positively related to the perceived usefulness of autonomous ships. Results showed a correlation of r = 0,456.

All coefficients in the original TAM model supports H1 to H5, proving the original TAM model to be a well suited tool for measuring acceptance of autonomous ships. However, we see that the relationship that PEOU have with both PU and ATT, are all a bit lower than the other three correlation coefficients in the model. Yousafzai, Foxall, and Pallister (2007) conducted a meta-analysis of 95 TAM studies, analyzing the weighted averages of all correlation coefficients in the model. Their results showed that PEOU, on average, produce the lowest correlation coefficient in the model, corresponding to the findings in this study. In fact, the 95 studies yielded average correlation coefficients that are noticeably lower than the coefficients obtained in this study (table 13).

Table 13

Comparing correlation coefficients to the coefficients of Yousafzai et al. (2007)

Relationship	Meta-analysis	Present study	Evaluation of present study
PEOU↔ATT	r = 0.42	r = 0.452	Strong r
PEOU↔PU	r = 0.41	r = 0,456	Strong r
PU↔ATT	r = 0.48	r = 0.731	Strong r
PU↔BI	r = 0.50	r = 0.744	Strong r
ATT↔BI	r = 0.51	r = 0,801	Strong r

A similar meta-analysis by Schepers and Wetzels (2007), revealed similar results as the one of Yousafzai et al. (2007). The analysis reviewed 63 TAM studies, and the average correlation coefficients are presented in table 14.

Table 14

Comparing correlation coefficients to the coefficients of Schepers and Wetzels (2007)

Relationship	Meta-analysis	Present study	Evaluation of present study
PEOU↔ATT	r = 0.465	r = 0.452	Medium r
PEOU↔PU	r = 0.491	r = 0,456	Medium r
PU↔ATT	r = 0.554	r = 0.731	Strong r
PU↔BI	r = 0.555	r = 0.744	Strong r
ATT↔BI	r = 0.469	r = 0,801	Strong r

Comparison of the coefficients in the present study, to the ones in the meta-analyses, reveals that the coefficients in the present study are generally high and above average. It can therefore be argued that the four scales used to measure the original constructs in TAM are reliable when applied to autonomous ships, answering the second research question.

Augmenting TAM with Trust and Perceived Risk. Correlation analysis of the TAM model, augmented with trust and perceived risk, showed that both concepts are significantly

correlated to the variables postulated in hypotheses 6 through 9. Analysis of trust showed a significant relationship with both PU (r = 0,655) and BI (r = 0,725). As postulated, trust was negatively correlated to perceiver risk (r = -0,487), which in turn was negatively correlated to BI (r = -0,473). Consequently, hypotheses 6 through 9 were supported.

In order to evaluate if the correlation coefficients obtained in this study were of magnitudes that are not only statistically significant, but also acceptable compared to the result of others, a comparative table was constructed (table 15).

Table 15

Comparing correlation coefficients

Study	Augmented with TRU	Augmented with PR	Relationship	r
1. Ghazizadeh, Peng, Lee, and Boyle (2012)	yes	no	TRU↔PU TRU↔BI	0,49** 0,61***
2. Choi and Ji (2015)	yes	yes	TRU↔PR TRU↔PU TRU↔BI PR↔BI	-0,170*** 0,564*** 0,436*** -0,045
3. Pavlou (2003)	yes	yes	TRU↔PR TRU↔PU TRU↔BI PR↔BI	0,51** 0,52** 0,53** 0,71**

Note. p < .05, **p < .01, ***p < .001

.

Comparing the studies showed that this study produced acceptable results, compared to the other three. The present study has coefficient values that are higher than those of the first two, and results that are similar to the ones in the third. This indicates that trust is a major construct in

the extended TAM model which aims at measuring acceptance of autonomous ships, thus answering the third research question.

Looking at the correlation matrix in table 7, we see that trust not only correlates strongly with BI, but also with ATT (r = 0,786). The correlation coefficient is actually higher than that of BI. In the literature review in chapter 2, it was argued that trust would serve as an important factor in determining people's acceptance of automation as it is situated between the users' attitude towards an automated system and their intention to use it. As the results of the correlation analysis supports this notion, it can be argued that the conceptual model should be revised, adding a direct relationship to both BI and ATT.

In chapter 3, it was argued that perceived risk is a key component of trust in which trust has negative impact on. Naturally, we see the same for perceived risk, as we did with trust. The correlation is somewhat stronger with ATT (r = -0,489) than it is for BI (r = -0,473). Hence, the same can be argued for perceived risk, including a direct relationship between PR an ATT in the conceptual model.

Augmenting TAM with OPEN and CONS. The relationship between OPEN and ATT, as well as CONS and ATT, proved to be statistically insignificant, answering the last research question. These findings were surprising given the fact that highly accredited research says otherwise. The value-attitude-behavior hierarchy, developed by Homer et al. (1988) have been validated by many. They argued that values only influence specific behaviors through the mediating role of mid-range cognitions (i.e. attitudes). The causal sequence hierarchy that they proposed is the same hierarchy that can be seen in the conceptual model.

The Validity of an Extended Technology Acceptance Model

According to Schwartz (2012), previously discussed in chapter 2, attitudes and behaviors are guided by the constant trade-off between competing values. His proposed circular structure (figure 4) illustrates the relationships of conflicts between his ten motivationally distinct value types, as well as the higher order value dimensions. It was argued during the development of hypothesis 10 and 11 that the values of openness to change and conservation could be compared to the values of adopters that are more innovative, and those who are less. However, the values failed the correlation test and cannot be used as a measure of innovativeness towards autonomous ships.

Not only was the relationships with ATT insignificant, OPEN and CONS were significantly correlated with each other (r = 0,537). This contradicts Schwarz' notion of bipolar value dimensions, meaning that one should be negatively correlated with the other and in constant conflict. The findings in this study contradict every theory that led to the development of the two hypotheses. What could be the reason behind this?

Cronbach's alpha coefficient for the scales used to measure the values showed good internal consistency of α =0.72 and α = 0.86. The same result was found in a study by Lindeman and Verkasalo (2005). The ten values of Schwartz have been validated and are considered to be applicable across cultures. However, the study was translated to Norwegian for the purpose of minimizing misconceptions. As the translation was performed by the author and not a hired translator, the study cannot guarantee a translation that is a hundred percent accurate. However, after translating the survey from English to Norwegian, the translation was compared to a German translation of the same instrument. This was done as both languages belong to the same language family, making it easier to compare translations.

Another possible reason for the rejected hypotheses could be that the two instruments used to measure values and the extended TAM used different rating scales. SSVS used a 9-point rating scales, specifically developed to measure values. The extended TAM model adopted the standardized Likert scale of the original TAM model. According to Coleman, Preston, and Norris (1997), comparison of scores derived from unequal rating scales with unequal number of responses, could cause problems.

There could be a number of underlying issues that could explain why the hypotheses failed. The possible issues discussed above are only speculations, and finding a cause would require a more in depth investigation, in which would be too time consuming. Nonetheless, results from the correlation analysis imply that H10 and H11 should be removed from conceptual model.

Regression Analysis of the extended Technology Acceptance Model (TAM)

Simple linear regression analysis. Significant correlations of all variables in the original TAM model allowed for regression analysis of the nature of the relationships itself. Simple linear regression was conducted for relationships containing only one independent variable. Hypothesis 8 was the only hypothesis in which there was just one predictor. Results show that TRU accounts for 23.8 % in the variance of PR. This effect is evaluated as high when compared to the studies mentioned in table 15. Figure C1 in appendix C presents the scatter plot and the line of best fit. As illustrated, the effect of TRU on PU was negatively directed, giving a visual representation of the negative effect of TRU on PR, postulated in H8.

Multiple linear regression analysis. The remaining 8 variables were analyzed using multiple regression. Three sets of analyses were conducted in order to cover all of the postulated relationships. The first being the predictive effects of PEOU, PU, OPEN, and CONS on the dependent variable ATT. Results showed that, not surprisingly, OPEN and CON were insignificant. Insignificance in a correlation analysis means insignificance in a regression analysis. The two remaining variables together accounted for 57.4 % in the variation of ATT. Again, we see a high r^2 value in the extended TAM model. Studying the regression equation (equation 2), we see that PU is the most influential predictor of the two. Again, the results in a regression analysis explain the nature of the correlation between two variables and are therefore related to correlation analysis. Hence, the largest correlation in the correlation analysis is usually the largest predictor in regression analysis. The standardized beta-coefficients detailed in table 10 are similar to the r value. It explains the strength of the relationship that each independent variable have on the dependent. Here we see that PEOU are close to not being significant. The reason for why the significance dropped from the correlation analysis to the multiple regression analysis is that correlation makes no distinction between independent and dependent variables.

The second regression analysis explored the effect that TRU, PU, PR, and ATT had on BI. Results showed that the four predictors account for 70.07 % of the variation in BI. All of the predictive variables had varying degrees of predictive values, but they were all significant in explaining BI. As in the correlation analysis, PR had a negative effect on BI.

The last regression analysis investigated the effects of PEOU and TRU on PU. Both variables were significant in predicting PU (r^2 = 0,456).

All of the multiple regression analyses produced high r^2, meaning that all analyses showed predictive powers of the independent variables. Hence, all variables were significant. In order to

cover all of the first 11 hypotheses, four regression analyses were conducted. Results from correlation and regression analysis supported the first 9 hypotheses, the criterion for executing the next two analyses; exploring mediating effects.

Mediation. In order to investigate the effect of possible mediating effects of variables in the model, two sets of analysis was conducted. The first analyzed the possible mediating effect of PU on ATT. The four-step process was performed, showing significant relationships of the first three. In order to prove a significant mediation of the effect that PEOU has on ATT, the last step had to produce a significance of PEOU that was lower than in the first step. Results showed that PU partially mediates some of the effect. The results from the first mediations analysis underpinned the claim of Henderson and Divett (2003), presented in the literature review. The second analysis explored the possible effect of not only one, but two mediators. Results showed that PR and PU mediate some of the effect that TRU has on BI. Similar results

Analysis of mediation provided a deeper understanding on how PEOU and TRU transmit their effect on to their dependent variable. The analysis completed the investigation of the nature of the relationships in the conceptual model.

Revised Conceptual Model

Analysis of correlation between pairs of variables, as well as regression analysis, suggests that values are not correlated to attitude towards using autonomous ships. The variables OPEN and CONS can therefore be removed from the conceptual model. Results also showed that both TRU and PR were positively correlated to ATT. Based on the discussion presented above, a revised conceptual model is presented (figure 19).

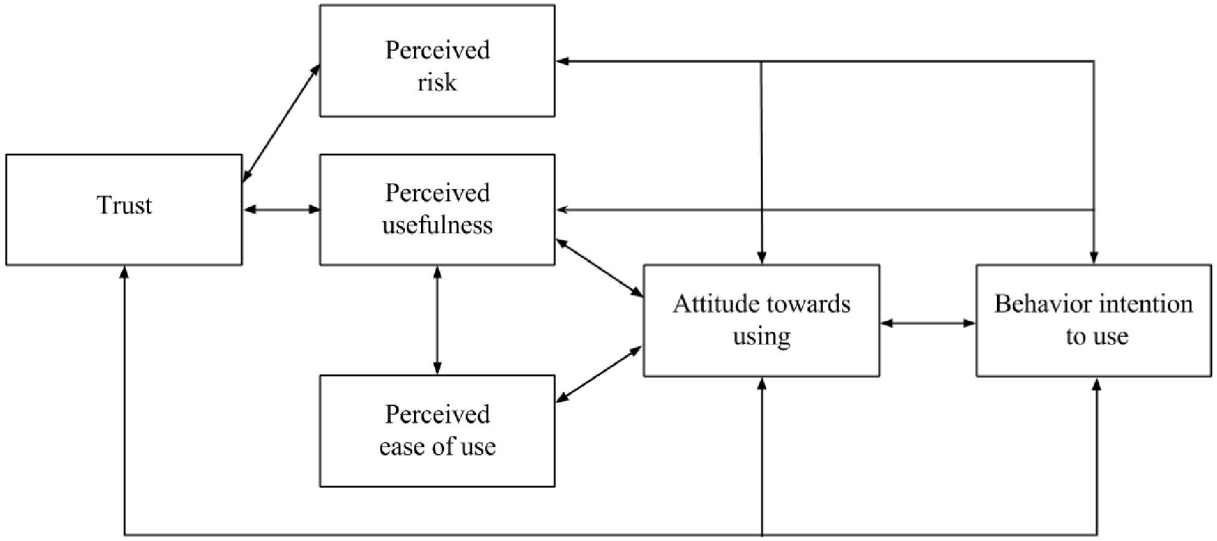

Figure 19: Revised conceptual model

Limitations

The limitations of this study starts with the possible issue of sample size. The gathering of data was conducted over internet, usually resulting in a lower completion rate of the survey compared to distributing it in person. The small sample can severely limit the validity of the research. The same can be argued for the selection of methodology used to measure the 8 scales. The length and number of items used in the instruments was shortened to a minimum in order to gathering quantitative data. The reliability could therefore be expected to be lower than if the original SVS instrument, together with the original TAM instrument, was used. Adding to that, TAM recommends that when measuring potential users' acceptance of a technology, users' should be exposed to the technology before their acceptance is measured. As this was unrealistic with autonomous ships, a through explanation of the ships was provided prior to measuring the

acceptance. However, the author cannot be sure that this has the same effect as being exposed to the technology.

Adding to this, the study did not conduct a pilot study. Conducting a preliminary analysis of the scales could give results indicating that the variable OPEN and CONS were insignificantly correlated to ATT. The insignificance could be explained by the limited time used to translate the survey. Other limitations of the study include the unequal representations of males and females and convenience sampling bias.

Conclusion and Recommendations

The research investigated an extended Technology Acceptance Model (TAM) for the purpose of developing a reliable tool for measuring potential user acceptance of autonomous ships. The study further reinforced the notion of strong relationships between the original constructs in TAM. Synthesizing previous work, TAM was augmented with Trust, Perceived Risk, as well as the values of Openness to Change and Conservation. Results showed that trust and perceived risk were important concepts in measuring acceptance of autonomous ships.

While previous studies have proved the mediating role of attitudes on the effect that values have on behaviors, values do not affect attitudes towards using autonomous ships, and consequently, behavioral intention to use them. Analyses of the relationships between the different constructs, as well as the nature of the relationship, resulted in a revised conceptual model, in which the two value variables were removed. Trust and perceived risk were considered to have direct influences on not only behavioral intention to use, but also attitudes towards using.

Recommendations

The study conducted correlation and regression analysis for the purpose of investigating the relationships between the different construct in the extended TAM model. The next step in validating the extended TAM model would be to perform Structural Equation Modeling (SEM), in which path analysis, factor analysis, and other statistical methods are performed. As this research where interested in exploring correlations between construct, supporting the postulated hypotheses, a more confirmatory approach may be suitable for future research.

It could also be interesting to see if other external variables could be added to the extended TAM model for measuring acceptance of autonomous ships. Lastly, it is also suggested that future research of acceptance of autonomous ship dig deep into the potential adopters of autonomous ships.

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Appendix A

HSN University College of Southeast Norway

Assessment of personal values and attitudes towards using Autonomous Ships

Dear respondent,

I invite you to participate in my research study: "Assessment of personal values and attitudes towards using Autonomous Vessels"

As part of the final degree of Master in maritime management at the University College of Southeast Norway, I am in the process of writing my Master Thesis. The purpose of the research is to characterize personal values of seafarers, and their attitudes towards autonomous ships. The rationale behind this research is that several theories show that personal values can have a major impact on the attitudes we have, and the decisions we make. This will in turn have an impact on how quickly innovations will spread through a specific demography.

The survey consists of 3 parts and have been designed to collect information on:

1: Demographic factors
2: Personal values
3: Attitude towards using autonomous vessels

Survey guidance
I hope that you will take the time to complete the survey as it will contribute positively towards the quality of the thesis. The survey will require 5-10 minutes of your time and I kindly ask you to answer the questions as best as you can. In each question you are asked to tick off the answer corresponding to your perception of the question.

You can maneuver back and forth in the survey by clicking "previous" and "next" at the end of each page. At any time, you are able to leave the survey and return at a later point in time to complete it.

Anonymity
Your participation in this research project is completely voluntary. Your response will remain confidential and anonymous. Data from this research will be kept under lock and key and reported only as a collective combined total.

I appreciate your willingness to help me, and I look forward to receiving your reply.

Sincerely,

Viktor Olai Stokvik Roestad
Master's student at University College of Southeast Norway

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Assessment of personal values and attitudes towards using Autonomous Ships

Part 1: Personal Information (Demography)

The introductory questions concern you and your status of employment. The data can later be used anonymously in analysis at a higher level.

1. Gender:

- ◯ Male
- ◯ Female

2. What is your age?

- ◯ 29 or younger
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60-69
- ◯ 70 or older

3. What is your highest level of education?

- ◯ Primary & secondary school
- ◯ High school (university-preparatory)
- ◯ High school (vocational studies)
- ◯ University and College: 0-4 years
- ◯ University and College: more than 4 years

4. What is your average yearly income?

- ◯ Less than 200 000 kr
- ◯ 200 000 - 400 000 kr
- ◯ 400 000 - 600 000kr
- ◯ 600 000 - 800 000 kr
- ◯ 800 000 - 1 000 000 kr
- ◯ More than 1 000 000 kr
- ◯ I do not want to answer

5. What is your current level of employment?

- ◯ Full-time
- ◯ Part-time
- ◯ Self-employed
- ◯ Unemployed
- ◯ Retired
- ◯ Student/Cadet
- ◯ Other

6. Are you employed in one of the following sectors of maritime industry? Please tick off the appropriate sector:

- ◯ Vessel operations (Merchant shipping, Naval shipping, Cruise industry, Ports)
- ◯ Shipbuilding (Shipbuilding (merchant), Shipbuilding (naval), Marine equipment)
- ◯ Marine resources (Offshore oil & gas, Renewable energy, Minerals & aggregates)
- ◯ Marine Fisheries (Marine fishing, Marine aquaculture, Seaweed, Seafood processing)
- ◯ Other marine related activities (Maritime tourism, Research & Development, Marine services, Marine IT, Marine biotechnology, Ocean survey, Education & training, Submarine telecoms)
- ◯ None of the above (please specify)

7. Are you part of the crew on board a ship? Please tick the appropriate category:

- ◯ Deck officer
- ◯ Engineering officer
- ◯ Petty officer (Boatswain's Mate, Carpenter's Mate, Electrician etc.)
- ◯ Engine crew
- ◯ Deck crew
- ◯ Chief steward and steward crew
- ◯ Other
- ◯ I do not work aboard a ship

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Assessment of personal values and attitudes towards using Autonomous Ships

Part 2: Personal Values

The next questions concerns personal values. The following statement can be used as a definition of personal values: "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence"

8. Below is a list of ten values. Each value (written in CAPITAL) is followed by descriptors (listed in parentheses). Please, scan the list and select the value that is most important to you.

9. The same list of values can be found below. Please, scan the list for a second time and select the value that is least important to you.

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Assessment of personal values and attitudes towards using Autonomous Ships

Part 2: Personal Values cont.

Please, rate the importance of the following values as a life-guiding principle for you. Use the 8-point scale in which 0 indicates that the value is opposed to your principles, 1 indicates that the value is not important for you, 4 indicates that the values is important, and 8 indicates that the value is of supreme

The Validity of an Extended Technology Acceptance Model

importance to you.

10. Please rate the importance of each value

	Opposed to my principles 0	Not Important 1	2	3	Important 4	5	6	7	Of supreme importance 8
POWER (social power, authority, wealth)	○	○	○	○	○	○	○	○	○
ACHIEVEMENT (success, capability, ambition, influence on people and events)	○	○	○	○	○	○	○	○	○
HEDONSIM (gratification of desires, enjoyment in life, self-indulgence)	○	○	○	○	○	○	○	○	○
STIMULATION (daring, a varied and challenging life, an exciting life)	○	○	○	○	○	○	○	○	○
SELF-DIRECTION (creativity, freedom, curiosity, independence, choosing one's own goals)	○	○	○	○	○	○	○	○	○
UNIVERSALISM (broadmindedness, beauty of nature and arts, social justice, a world at peace, equality, wisdom, unity with nature, environmental protection)	○	○	○	○	○	○	○	○	○
BENEVOLENCE (helpfulness, honesty, forgiveness, loyalty, responsibility)	○	○	○	○	○	○	○	○	○
TRADITION (respect for tradition, humbleness, accepting one's position in life, devotion, modesty)	○	○	○	○	○	○	○	○	○
CONFORMITY (obedience, honoring parents and elders, self-discipline, politeness)	○	○	○	○	○	○	○	○	○
SECURITY (national security, family security, social order, cleanliness, reciprocation of favors)	○	○	○	○	○	○	○	○	○

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Assessment of personal values and attitudes towards using Autonomous Ships

Part 3: Autonomous Ships

You will now be asked to share your view of Autonomous ships. Note that there is no right or wrong answers. Answer all questions to the best of your ability, and only use the response option "Neither agree nor disagree" if you are unable to evaluate a statement.

Autonomous ships can be defined as a vessel with "next generation modular control systems and communications technology that will enable wireless monitoring and control functions both on and off board. These will include advanced decision support systems to provide a capability to operate ships remotely under semi or fully autonomous control".

MUNIN, a collaborative research project co-funded by the European Commission, defines an autonomous vessel as a vessel primarily guided by automated on-board decision systems but controlled by a remote operator in a shore side control station. The rationale behind this research is that Europe is facing significant challenges with increased transport volumes, environmental requirements and a growing shortage of crew and officers. MUNIN argue that these ships could be the solution to the problem. MUNIN emphasizes four characteristics of Autonomous ships as they consider important:

- The speed of autonomous ships can be lowered (e.g. from 16 to 11 knots).
- Expenses spent on crew can be cut
- CO2 and other emissions will be reduced.
- Human errors will be reduced and the overall safety will increase.

11. Below is a list of 18 statements concerning autonomous ships. With the description of the autonomous ship in mind, please rate each statement on a scale from 1 (strongly disagree) to 7 (strongly agree)

	Strongly disagree 1	Disagree 2	Somewhat disagree 3	Neither agree or disagree 4	Somewhat agree 5	Agree 6	Strongly agree 7
Using autonomous ships will increase my productivity	○	○	○	○	○	○	○
Using autonomous ships will increase my performance	○	○	○	○	○	○	○
Using autonomous ships would enhance my effectiveness	○	○	○	○	○	○	○
Learning to operate autonomous ships would be easy	○	○	○	○	○	○	○
Getting autonomous ships to do what I want would be easy	○	○	○	○	○	○	○
Interacting with autonomous ships would not require a lot of mental effort	○	○	○	○	○	○	○
Using autonomous ships is a good idea	○	○	○	○	○	○	○
Using autonomous ships is a wise idea	○	○	○	○	○	○	○
I am positive toward autonomous ships	○	○	○	○	○	○	○
I intend to use autonomous ships in the future	○	○	○	○	○	○	○

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	Strongly disagree 1	Disagree 2	Somewhat disagree 3	Neither agree or disagree 4	Somewhat agree 5	Agree 6	Strongly agree 7
I expect that I would use autonomous ships in the future	○	○	○	○	○	○	○
I plan to use autonomous ships in the future	○	○	○	○	○	○	○
Autonomous ship is dependable	○	○	○	○	○	○	○
Autonomous ship is reliable	○	○	○	○	○	○	○
Overall, I can trust autonomous ships	○	○	○	○	○	○	○
Autonomous ships would lead to financial loss for me	○	○	○	○	○	○	○
Autonomous ships might not perform well and create problems	○	○	○	○	○	○	○
Using autonomous ships would be risky	○	○	○	○	○	○	○

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Appendix B

NSD

Marius Imset
Institutt for maritim teknologi, drift og innovasjon Høgskolen i Buskerud og Vestfold
Postboks 235
3603 KONGSBERG

Vår dato: 27.04.2016 Vår ref: 48112 / 3 / HIT Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 29.03.2016. Meldingen gjelder prosjektet:

48112	*Vurdering av peronlige verdier og holdninger til autonome skip*
Behandlingsansvarlig	*Høgskolen i Sørøst-Norge, ved institusjonens øverste leder*
Daglig ansvarlig	*Marius Imset*
Student	*Viktor Olai Stokvik Roestad*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/meldeplikt/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 13.05.2016, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Kjersti Haugstvedt

Hildur Thorarensen

Kontaktperson: Hildur Thorarensen tlf: 55 58 26 54
Vedlegg: Prosjektvurdering

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

NSD – Norsk senter for forskningsdata AS Harald Hårfagres gate 29 Tel: +47-55 58 21 17 nsd@nsd.no Org.nr. 985 321 884
NSD – Norwegian Centre for Research Data NO-5007 Bergen, NORWAY Faks: +47-55 58 96 50 www.nsd.no

Appendix C

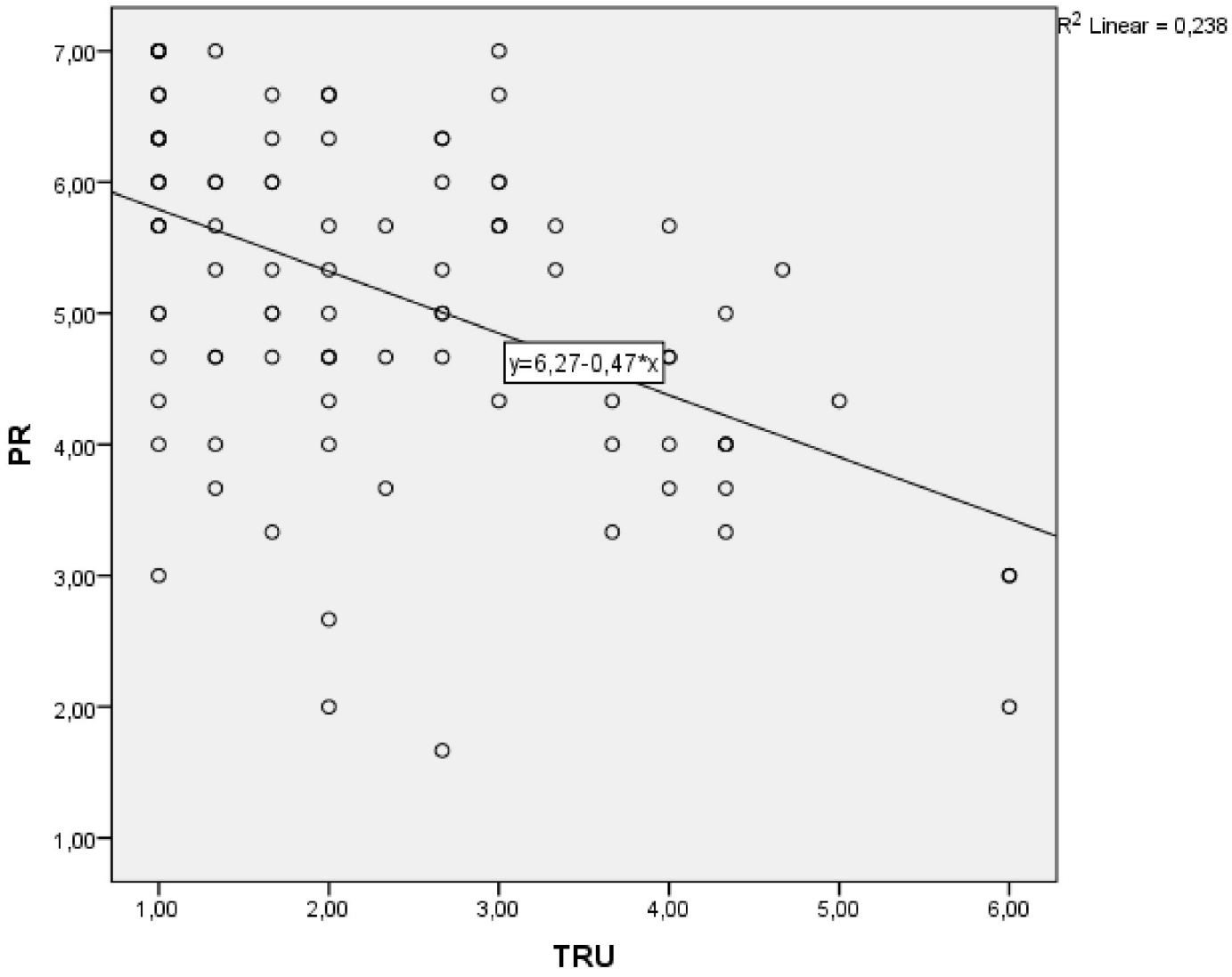

Figure C1: Hypothesis 8: DV: Perceived risk, IV: Trust