



Bachelor Thesis (B. Eng.)

Different Levels of Technical Acceptance in Japan and Germany: Where are Differences and Why? Exemplary Investigation of Differences Between Students of the Two Nations



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Cover photo: Shinkansen at Koriyama Station; Source: Florian Fejer

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Zusammenfassung

In dieser Bachelorarbeit wurden Unterschiede zwischen deutschen und japanischen Studenten und deren Akzeptanz von Technik untersucht. Im Falle solcher Unterschiede sollten mögliche Ursachen gefunden werden. Dies geschah vorwiegend durch Literaturrecherche, welche auch nötig war, um ein Model für Technikakzeptanz aufzustellen, das im Rahmen dieser Bachelorarbeit anwendbar war. Wie effektiv das Model war, konnte nicht vollständig geklärt werden, aber es diente als Grundlage für die Online-Befragung. Diese richtete sich an deutsche (hauptsächlich im Raum München) und japanische (hauptsächlich im Raum Tokyo) Studenten und stand für etwa drei Wochen zur Verfügung. Die Umfrage untersuchte die Haltung von Studenten zu den Themen virtuelle Realität, Robotik und alternative Zahlungsmethoden. Es wurden keine deutlichen, allgemeingültigen Zusammenhänge zwischen Nationalität und Technikakzeptanz gefunden. Die Ergebnisse deuteten Unterschiede in einigen Bereichen der Robotik und alternativen Zahlungsmethoden an. Durch die geringe Teilnehmerzahl ist die Aussagekraft jedoch eingeschränkt und bedarf einer größer angelegten Untersuchung.

Abstract

The thesis aimed to clarify whether there are differences in the technical acceptance of students from Germany and Japan. If applicable, the thesis pointed out possible reasons for differences. To achieve this, it was necessary to conduct research in existing literature. A literature review also led to a model capable of observing the level of technical acceptance and factors connected to acceptance. While the effectivity of the model could not be completely confirmed, it became the basis for an online survey. The survey was distributed to students in Germany (mainly Munich) and Japan (mainly Tokyo) and accessible for about three weeks. The survey investigated the stance of the students towards the topics virtual reality, robotics and alternative means of payment. No strong, general correlation between the nationality of the students and their rate of technical acceptance was found. The results indicated differences for some items of robotics and alternative means of payment, but due to a small number of participants, the significance of the indications is low and requires a more thorough investigation on a bigger scale.

Erklärung i. S. des § 35 Abs. 7 RaPO

Ich erkläre, dass ich die vorliegende Bachelorarbeit selbständig verfasst, noch nicht anderweitig für Prüfungszwecke vorgelegt, keine anderen als die angegebenen Quellen oder Hilfsmittel benützt sowie wörtliche und sinngemäße Zitate als solche gekennzeichnet habe.

München, 18. März 2019

Table of Contents

Acknowledgement

Zusammenfassung

Abstract

Erklärung i. S. des § 35 Abs. 7 RaPO

Table of Contents

List of Figures

List of Tables

List of Abbreviations

1. Introduction	1
1.1. Definition of the Problem.....	1
1.2. Research Objectives	2
1.3. Dissociation	3
2. Technical Acceptance	4
2.1. Definition.....	4
2.2. Factors Potentially Influencing Technical Acceptance	6
2.2.1. Society.....	6
2.2.2. Culture.....	7
2.2.3. Politics and Economy	8
3. Models of Technical Acceptance	10
3.1. Global Acceptance of Technology Model	10
3.2. Theory of Reasoned Action	11
3.3. Technology Acceptance Model	12
3.4. Technology Acceptance Model 2.....	13

3.5.	Unified Theory of Acceptance and Use of Technology.....	15
3.6.	Conclusion	17
4.	Evaluation	20
4.1.	Analysis of Target Group.....	20
4.1.1.	Japan	21
4.1.2.	Germany.....	21
4.2.	Objects of Investigation.....	22
4.2.1.	Virtual Reality.....	22
4.2.2.	Robotics.....	24
4.2.3.	Alternative Methods of Payment.....	25
4.3.	Method of Evaluation.....	28
4.3.1.	Choosing the Survey Tool	29
4.3.2.	Choosing the Questions	30
4.3.3.	Conducting the Survey.....	31
4.4.	Results of the Evaluation	33
4.4.1.	Virtual Reality.....	37
4.4.2.	Robotics.....	44
4.4.3.	Alternative Methods of Payment.....	51
4.5.	Retrospective on Expectations and Limitations	63
4.6.	Interpretation	64
4.6.1.	Virtual Reality.....	64
4.6.2.	Robotics.....	65
4.6.3.	Alternative Means of Payment	66
5.	Conclusions	68
5.1.	Answering the Research Questions and Validating the Hypothesis.....	68
5.2.	Outlook.....	70

Bibliography

Appendix

List of Figures

FIGURE 1: SIMPLIFIED DYNAMIC ACCEPTANCE MODEL	5
FIGURE 2: ELEMENTS AND RELATIONS OF THE THEORY OF REASONED ACTION	11
FIGURE 3: TECHNOLOGY ACCEPTANCE MODEL	13
FIGURE 4: TAM2-MODEL	14
FIGURE 5: UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY	16
FIGURE 6: COMBINATION OF TAM2 AND UTAUT	18
FIGURE 7: NUMBER OF ACTIVE VIRTUAL REALITY USERS WORLDWIDE FROM 2014 TO 2018	23
FIGURE 8: ALTERNATIVE METHODS OF PAYMENT IN JAPAN AND GERMANY IN 2012	26
FIGURE 9: MESSAGE TO JAPANESE STUDENTS VIA LINE MESSENGER	32
FIGURE 10: PARTICIPATION OVER TIME	34
FIGURE 11: ITEM VR02	37
FIGURE 12: ITEM VR03	38
FIGURE 13: ITEM VR04	39
FIGURE 14: ITEM VR05	40
FIGURE 15: ITEM VR08	43
FIGURE 16: ITEM RB02	44
FIGURE 17: ITEM RB03	45
FIGURE 18: ITEM RB04	46
FIGURE 19: ITEM RB05	47
FIGURE 20: ITEM RB08	50
FIGURE 21: ITEM AP02	51
FIGURE 22: ITEM AP03	52
FIGURE 23: ITEM AP04	53
FIGURE 24: ITEM AP05	54
FIGURE 25: ITEM AP08	57
FIGURE 26: ITEM SD02	58
FIGURE 27: ITEM SD03	59
FIGURE 28: ITEM SD04	60
FIGURE 29: ITEM SD05	60
FIGURE 30: ITEM SD07	62

List of Tables

TABLE 1: COMPETITIVE ADVANTAGES OF DIFFERENT CULTURAL PROFILES	8
TABLE 2: APPLICATION FIELDS OF ROBOTS RELEVANT TO TARGET GROUP	25
TABLE 3: ANALYSIS OF MERGED RESULTS OF TECHNOLOGICAL SECTIONS IN THE SURVEY	36
TABLE 4: MERGED RESULTS OF VR06	41
TABLE 5: MERGED RESULTS OF VR07	42
TABLE 6: MERGED RESULTS OF RB06	48
TABLE 7: MERGED RESULTS OF RB07	49
TABLE 8: MERGED RESULTS OF AP06	55
TABLE 9: MERGED RESULTS OF AP07	56

List of Abbreviations

Abbreviation	Term
CVS	Chinese Value Survey
e.g.	For example (exempli gratia)
IBM	International Business Machines
IDC	International Data Corporation
i.e.	That is to say (id est)
GAT	Global Acceptance of Technology
Mbps	Megabit per second
MSD	Musculoskeletal Disorders
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
VR	Virtual Reality
WMIS	Worldwide Mobile Internet Study

1. Introduction

The following sections describe the objectives of this thesis and the reasoning why this thesis treats the chosen topic. The last subchapter argues which aspects are not part of this thesis, despite possible relationships to the topic.

1.1. Definition of the Problem

Every year new technologies find their way into our lives, while others mostly shape industry or science. But even the most progressive and developed technologies need to be accepted by their potential users, before they can unfold their usefulness. Different areas of technology have a different relation of risk and usefulness to their users. If the risks can be justified, the acceptance is more likely.

The economic relations with Asian nations have already been increasingly meaningful for nearly two decades. Even recently the Asian market has proved to be of major importance for German businesses (Ostasiatischer Verein e. V. 2018, 31). Be it the automotive, robotics or entertainment industry: advanced or more cost-efficient technology from Asia found its way to Germany. For example, Japanese manufacturers of industrial robots cover not only a major part of the German demand, but even half of the worldwide demand (Schneider 2018).

Based on these observations, the main purpose of this thesis is to investigate the following hypothesis:

The acceptance of upcoming consumer technology is higher for Japanese students than for German students. This can be exemplified by the technologies “virtual reality”, “modern alternatives to cash payment” and “robotics”.

Possible reasons for differences in the acceptance of new technologies could, for example, be found in cultural differences between eastern and western cultures (Schepers and Wetzels 2007, 100) and differences of cognitive reception as a result of different interactions of genes (Kitayama et al. 2014, 1173–75). Infrastructure (e.g., better accessibility of high-speed internet), education and politics are also necessary to consider. The criteria to evaluate technical acceptance are also a crucial aspect. For this reason, the thesis will examine various other studies with different priorities and models, like the Global Acceptance of Technology (GAT) model, which has been used for the search of universal consumer demand characteristics for mobile data services (Fife and Pereira 2005). One of the most widely

used models is the Technology Acceptance Model (TAM; Jockisch 2009, 236). A meta study, which compared multiple studies, confirms that "[...] the TAM is a powerful and robust model for predictions [...]" (King and He 2006, 752). This and other studies criticized the TAM in comparison to other models, since the conclusions appear to be not equally meaningful for all applications. There are already multiple studies focusing on technical acceptance of young adults in Germany. A majority of them self-proclaims them as medium or highly interested in technology (Tully 2003, 36).

The target group of the empirical research are students. They are considered as highly relevant, since in contrast to pupils they have sufficient financial means. Also, they can organize time more freely than employees and are often more familiar with established standards, like the internet as a source of information. The online survey will consider a suitable acceptance model and empirical research methods (Brosius, Haas, and Koschel 2016).

1.2. Research Objectives

While the main purpose remains to validate or falsify the hypothesis, the content of this thesis strives to answer the following research questions:

- How relevant are the three technologies chosen for the survey?
- Which major factors influence the differences in technical acceptance between Germany and Japan?
- What is the preferred method of measuring the acceptance of technology?
- How well are the three chosen technologies accepted by students in Japan and Germany?

To find answers to these questions, the initial task is to define technical acceptance within the scope of this research. To achieve this, the thesis compares various theoretical models that have been used in studies close to this research topic. The analysis results in identifying the most suitable model within the context of this bachelor thesis. Based on the results of this analysis and suitable empirical methods, the survey aims to get insights on the acceptance of technology of students in Japan and Germany. Before evaluating the survey, literature research will analyze the current general state of technical acceptance in Japan and Germany and possible developments that led to this state.

The results of the research work and of the survey will be compared. Reasons for the differences of target unspecific acceptance and the technical acceptance of

students are worked out as far as possible. The bachelor thesis may show indications whether and what kind of changes within the acceptance of new technologies industry and science need to adjust to.

1.3. Dissociation

This bachelor thesis limits the empirical research to students. The comparison of students of the two nations is the most likely to succeed, due to established contacts to multipliers, which allow contacting multiple students of Munich and Soka University. Within the given time they are within reach of about 50-100 students per nation. The survey will mainly cover technologies relevant and potentially available to students, thus not focusing on industrial or research technology. At the time of writing, the planned technologies for the survey are “virtual reality”, “modern alternatives to cash payment” and “robotics”. The survey excludes criteria that are not confirmable in the scope of a survey, like genetics. Even if these criteria are listed as possible causes for differences in the acceptance of technology.

2. Technical Acceptance

The beginning of this chapter defines the term “technical acceptance” and some further necessary differentiations. The following chapters explain in more detail the possible factors influencing technical acceptance. Because of their complexity, this thesis does not aim to necessarily provide evidence proving those factors.

2.1. Definition

This chapter defines the concept of technical acceptance, which is not to be confused with technology acceptability. Both terms have in common that they require to observe usage of technology and the environment in which technology is used. Depending on the scientific field, different terminology and definitions in relation to technical acceptance can be found. Technical acceptance is a research field on its own and therefore requires adequate research methods. Acceptance is an empirical factor which is measurable and has constructive use cases in the society (Pe-
termann and Scherz 2005, 50).

Technologies are very different and require to be viewed in a differentiated way. A generalized statement about technical acceptance would have a very limited informative value. Renn and Zwick suggest to break down technologies into three categories: consumer technology, technology at the work place and external technology (Renn and Zwick 1997, 23–24). Technology at the workplace is considered irrelevant for the target group of this thesis. A valid alternative for students is the technology at their educational institution. External technology refers to public technologies that affect most members of society. For example, this includes power plants, public transportation or telecommunications. Consumer technology covers all the products that members of the target group own or privately use. Smartphones, notebooks or refrigerators are examples for this category.

Kollmann introduced a dynamic acceptance model, which is based on Everett M. Rogers' innovation decision process. The model divides the process of acceptance into three dimensions, which ultimately lead to full acceptance of a technology. Kollmann applies the model to consumer goods and consumer systems (Kollmann 1998, 90–94). The first dimension describes the attitude towards or rating of the object of acceptance. A high rating on this dimension leads to a positive attitude towards a technology, including the intention or readiness to act, but not actual acting. The second dimension is the logical and temporal successor to the first dimension, leading to action. The main component of this dimension is the acting

of the subject. Another form of acting could mean to actively engage or support a technology. The final dimension of Kollmann's model is the utilization acceptance. The technology is evaluated after its implementation and found to be satisfying (Kollmann 1998, 90–94).

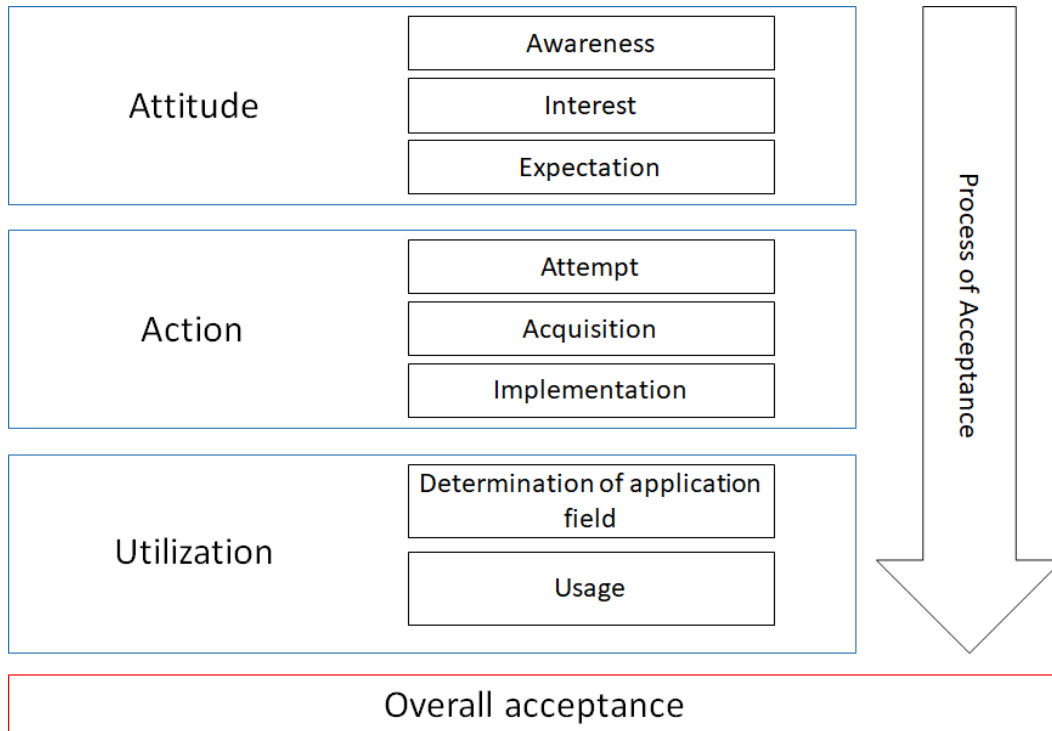


Figure 1: Simplified dynamic acceptance model (adapted from Kollmann 1998)

The following example illustrates this model through the process of buying a new car. Deciding for a specific car requires awareness of and interest in the car model in question, creating an expectation and resulting in the willingness to buy the car, but not yet buying it. The example continues with trying out the new car and buying it, if it is still found to be suitable. To conclude the example, the buyer uses the car. If the technology is found to be unsatisfying, it is possible to return to a previous dimension of the model.

The third chapter describes a few technology acceptance models and the process of determining the most relevant model in more detail.

2.2. Factors Potentially Influencing Technical Acceptance

This section aims to present an overview about which factors potentially influence differences in technical acceptance. It is not a comprehensive list, but reveals potential connections, if possible, directly comparing Germany and Japan. Some of those factors are thoroughly proven, some still need further proof.

2.2.1. Society

For a start, a look at the statistics seems helpful to get a first insight. An interesting aspect is the high median age of Japan and Germany. Japan ranks on the second place with a median age of 47.7 years and Germany on the third place with 47.4 years. A higher median age could mean a higher need for more advanced technologies since more elderly require the support of comparably fewer workforce. Another aspect is the distribution of ethnic groups. In Japan, 98.1% of the population are Japanese, while in Germany 87.2% are Germans. The population of Germany is more diverse. On the other hand, the population is locally more widespread distributed, whereas in Japan the population is more centralized. Especially the Tokyo area which is home to about one third of the total population (Central Intelligence Agency 2016).

For both nations it should be considered that new technologies are used for familiar goals, like making money, impressing others or making life more comfortable and easier. How other people use new technologies also affects our choices in regard to social circles we belong to (Hofstede 2010, 20). Another important part of a society is religion. Shire quotes the perspective of sociologist Barrington Moore, who sees Japan as an example of conservative modernization. Schmucl N. Eisenstadt went even further with his claim of Japan being the only case of non-axial modernization of a society, meaning that only Japan was not oriented on a world religion during its modernization (Kevenhörster, Pascha, and Shire 2010, 167).

Particularly with regard to students, the following example looks at what the Japanese society expects from its students. Continuity is very relevant in the resume of Japanese students. In international comparison, there are usually fewer gaps and the career path is more linear. Possible reasons for small gaps might be retrying university entrance exams or a longer vacation (about 3 weeks) after graduating from university. Taking a year off for travelling, voluntary service or similar means is very unusual in Japan. This is especially valid for male students, who are even

more expected to focus on career than women (Kevenhörster, Pascha, and Shire 2010, 199–201). Lastly, Hofstede mentions an aspect about the connection between society and technology that should not be neglected: "There are many things in societies that technology and its products do not change" (Hofstede 2010, 19). Meaning, often it is not technology that changes society, but the other way around.

2.2.2. Culture

Many other factors are connected to culture. After all, every other aspect mentioned in this chapter is more or less connected to culture. Nevertheless, it took decades after the research on technical acceptance began, until culture was considered as a factor. For example, the introduction mentioned the meta study of Schepers and Wetzels. Another example is Cardon's and Marshall's study on National Culture and Technology Acceptance: The Impact of Uncertainty Avoidance (2008). One of the first major investigations on the topic of cultural differences was conducted by Geert Hofstede. A major part of Hofstede's argumentations and explorations is based on a large body of survey data from the large multinational corporation International Business Machines (IBM). The data was remarkable since the employees, who participated in the survey, differed mainly in their nationality. Initially, 40 nationalities were represented in total. The five cultural dimensions discovered as part of his research are, according to Hofstede: power distance, uncertainty avoidance, individualism and collectivism, femininity and masculinity and long- and short-term orientation. The following table shows possible effects in different characteristics.

Power Distance (small)	Power Distance (large)
Acceptance of responsibility	Discipline
Uncertainty Avoidance (weak)	Uncertainty Avoidance (strong)
Basic innovations	Precision
Collectivism	Individualism
Employee commitment	Management mobility
Femininity	Masculinity
Personal service	Mass production
Custom-made products	Efficiency
Agriculture	Heavy industry

Short-Term Orientation	Long-Term Orientation
Fast adaption	Developing new markets

Table 1: Competitive advantages of different cultural profiles in international competition (adapted from Hofstede 2010, p. 405)

While not all points shown in the table are equally relevant for students and their environment, in 1979 the IBM model was applied to students and came to similar results. Hofstede and Michael Harris Bond from the Chinese University of Hong Kong noticed the questionnaires originated from western minds. To exclude a potential bias, Bond asked Chinese colleagues from Hong Kong and Taiwan to help creating a new questionnaire based on the values of Chinese people. The result was called Chinese Value Survey (CVS). Three of the problem dimensions that were found in the IBM model could be confirmed in the CVS. A new dimension was added, which could be applied to the IBM model as well (Hofstede 2010, 37–38). Later, in 2010, the model was confirmed to be still valid.

A different approach on culture is looking at genes. Published in 2014, a group of scientists researched the interaction of genes and culture. Specifically, they investigated variants of the dopamine D4 receptor gene (DRD4). 398 European American and Asian-born Asians built the foundation of their research. The results of their research further prove the connection of genes to independence and interdependence, but also the particularly importance of DRD4 and how it coevolved with human cultures (Kitayama et al. 2014, 1174–75).

Another aspect very strongly connected to culture is history. Investigating deeper in the course of history of Germany and Japan would require a thesis on its own, but Hofstede took, for example, a look at how nations historically developed. He describes a connection between society, nations and history, all being part of culture. Common culture doesn't necessarily apply to nations, but to societies. Historically the boundaries of nations and societies might overlap, but colonial borders, for example, are a historical construct that divided societies and changed during history (Hofstede 2010, 21).

2.2.3. Politics and Economy

Naturally, politics are closely connected to the previous chapters, since politicians are still only persons who are subject to their society and culture and political regulations strongly interfere with economic matters. Still, it is worth to take a brief look specifically on these areas. Both nations face the challenge of limited living space.

This is especially true for Tokyo, where about one third of the Japanese population lives. Compared to Germany, in Japan are about twice as much retail and wholesale stores per 1000 citizens. Reasons for that might be the shortage of storage room in big cities and the higher consumer demand for fresh and convenient products (Kevenhörster, Pascha, and Shire 2010, 23). The limited space requires more strict social regulations which in turn require a different use of technologies. Wolfangel interviewed Yun Suen Pai from Keio University, who demonstrated the usage of VR in small rooms during an experiment. He stated that according to his research experience, the technology is in need to be freely usable. He refers to the necessity of saving space in the more and more limited room of the future, requiring technology to adjust, too (Wolfangel 2018, 60).

Looking at energy as foundation of all technology, the development of German electricity generation is rather different compared to Japan. The latter still relies more on fossil and nuclear energy sources, while Germany has a more active anti-nuclear movement and gradually extends the usage of renewable energy sources. About the technology that relies on those energy sources, both nations' infrastructure ranks at the top of the world. For example, Japan boasts about 170 million mobile cellular telephone subscriptions, compared to Germany's 106 million. Another highly relevant criterion for the development of a country is the internet connection. About 92% of the Japanese population use the internet, with an average speed of 17.4 Mbps. For Germany it is 89.6% of the population who access the internet with an average speed of 12.9 Mbps (Central Intelligence Agency 2016).

The infrastructure is not only relevant to the citizens, but also the industry. Japan's industry is even more focused on processing than Germany's industry. In 2003, 23.3% of the working population worked in the processing sector, compared to 18.7% in Germany. Both, Germany and Japan, rely on their exports more than many other developed countries (Kevenhörster, Pascha, and Shire 2010, 21). The numbers from 2003 can be supplemented by the impression of the Japanese professor Masayasu Watai, who specified the kind of industry: "It feels like Germany is aiming more towards industrial goods, while Japan focuses a little more on everyday and entertainment goods" (interview with M. Watai, 2018, November 14).

3. Models of Technical Acceptance

Chapter two explained a basic model of technical acceptance, but there are more elaborated and proven models that were applied on various technological fields. The following chapters give an overview of models, which were mentioned noticeably frequent in literature. Each section gives a basic description and shows application fields of the respective model. The chapter culminates in a conclusion for the acceptance models, which were chosen for the survey of this work.

3.1. Global Acceptance of Technology Model

The Global Acceptance of Technology Model (GAT) came up as a result of the need for a framework that takes social factors like demographic and culture into account. It seemed very promising because of the global aspect and its wide scaled application test. Fife and Pereira applied the GAT framework on the results of the Worldwide Mobile Internet Study (WMIS) from 2004/2005. The study was about mobile data end-users of multiple nations. Over 10 000 users of Europe, Asia and the US participated in the survey (Fife and Pereira 2005, 1). For the sake of the framework, the majority of data from the study was limited to Hong Kong, Japan, Korea, Taiwan, Finland, China, Australia, Greece, the UK and the USA. Unfortunately for this thesis, Germany did not find consideration. For example, the study included data of mobile data revenues, knowledge sources of users to learn about wireless data services or the penetration rates of cellphones and personal computers in some countries.

Continuing the GAT framework approach, its developers compared it to other models. The Technology Acceptance Model (TAM) is more specialized than the GAT, meaning it is more limited to a specific use case, e.g., limited to a certain technology. But compared to the Unified Theory of Acceptance and Use of Technology (UTAUT) model, the GAT framework is more specific. Contrary to UTAUT and TAM, GAT specifically considers three major factors, which Fife and Pereira found lacking in existing models. Technology was adapted at different rates across national markets, technologies were adopted at different rates within the same ethnic groups across national markets or by groups of the same age across different national markets (Fife and Pereira 2005, 3).

To achieve an evaluation of those factors, GAT assumes that the adaption of technologies is connected to the following principles: “[...] ‘perceived relative value’, of the applications, and the effects of ‘user-compatibility drivers’, ‘cultural socialisation

drivers', and 'technology-adaption catalyst'[...] (Fife and Pereira 2005, 4). Perceived relative value refers to a derivation of social and/or economic benefits that users perceive when adopting new technologies. User-compatibility drivers describe the factors of the individual user's experiences and environment. Environment includes features like contact with media, education or the social networks. Cultural socialization drivers can be understood as less tangible than user-compatibility drivers, since they are on the level of social norms and values. Organizational norms and values also have a part in this factor (Fife and Pereira 2005, 4), for example, how technology is used by different social groups. Lastly, the technology-adoption catalyst is the factor that initializes adoption. This can be the individual that adopts technology voluntarily or parts of society that are made to adopt technologies by authorities.

Fife and Pereira applied the GAT framework on various figures of the WMIS, which would become too detailed for the purpose of this thesis. Overall, the GAT framework was successfully applied in this case, but mainly uncovered a discrepancy between the data of the US and Asian countries. In other cases, the validity of the GAT framework's principles seemed to be confirmed, but to a lesser degree than in the comparison of the US with Asian nations.

3.2. Theory of Reasoned Action

Fishbein and Ajzen introduced the Theory of Reasoned Action (TRA), which focuses on various factors influencing the volitional behavior of individuals. The model requires the subjects to have access to all available information to make a thought-out decision. It therefore excludes behaviors that are forced, spontaneous, a regular habit or similar cases. The basic model knows four major scopes affecting behavioral intention. They are shown in the following figure.

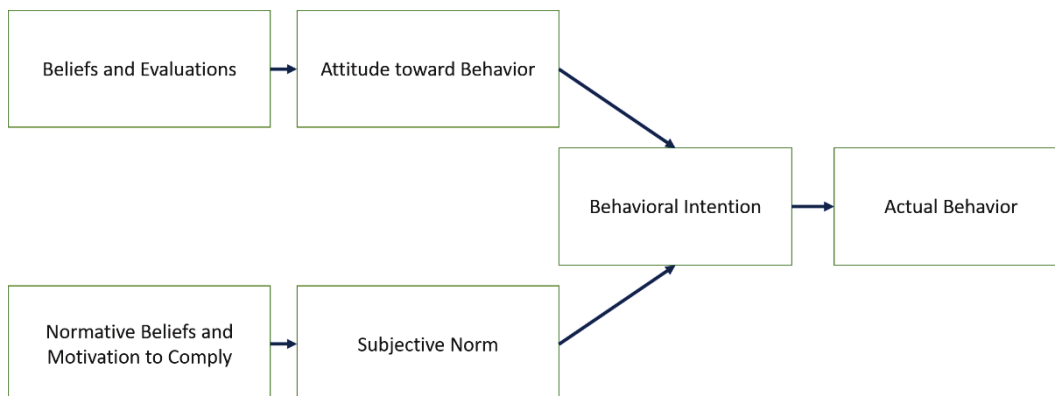


Figure 2: Elements and relations of the theory of reasoned action (adapted from Ajzen and Fishbein 1980, 100)

Attitude toward behavior is based on the subject's beliefs and previous as well as current evaluations. The influence of society, government or similar establishments creates a subjective norm, which still depends on the subject's willingness to comply. It should be pointed out that the behavioral intention does not necessarily equal the actual behavior. Therefore, the figure displays them in separate boxes.

Sheppard et al. acknowledge the validity of the TRA, but they highlight its limitations. They see three main problems, which result from the frequent application of the TRA framework to ever similar circumstances. The first problem they see is about the behavior of the subject, which is not completely volitionally controllable. Furthermore, the situation usually involves the subject to be confronted with a choice problem. Lastly, in many use cases the intention of the subject is looked at when the subject does not have access to all necessary information to build a confident intention (Sheppard, Hartwick, and Warshaw 1988, 325–26).

In 2010, the authors addressed some of the deficits and in some cases improved their model. Fishbein and Ajzen described some of their model's restrictions and stated the intention was to develop a model applicable to behaviors not the outcome of behavior. External factors are therefore not considered when applying the model. Also, the model relies heavily on how subjects define their goal intention and the consequences of failure in achieving those (Sheppard, Hartwick, and Warshaw 1988, 326). The exact changes of the updated model are omitted, since they do not have a noteworthy influence on the outcome of the model choice for this thesis.

3.3. Technology Acceptance Model

The Technology Acceptance Model (TAM) from 1989 is probably one of the most prominent models, as it is mentioned and investigated in much of the literature studied for the purpose of this thesis. Also, it is the foundation for many other models and theories. Judging by the name, it seemed very suitable for the hypothesis of this paper. The purpose of the original model was to investigate the process of how users come to accept information technology. The model delivers an approach on how to investigate the twisted relations of acceptance. The model verifies the data resulting from questionnaires by taking latent variables into account (Jockisch 2009, 235–36). According to Davis' original model, two factors play a major role in this process: Perceived Usefulness and Perceived Ease of Use. He defines them in the following way:

“[Perceived Usefulness is] the degree to which a person believes that using a particular system would enhance his or her job performance” and “[Perceived Ease of Use is] the degree to which a person believes that using a particular system would be free of effort” (Davis 1989, 320).

Assuming a person with positive attitude toward the use of a technology will actually use it, the user is more likely to use the new technology the bigger the usefulness of it and the easier it is to use. Davis also includes external factors which influence acceptance, but the original model does not explain them in more detail. While the TAM was not targeted for a specific use case, critics also pointed out its too general approach, which is not sufficient to reflect the complexity of acceptance (Jockisch 2009, 237).

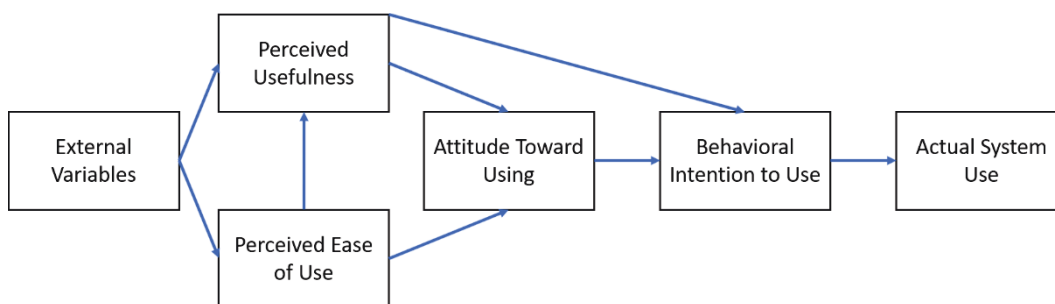


Figure 3: Technology acceptance model (adapted from Davis, Bagozzi, and Warshaw 1989, 985)

Contrary to the previously introduced models, TAM does not include any elements superfluous in regard to the hypothesis or elements hardly measurable in the scope of this thesis' survey. Therefore, it seems reasonable to investigate the direct successor to the TAM.

3.4. Technology Acceptance Model 2

With Venkatesh and Davis, two experienced researchers in the field of acceptance worked on the development of the Technology Acceptance Model 2 (TAM2). The model aims to overcome the restrictions of the previous model, extending the fields of application and closing the gaps in the theory behind TAM. Perceived usefulness and the construct of usage intention are also essential parts of TAM2. Contrary to TAM, TAM 2 breaks down the external factors by splitting them into more detailed elements. The elements belong either to the category of the social influence process or the cognitive instrumental process (Venkatesh and Davis 2000, 187). The following figure shows their relation to each other.

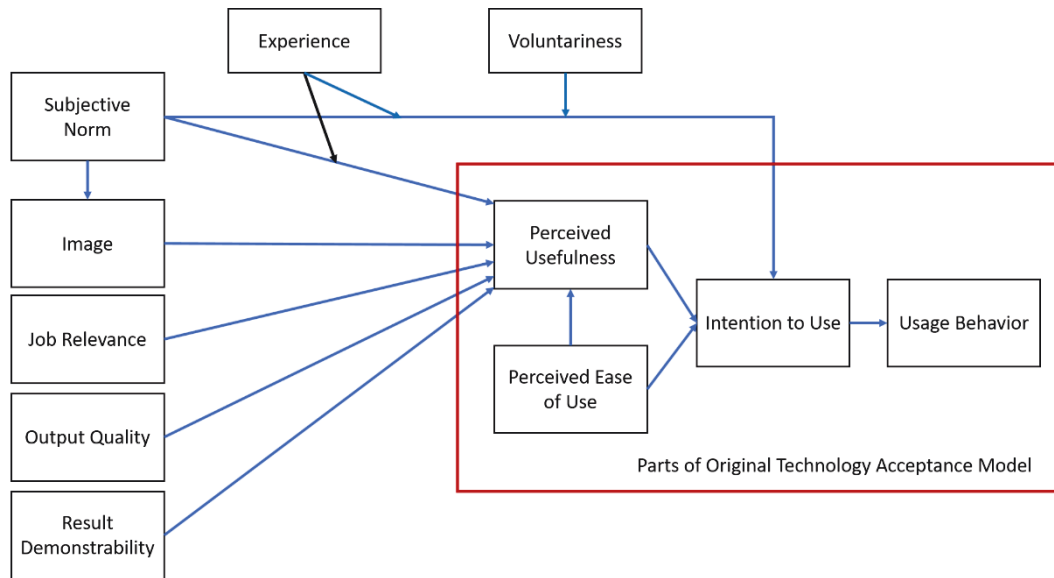


Figure 4: TAM2-model (adapted from Venkatesh and Davis 2000, 188)

Subjective norm, voluntariness and image belong to the social influence process. The term subjective norm is used according to the TRA, where it refers to how a person perceives the expectations of important others about how the person should behave. The person might act different from his own beliefs if the person thinks important others expect him to act or not to act in a certain way. Voluntariness is connected with the subjective norm. The degree varies, since users act differently when confronted with a mandated introduction of a system. Overall, voluntariness was confirmed to increase or reduce the impact of the subjective norm on the intention of use. The image of an individual is connected to the subjective norm. The term refers to how an individual wants to be seen by one or multiple social groups. Lastly, experience is not listed as a direct element of the social influence process but has a considerable impact on the perceived usefulness and the intention to use. An experienced individual is influenced less by subjective norms or the image he reflects, since his experience allows him to judge more practical whether the individual wants to continue using a system and how useful it is to him (Venkatesh and Davis 2000, 187–90).

The cognitive instrumental process is the framework containing the elements job relevance, output quality and result demonstrability. The listed elements do only affect perceived usefulness directly. While the terms are mostly self-explanatory, Venkatesh and Davis describe job relevance as how relevant the results of usage are for the job. Output quality describes what quality the individuals think the result of their working with a system will have. Result demonstrability is less tangible. It

refers to the fact that even an effective system can be perceived as not useful, if the process of the system is obscure, often not visible to the individual. All components are considered from the view of the individual and how it perceives those factors (Venkatesh and Davis 2000, 190–92).

TAM2 offers many points that can be included in the model for this thesis. TAM2 was developed further in 2008. TAM3 is the third evolution of the TAM. TAM3 follows a different approach, since it focuses less on the explanation of why and how acceptance occurs, but more on how to actively intervene in the process of acceptance (Jockisch 2009, 238–39). Therefore, there is no need to go into the details of TAM3.

3.5. Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) aims to offer a model suitable for a broad field of application, proven through empirical research, without copying aspects with the same goal. Venkatesh et al. publicized the theory in 2003. In principle, UTAUT combines the core principles of eight acceptance models, of which two have already been analyzed previously in this thesis. The following list presents an overview of the applied theories:

- Theory of Reasoned Action (see chapter [3.2](#))
- Theory of Planned Behavior (TPB)
- Social Cognitive Theory
- Technology Acceptance Model (TAM; see chapter [3.3](#))
- Combined TAM and TPB
- Model of PC Utilization
- Motivation Model
- Innovation Diffusion Theory

According to the authors, “[...] the eight models explained between 17 percent and 53 percent of the variance in user intentions to use information technology [...]. UTAUT was then tested [...] and found to outperform the eight individual models (adjusted R² of 69 percent)” (Venkatesh et al. 2003, 425). Of the existing models, the authors worked out four key elements influencing the behavior directly, with the facilitating conditions being the only factor not affecting the intention, but only the actual use behavior.

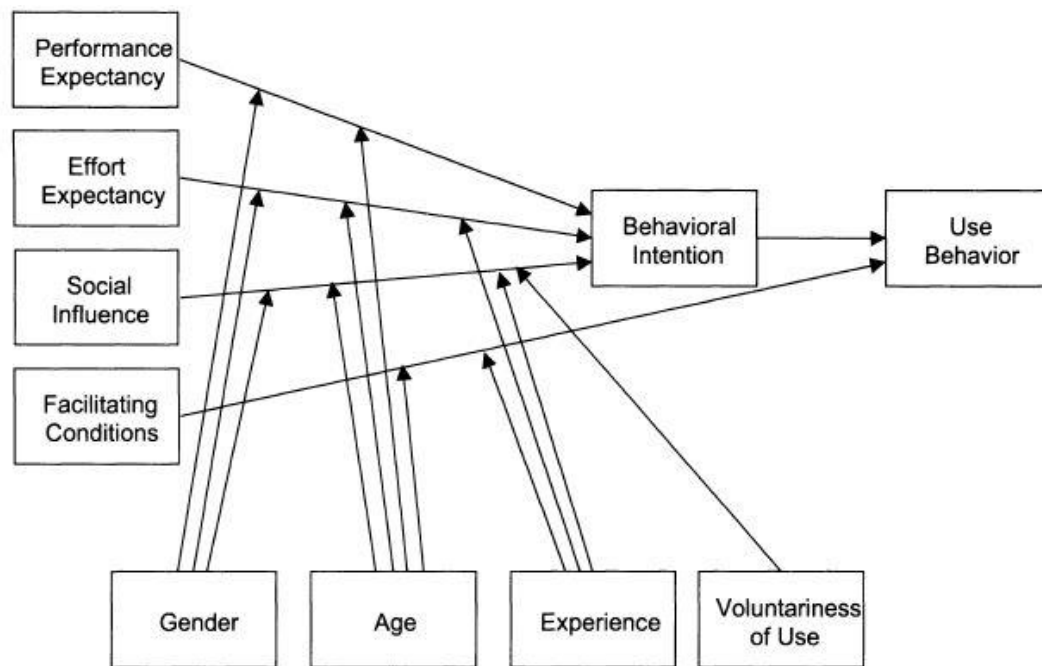


Figure 5: Unified theory of acceptance and use of technology (adapted from Venkatesh et al. 2003, 447)

Performance expectancy is the least relevant factor to the subject of this thesis. It is described as the degree, to which an individual believes to perform better in a job when using the system or technology in question. If it can be applied accordingly to the environment of students, it remains a valid point within the scope of the thesis. The effort expectancy defines how easy a system/technology is expected to be usable. Social influence refers to the extent an individual considers the opinion of important others on whether he should use a new technology or not. The facilitating conditions pay tribute to the individual's believes in whether supporting infrastructures to use the technology exist (Venkatesh et al. 2003, 447–53).

The theory suggests gender, age, experience and voluntariness of use as variables with moderating influence. It is remarkable how different those variables affect each factor, with age being the only one with an effect on everything (Venkatesh et al. 2003, 449–53). UTAUT experienced several overhauls and extensions and was applied to various technological fields and target groups, mostly in working environments, but in a few cases also to students. Critics see a problem in the overwhelming number of variables of the updated models. As a consequence, this chapter introduced the original, but more proven model of 2003.

3.6. Conclusion

A brief review of the introduced models delivers the argumentation for TAM2 and UTAUT, which are the models applied on the design of the survey. Their combination is showcased at the end of this section.

GAT looks the most promising, because of its international character, which fits to the research goal of this thesis. Despite its international conception, GAT proved to be unsuitable since it aims more towards analyzing adaption, rather than acceptance, which is different according to the definition in the second chapter. In addition, its relevance is questionable because the authors discovered a remarkable difference only between the US and Asian countries. While it indicates a difference between the western world and Asia, it cannot necessarily be applied to Germany and Japan as well.

While the TRA experienced many use cases, its application requires conditions which are not applicable in the scope of this thesis. For example, critics stated the participants would need to have access to all available information about the topic in question. It cannot be ruled out that the only source of information for some of those topics is the brief introduction given within the survey. The limited consideration of external factors and restricted applicability on the topics of the survey lead to the decision of excluding the TRA from the final model applied within this thesis.

The general approach of the TAM leaves a good impression, but it appears to be too inaccurate when it comes to the factors leading to acceptance, since external factors are not particularly taken into account. This is contrary to the part of the model, which focuses on the use of a technology. This part is overly differentiated for the purpose of the survey (attitude toward using, behavioral intention to use, actual system use). Since this impression has been confirmed by several studies and meta-studies, TAM is not applied on this survey.

TAM2 addresses the points of criticism on TAM. External factors are considered in detail, with little adjustments most elements of the model seem to be applicable on students. Experience is difficult to evaluate since participants of the survey are unlikely to remember all of their touchpoints with a certain technology. To achieve at least some statement regarding experience, the time period could be reduced. In case of this questionnaire, the students are asked about the experience with a technology within a year. Voluntariness is assumed to be given, since the survey offers no question about technology used in mandatory application fields. A student

using technology is not expected to use it out of force, even in the frame of classes, where students do not need to fear to lose their job or a decrease in salary.

UTAUT overperforms. Too many factors, of which some are not applicable or hardly measurable within the scope of this thesis. Experience is tried to be measured within the survey, but depending on the technology, it is unlikely to gather a reasonable result since participants will hardly remember how many times they had contact with a technology and with which intensity. Voluntariness of use is assumed to be given and cannot be reasonable measured since there is no particular actual use case of a technology.

The final model that is applied on the results of the survey has the goal to answer how well the investigated technologies are accepted by students in Germany and Japan. The overall goal is to determine whether the acceptance rate of upcoming consumer technology is higher for Japanese students than for German students. To achieve this, the target model needs to be capable of finding measurable and relevant variables. If a discrepancy between Japanese and German students appears while viewing them under the same conditions, it might hint to a cultural factor that is not captured by the applied model.

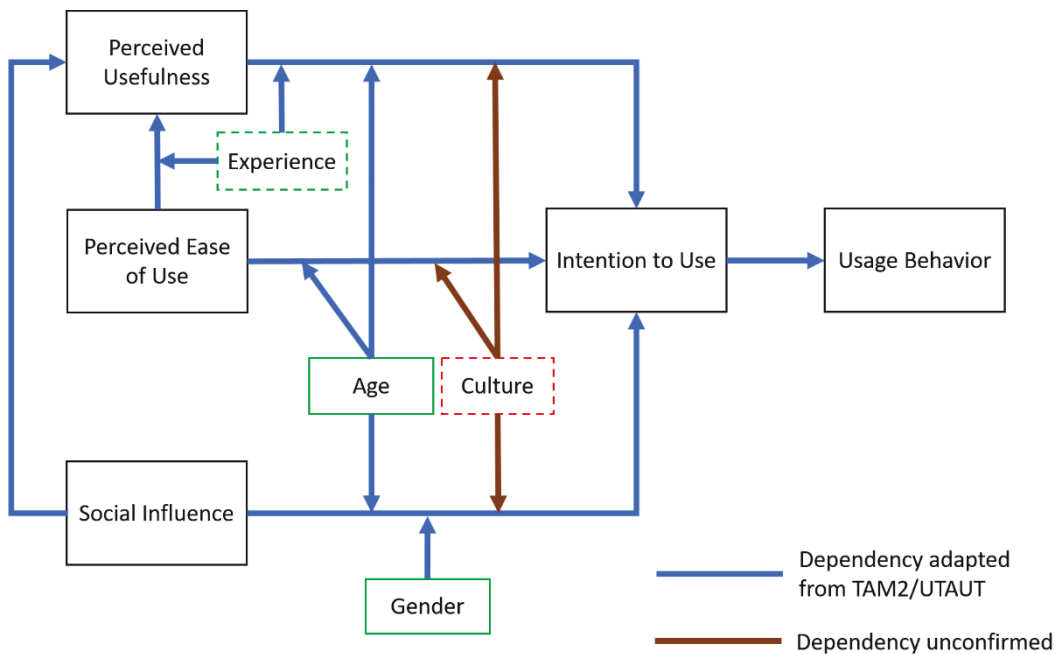


Figure 6: Combination of TAM2 and UTAUT

The analysis of the introduced models suggests that TAM2 and UTAUT are the closest to be useful for the purpose of this research. Since each on its own is not

perfectly suitable, their combination results in the shown model. For example, social influence of UTAUT corresponds to TAM2's elements subjective norm and image. Items in green squares refer to moderating variables (from UTAUT) which have been validated in multiple empirical surveys. The dashed line of experience indicates its limited verifiability. This survey only addresses experience made with a technology within one year, but it would be more reasonable to measure experience without relying on the statements of the participants. In TAM2, acceptance was measured multiple times and allowed conclusions about the experience of participants. This is not achievable in the scope of this thesis. The red dashed line highlights culture as an unverified item, which has not been mentioned in any of the introduced models. The second chapter lists thoughts about the aspects and influence of culture.

4. Evaluation

As mentioned throughout the first chapter, the research design is based on conducting an online survey. The results of the survey shall test the hypothesis and help answering the research questions.

The first part of this chapter tries to specify the target group of the survey. Each respective group of students lives in circumstances, which may have an impact on the results of the survey. Relevant circumstances, which can already be observed or found in other studies are stated. Hints or evidences of other factors discovered by the survey are mentioned as part of the interpretation.

Following the target group, chapter 4.2 explains the fundamental state of the topics of each section in the survey. This includes a short overview of the current state of technology, listing the known/expected influence on the target group and with that, the argumentation for including the section in the survey.

Chapter 4.3 describes the theoretical reasoning behind the conception of the survey, including the choice of the model of technology acceptance and the construction of the questions. Also, the chapter delivers the argumentation for the choice of the survey tool and the process of conducting the survey.

Chapter 4.4 consists of the actual results. It elucidates descriptive characteristics, followed by an introduction and analysis of all items. Possible reasons of the outcome and correlations between the investigated factors are listed as well. The chapter concludes with a comparison to the expected results. Chapter 4.5 describes the limitations of the survey and compares the results with the expectations. The final chapter delivers an interpretation of the results, especially in consideration of the acceptance model.

4.1. Analysis of Target Group

According to the hypothesis, the target group of the survey are students in Japan and Germany. There are some expected differentiations between each group of students, which have to be considered. The following two chapters will deal with the expected differences, whereas the survey might uncover additional differences, which shall be analyzed in the chapters concerning the results and interpretation.

Remarkable differences to other target groups are the possibility to earn money for themselves (contrary to pupils and younger persons) and to have more available time than working adults (which allows for more contact with the technologies

evaluated by the survey). By choosing students as the target group, the survey does not focus on technologies that students are unlikely to have knowledge of (e.g., military technology).

4.1.1. Japan

Due to established connections of the author of this thesis, most of the participating students are enrolled at Soka University. As of August 2018, a total of 7,708 undergraduate and graduate students were enrolled to Soka. About 550 of those students are non-Japanese and thus not relevant for the survey. To conclude the relevant statistical data, 811 of the total number of students belong to faculties with technical affinity (Faculty of Science and Engineering, Soka University). The experiences gained in technical studies might lead to a bias and also increase the chance of having contact with some of the technologies in question (e.g., programming of robots as part of the curriculum).

Due to the limitation to mostly one university in Japan with less than 500 graduate school students, the range of the age of the participants will be smaller than of German students. Usually undergraduate studies in Japan takes four years until completion, which means participants of the survey will be mostly between 18 and 22 years old. Soka University is located in Hachiōji in the west of Tokyo but accepts students from everywhere. Unfortunately, there is no data available, but students, who mostly grew up in smaller towns or villages, might have different possibilities of contact with technology. Also, it is very typical to spend the first year in a dormitory in vicinity of the university, which affects the financial circumstances of the students and possibly isolates students to a certain degree. Finally, it is also common for Japanese students to join a club, which might affect their behavior. Students of other universities than Soka University are only reached by coincidence (e.g., sharing of the survey).

4.1.2. Germany

Due to the location of the author, most students will be located in Munich. Through sharing of the survey, students of other German regions might be reached, too. Most of the about 120,700 students in Munich belong to three big universities, of which two offer many technical majors. 67% of the total number of students are undergraduate students and 17% are graduate students (Jobmensa). With the higher number of graduate students, but a shorter duration of undergraduate

studies, the age span of German students is expected to be not too different from Japanese students.

Due to the more open migration politics of Germany, the participants of the survey might hold a German citizenship, but descend from different cultural roots, which might influence the results. To minimize biases based on the major of the studies, the author aims to achieve an even relation of students of more technical universities and more general universities. To easily reach many students in the given time, the participants will mostly be picked randomly in the surrounding of university facilities. Dormitories are less common in Germany than in Japan, but communities sharing a flat, which are more common in Germany, might lead to comparable circumstances.

4.2. Objects of Investigation

The following chapters present a brief introduction to each section included in the survey. Each chapter contains the motivation and reasoning of including the section in the survey and which purpose it fulfills. If necessary or helpful, the chapters give a short clarification on technical terms and the current state.

4.2.1. Virtual Reality

Virtual reality (VR) is the first section of the survey. The survey includes this technology, because it acts as an example for a technology that is still somewhat new, but present on the private market and media for several years. While it can be subject of discussion which milestone in history is the origin of virtual reality, during the 21st century the interest in VR spiked. Companies with big budgets, like Facebook, Valve, Google, Sony, HTC or Samsung entered the market and pushed the number of active virtual reality users.

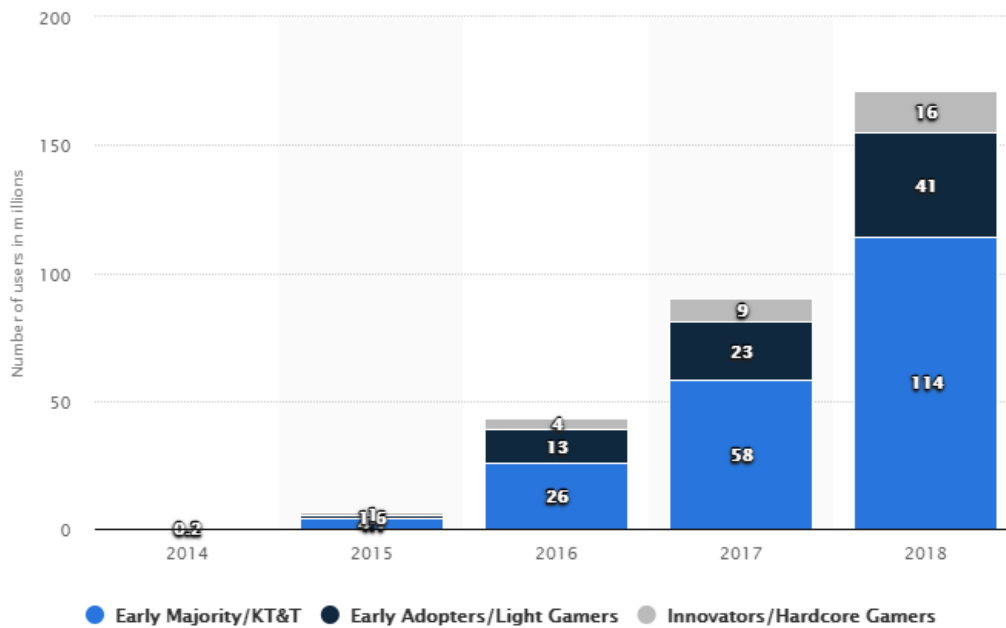


Figure 7: Number of active virtual reality users worldwide from 2014 to 2018 (in millions; Statista 2019)

According to the International Data Corporation (IDC) and their Worldwide Quarterly Augmented and Virtual Reality Headset Tracker report of the third quarter of 2018, shipments of VR devices rose by 8.2% compared to the third quarter of 2017. This number appears small compared to the 67.6% of augmented reality devices but can be justified by the decline of screen less VR devices (-58.6%). Standalone (428.6%) and table tethered VR devices (69.0%) still see a notable increase in shipment numbers (IDC 2018).

The following paragraph introduces this section of the survey to the participants:

The following questions are about Virtual Reality (VR). Virtual reality is a computer-generated, interactive reality with image, often sound and rarely other sensory stimuli. Augmented Reality (AR), which augments the real world with virtual aspects, is not part of the survey (e.g., Pokémon Go).

The description briefly describes the main features of virtual reality and how it differs from augmented reality. The questions VR06 and VR07 list further examples for application fields of VR. Gaming and movies are more typical experiences and thus, more developed than, for example, the VR approaches to marketing, education or medicine. There are multiple approaches to use VR in, for example, medical circumstances. Sisto et al. suggest using virtual reality for the prevention of Musculoskeletal Disorders (MSDs). While there are already some unproven methods to help fighting this disease, Sisto et al. argument how their VR application could

increase motivation and efficiency of exercises, while reducing risk of injuries (Sisto et al. 2018, 43).

Of course, there are further, sometimes more uncommon application fields, but the selection for the survey is assumed to be imaginable for the participants and not overly futuristic (i.e., development approaches market introduction or passed this point already). Chapter 4.4 evaluates answers, which could offer indications on whether the analysis of VR was correct.

4.2.2. Robotics

Robotics is the second section of the survey. Robots in industrial use cases are not new and already an established standard in some industries. According to the World Robot Report 2018, there are 322 industrial robots for every 10,000 employees in Germany. With this ratio Germany ranks number three worldwide, only surpassed by South Korea and Singapore and followed by Japan. Especially in Europe, the importance of robotics is explained by the demand of the automotive industry, whereas in Asian nations the electronics industry has an even slightly higher demand for robots (Schneider 2018).

The survey includes this technology not because of its industrial relevance, which is neglectable for the target group. Robotics is intended as an example for an upcoming technology that still needs to be established on the market of end consumers. Questions RB06 and RB07 list exemplary application fields for robots. Those examples include robots that are not totally unlikely to be experienced by students, but probably not used by them (e.g., safety robots). The following table lists all robots considered relevant:

Application areas	Examples
Robots for domestic tasks	Robot companions/assistants/humanoids Vacuuming, floor cleaning Outdoor cleaning
Entertainment robots	Toy/hobby robots Multimedia/remote presence Education and research
Home security & surveillance	Alarm/remote surveillance
Medical robotics	Diagnostic systems Robot assisted surgery or therapy Rehabilitation systems

Rescue & security applications	Fire and disaster fighting robots Surveillance / security robots
General service systems	Hotel & restaurant robots Mobile guidance, information robots Robots in marketing Robot joy rides

Table 2: Application fields of robots relevant to target group (adapted from Classification of service robots by application areas 2016, 11–12)

The following paragraph introduces this section of the survey to the participants:

The following questions are related to robots. In the following, a robot describes a device that performs certain mechanical activities instead of a human being. It acts remotely or according to sensor signals or programmed command sequences. These include, for example, cleaning robots, toy robots or search and rescue robots.

To underline the relevance of the chosen examples for robotics, several examples have been viewed. Mauch describes the integration of a programmable robotics kit of the LEGO Corporation into the mathematics curriculum of middle school students. This so called Mindstorms increased motivation, problem solving skills and cooperative learning ability of the participating students (Mauch 2010, 211). Another, more general example, comes from Bugmann and Copleston, who conducted a survey to learn about expectations of users with regard to service robots. The questionnaire referred either to named application fields (e.g., household) or to specific tasks within those fields. Throughout the age group 18-60 years old, the participants indicated the most interest in general cleaning, preparing meals and security in the household (Bugmann and Copleston 2011, 360, 363). These examples gave reason to include this section in the survey. The results can be found in chapter [4.4](#).

4.2.3. Alternative Methods of Payment

Alternative methods of payment are the third section of the survey. Within the survey, this technology serves as an example for an established technology with new aspects. While forms of money resembling today's cash already existed for several centuries, it was the internet, which opened new ways of payment. Some of those alternatives to cash have already vanished, while others found their place on the market and others still need to find it. Freely available data covered mostly which alternative methods of payment are used to which extent but were mostly limited to the area of electronic commerce (e-commerce) or to nations irrelevant to the thesis.

While this section of the questionnaire is not limited to e-commerce, questions AP06 and AP07 also suggest areas of commerce. This gave reason for a more thorough look on the data available free of charge. The following figure compares data of alternative methods of payment used in e-commerce in the year 2012. The column 'Other' does not refer to cash but summarizes alternatives that were too small in numbers to be listed separately, e.g., digital currencies or local card schemes. 'Mobile' refers to direct carrier billing and mobile wallets used on smartphones, while 'e-wallets' describe a digital container for various online funds like Alipay or V.me. 'Direct Debits' allow the direct withdrawal of funds from a bank account like the German 'Elektronisches Lastschriftverfahren'. 'Bank transfer' requires authorization of the customer's bank and 'Card' references credit/debit cards. The report predicted an increase for users of alternative methods of payment in 2017, but access to more recent reports is not available.

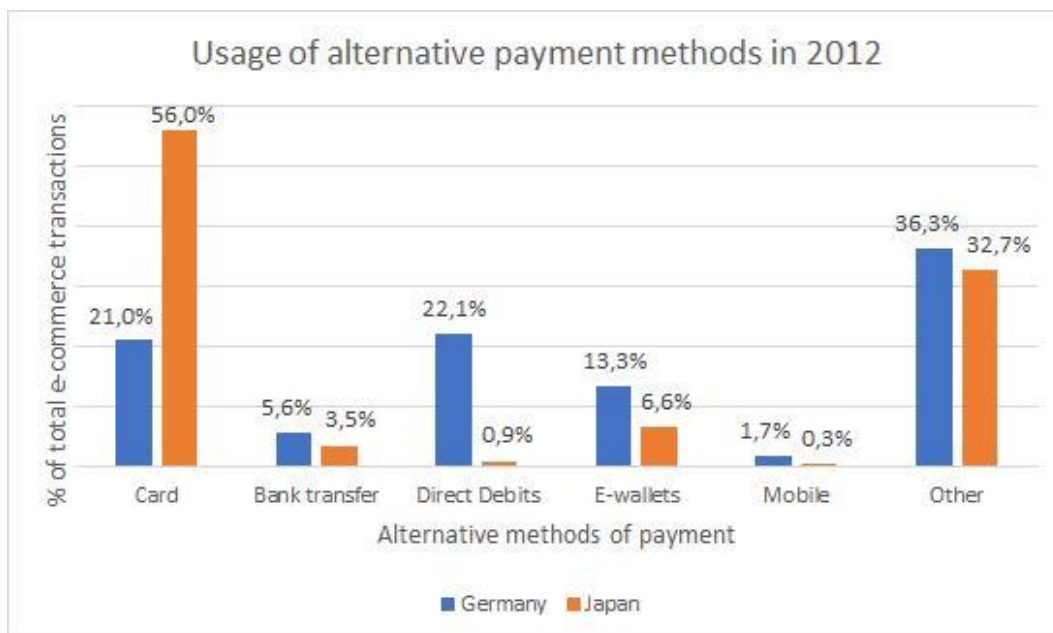


Figure 8: Alternative methods of payment in Japan and Germany in 2012 (adapted from worldpay 2014, 38, 45)

Surprisingly, some media convey a different view on this topic. According to The Japan Times, paying in cash is still common in Japan. The state will offer tax incentives for users of cashless payment (Tsubuku and Brasor 2018). Also, several businesses like Line, Yahoo Japan and Rakuten reported about their plans to expand their electronic payment methods in Japan.

The following paragraph introduces this section of the survey to the participants:

The following questions refer to alternative methods of payment to cash. Essentially this means any electronic means of payment, i.e., no cash or checks. Here are some examples: credit/debit cards, PayPal, Bitcoin, Apple Pay, loyalty points, online banking etc.

The survey aims to investigate the attitude toward alternative methods of payment and their usage. Since there are no statistics of the trend over the years among students, the survey's results found in chapter [4.4](#) deliver some insight on the current state.

4.2.4. Sociodemographic Features

The fourth and final part of the survey asks for sociodemographic characteristics of the participants. Those are necessary to connect the answers to questions of technical acceptance with personas. The most relevant question of this section is the question for nationality, since the hypothesis claims differences between the technical acceptance of students of Japanese and German nationality. The remaining six questions are of supportive nature and not essential for testing the hypothesis but help ruling out other factors than nationality.

As every other section of the survey, the sociodemographic questions are based on the adaption of technical acceptance models to the given circumstances. The exact reasoning is found in chapter [three](#). The results of several applied models implied a relation of technical acceptance to sociodemographic factors of the participants, especially age, gender and experience. The latter is questioned within each technological section, but external factors appeared to have an impact on the attitude of participants towards technologies, too. Those are evaluated in the sociodemographic section. Namely, those factors are assumed to be:

- the available money, which influences what technologies are affordable.
- the pursued academic degree, graduate students might be more experienced in their (technical) studies and possibly spent more time in a student job.
- the pursued major, since technical studies could allow for more experience and opportunities for contact with certain technologies (e.g., media engineer).
- affiliations with clubs and associations, leading to a more limited social environment or additional opportunities for contact and experience with technologies (e.g., robotics club).

Sociodemographic questions allow to discover more correlations to certain groups of persons in more detail. Because of their widespread usage they are often perceived as a boring part of the survey. Answering typical questions at the beginning lowers the motivation to participate. This positioning also considers the intimacy violated by some sociodemographic questions. Some participants might be unwilling to share private information, even if anonymized, and not participate further. Positioning critical questions at the end ensures that data up to that point remains in the data pool (Brosius, Haas, and Koschel 2016, 104).

4.3. Method of Evaluation

Methods of empirical research apply to the design of the evaluation, which is the major part of this final thesis. According to Brosius et al. the empirical approach requires to collect experiences within reality and applying the constructed systematic to the respective area of communication science. All steps need to be comprehensible enough to be repeatable by others (Brosius, Haas, and Koschel 2016, 2). As a result of the lack of time and financial means to reach a three-digit number of students in each nation, especially the distant Japan, the author chose to conduct an online survey. The online survey aims to gather sufficient and comparable data to test the hypothesis and make mostly quantitative statements. The comparably low number of participants only allows a limited significance of the results. Some of the questions will allow to make qualitative statements about the target group and their correlation to certain factors influencing technology acceptance.

The online survey does not require an interviewer in person and no further acting after preparing and starting the survey, which are major advantages. Another advantage of online surveys is the anonymity of the participants. Brosius et al. see a lower risk of answering according to social expectations (Brosius, Haas, and Koschel 2016, 121). This may allow the participants to give their honest opinions and data. In case of upcoming questions, the participants have access to the mail of the author. This can be seen as substitute for possible inquiries, which would be available in person during an interview.

Due to the lack of individual contact data, the survey is accessible online without any restrictions. This provides potential participants with an easy access and should encourage to participate. To improve the rate of response further, the number of questions and their complexity is as low as necessary to cover all relevant items (for further details about the questions see also chapter [4.3.2](#)). The

advantage of anonymity comes at the cost of an unavoidable disadvantage. A major risk of online surveys is their non-binding nature. Without observation, it is easy for potential participants to simply ignore the survey or to give untrue answers. Especially sociodemographic details can easily be falsified (Brosius, Haas, and Koschel 2016, 121).

The following aspects of the online survey are noteworthy but are neither advantages nor disadvantages. Some survey tools allow the measurement of the time, which was taken to answer a question. This allows to make statements about the quality and validity of the answers. For example, a question, which requires reading a text of 30 sentences can hardly be answered within a few seconds (Brosius, Haas, and Koschel 2016, 121). Using a progress bar reduces the risk of aborting the survey. Participants can estimate their progress and the needed time to finish the survey (Welker, Werner, and Scholz 2005, 79).

An interview with a Japanese expert on parts of this topic led to some supportive statements. Some of the first chapters refer to the statements of this expert. Unfortunately, this expert could not specifically apply his profound knowledge to the target group of this thesis, which is why the interview with an expert was not sufficient to reach the goal, mentioned in the first paragraph. In addition, no German equivalent to the Japanese expert was reached, which would make the argumentation one-sided. Overall, the evaluation is considered a cross-sectional study, due to its one-time execution.

4.3.1. Choosing the Survey Tool

The name of the chosen survey tool is 'SoSci Survey', which was not only recommended by the supervising professor, but also in the final choice of the author. The alternative was 'Unipark', which appeared to be simpler to use. The author made the decision in favor of SoSci Survey, since it has more versatile export possibilities, offered a fully accessible demo and more options for questions. For scientific, noncommercial projects, which are not conducted in cooperation with a business, the tool is free of charge.

SoSci Survey offers many tutorials, which made adjusting the questionnaire easy. It also offers the option for a pretest and multiple options for sharing the survey. The tool also offers various methods of exporting gathered data. Another important aspect was the handling of multi-language surveys. With SoSci Survey, the survey

had not to be completely copied, but the text had just to be translated. The participants can choose the language at the beginning of the survey.

4.3.2. Choosing the Questions

The structure and wording of the technology related questions follow the theoretical principles of a mixture of technology acceptance models. The Technology Acceptance Model 2 (TAM2), an advanced version of the TAM, influenced major parts of the first three sections of the survey. UTAUT played a bigger role for the socio-demographic part. In combination they sufficiently cover some external factors. As far as those external factors can be evaluated through an online survey, the questions aim to do so. A more detailed analysis and argumentation of relevant and applied models can be found in chapter [three](#).

The survey mostly uses closed questions. This kind of questions only allow a choice of given answers, what makes the conversion to statistics or diagrams easier than with open questions. A few open questions, which are more typical for qualitative questionnaires, are included to gather information which is not expected and therefore not predictable when creating closed questions (Brosius, Haas, and Koschel 2016, 86). Further measures have been taken into consideration to increase the participation rate. The number of questions is as low as possible but as high as necessary to cover the core aspects of the mixed TAM2/ UTAUT model. Control questions are not included to keep the amount of time needed to finish the survey below ten minutes and thus increase the willingness to complete the survey. Nonetheless, some of the questions evaluate multiple aspects, which the combined model considers relevant for the acceptance of technology. The following scheme applies to each of the technology related sections of the survey:

1. Introduction to the technology
2. Question (usage behavior): Have you ever used *technology x*?
3. Question (usage behavior/social influence): In my environment *technology x* is often used.
4. Question (social influence): People who are important to me convey a positive opinion of *technology x*.
5. Question (perceived ease of use): I think *technology x* is mostly easy to use.
6. Question (perceived usefulness): *Technology x* is useful in the areas of ...
7. Question (perceived usefulness/intention to use): I think in 5 years *technology x* will be useful in the areas of ...

8. Question (intention to use): It is likely that I will use *technology x* in the next 3 months.

The introduction serves the purpose of giving participants an image of the technology in question and differentiate from technology irrelevant for the survey. The texts do not go into details but list examples if necessary. Either numerous or no examples are given, so participants do not answer with, for example, a single brand in mind. Within the technology related questions, each page includes a reminder in case no answer was chosen. To encourage truthful answers, no questions require an answer to proceed the survey. This is to avoid participants answering question they do not want or cannot answer. The alternative to add the option of not wanting to answer to each question seems more demanding. The pretest gave reason to not even implement a reminder for the section of sociodemographic questions, since this kind of questions tends to be more private for participants.

Only some items contain an interval scale in order to not overly challenge the willingness to share details, compared to two-choice-questions. If used, Likert Scales allow a more detailed and differentiated degree of answers. Ordinal and nominal scales contain a maximum of five options. This should cover the expected answers, while not reaching an exaggerated degree of differentiation and granularity of details. It still allows to see how participants see themselves in comparison to their expected mean value (Brosius, Haas, and Koschel 2016, 87–89). The range of the scales is even, which allows choosing the middle, indicating an indifference towards the item. Brosius et al. acknowledge the risk of participants choosing the middle just because it is the easiest answer, not requiring a decision. But they also warn that participants should be given the possibility to answer in a way that actually reflects their opinion. Which also includes ambivalence (Brosius, Haas, and Koschel 2016, 90).

The order of the questions is not randomly, every participant is confronted with the same circumstances. The survey does not use any media assets to avoid conflicts with the internet network of Soka students, which restricts some contents.

4.3.3. Conducting the Survey

Preceding the survey, a pretest was carried out for three days. During this time, three selected participants completed and analyzed the survey. The participants were students of different majors, since the target group of the survey are students as well. The input of the testers led to improvements of the wording in the

introductions to the topics robotics and alternative methods of payment. Also, the layout experienced adjustments to improve user experience. The pretest confirmed the estimated time of less than ten minutes to complete the questionnaire. Following the pretest, a fluent Japanese speaker reviewed the Japanese version of the survey.

The survey is available in the following languages: German, English and Japanese. The English version was a necessary step for the Japanese variant, since the translator of the Japanese version is not fluent in German. Since the language of the thesis is English, the English translation prove useful for the evaluation. Unfortunately, this measure allowed for participants, who neither spoke German nor Japanese and therefore were not part of the target group. English questionnaires are considered irrelevant for the results.

Japanese students were mostly reached by student internal channels, for example the messenger app LINE. By contacting the group leaders of (international) dormitories, about 200 students were reached, including international students (the exact share of international students is not official, but less than 50%). A mean to contact dormitories for Japanese students was not available. In addition, personally known members of student clubs were asked to share the survey with club members. The following figure shows the message shared with Japanese students.



Figure 9: Message to Japanese students via LINE messenger

German students were mostly acquired in person. Since the University of Applied Sciences Munich offers mostly technical majors, participating students might have more experience with technologies than the average students of Soka University. To avoid biased students, most students were acquired at the Ludwig Maximilian University, which offers many non-technical majors. Students of this university

were confronted with a Quick Response Code (QR Code) to quickly access the survey.

About 100 German students were asked to participate, mostly by sharing the QR Code with them in person. About one third of them was not able to make use of the QR Code, since they did either not know the technology and/or did not possess a scanner or camera acting as a scanner for the QR Code. Another problem was the difficulty to identify persons as students and which nationality they belong to. This led to invalid questionnaires of non-students or exchange students, who are not relevant for the hypothesis. To counter this unexpected development, the survey was also spread through the survey sharing platform <https://www.thesisus.de/>, which adds the option to participate in a lottery and attracts additional participants.

The survey was available from January 7 to January 31, 2019. This time frame was mostly set by new year holidays and the examination period from the end of January/beginning of February, which was expected to negatively affect the willingness to participate. A reminder to participate was given to five students towards the end of January. The dormitory and club groups did not receive a reminder, since those communication channels do have other purposes than sharing surveys.

4.4. Results of the Evaluation

The survey began in the night of January 7 (JST: January 8) and ran until January 31. Within this period the survey has been clicked 170 times. 89 participants clicked through the survey and 67 of them reached the last page. Seven cases have been filtered out, since they indicated they were neither Japanese or German by using the English survey to participate. Therefore, in regard to the hypothesis they are not relevant. The total number of valid entries is 60. In two of the 60 cases the participants answered SD04 with not being Japanese or German. Their responses are still included, since using the German survey gives reason to assume they are at least familiar with Germany. Assuming a higher number of participants, it would be preferable to exclude all participants who neither checked Japanese or German in the survey.

The survey was shared with about 200 Japanese and 100 German students. Since German students could be acquired in person, their participation rate was expected to be higher (more personal than receiving a written invitation by a stranger). With 89 participants, this leads to a participation rate of about 30%, 22% if only considering the completed questionnaires and 20% if only taking the valid questionnaires

into consideration. The following figure shows the temporal development of the participation rate.

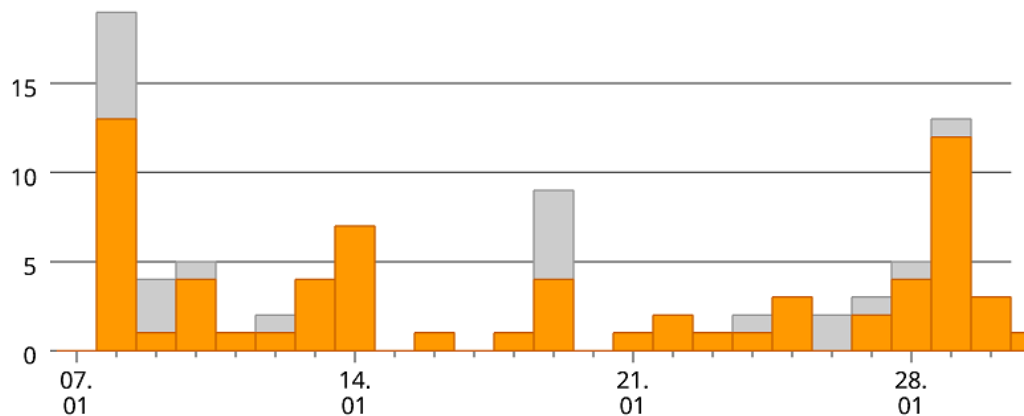


Figure 10: Participation over time

The graph clearly shows the spikes in participation whenever the survey was shared through multipliers or on days the QR code was shared in person. On January 21, the survey was publicized online for German students. Since then, most days recorded at least one valid survey entry. The following table presents an overview of the different characteristics of most of the technical questions. In this table, the combined answers of Japanese and German participants are taken into account. The table does not include the questions number six and seven, because of their different type of question compared to the rest (metric vs nominal). A separate table for each of those questions displays their data.

Statistical overview of combined data (Japanese and German students)

Item	Valid entries (N)	Minimum	Maximum	Mean value	Standard deviation of mean value	Standard deviation	Variance
VR02 (UB)	60	1	2	1.67	.061	.475	.226
VR03 (UB/SI)	60	1	4	2.00	.124	.957	.915
VR04 (SI)	60	1	5	2.98	.160	.242	1.542
VR05 (PEOU)	60	1	5	3.33	.153	.188	1.412
VR08 (IU)	60	1	5	2.75	.215	1.663	2.767
RB02 (UB)	60	1	2	1.67	.061	.475	.226
RB03 (UB/SI)	60	1	5	2.10	.132	1.020	1.041
RB04 (SI)	60	1	5	3.35	.163	1.260	1.587
RB05 (PEOU)	60	1	5	3.50	.149	1.157	1.339
RB08 (IU)	60	1	5	2.70	.223	1.730	2.993
AP02 (UB)	60	1	2	1.18	.050	.390	.152

AP03 (UB/SI)	60	1	5	4.07	.144	1.118	1.250
AP04 (SI)	60	1	5	3.40	.141	1.092	1.193
AP05 (PEU)	60	1	5	3.35	.106	.820	.672
AP08 (IU)	60	1	5	3.02	.094	.725	.525

Table 3: Analysis of merged results of technological sections in the survey

The codebook is available in digital form. In general, a bigger value indicates a more positive answer, except for the items VR02, RB02 and AP02. The numbers indicate that for every item except VR03, the minimum and maximum values have been selected at least once. Looking at the mean values (excluding VR02, RB02 and AP02, since using a technology is not equally possible for every participant, e.g., different amount of money available), the general impression shows a more positive picture of alternative methods of payment (overall mean value = 3.46, compared to virtual reality (overall mean value = 2.77) and robotics (overall mean value = 2.91). Another peculiarity is the notable difference of the standard deviation of robotics and virtual compared to alternative methods of payment. Especially robotics is a topic with differentiated views.

The results for VR06, VR07, RB06, RB07, AP06 and AP07 are displayed in their respective section of this chapter. For VR, the numbers indicate that participants see a slight improvement of the usefulness of VR over the next five years (mean value 3.48 to 3.53). Compared to VR, robotics is expected to drop in its usefulness over five years but see an overall bigger usefulness than VR (3.85 to 3.75). Alternative means of payment lie in the middle when it comes to usefulness, but in five years they are expected to be the most useful of the three technologies (3.66 to 3.88).

The following subchapters graphically show the results of each questions, supplemented by a written explanation. The separated data of Japanese and German participants is evaluated following the combined evaluation. To avoid too much graphical input, no figures visualize the separated results.

4.4.1. Virtual Reality

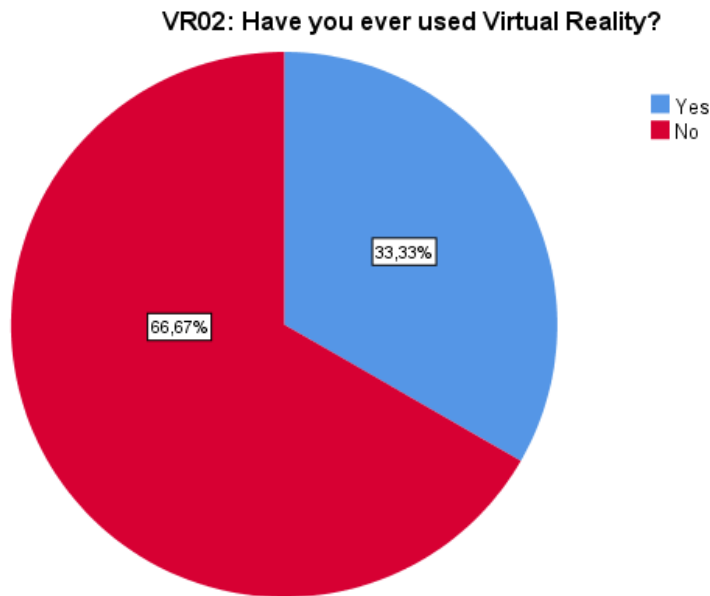


Figure 11: Item VR02

Two thirds of the participants never used virtual reality. With 60 valid entries, this equals to 40 persons who never used virtual reality and 20 who did. Of the three technologies introduced for the survey, virtual reality is probably the newest addition to the consumer market. Using the technology does not necessarily require owning it, which, considering the high price for a full virtual reality ready setup, might explain the number of positive answers.

Japanese students have less hands-on experience with virtual reality. 23.8% of the Japanese students have ever used this technology so far, whereas 76.2% disagree to this question. Five of the five students with VR experience also submitted numbers of how many times they used it. Three students have a one-time experience with VR, but respectively one student has a three- and five-times experience.

German students have a little more practical experience with virtual reality. 38.5% of them have actually used virtual reality, the remaining 61.5% have not. Looking at the frequency VR has been used, 15 of 15 students with experience answered. Twelve of them have made the experience one or two times. Two students answered with a use of three times and one student even ten times.

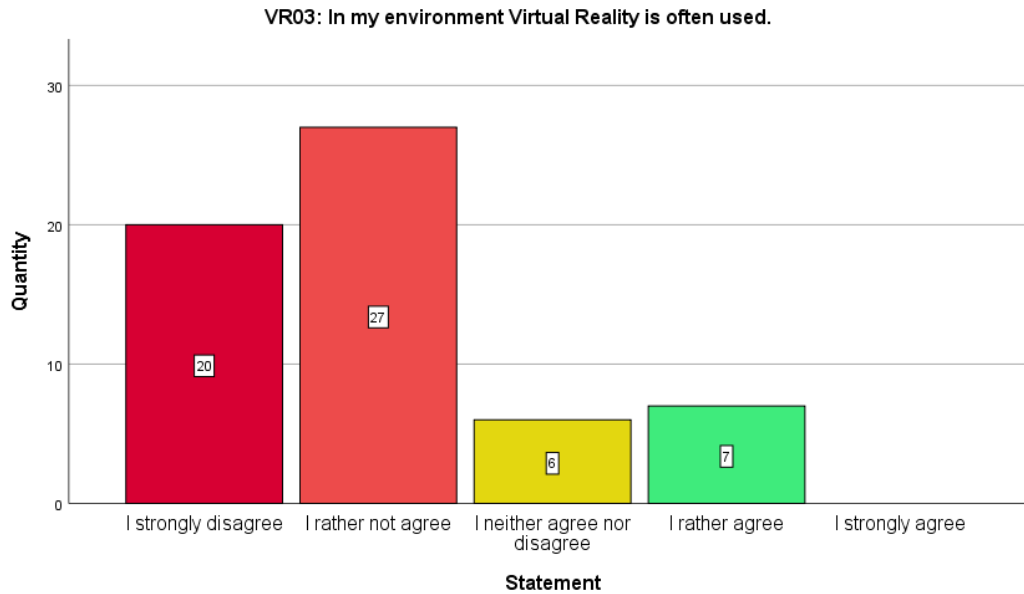


Figure 12: Item VR03

This item is the only item without a single participant strongly agreeing to the statement. On the contrary, most of the students disagreed to this item (78%). About 10% had a more neutral view and about 12% leaned in favor of this item. These results are in line with the previous item, where two thirds of the students have never used virtual reality. Consequently, most participants perceive this technology as not much used in their surroundings. Still, this question is hard to evaluate since virtual reality is not mainstream enough to be encountered frequently in public. Virtual reality at home or in arcade halls, for example, is more likely to be encountered by people who are already interested in this technology.

Japanese students agree more often to this statement. 38.1% are at least neutral or slightly positive inclined. In contrast to this number, 61.9% are either slightly or strongly disagreeing to this statement.

German students more often answered negatively. 87.2% don't think virtual reality is used often in their environment. 12.8% are not sure about this statement or rather agree. Here is a clear tendency of German students encountering VR less often in their environment than Japanese students, despite the German students having used it more often.

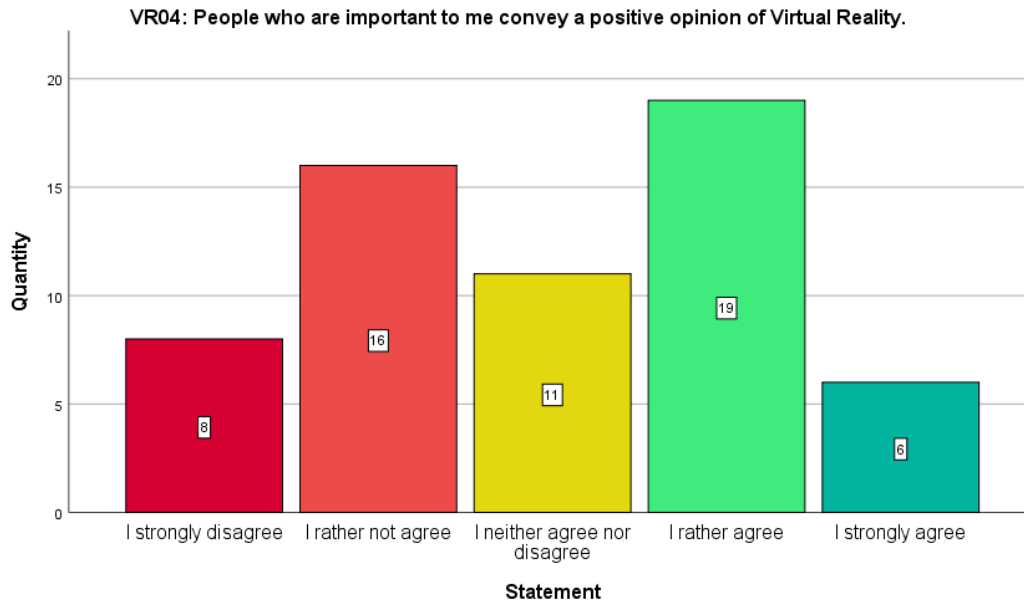


Figure 13: Item VR04

About 18% of the students do not experience social influence through the opinion of people important to them. The reason for that could be virtual reality being no topic at all or the conveyed opinion is neutral. Slightly more people strongly disagree to the statement of this item (~ 13%), compared to strongly agreeing (10%). But overall, the students experience a slightly more positive view (~42%) on virtual reality. Nevertheless, negative opinions are conveyed nearly equally as much (40%).

Japanese students tend to avoid the extremes. Few Japanese students strongly disagree (9.5%) and no one strongly agrees. Most Japanese students (33.3%) slightly disagree and a similar number of students tends to agree or can neither agree or disagree (28.6%).

German students have stronger opinions. 15.4% completely disagree and 15.4% strongly agree to this item. But only 12.8% of the students chose the middle. A few more students perceive positive opinions (33.3%) of their socially important people rather than not (23.1%).

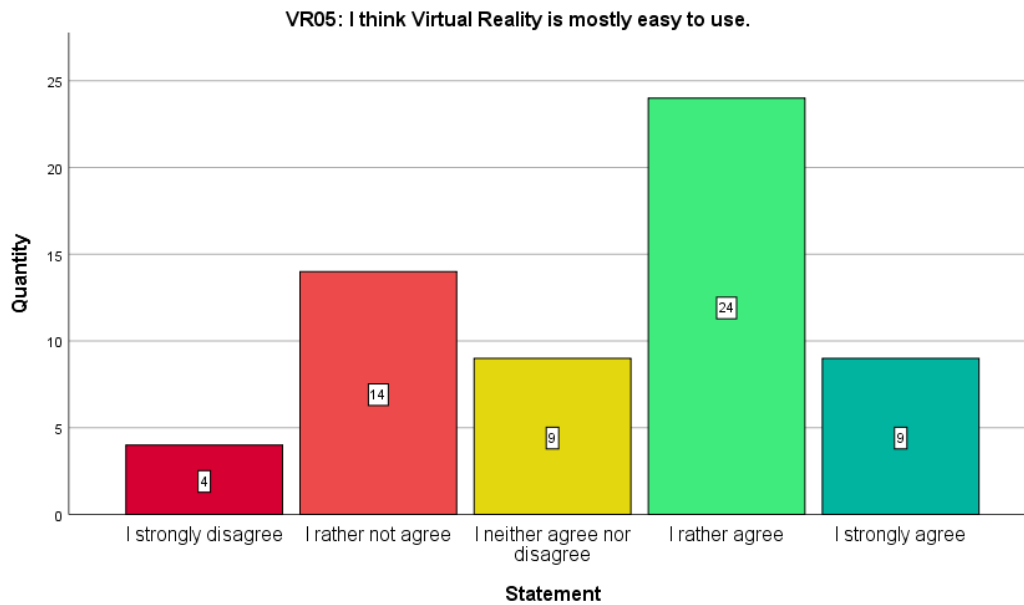


Figure 14: Item VR05

The majority of students experience virtual reality as mostly easy to use (55%) but not few students might have difficulties using virtual reality (30%). Only few students (15%) have a mixed feeling about the ease of use with virtual reality. While the term ‘mostly’ in the statement of this item tried to account for the varying difficulty of the different virtual reality devices, the ambivalent statement could hint to students having mixed experiences with virtual reality technologies. For example, building a VR setup for use at home requires more knowledge, than just trying it out during an exhibition.

Japanese students are mostly inclined to agree to this statement. 12.8% even completely agree and 38.1% rather agree. Only 4.8% strongly disagree, but 23.8% rather disagree. 14.3% of the Japanese participants have a mixed opinion.

German students seem to think like Japanese students about the ease of use. As with Japanese students, the smallest number of German students strongly disagrees on VR being easy to use: (7.7%). 23.1% rather disagree, 15.4% chose the middle and the majority slightly agrees (41.0%). Only 12.8% agreed even strongly.

		VR06_01	VR06_02	VR06_03	VR06_04	VR06_05
N	Valid	60	60	60	60	60
	Missing	0	0	0	0	0
Mean		4.23	3.13	3.07	3.37	3.58
Std. Error of Mean		.244	.327	.254	.326	.337
Std. Deviation		1.890	2.534	1.965	2.524	2.612
Variance		3.572	6.423	3.860	6.372	6.823
Minimum		-9	-9	-9	-9	-9
Maximum		5	5	5	5	5

Table 4: Merged results of VR06

The question was unusual often skipped (minimum value of -9). Maybe people without experience did not want to give their opinions on usefulness of a technology they have not used so far. Looking at the mean values, most students can see the usefulness of VR in gaming (4.23) while it is perceived the least useful for education (3.07). Since VR is probably most often encountered for entertainment purposes it is interesting to see medicine as the second most useful field of application, which could probably be extended to other job-related simulations (as given in the example of the item, e.g., piloting).

Analyzing each subitem separately as with the other questions would bloat this section unnecessarily. Therefore, only the most noticeable differences are mentioned. For VR06_01, both students generally rather agree or even strongly agree. For VR06_02, German students rather agree (35.9%) or rather disagree (35.9%). Japanese students are more positive, 52.4% strongly agree, compared to 7.7% of the German students. The statements for VR06_03 are similar. Likewise, with VR06_04, where German prefer to rather agree (41.0%) and Japanese strongly agree (33.3%). For VR06_05, more German than Japanese students remain undecided or rather agree.

		VR07_01	VR07_02	VR07_03	VR07_04	VR07_05
N	Valid	60	60	60	60	60
	Missing	0	0	0	0	0
Mean		4.17	3.30	3.02	3.52	3.63
Std. Error of Mean		.326	.329	.334	.331	.334
Std. Deviation		2.526	2.547	2.587	2.568	2.584
Variance		6.379	6.485	6.695	6.593	6.677
Minimum		-9	-9	-9	-9	-9
Maximum		5	5	5	5	5

Table 5: Merged results of VR07

In five years, the participants expect VR to be even less useful for education (3.02) but it has to be considered that VR07_01 and VR07_03 have been skipped twice as much compared to VR06. Keeping that in mind, gaming remains the most useful application of VR, but dropped compared to five years before. Within five years, participants expect a rise in usefulness for the application of VR in movies, marketing and medicine.

As with VR06, only the most prominent differences are highlighted. For VR07_01, no student selected to strongly disagree or rather disagree, but 5.1% of the German students either skipped the item or were unable to decide. For both nationalities, students mostly agreed, but 71.4% of the Japanese chose to strongly agree, compared to 59.0% of the German students. For VR07_02, Japanese students were clearly positive inclined. 47.6% strongly agreed, 42.9% rather agreed, compared to respectively 17.9% and 25.6% of the German students, who mostly remained undecided (30.8). German students favored to rather agree (20.5%) or could not decide (23.1%). Again, Japanese students had a rather positive (38.1%) or strong positive opinion (28.6%) about VR07_03. For VR07_04, more Japanese (43.9%) than German (33.3%) strongly agreed. Similar behavior is seen for VR07_05, but overall the selection was similar.

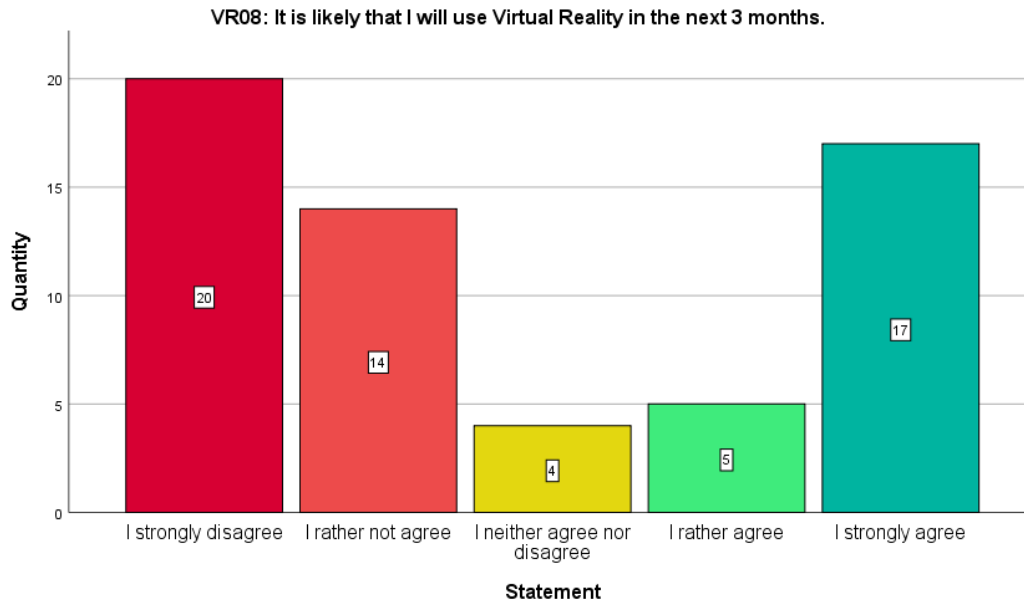


Figure 15: Item VR08

The students reacted strong to this item, though, mostly in disagreement (~ 57%). But at least 28% of the students even strongly agreed to this statement and a total of nearly 37% expect to use virtual reality soon. This is more than a third of the total students who claimed to have already used virtual reality. Only few students (<7%) were unable to estimate whether they would or would not use virtual reality within the next three months. Therefore, only few students think they randomly encounter opportunities to use virtual reality but rather look for or avoid those opportunities.

Japanese students tended stronger towards the negative spectrum of answers than German students. Like them, 33.3% strongly disagree, but contrary to them 38.1% rather disagree. Not many chose the middle (7.7%) or slightly positive (7.7%), about double as much strongly agreed.

German students have overall stronger positive expectations (35.9%). The number of students rather disagreeing (15.4%) is less than half the size of the Japanese students. The other values are very similar or even the same for strongly disagreeing. This is particularly interesting, since fewer German students have already had experience with VR and more Japanese students see use of VR in their environment.

4.4.2. Robotics

RB:02 Did you already have direct contact with robots in any form?

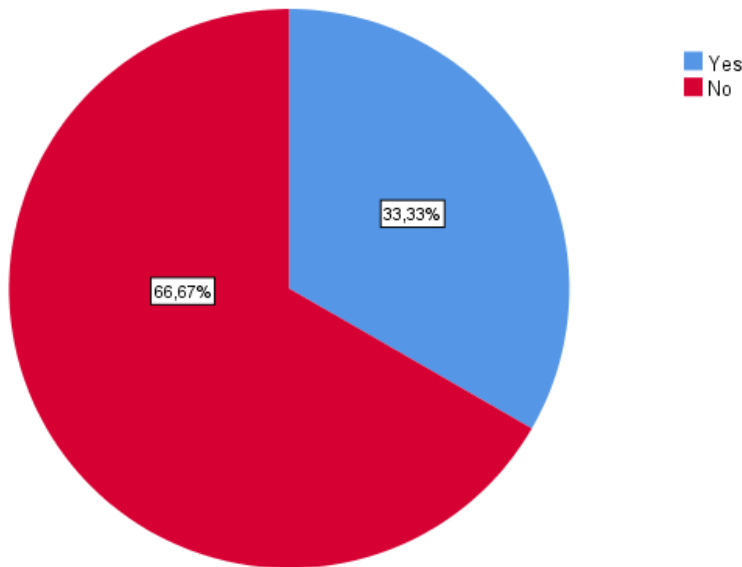


Figure 16: Item RB02

Surprisingly, the numbers of RB02 equal the results of VR02. The students have as much practical experience with virtual reality as with robots. Two thirds of the participants think they never had contact with robots. With 60 valid entries, this equals to 40 persons who did and 20 persons who did not come in contact with robots. Of the three technologies introduced for the survey, robotics is overall probably the most established technology, but for the consumer market less tangible than the other two technologies. The biggest challenge of this section is that participants might have very different views of what counts towards robotics. Some might already take automated vending machines as robots whereas others think of fully-fledged humanoid robots.

Japanese students who participated in the survey have more often used some form of robot. 38.1% of the students have and 61.9% have not used a robot ever. Factoring in how many times the students have used a robot, the tendency shifts towards German students. Three of the Japanese students indicated a one-time use, one student used robots twice and another student thrice.

German students have slightly less experience with robots. 30.8% of them used some robot, compared to 69.2% who never did. For the single digit numbers, the values are similar to Japanese students, but respectively one student indicated to have used robots ten, twenty and even fifty times.

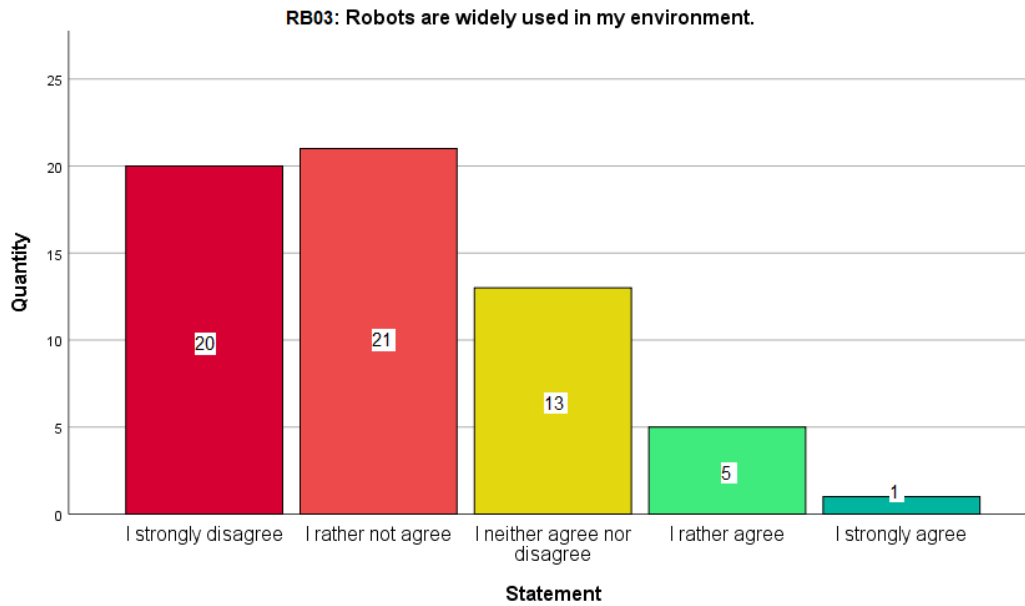


Figure 17: Item RB03

The graph shows a clear negative tendency. Over 68% of the participants perceive robots as not widely used in their environment, with even one third of the total participants strongly disagreeing to this item. Only 10% think of robots as widely used, which is slightly less than for an entertainment technology like virtual reality. On the other hand, 21% cannot agree nor disagree, which is overall a less negative view on robots than on VR. The reason for this result could be the uncertainty about what is considered a robot and what not.

Japanese students mostly opposed this statement. The relative number of students who strongly disagree is the same as for German students (33.3%), but instead of rather disagreeing (28.6%), more Japanese students remained undecided (28.6%). No Japanese strongly agreed, but 9.5% at least rather agreed.

German students have a similar but overall even more negative opinion, even though the single strong agreement comes from a German student. 7.7% rather agree, but more students rather disagree (38.5%) than having a mixed opinion (18.9%), as Japanese favor.

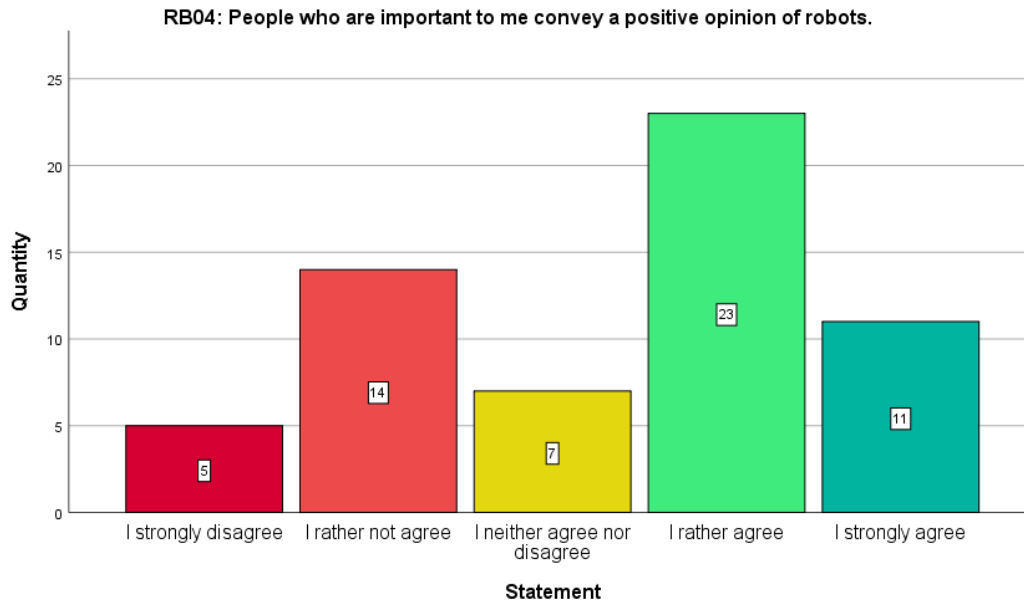


Figure 18: Item RB04

As with VR04, only few students (< 12%) do not perceive a noticeable positive or negative social influence through the opinion of people important to them. Contrary to the results of virtual reality, the opinion conveyed about robots tends to be more positive. Nearly 57% of the students tend to agree to the statement made in this item, compared to about 32% disagreeing to the statement. Slightly more people strongly disagree to the statement of this item (~ 13%), compared to strongly agreeing (10%).

Japanese students mostly approved of this statement, but not as strong as German students. Only 9.5% strongly agreed, but 38.1% rather agreed. The biggest difference is the relatively high number of students who neither agree nor disagree (23.8%). A smaller proportion rather disagreed (19.0%), but 9.5% strongly disagreed.

German students have a bigger share of students who strongly agree (23.1%). The number of rather agreeing students (38.5) is close to the Japanese share, but much fewer students have a mixed view (5.1%). Nearly a third of the students have a negative impression of the conveyed opinions, with 25.6% rather disagreeing and 7.7% strongly disagreeing.

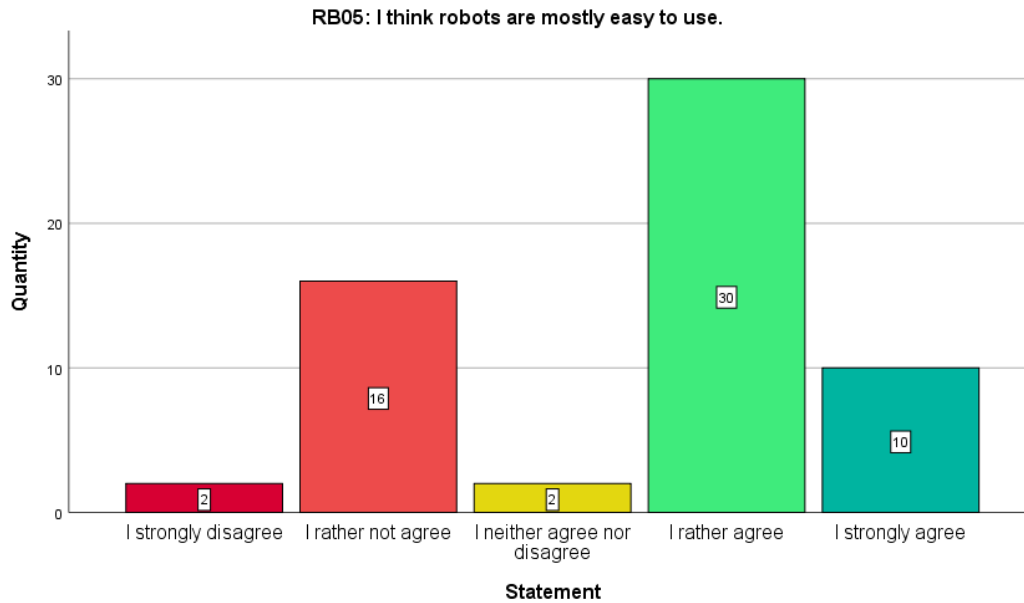


Figure 19: Item RB05

In comparison with virtual reality an even bigger majority of students think robots are mostly easy to use (<67%) with some students (<27%) who oppose this item slightly. A clear minority of the students have mixed feelings (~3%) or even strongly disagree (~3%) to the idea of robots being mostly easy to use. An interesting aspect of this item is the idea that virtual reality is supposed to be more accessible for the consumer market (although still relatively new), whereas many of the different forms of robots are not explicitly usable by consumers. Noteworthy is also the idea that some forms of robots are more present in everyday life compared to virtual reality.

Japanese students avoided strong opinions on this item more than the German students. No student strongly disagrees and 9.5% strongly agree. Also, similar to German students, very few had a mixed opinion (4.8%). 33.3% rather disagree and 52.4% rather agree, showing a positive tendency towards the ease of use of robots.

A few German students strongly disagree (5.1%), compared to 20.5% strongly agreeing. Like Japanese students, only 2.6% of the students neither agreed nor disagreed. The relative share of students rather disagreeing (23.1%) is smaller compared to Japanese students, as with rather agreeing (48.7%).

		RB06_01	RB06_02	RB06_03	RB06_04	RB06_05
N	Valid	60	60	60	60	60
	Missing	0	0	0	0	0
Mean		3.62	4.30	2.93	4.52	3.88
Std. Error of Mean		.139	.102	.161	.108	.139
Std. Deviation		1.075	.788	1.247	.833	1.075
Variance		1.156	.620	1.555	.695	1.156
Minimum		1	2	1	1	2
Maximum		5	5	5	5	5

Table 6: Merged results of RB06

While probably few people happened to encounter a robot used for safety purposes, it is perceived as the most useful area of application for robots, followed by service robots. No one completely disagreed to the usefulness of service robots, the same as for robots used in medicine. These are seen as third most useful field. For entertainment purposes robots are still comparable useful, but few people can imagine them being useful for educational purposes. The accuracy is higher for this item than for its VR counterpart, probably since it was never skipped.

Again, only the most remarkable differences are listed for each subitem. For RB06_01, Japanese students selected more positive values than German students. No Japanese strongly disagreed and only 4.8% rather disagreed, compared to respectively 7.7% and 12.8% of the German students. The relative share of Japanese students strongly agreeing is more than 4-times higher compared to the German students. For RB06_02, no student strongly disagreed, but Japanese were less indecisive but more positive inclined. For RB06_03 Japanese students showed a clear positive tendency, whereas German students had more negative or mixed opinions. German and Japanese students had a similar mindset about RB06_04. The most remarkable difference in RB06_05 is the higher share of German students with a mixed opinion (25.6%) and Japanese students rather agreeing (33.3%) or even strongly agreeing (47.6%).

		RB07_01	RB07_02	RB07_03	RB07_04	RB07_05
N	Valid	60	60	60	60	60
	Missing	0	0	0	0	0
Mean		3.53	4.32	3.02	4.05	3.83
Std. Error of Mean		.266	.238	.261	.330	.252
Std. Deviation		2.062	1.846	2.021	2.554	1.950
Variance		4.253	3.406	4.084	6.523	3.802
Minimum		-9	-9	-9	-9	-9
Maximum		5	5	5	5	5

Table 7: Merged results of RB07

Robots used for safety experience the biggest change when asked about their usefulness in the next five years. Their mean value drops by over 10%. The changes for other kinds of robots are significantly smaller. The share of service robots rose by a tiny margin. They are perceived as the most useful kind of robots, followed by safety robots which are still considered useful. Robots used for education remain the least useful robots, but their mean value increased, too. The variance for the values of this item is noticeably high.

Japanese students have a stronger positive tendency towards item RB07_01. Germans are also mostly on the positive spectrum, but more of them gave a mixed (20.5%) or rather negative statements (12.8%). No student strongly or rather disagreed on item RB07_02, but nearly double as much German students have a rather positive view. Japanese students compensate through a higher share of students strongly agreeing. For RB07_03, most of the German students rather agree (28.2%), but a similar number rather disagrees (25.6%) or do not have a tendency (32.1%). Noticeably more Japanese students strongly agree (33.3%) or rather agree (33.3%). The values of RB07_04 are very similar within each nationality. For RB07_05, German participants are more undecided (20.5%), but Japanese students have a stronger positive opinion (47.6%) despite a higher share of students rather disagreeing (14.3%).

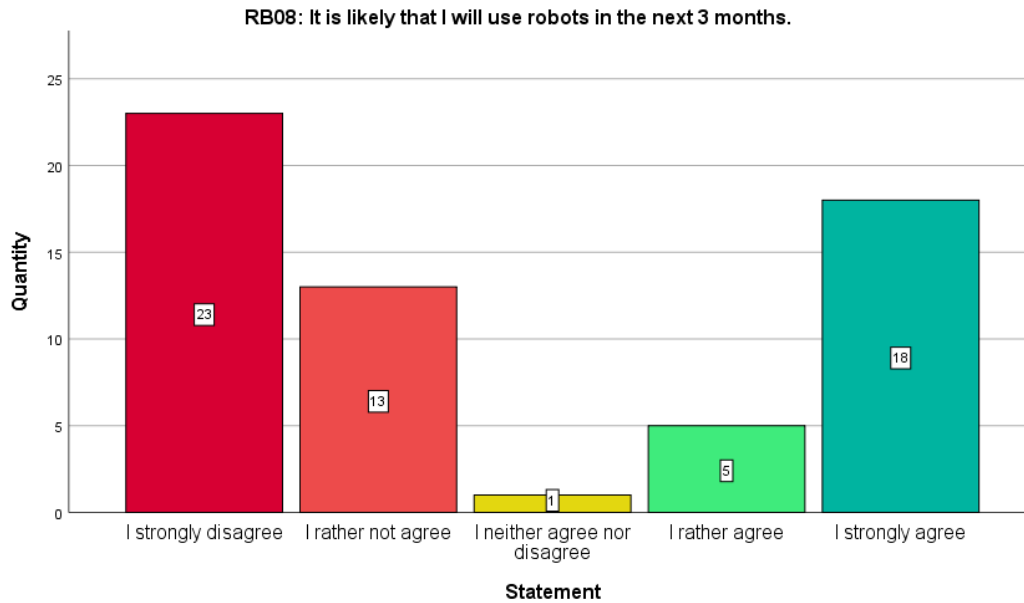


Figure 20: Item RB08

Similar to VR08, the student's reactions to this item are very opposing but again, mostly in disagreement (60%). 30% of the students agreed strongly to this statement, with a total of about 38% who can imagine using some form of robot soon. Again, this is more than the third of total students who claimed to have already used robots. A single student (<2%) is undecided about whether he/she would or would not use some form of robot within the next three months.

Japanese students are again less pronounced on the extremer opinions. 28.6% strongly disagree and 19.0% strongly agree. Nobody chose the middle value. 38.1% rather disagree and 14.3% rather agree, leading to an overall more negative tendency.

35.9% of the German students strongly agreed, but 43.6% strongly disagreed. Combined with 12.8% rather disagreeing and only 5.1% rather agreeing, the tendency is negative towards this item.

4.4.3. Alternative Methods of Payment

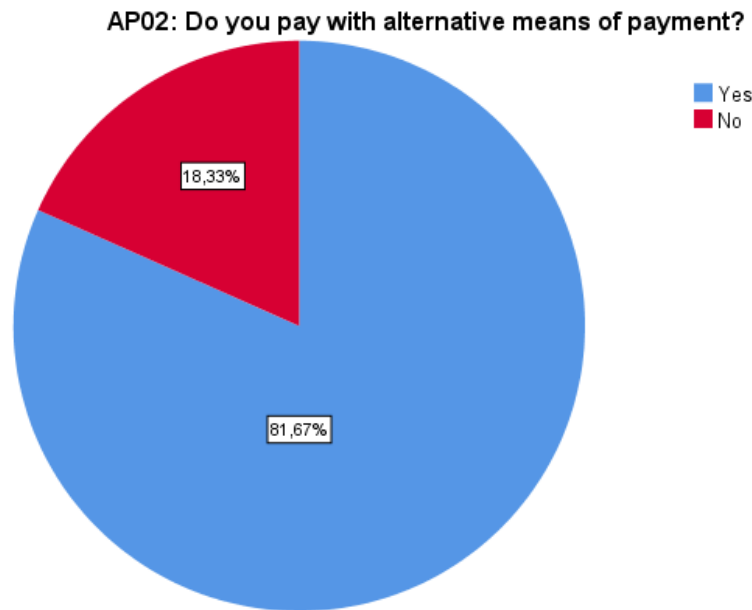


Figure 21: Item AP02

The item AP02 finds much more agreement than the previous questions of this type (VR02, RB02). A majority of nearly 82% have already used alternative means of payment. Therefore, students have much more practical experience than with virtual reality and robots. Of the three technologies introduced for the survey, the alternative methods of payment are the most practical in everyday life and available for many years, at least some forms. Through to the high numbers of uses it is likely they are mostly estimations.

Japanese students mostly have already used alternative means of payment (66.7%). A lot of different numbers have been submitted. 83.4% of the submissions were lower or equal to 100 uses in 2018, 8.3% with 150 uses and 8.3% with 300 uses.

German students have even more practical experience with other payments than cash. 89.7% of them have used some form of alternative payment. Of those who submitted their estimation, 69.8% used alternative means of payment up or equal to 100 times. Other indications were 175 (3.0%), 200 (15.2%) and 500 (6.1%). Also, 365 made 6.1% of the answers, likely to indicate they use alternative means every day of the year.

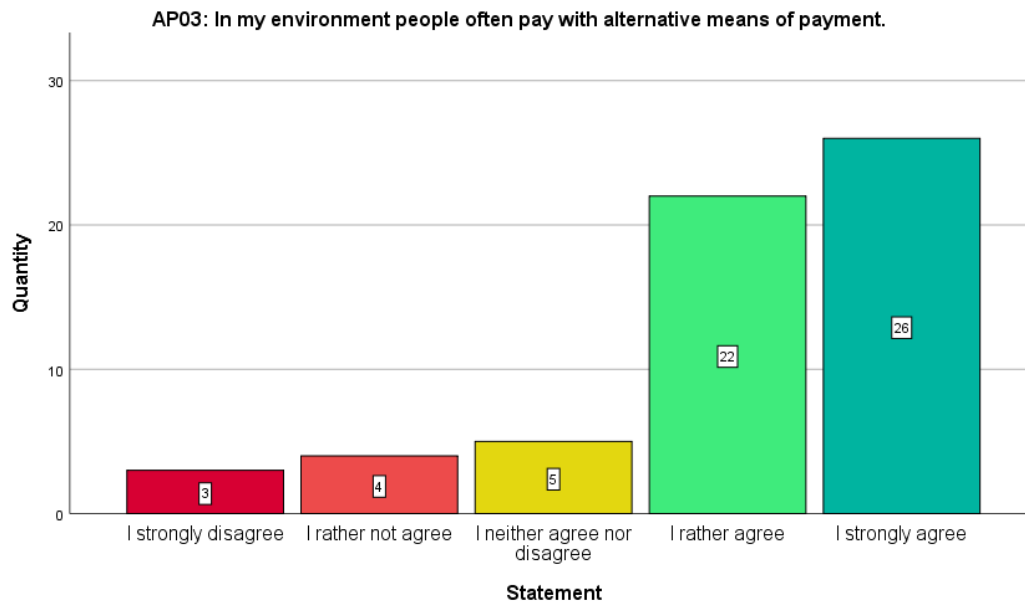


Figure 22: Item AP03

The graph nearly shows the opposite of the corresponding VR03, but in this case all extremes are present. The statement is clearly positive. An overwhelming majority of the students (80%) perceive their environment as active users of alternative means of payment. This clearly speaks for its wide spreading. Still, there are nearly 12% of the students who do have the impression that cash is the dominating mean of payment. About 8% had a more neutral view and are undecided about which method of payment is used often. A difficulty with this question is the unclear perception of what ‘often’ means to each participant.

Of the Japanese students, 19.0% indicated they rather disagree and 4.8% strongly disagree. Therefore, they make up most of the negative entries. 4.8% neither agreed nor disagreed, 42.9% rather agreed and 28.6% strongly agreed.

German students had a stronger positive opinion, 51.3% strongly agreed, but only 33.3% rather agreed. More German students had a mixed opinion (10.3%), but fewer negated their environment uses alternative means often. No student slightly disagreed, but 5.1% disagreed strongly.

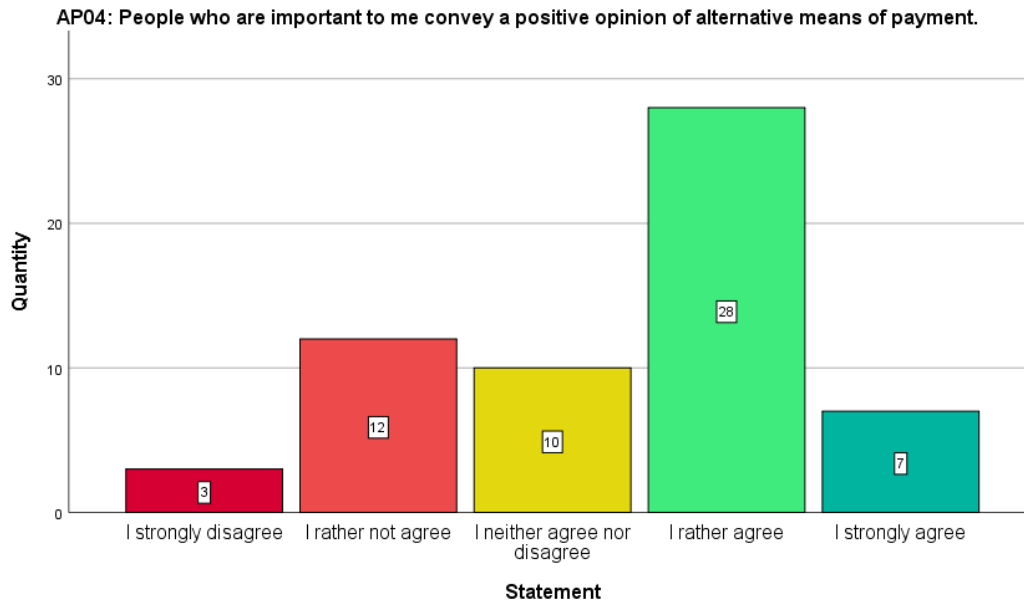


Figure 23: Item AP04

In comparison to VR04 and RB04, a similar number of students (<17%) feels rather indecisive about which opinion people within their socially important circle convey. Different to the counterparts of the other sections is the mostly positive opinion that seems to be prevalent. Nearly 47% of the students rather agree to this statement, totaling in over 58% in favor of this item. A quarter of the students experiences negative opinions about alternative means of payment.

Japanese students were more inclined to disagree. 4.8% did so strongly, but 28.6% at least rather disagreed. Close to the relative number of undecided German students, 19.0% of Japanese students were undecided. 38.1% rather agreed and 9.5% strongly agreed.

5.1% of the German students strongly disagreed about this item, 15.4% rather disagreed and the same amount neither disagreed or agreed. 51.3% rather agreed and 12.8% strongly agreed, which indicates German students perceiving a more positive social environment when it comes to alternative means of payment.

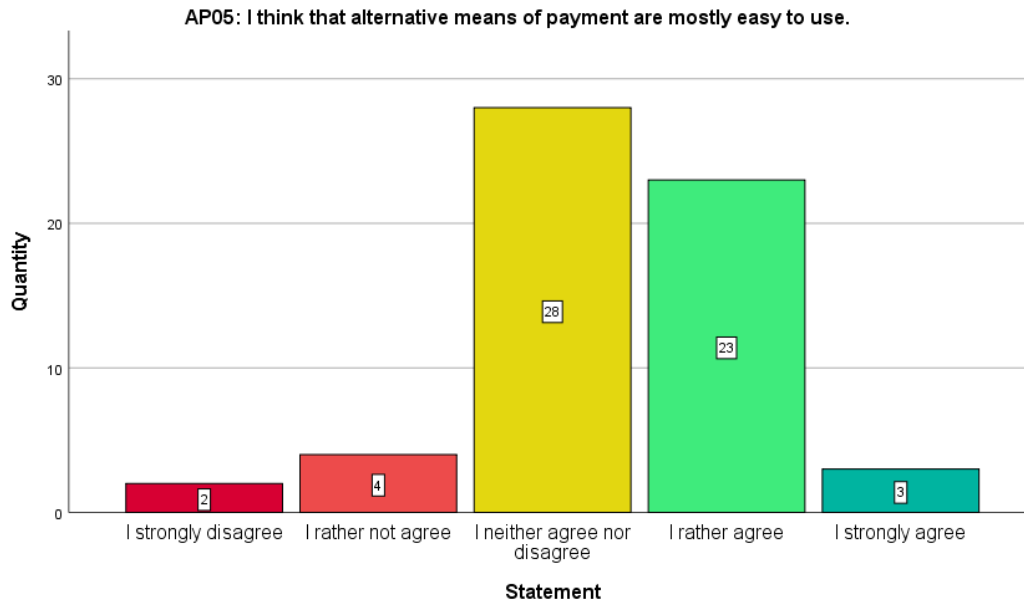


Figure 24: Item AP05

Contrary to virtual reality and robotics, only few students (10%) think of alternative means of payment being not easy to use. Nearly half of the students have a mixed view (<47%) on the ease of use, which could hint at different experiences with different means of payment. A similar number of students think positive about the ease of use, with only 5% agreeing strongly but at least 38% with a slight positive tendency.

Japanese students answered slightly more negative, but overall very similar to German students. 4.8% strongly disagreed and 14.3% rather disagreed. 42.9% were undecided about the ease of use, but 33.3% rather think alternative means of payment being mostly easy to use. 4.8% even agreed strongly to this.

Fewer German students strongly disagreed (2.6%) or rather disagreed (2.6%) to this statement. 48.7% had a neutral stance on this, 41.0% a rather positive and 4.8% a strongly positive stance.

		AP06_01	AP06_02	AP06_03	AP06_04	AP06_05
N	Valid	60	60	60	60	60
	Missing	0	0	0	0	0
Mean		4.23	3.77	4.30	2.32	3.68
Std. Error of Mean		.129	.174	.257	.172	.166
Std. Deviation		.998	1.345	1.994	1.334	1.282
Variance		.995	1.809	3.976	1.779	1.644
Minimum		1	1	-9	1	1
Maximum		5	5	5	5	5

Table 8: Merged results of AP06

Students think of mail orders as being the most useful field of application for alternative means of payment. It is closely followed by banking transactions. On the third position is the usefulness of alternative means for service transactions like public transport, which is closely followed by the usefulness for stationary trade like in supermarkets. Clearly most people perceived alternative means of payment the least useful for street trades, with about 37% lower approval of the statement compared to stationary trade. AP06_03 has a minimum value of -9 and therefore was the only item that was skipped.

As with similar items before, only major differences between German and Japanese students are highlighted for each subitem. For AP06_01, more Japanese students had a rather negative (9.5%) or neutral (19.0%) view on this, whereas more German students had a strong positive stance (59.0%). For AP06_02, it is the opposite of 01. More Germans are strongly (15.4%) or rather disagreeing (10.3%) or could neither agree or disagree (17.9%). Most of the Japanese students rather (38.1%) or strongly agree (52.4%). German and Japanese students have a very similar mindset about AP06_03. There is a clear difference between the students for AP06_04. Most Germans strongly (41.0%) or rather disagree (41.0%), whereas more Japanese are neutral (19.0%) or rather positive (19.0%). For AP06_05, most Japanese students found their opinion in the middle (28.6%) or on the strong positive side (38.1%). In comparison, more German students rather disagreed (12.8%) or rather agreed (28.2%).

		AP07_01	AP07_02	AP07_03	AP07_04	AP07_05
N	Valid	60	60	60	60	60
	Missing	0	0	0	0	0
Mean		4.42	3.90	4.22	2.75	4.13
Std. Error of Mean		.124	.256	.336	.262	.149
Std. Deviation		.962	1.980	2.604	2.030	1.157
Variance		.925	3.922	6.783	4.123	1.338
Minimum		1	-9	-9	-9	1
Maximum		5	5	5	5	5

Table 9: Merged results of AP07

Surprisingly, mail order is the only item that dropped in the rate of approval for its usefulness in the future, though only by about 2%. For every other item the participants expect alternative means of payment to become more useful in the next five years. For stationary trade and banking transactions the expectations on their future usefulness are the highest. For stationary trade about 12% expect alternative means to become more useful, for banking transactions about 4%. Unfortunately, for AP07_02 - AP07_04 the variance is considerably higher than for the other two items.

For AP07_01, Japanese students more often selected to rather disagree (14.3%) or stick to the middle (19.0%), in contrast to Germans who more often favored to strongly agree (71.8%). The difference for AP07_02 is that some German students had a more diverse opinion, mostly ranging from rather disagree (10.3%), neutral (12.8%) to rather agree (41.0%). Few of the Japanese entries indicate slight disagreement (4.8%) or mixed opinions (9.5%), but significantly more strongly agreed (71.4%). The opinions about AP07_03 were mostly unisonous and most of the students strongly agreed. For AP07_04, German students were more inclined to rather disagree (33.3%), whereas most of the Japanese students had a neutral (33.3%) or strong positive (33.3%) opinion. The attitude towards AP07_05 was very alike.

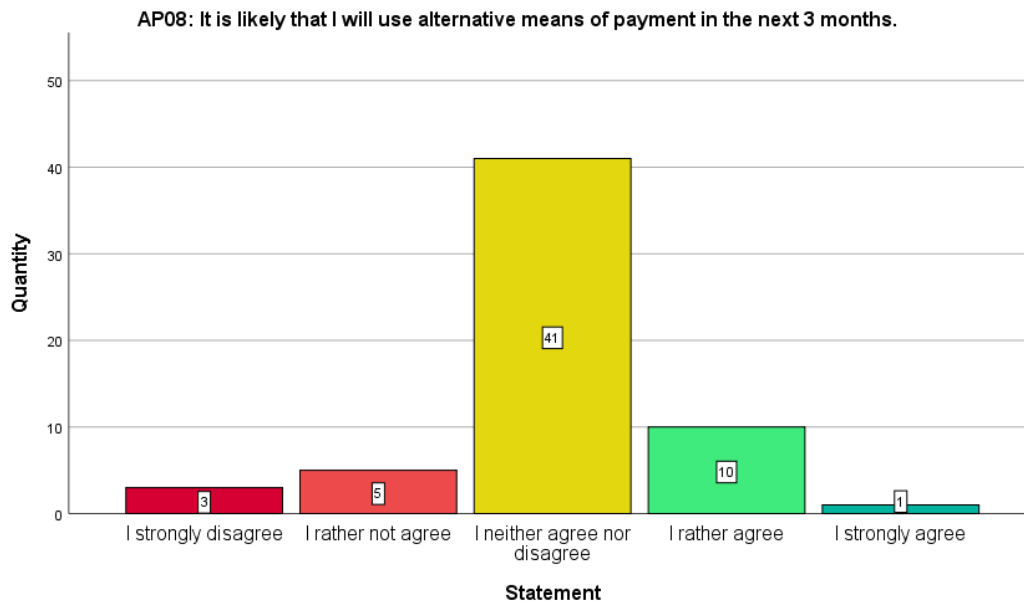


Figure 25: Item AP08

The graph shows a very different picture compared to its counterpart items VR08 and RB08. The students are mostly (~68%) undecided when confronted with the statement about their future usage behavior. A small majority (~18%) of the students who could make a decision, are in favor of using alternative means of payment within 3 months. Only few students (~13%) have difficulties imagining themselves to use other means than cash in the near future.

One Japanese student (4.8%) strongly agreed, but no Japanese student strongly disagreed. 19.0% rather disagreed, which is more than Germans did, but fewer neither agreed or disagreed (61.9%) and fewer Japanese students rather disagreed (14.4%).

German students more often strongly disagreed (7.7%), but only 2.6% rather disagreed. Most of the Germans selected the middle value (71.8%) and no German strongly agreed. 17.9% rather agreed. Overall, the students are surprisingly undecided, considering this technology has the clearest purpose.

4.4.4. Sociodemographic Features

SD02: Which biological gender do you associate with?

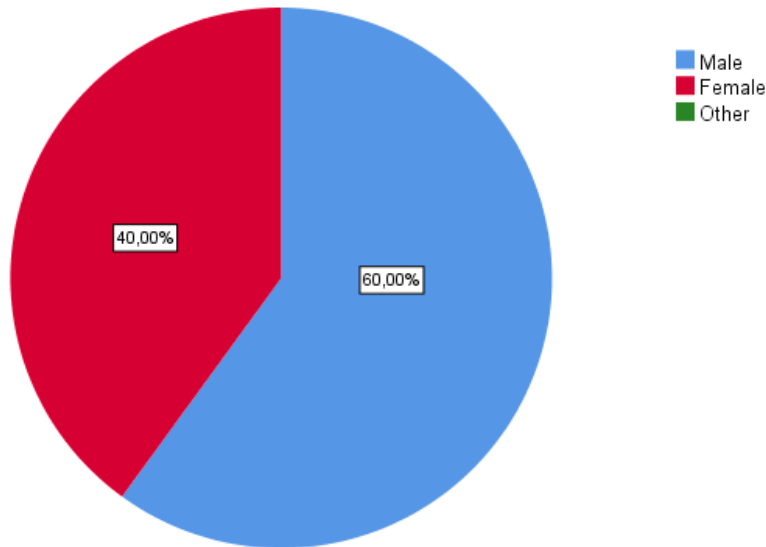


Figure 26: Item SD02

None of the participants identified themselves as part of another biological gender than male and female. 60% (36 students) of the participants identify themselves as male and 40% (24 students) as female.

Two thirds of the Japanese students are male, one third female. Using a dormitory for men as a multiplier for the survey most likely has the biggest impact on the tendency towards male participants.

Of the German students, 56.4% are male and 43.6% are female. Since German participants were mostly acquired in person, it was easier to achieve more balance between male and female participants.



Figure 27: Item SD03

Since the target group of the survey were students, most participants range from 19-26 years old, with a mean value of 22,37 and its deviation of 3,66. No participant was younger than 19 years old and two participants were at least 30 (30 and 40). Those exceptions could be in doctoral studies or some other, less common form of studies. But it is also possible they attend a common bachelor or master study.

The Japanese students participating in the survey were on average 19.95 years old, with no student older than 22 years old. 47.6% of the students are 19 years old, 28.8% 20 years old, 14.3% 21 years old and 14.3% are 22 years old. They cover the whole range of the expected age for undergraduate students in Japan.

German students are on average 23,67 years old, but the deviations are much bigger, since the students range from 19 years old to even 40 years old. Arguably, a considerable number of the participating German students are probably not only undergraduate and graduate students, but also other forms of students. Also, in Germany it is probably more common to study after doing gap years or working, which would explain the higher average age.

SD04: Which nationality do you belong to?

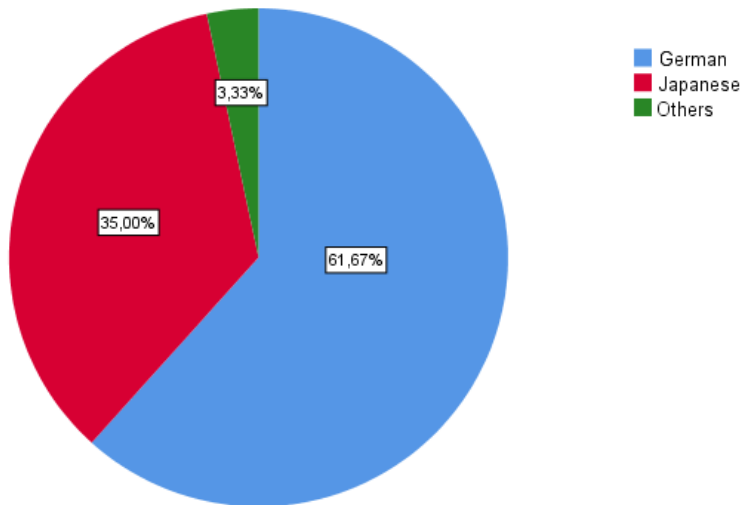


Figure 28: Item SD04

Considering the easier access to German students, an unsurprising majority of 37 students are German. Two students are neither Japanese or German nationals, but since they were able to use the German questionnaire form, they are added to the data sets from participants in Germany, adding up to 39. Only 21 participants are Japanese.

SD05: Which academic degree are you currently pursuing?

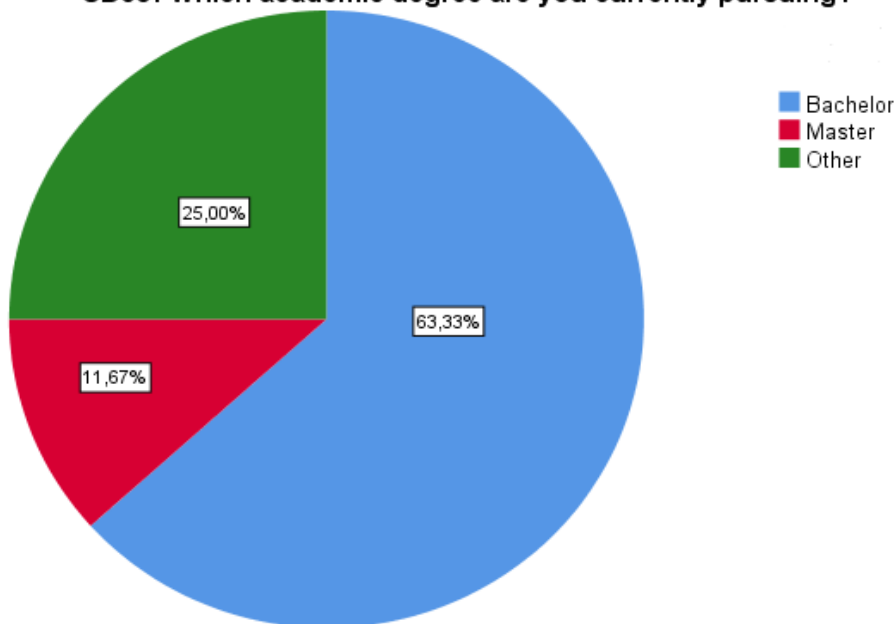


Figure 29: Item SD05

The majority of students (38) is pursuing a bachelor's degree. Students pursuing a master's degree have the smallest share (7). An unexpected high number of students (15) is pursuing another kind of academic degree.

Japanese students mostly strive for a bachelor's degree (66.7%). The survey did not register any Japanese graduate students, but 33.3% of the Japanese assigned themselves to another form of student.

German students are mostly pursuing undergraduate studies (61.5%), but at least 17.9% are graduate students. 20.5% of the Germans referred to themselves as some other kind of student. For example, this could include remote college students or PhD students.

SD06:

What do you study?

According to the comprehensive table appended, the responses of the students were clustered into three types of majors: those that belong to languages, to liberal arts and to sciences. Overall, most of the students (55%) study some kind of liberal art. Most of them are related to business and economy, education or social sciences. Language related studies are represented the second most (<22%), followed by sciences (20%). Two entries fit not even remotely in any of the listed categories: nursing and a withhold statement.

Despite avoiding campuses of students studying technical majors in Germany, a striking occurrence is that only German participants come from science majors. Since Soka University offers some science majors (according to the statistical numbers issued by the university), the small example is not very representative for the average. Another anomaly is the difference in language studies. While the German participants study comprehensive German, Japanese and Chinese, the Japanese participants focus more on literature. Especially the more technical background of some of the German students could result in different experiences.

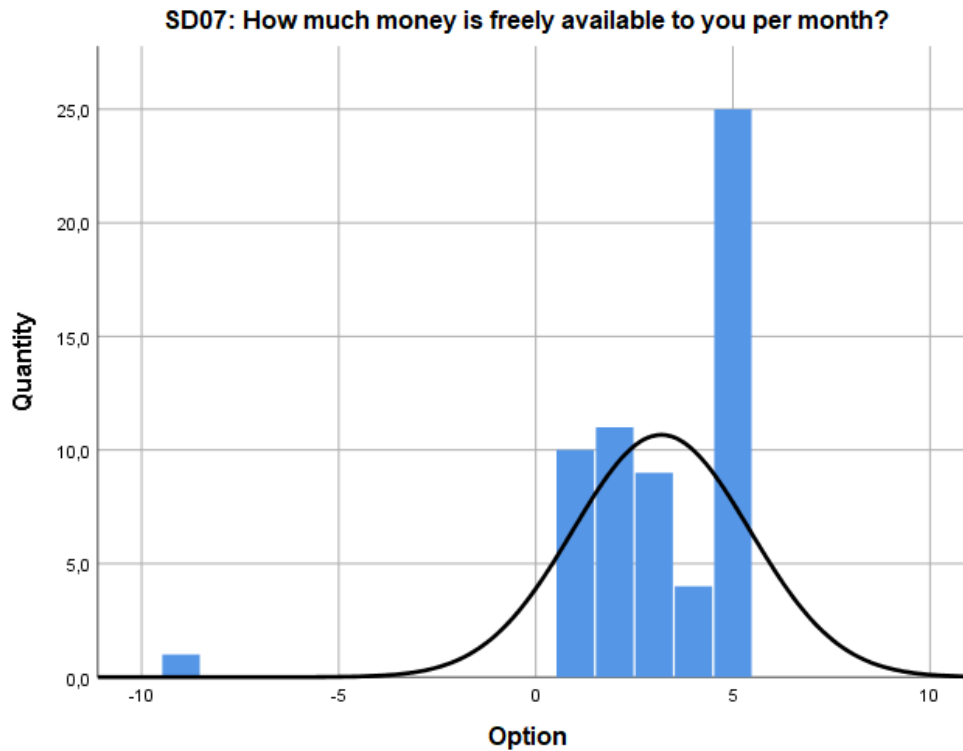


Figure 30: Item SD07

As the graph indicates, the values are not within a standard curve. The value of -9 originates in a candidate choosing the option to skip this question. Nevertheless, nearly 42% of the students selected option five, indicating an amount of money available per month that is higher than 250 euros. On the opposite side of the spectrum stands a sixth of the participants who have to get through the month with up to 100 euros. Excluding the single deprived response, this leads to a mean value of 3.33. On average, students have more than 151–200 euros available per month. A challenge in analyzing this combined dataset is the different currencies. The values in euros are not converted exactly to yen, but to the expected counterparts. For example, 10 euros are expected to equal 1000 yen. Additionally, the usage of price ranges instead of fixed values should dampen the impact of currency exchange.

Japanese students have a lower amount of money freely available each month. Respectively 23.8%, 28.6% and 23.8% state to have up to 100 euros, 150 euros and 200 euros. Consequently, 76.2% of Japanese students have less than 200 euros available per month. 9.5% of the students have more than 200 and up to 250 euros and 14.3% more than 250 euros available per month.

More than half of the German students have over 250 euros freely available per month (56.4%). Comparing the same range of available money as done for Japanese students, 35.9% of the German students have up to 150 euros per month to spend freely. 5.1% of the students can freely spend up to 200 euros a month. One German participant chose to skip the question.

SD08:

Are you a member of a club or association?

According to the comprehensive table appended, about 37% of the students are member of some kind of club or association. Since the number of German participants is considerably higher, a closer look is necessary. One third of the Germans is a member of a club/association. Most of them are sports related, e.g., martial arts, fitness or dancing. Of the Japanese students, about 43% belong to a club/association, most of them to an animal care club, but also a few clubs which are unknown in Germany.

Universities in Japan usually offer a wide range of activities through clubs and circles which become their own kind of social area and follows social rules more strictly than clubs or associations in Germany. Unfortunately, only few of the university's clubs are represented in this survey. Since no student belongs to a group with technical themes, this item has no noteworthy impact on the technical experience of the students which could lead to a change in their acceptance of technologies.

4.5. Retrospective on Expectations and Limitations

Shortly after initiating the survey it became apparent that the participation rate would be lower than expected. While on the German side it was possible to become active and reach out to more students (not increasing participation rate), for Japanese students this was a limited option. The concept relied heavily on dormitories and clubs serving as a multiplier to reach a wide variety of students. On the German side, the biggest problem was the difficulty to identify German students. Many persons in the university's area either appeared not German or too old to be a bachelor or master student. Through the necessity to profile them, it is also possible participants have been selected not randomly but by the expectations of the author. For example, this way the gender distribution was more balanced for German students, but on Japanese side the survey reached few female participants.

Because of the small sample size of participants, the impact of a single candidate skipping a question, being of unusual age or similar other occurrences distort the normal distribution curve noticeably. The relative impact of a single student is high if there is such a small total number of students.

The survey tool, wording and translation received good feedback. Specifying the number of uses of a technology and the available money per month proved a little more difficult for the participants. In hindsight, the results of those questions were also more difficult to interpret since the range of values was too big and not all students, who used a technology, also submitted how many times they used it. Looking at the topics, alternative means of payment seemed to be the most familiar technology, as expected. For robots, the opinions were the most diverse. While the introduction to this topic and some questions gave specific examples, it seemed that the students are likely to have different interpretations of what is considered a robot and what not. Considering the limitations, the survey showed at least some tendencies, which are presented in the following chapter.

4.6. Interpretation

While the previous sections looked at each item and, in some cases, anomalies have been mentioned, this chapter looks at the greater picture of technical acceptance. To achieve this, each technical field is looked at with the model of technical acceptance in mind. For this, it is assumed the combination of TAM2 and UTAUT is valid for this use case. Verifying this would require a bigger sample size and more items that repetitively address the same aspect, e.g., multiple items asking for the ease of use of the same technology. Another part of this section is the discovery of correlations, which not automatically leads to causality. Phi and Cramer's V are used to analyze correlations between the nominal variables of each technology and the nationality. Since the hypothesis claims a difference between students of Japanese and students of German nationality, nationality was the constant in each correlation. Starting from a null hypothesis (indicating no connection between the two items) it was the goal to find a value of significance showing either a positive or negative correlation. The stronger the clearer.

4.6.1. Virtual Reality

Japanese students participating in the survey had less experience with virtual reality than German students. The relative difference is 14.7% is not very significant but looking at the numbers of how many times VR had been used, Japanese

students tended to have used it more frequent. The correlation analysis does not show a significant correlation between the usage behavior and the nationality, though it is marginally stronger between nationality and the number of uses. Looking at the environment, it appears that Japanese encounter VR more often in their environment, despite fewer of them using it. But the overall tendency is that students of both nationalities do not think VR is often used in their environment. In accordance to this tendency, there is no sign of a significant correlation between usage behavior/social influence and nationality.

A similar result shows the analysis of the correlation between nationality and social influence in VR04. For students of both nationalities the opinions are very mixed when it comes to the opinions they perceive from people important to them. Very little significance was found in the correlation of nationality and the ease of use of VR. As the graphical evaluation already indicated, VR is perceived mostly as easy to use by the majority of students in both countries. The analysis did not find a noteworthy correlation when it comes to perceived usefulness of VR. Just some tendencies of Japanese students seeing more usefulness for VR in movies and Germans slightly more in medicine. Slightly more Japanese students expect a rising usefulness of VR in the future, but again no significant correlation. Fewer Japanese students have the intention to use VR in the near future, but the difference is not strong enough to indicate a correlation between nationality and the intention to use VR. Overall, no correlations between nationality and virtual reality have been found.

4.6.2. Robotics

In the field of robotics, the differences between Japanese and German students are more apparent. The first item deals with the usage behavior. More Japanese students have used robots, but less frequent than the few Germans who used robots. The correlation between nationality and the usage of robots is weak, but so far, the most significant value, although not significant enough (0.087) to make a clear statement, but worth are more thorough look with more data sets available. The number of how often robots have been used did not show any significant connection to nationality. The overall attitude towards robots being used in the own environment was mostly negative. This view was shared between Japanese and German students, with Germans disagreeing even stronger. The value of correlation is of irrelevant significance. The social influence is also rather insignificant.

As the cross calculation already indicated, students of both nationalities mostly perceived a rather positive opinion on robots, though the agreement from Germans was stronger and more Japanese remained undecided. The correlation between nationality and the ease of use is of no significance when it comes to robots. Participants of both nationalities mainly agreed on robots being mostly easy to use. Most of the correlations of the items regarding the perceived usefulness of robots were insignificant, except for robots used for entertainment. The correlation is significant (0.032) and has a medium positive value (between 0.375 and 0.530). Simply put, Germans are more likely to oppose the usefulness of entertainment robots. This finding deserves a more thorough look but requires more data entries to be validated. It is possibly the result of an abnormal curve that coincidentally leads to this correlation, especially since this phenomenon appears for no other form of robot. The intention to use robots in the next three months is similar for students of both nationalities, with Japanese expressing their opinion weaker. Overall, the results of German and Japanese students were similar, except for the usage behavior and the perceived usefulness, which would require a deeper investigation with more participants.

4.6.3. Alternative Means of Payment

Students of both nationalities have a lot of experience with alternative means of payment, but more German students have practical experience. Also, more Germans have paid more often with other forms of payment than cash. The analysis shows a weak but significant (0.082) positive correlation. The values are 0.289 and 0.277. Using a bigger pool of data would allow for a valid analysis. No hints for a correlation were found in the number of uses. Likewise, no correlation is found between the usage behavior in the environment of students and their nationality. Japanese were inclined slightly more negative, but overall, both nationalities perceive their environment as paying often with other means than cash. Fewer Japanese think the social influence on them conveys a positive view on alternative means of payment, but the difference to German students is too small for a correlation. This is even more obvious for the ease of use, towards which students of both nationalities have a very mixed, but slightly more positive attitude.

When it comes to the perceived usefulness, most items show no significant correlations to nationality. For stationary trade, the value of significance even reaches the maximum (0.999), indicating its insignificance. The exception is street trade, for which Japanese perceive more usefulness, whereas Germans in general see

no usefulness of alternative means of payment. As for robotics, the analysis shows a medium value of major significance (0.011) and therefore deserves an in-depth analysis with more data sets. Looking at the perceived usefulness in the future, banking transactions stand out. In this case, Germans expect a more positive development. The correlation reaches a medium value but has a major significance (0.019). Interestingly, even in the future stationary trade reaches the maximum value of insignificance. To conclude this section, no correlations were found for the intention of use. Students of both nationalities in general neither agreed or disagreed. Overall, hints for a correlation were again found in the usage behavior, but also twice in the perceived usefulness: of street trade and for banking transactions.

5. Conclusions

This chapter concludes the thesis by answering the research questions of the first chapter and looking at the progress made towards confirming or falsifying the hypothesis. Lastly, the implications of this thesis lead to an outlook.

5.1. Answering the Research Questions and Validating the Hypothesis

The following recap answers the research questions in order of their answer within this thesis.

- Which major factors influence the differences in technical acceptance between Germany and Japan?

While there are differences in the political path both nations follow, ultimately most differences can be traced back to culture. It is peoples, who work in politics and economy. What connects them is the society they live in and the structure of a society is strongly connected to culture. After all, Germany and Japan are even quite similar in the path of their economy, while for the three other example areas some bigger differences were found.

- What is the preferred method of measuring the acceptance of technology?

There are many different approaches to measure acceptance. The models evolved over time and often became more complex, more comprehensive or focused on different aspects in the process of acceptance. The preferred method for this case was a combination of the TAM2 and UTAUT, since these models have proven their value in other research works with similar technical circumstances. Another relevant factor was the measurability of the elements of an acceptance model, which is given for many of the aspects of the two mentioned models.

- How relevant are the three technologies chosen for the survey?

Each of the three technologies represents a technology which is expected to be in a different state of the acceptance process. Alternative means of payment have very different forms but usually the same goal: paying. Since this is an everyday aspect of life, it represents the most widespread technology. Robots have many different forms and can be used in very different circumstances. They exist longer than virtual reality but usually less obvious than payment, at least for private consumers. VR represents the newest technology and stands more at the beginning

of the acceptance process. It is still more of a niche product, but the variants of this technology often have more defined use cases. All the technologies are highly relevant in at least one application field.

- How well are the three chosen technologies accepted by students in Japan and Germany?

In accordance with the previous question, alternative means of payment are accepted the most. In general, all items related to this technology have been answered more positive than for other technologies. The use case is usually very clear, whereas the acceptance of the other technologies heavily depends on the application field. For robots, students perceive more relevant use cases than for virtual reality, especially in Japan, but both technologies find acceptance depending on what for they are used.

Finally, it is necessary to look at the hypothesis made in the first chapter.

The acceptance of upcoming consumer technology is higher for Japanese students than for German students. This can be exemplified by the technologies “virtual reality”, “modern alternatives to cash payment” and “robotics”.

The hypothesis cannot be verified, but also not completely falsified. The evaluation is based on a survey with few participants. For the survey itself, it is not guaranteed the circumstances followed the principle of objectivity. The Japanese students are from a regionally very limited area of Japan, while the author picked participants who looked like German students. The aspect of validity is respected, but there is potential for improvement by using more items researching the same aspect of the acceptance model. This could further increase the accuracy of the model but has been neglected in expectation the willingness to participate would decrease with even more questions. Because of the small sample size, the results are not reliable. Reaching the same number of students with the same survey is likely to come to different results, since not all results followed a normal distribution curve. Conducting the survey over a longer period under objective circumstances and reaching more students is likely to improve the reliability. For a few aspects of robotics and alternative means of payment correlations were found, but given the circumstances previously described, the correlations are likely an aspect of coincidence and would need further investigation.

5.2. Outlook

Despite cultural differences being a major point of the thesis, most nations have a common interest in further developing technology. And yet, often the implementation of technology has only been looked at from a technical vantage point and the differences in expectations or thinking have been neglected. The thesis could not comprehensively clarify whether and to which degree different cultures account for different thinking. The most prominent reason for that is the limited number of participants of the survey and their limited representativeness. A bigger scale of the survey and a more concise approach on the technologies represented in the survey are likely to produce clearer results. Furthermore, it could be relevant to further investigate differences of the acceptance of technology within other target groups. For example, the group of working adults is very relevant since their work effectiveness is connected to their acceptance of the technology used in a company. Also, since Germany and Japan both face the challenge of an aging society, it would be interesting to investigate differences in the technology acceptance of seniors. This could, for example, lead to a more efficient approach on how to support elderly citizens.

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Appendix

SD06 – Comprehensive Original Answers

German respondents	Category	Quantity
Germanistik	Languages	8
Germanistik		
Germanistik		
Japanologie		
Sinologie		
Japanologie-Sinologie		
Japanologie		
Japanologie		
Rechtswissenschaft	Liberal Arts	19
Rechtswissenschaft		
Lehramt		
Bildungswissenschaft		
Bildungswissenschaften		
Lehramt		
Prävention und Gesundheitsmanagement		
BWL		
BWL		
International Management		
Logistik		
Geschichte		
Geschichte		
Soziologie		
Kommunikation		
Musikwissenschaft		
Soziale Arbeit		
Politikwissenschaften		
Numismatik		

Technische Redaktion und Kommunikation	Sciences	12
Physik		
Wirtschaftsinformatik		
Chemieingenieurwesen		
Medieninformatik		
Mikrosystemtechnik		
Chemie		
Biologie		
Regenerative Energien/Elektrotechnik		
Maschinenbau		
Informatik		
Psychologie		

Japanese respondents	Category	Quantity
Russian language	Languages	5
文学 (Literature)		
文学部 (Literature)		
日本文学 (Japanese literature)		
英文学 (English literature)		
教育学 (Education)	Liberal Arts	14
教育 (Education)		
教育 (Education)		
教育学 (Education)		
国際教養 (International education)		
国際化 (International relations)		
社会学 (Sociology)		
社会学 (Sociology)		
経済 (Economy)		
経済学 (Economy)		
国際政治 (International politics)		
Public policy		

法律 (Law)		
経営学 (Business administration)		
看護学 (Nursing)	Others	2
No statement		

SD08 – Comprehensive Original Answers

German respondents	Japanese respondents
Church, dancing school	落語研究会 (Japanese form of comedy monologues)
Sports club	ROUTE
Dancing school	ABT
Sports, youth	ABT
Natural history community...	ABT
Language exchange	Animal Breakthrough Team
Sports club and charitable organization	ABT
Football	ABT 学生国際センター (International Student Center)
Fitness	ボランティア (Volunteer)
Sports club	
Martial arts club	
Martial arts club	
Culture	