Barriers to Innovation Diffusion
for Social Robotics Start-ups
And Methods of Crossing the Chasm

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Abstract

Social robots and artificial intelligence are radical innovations at the cutting edge of technology. Touted as the fourth industrial revolution, the future is looking bright for social robotics, and for the markets which can benefit from this technology. However, despite a wealth of research regarding technical functionality, there has been little research conducted into the future strategies required to ensure the successful diffusion of these innovations into society or effective methods of influencing rapid adoption rates in target markets.

The following research questions have been designed to identify potential solutions to existing and future problems facing the social robotics industry: What are the barriers to the early stages of the diffusion of innovation for social robotics start-ups? How can these innovative companies cross the chasm? In order to formulate the findings, primary research was conducted in the form of interviews within three categories: academics, practitioners and social robotics experts. Secondary research was undertaken to analyse and compare primary findings. The research is purely qualitative as quantitative data was purposefully disregarded due to limitations on time and scope.

In summary, social robotics start-ups face significant barriers to diffusion such as inherently expensive products and misaligned customer expectations. Attracting ‘pragmatists in pain’ is vital to be able to cross the chasm and a strong reference base is necessary for social robots to be adopted in the mainstream market. Start-ups need to meet the demands of the ‘expected product’ to attract the early majority (pragmatist) segment, providing a greater possibility of crossing the chasm and enabling rapid adoption. It is assumed that either a mass or niche strategy can be chosen, depending on the type of product in subject. An adaptation to the technology adoption life cycle has been made in the form of the ‘double-bell curve’ and the ‘V’ in the chasm has been identified within the process of successful diffusion. Methods of improving the rate of adoption have been applied in consideration of the ‘technology acceptance model’, with a heavy focus on increasing trialability and observability. There is a risk of potential ‘overadoption’ in the social robotics industry, however the changing shift in customer attitudes towards technology adoption lowers boundaries to diffusion.

Key Words: Crossing the Chasm, Diffusion, Innovation, Social Robotics, Technology Adoption.
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## Definitions and Abbreviations

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<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Artificial Intelligence (AI)</td>
<td>Machines that think, act and behave in a manner which meets the expectations of common human interaction (Russell et al., 1995)</td>
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<td>B2B</td>
<td>Business to Business</td>
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<td>B2C</td>
<td>Business to Consumer</td>
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<tr>
<td>B2B2C</td>
<td>Business to Business to Consumer</td>
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<tr>
<td>Crossing the Chasm</td>
<td>“The deep and dividing chasm that separates the early adopters from the early majority” (Moore, 1991, p. 15)</td>
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<tr>
<td>Diffusion</td>
<td>“The process by which an innovation is communicated through media over time among members of a social system” (Rogers, 1995, p. 5)</td>
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<tr>
<td>Disruptive Innovation</td>
<td>New innovations that disrupt existing technologies and creates new markets (Christensen, 1997)</td>
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<tr>
<td>Innovation</td>
<td>“An idea, practice, or project that is perceived as new by an individual or other unit of adoption” (Rogers, 2003, p. 12)</td>
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<tr>
<td>Robot</td>
<td>Physical, autonomous, multifunctional and reprogrammable machine (Hegel et al., 2009)</td>
<td></td>
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<tr>
<td>Social Robot</td>
<td>Robot developed for the specific purpose of human-robot interaction (Hegel et al., 2009)</td>
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<tr>
<td>Technology Adoption Life Cycle (TALC)</td>
<td>A model explaining how “technology is absorbed into any given community in stages corresponding to the psychological and social profiles of various segments within that community” (Moore, 1991, p. 9)</td>
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1. Introduction

This chapter provides an introduction to artificial intelligence and the social robotics industry as a whole. Additionally, the research purpose and research questions are proposed along with the delimitations of the research.

1.1 Background

Social robots and artificial intelligence are radical innovations at the cutting edge of technology and are significantly changing the world during a period which is considered by many as the fourth industrial revolution, an era that is unlike any that humans have come across before and have yet to fully grasp (Schwab, 2017). The rapid development of machine learning and deep learning, along with progression in neural networks which mimics the activity of the human brain, are making advanced robotic machines and artificial intelligence smarter than ever.

To begin, it is important to distinguish the difference between ‘robots’ and ‘social robots’ in order to understand the application of this research. Robots are defined as objects that are physical, autonomous, multifunctional and reprogrammable (Hegel et al., 2009). Traditional robotic machines can be found in warehouses used for autonomous, repeatable manufacturing purposes, where there is a requirement for tasks to be completed in an efficient and cheaper manner. Social robots, however, are inspired by biology; they are developed for the specific purpose of human-robot interaction and are able to communicate, adapt and learn in social contexts. Social robots are built with conversational artificial intelligence, which breaks down barriers to technology for all those who interact with them and rely on the natural communicative skills that humans possess.

The social robotics industry is in its infancy and is predicted to be extremely disruptive; it is projected to have huge impacts upon business, society and the global economy (Williams, 2016). Despite the early stage of the industry, vast developments of these new technologies are currently opening up varying applications in real-world settings. For example, social robots can be utilised in hospitals to interact with dementia patients, or in schools to develop autistic children’s social skills, perhaps in public spaces as an information source or potentially launched as a consumer product, in a similar way to today’s mobile phones and personal computers. The increased speed of technological advancement is initiating unprecedented shifts in many industries and despite causing profound uncertainty, can propel human life to new levels. However, existing job roles are being replaced with automated robots and social robots, instigating a negative perception towards this disruptive technology. But as a result, there is a demand for emerging job roles to be created in order to support and further develop these new innovations, in a similar fashion as the previous industrial revolutions in agriculture, textiles and transport.

As previously mentioned, social robots are built with Artificial Intelligence (AI) which was devised prior to the development of advanced robotics. This was first termed by John McCarthy in 1956, after Alan Turing’s paper “Computing Machinery and Intelligence” created the foundations of the field (Smith, et al., 2006). AI can be defined using two primary variables; the first being thought processes and reasoning, the second being behaviour. AI can be applied either to general-purpose fields or specific problem-solving tasks. There are many disputes as to what defines ‘intelligence’, however in order to be considered artificially intelligent, these machines must think and act rationally, whilst behaving in manner which meets the expectations of common human interaction (Russell et al., 1995). The ‘Turing Test’ was
created in 1950 by Alan Turing, to test if a person is unable to distinguish the difference between a machine and a human, posing the question; “Can machines think?”. If the person cannot tell the difference, the machine can be deemed as ‘intelligent’. It is also suggested that AI incorporates artificial emotion; described as a concept that is used to make robots respond emotionally to real-world stimuli and interactions with humans (Michaud et al., 2000).

Despite the promising applications of AI and social robots, there appears to be several distinct barriers to diffusing these products into society. Therefore, this research has been initiated to provide solid foundations to build upon for social robotics start-ups in formulating strategies that will increase the likelihood of future success. There is the potential for these findings to be applied to larger scale organisations (and perhaps alternative industries), however at the time of writing, the majority of all social robots are being developed by start-up companies.

This research paper is commissioned by Furhat Robotics and the department of Industrial Economics and Management at KTH (Royal Institute of Technology) for the Entrepreneurship and Innovation master’s degree programme.

1.2 Research Questions and Objectives

The primary research question addressed in this thesis is:

What are the barriers to the early stages of the diffusion of innovation for social robotics start-ups?

A secondary research question is also applied:

How can these innovative companies cross the chasm?

This research has been initiated during the infancy of the social robotics industry. At the time of writing, there is no social robotics company that has ‘crossed the chasm’ (progressing from the early market to the mass market), therefore necessitating research regarding the barriers that these start-ups are likely to experience. There is a plethora of research relating to the technical aspects of social robots, however there is a significant lack of research into methods of diffusing these innovations into society and how start-ups can effectively implement this process. All theories and models relating to the research questions will be described in the literature review section (Chapter 2).

The primary objectives of this research are to delve into methods of diffusing social robots into society and to combine the opinions of academics, practitioners and social robotics experts alike, supported by secondary research, in order to formulate suggestions for future strategies.

1.3 Delimitations

This study is primarily based on qualitative data, derived from primary interviews and secondary research of existing literature. There is no quantitative data analysis included in these findings.

This research is specifically focussed on developed countries; the rate of adoption is likely to be different for developing countries and due to the high-tech nature of the product, will likely not initially be diffused in under-developed countries.

The number of interviews conducted has been limited due to the scope constraints. However, the candidates chosen were reviewed to ensure they were representative of the whole group of potential candidates.
There will be no focus on the post-chasm enterprise. This research delves into the early-stage growth (innovators, early adopters and early majority segments) and in particular crossing the chasm. The late-stage growth of companies in the social robotics industries (late majority and laggards) will not be analysed. The research is applied to the social robotics industry in the B2B, B2C and B2B2C markets.

There is the potential to analyse further academic theories that will apply to this research, however in order to effectively answer the research questions, these have been dismissed but are suggested as topics for further research. The research question in focus is very specific, therefore there is no focus on minor related theories.

2. Literature Review

This chapter includes existing literature relevant to the research questions outlined above. Each of these models, theories and concepts are analysed deeply in order to understand the research findings. Within the literature review, multiple innovation types are defined, as well as the key aspects of the Diffusion of Innovations and Crossing the Chasm. Additionally, the ‘Whole Product’ concept is introduced and finally, the Technology Adoption Model.

Throughout the process of gathering established research, the researcher utilised numerous sources of secondary data. Google Scholar was used in order to discover research articles and publications relevant to the above topics. The Google search engine was used in order to gain access to online PDFs, websites and E-books pertaining to the applicable areas. Additionally, the KTHB Primo database was utilised for further access to academic papers.

2.1 Innovation Types

Innovation is defined as “an idea, practice, or project that is perceived as new by an individual or other unit of adoption” (Rogers, 2003, p. 12). According to Barnett, innovation takes place via a process whereby a new thought, behaviour or thing which is qualitatively different from existing forms is conceived and brought into reality (Barnett, 1953). Within this research, innovation will be primarily divided into two main types: incremental innovation and disruptive innovation. However, there are many typologies of innovation and researchers identify more than just two types, which are addressed below.

It must be stressed that “invention does not necessarily induce innovation” (Schumpeter, 1939, p. 80); these two terms are related but distinct and should not be confused with one another. Schumpeter notes that innovation can be viewed as a factor of change; innovations instigate change and growth in society.

Incremental innovation introduces relatively minor changes to the existing product, exploits the potential of the established design and often reinforces the dominance of established firms (Henderson & Clark, 1990). Disruptive innovations initiate the technology adoption life cycle; without these only incremental improvements to existing technology will occur. Geoffrey Moore, author of ‘Crossing the Chasm’ and high-tech marketing expert, states “disruptive innovations are more likely to be championed by end users than by technology professionals that operate the current infrastructure” (Moore, 1991, p. 63). It is important for start-ups and large corporations alike to “give managers of disruptive innovation free rein to realise the technology’s full potential” (Bower & Christensen, 1995, p. 53).
Traditionally, when first introduced, disruptive innovations are inferior in terms of performance in relation to existing products offered by incumbent organisations (Christensen et al., 2016). Typical characteristics of disruptive innovations offered to fringe markets include: smaller, cheaper, more accessible and convenient. Christensen (1997) suggested that large organisations experience barriers to innovation, termed as the ‘Innovator’s Dilemma’. Incumbent organisations are constrained when it comes to investing in disruptive innovations due to established profit models and their prioritisation of existing customer retention; therefore, investing in radically new products seems financially unattractive to them. Start-ups can often be better suited to target smaller niche markets inaccessible to large organisations because of their limited commitments to existing value networks (Yu & Hang, 2010).

Additionally, innovation can be classified along two dimensions: an innovation’s impact on components and the linkages between components (Henderson & Clark, 1990). In this description, disruptive and incremental innovation are extreme points on either end of the scale. Disruptive innovations establish new ‘dominant designs’, defined as the leader in the market place that achieves significant market share and forces competition into imitative behaviour (Utterback, 1996). On the other hand, incremental innovations refine and extend already established designs.

Despite disruptive innovations replacing established innovations and creating new, emerging markets, the inventors are not always the ones who receive the benefits. It has been found that within technology-intensive industries, incremental innovation “can influence the industry in a more significant way and be more beneficial to companies” than disruptive innovation (Rayna & Striukova, 2009, p. 5). Hence, why incumbents generally seek to improve already established innovations.

Another way to classify innovations is the conceptual framework whereby innovation is divided into three types: continuous innovations, dynamically continuous innovations and discontinuous innovations (Robertson, 1967). Continuous innovation entails alteration of a product with a minimum influence in the industry. Dynamically continuous innovation sits between discontinuous and continuous innovation, involving the creation of a new product but retaining established patterns of behaviour. Discontinuous innovation is the creation of a new product that solves needs in a completely new way. How these innovations can be spread across society is determined by the diffusion of innovations theory.

2.2 Diffusion of Innovations
“Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system” (Rogers, 1995, p. 5). The purpose behind the theory is to understand the reasons, methods and rates of how new innovations spread into society. It was Everett Rogers that suggested this theory and explained that it is the communication of new ideas, planned or spontaneous, that is the cause of social change. The theory draws upon the technology adoption life cycle and was created as the result of 508 studies across numerous fields of research such as education, rural sociology and medical sociology. The practical purpose behind the theory is to help businesses understand the likely adoption rates of innovations, which is found to differ greatly due to subjective opinions of the target markets and varying methods of communications used to reach different parts of society. Dearing (2009, p. 1) reinforced the validity of the theory, explaining that it is “the international richness of these [diffusion] studies, and the variety of new ideas, practices, programs and technologies that have been the objects of diffusion research”.

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Studies into diffusion have correspondingly identified “a mathematically consistent sigmoid pattern (the S-shaped curve) of over-time adoption for innovations” (Dearing, 2009, p. 4). It is suggested that if disruptive technology is introduced within any community, the market will automatically segregate into five segments, despite what type of innovation is presented.

The adopter categories are split into five psychographic profiles, along with estimated market size percentages (Figure 1): Innovators (2.5%), Early Adopters (13.5%), Early Majority (34%), Late Majority (34%) and Laggards (16%). It is suggested that each of the segments behave and mature gradually over time and needs or motivations differ according to the segment’s degree of innovativeness. Therefore, it is suggested that each segment cannot be addressed simultaneously.

The innovators segment is characterised by “higher social status... and more tolerance for uncertainty” (Rogers, 1995, p. 119). Making up 2.5% of the market, these ‘venturesome’ people are likely to be wealthier than those that fall in other segments and are consequently deemed as risk-takers. Rogers states that these individuals are not the first to adopt because they are aware of an innovation before everyone else, but they are the first to make the purchasing decision and move from ‘knowledge to decision’. Their favourable attitudes to new innovations and lower resistance to change in society results in a shorter decision period from product recognition to purchase decision. It is important to note that high levels of interest from this segment does not guarantee a systematic pattern of early adoption (Fichman, 1999).

The early adopters segment, making up 13.5% of the market, also have higher socioeconomic status than the later adopters, but have different characteristics than the innovators. These individuals “are a more integrated part of the local system” with the “greatest degree of opinion leadership in most social systems” (Rogers, 1995, p. 248). This segment is respected higher amongst the rest of the social system and is not too far ahead in terms of innovativeness, therefore impacting upon the rate of adoption for future segments as they become ‘influencers’ for the innovation. There maintains a degree of toleration for risk and expectation of change, therefore becoming a primary initiator of decreasing uncertainty of adopting a new innovation.
The early majority follows, making up a much larger 34% of the market. Rogers defines this segment as ‘deliberate’, suggesting that the knowledge to decision process is much longer. These individuals seek a ‘whole product’ that is proven to offer significant value whilst incrementally improving their lives. They are traditionally much more risk-averse than the earlier segments. Generally, these people seek minimum disruption and require well-established references, therefore will not adopt a new product without the input of influencers. However, the early majority are the connectors between the very early and relatively late adopters, therefore an important link and key driver in the diffusion process. This unique segment can determine the success of the diffusion of a new innovation into the mass market.

The late majority, also making up 34% of the total available market, are sceptical in nature and are expected to “adopt new ideas just after the average member of a social system” (Rogers, 1995, p. 249). Their reasons for adoption range from economic necessity, network pressures or due to the fact that innovations have gradually become an established standard. These individuals are not technologically comfortable, therefore require peer pressure in order to motivate adoption. Due to high risk-aversion, almost all uncertainty needs to be eradicated prior to innovation adoption. Risk, in this case, arises when “there is a possibility of adverse consequences if a purchase is made, or not made” (Hughes & Perrott, n.d., p. 3).

Finally, the laggards section makes up the remaining 16% of the market. Almost all innovations are viewed as high-risk, as these individuals are very ‘traditional’ in nature. These individuals are the last segment in the social system to adopt an innovation and have next to no influence over the other segments. Laggards can adopt a product so late in the life cycle, that the innovation has been superseded by a more recent innovation that is already adopted by the innovators segment. There must be certainty in adoption as it can be difficult to overcome their resistance to innovations and aversion to change. It can be argued that this segment can be disregarded throughout the early stages of adoption, but will need to be addressed in order to prevent rapidly declining sales in the latter stages.

It is understood that the innovation diffusion theory draws upon the technology acceptance model as they are similar in constructs and complement each other in analysing the process of adoption (Lee, et al., 2011), which is discussed in more detail in Chapter 2.4. In order to determine the rate of adoption amongst the target market, the five perceived attributes of innovations must be considered.

2.2.1 Attributes of Innovations and Rate of Adoption

The rate of adoption is the “relative speed with which an innovation is adopted by members of a social system” (Rogers, 1995, p. 232). The concept is generally considered as the rate of individuals who adopt a new idea over a specific period of time. Rogers described five characteristics, named ‘perceived attributes of innovations’, that can help determine the rate of adoption of technologies:

1. Relative Advantage: This relates to the adopters’ perception towards the new innovation; more specifically, it questions if the new innovation is better than the idea it is superseding? If an individual perceives the new innovation to have high value to them, the relative advantage will increase and consequently the rate of adoption also.

2. Compatibility: This helps to determine whether the new innovation is perceived by potential adopters as synonymous with their existing values, needs and past
experiences. An idea that is not compatible will be diffused at a significantly slower rate, unless if there is a change in the value system.

3. Complexity: This factor defines the complexity and the perceived difficulty to understand and use the innovation. Simpler ideas that are easier to understand by the masses will have a greater chance of becoming rapidly adopted, whereas highly complex innovations that require new skills to be developed by the adopter will naturally take longer to diffuse.

4. Trialability: If the new innovation can be tried and tested over a short period of time, the rate of adoption is likely to improve as uncertainty and perceived risk drops. For some innovations, it is more difficult to trial the innovation, therefore lowering the rate of adoption compared to innovations that can be easily tested. Trialability is deemed more important for the ‘early’ market, as the mainstream market and laggards in particular progress from ‘trial usage’ to ‘full-scale’ adoption more rapidly than any other segment (Rogers, 1995), so the trial period is of less importance.

5. Observability: If the value of adopting the innovation is easily displayed and communicated to others, there is a higher chance of adoption. An innovation that is more visible to other individuals within the social system will increase communication rates, regardless of whether they are positive or negative reactions. If the innovation adds significant value to the adopters’ lives and this is highly visible to others, the diffusion rate will rapidly increase.

These five characteristics determine 49 to 87 percent of the variation in adoption of new products (Rogers, 1995). Additional variables are suggested in order to determine the rate of adoption, such as the type of innovation-decision and the communication channels utilised. However, there lies the risk that the potential adopters are not ready to adopt the innovation, also known as ‘overadoption’.

2.2.2 Overadoption
“Overadoption is the adoption of an innovation by an individual when experts feel that he or she should reject” (Rogers, 1995, p. 236). Reasons pertaining to overadoption range from insufficient knowledge regarding the new innovation, lack of observability, the status-conferring aspect or the over-eagerness of the innovators to become the first to change.

There is the suggestion that innovative companies must be aware of times when it is advantageous to prevent ‘too much’ adoption; it might not always be beneficial to speed up the diffusion process. Reasons behind prevention could be due to an incomplete product, unjustified expenditure for the adopters or purchasing for improper use. If a technology is diffusing into a market that is not ready, or indeed if the product is not ready itself, this is likely to have major impacts upon the rate of adoption in the future.

2.2.3 Criticisms of the Diffusion of Innovations Theory
There are, however, criticisms to Rogers’ notions of the diffusion of innovations. The primary argument is that the original material is now outdated. New technology that is diffusing into society is disrupting the way in which previous innovations have been adopted in their relative markets. “Current innovations can be so radical that common models of innovation diffusion might not be enough for the understanding of innovation adoption” (Pace, 2013, p. 38). It is understood that the diffusion process of disruptive innovations has become multifaceted; the
The increasingly complex nature of these processes makes it difficult to determine the relevance of original theories (Peres et al., 2010).

Additionally, critics argue that the categories of adopters need to be redefined to become relevant for modern markets, but also to become more applicable to high-tech industries. The original diffusion of innovations theory was created based on the diffusion of farm practices; an industry that is not related to the present-day innovations and their respective adopters. One suggestion is to re-categorise the segments into ‘early’ and ‘main’ markets, as there are shared characteristics and behaviours pertaining to individual segments (Mahajan, 2014). The ‘early’ market segments are wealthy and have less risk of adoption, whereas each of the ‘main’ market segments seeks a fully functional, ‘whole product’, with minimised risk of adoption.

There is also a criticism that the diffusion of innovations does not take into consideration the changing characteristics and behaviours of the market segments over time; the primary focus of the theory is not about people changing, but the innovations themselves (Robinson, 2009). Customer expectations change over time and the increasingly digitally mediated lives in the developed world could potentially cause a change to the original characteristics of the five market segments.

The suggestion of ‘big-bang disruption’ challenges the notion of the traditional technology adoption life cycle and therefore Rogers’ process of diffusion. Instead of innovation diffusion following the life cycle, from the early market to the mainstream market, products can be introduced to every segment simultaneously. These fully developed innovations are attractive to the innovators as much as they are to the early majority, even upon first release. The Apple iPhone is a prime example of a product that was instantly attractive to multiple segments and achieved simultaneous rapid adoption, therefore dismissing the traditional growth curve.

It is of the researcher’s opinion that the original material is outdated. New digital communication channels can positively impact upon the adoption rates of innovations, therefore the time it takes to reach the mainstream market may be reduced. The researcher also supports the theory of the big-bang disruption, but very much depending on the innovation which is being diffused as it does not apply to most products. However, the researcher disagrees with the notion of re-defining the proposed segments. The adopter types remain relevant within industries today, as the shared characteristics do not warrant the complete merging of the segments into an ‘early’ and ‘main’ market. Additionally, the researcher believes that the market segments do not form a fluid continuum, due to the differences that can be identified in the personality and behaviour types.

There are multiple adaptations to the original technology acceptance model and diffusion of innovations theories based upon the criticisms cited above. One of the most popular and referred to adaptations is a framework called ‘crossing the chasm’, which addresses the criticism that the market segments do not form a fluid continuum.

### 2.3 Crossing the Chasm

“First there is a market... then there is no market... then there is” (Moore, 1991, p. 20).

A well-known adaptation to Rogers’ diffusion of innovations model is Geoffrey Moore’s ‘crossing the chasm’ theory (Rogers, 2003). It is important to note that this is not an academically supported theory, but rather a business framework that is widely used amongst practitioners. The suggested adaptation takes the form of a variation of the diffusion of innovation, specifically for high-tech B2B markets. Moore’s suggestion is that disruptive
innovations experience ‘cracks in the curve’ between each of the five adopter segments, suggesting the process does not follow a smooth continuum. Most notably, Moore identifies the largest gap between the early adopter and early majority segments; which he named ‘the chasm’. It is in this phase where a large majority of start-ups fail and Moore aimed to address the strategies that should be taken in order to attract the mainstream market. The model was devised for the high-tech B2B market which makes it highly relevant to today’s industries, a significant criticism of Rogers’ diffusion of innovations theory. Moore redefined the five market segments based on his observations of their characteristics and behaviours and also combined the segments into two groups as shown in Figure 2; ‘Early market’ and ‘Mainstream market’. The early market is described as a wealthy population eager to acquire new technology, those who seek breakthrough products for change and have a high-risk threshold. The mainstream market segments all require a complete product, something that can add value if adopted whilst maintaining their risk-averse nature.

The full description of Moore’s redefined segments can be found in the Appendices (Chapter 7.1). The redefined segments can be described briefly: The ‘Technology Enthusiasts’ (Innovators) are eager to acquire new technology and pursue new products aggressively. The ‘Visionaries’ (Early Adopters) dominate the early market buying decisions, seeking breakthrough products but are inherently more difficult to satisfy. The ‘Pragmatists’ (Early Majority) are the leaders for the mainstream market, typically risk-averse, reasonably price-sensitive but loyal post-adoption. The ‘Conservatives’ (Late Majority) can be fearful of high-tech products and are opposed to discontinuous innovations, yet a fruitful market if served appropriately. Finally, the ‘Sceptics’ (Laggards) do not participate in the high-tech market and purchase decisions are made out of necessity.

It is important to recognise that a boost in early sales does not indicate the emergence of a profitable mainstream market, but is simply due to the interest amongst the early market segments. Therefore, the revenue projection of a start-up is more like a staircase than a hockey stick, which is so renowned in previous literature (Moore, 1991). Therefore, it is important that
start-ups must be aware of ‘the chasm’, to help understand the cause behind falling sales performance.

2.3.1 ‘The Chasm’

“Chasm-crossing is not the end, but rather the beginning, of mainstream market development” (Moore, 1991, p. 75).

The chasm was identified by Moore as the largest of the cracks in the bell curve; sitting between the visionaries and pragmatists segments. Any company transitioning from one to the other will experience apparently plateaued sales or declining growth patterns. This is the period where many high-tech innovations fail, by not adapting their value offering to the pragmatists’ requirements and perhaps running out of funds. It is also important to understand that the goal of the post-chasm enterprise is to make money, whereas the pre-chasm enterprise is more focussed on proving customer demand for the new innovation.

In order to cross the chasm in high-tech B2B markets, a company’s primary objective must be, according to Moore, to identify and secure a ‘beachhead’ in a mainstream market, meaning there has to be a target niche market to focus on winning. If successful, this therefore creates “a pragmatist customer base that is referenceable” who can “provide access to other mainstream prospects” (Moore, 1991, p. 50). Identifying a target niche market and solving a specific solution by providing a ‘whole product’ creates the opportunity to secure market leadership position. Pragmatists are inclined to buy from market leaders, therefore it is advised that the go-to strategy must be achieving a large majority of the market share in a specified niche market, a.k.a. the “big fish, small pond approach” (Moore, 1991, p. 52). By creating a pragmatist customer base that can be referenced by others, the ‘bowling pin’ strategy comes into effect; by ‘knocking over’ the first market, this referenceable customer base will facilitate entry into adjacent niches and therefore lead to market expansion. If the company can effectively ‘cross the chasm’, the most fruitful segments of the market lie ahead, with 68% waiting to be achieved.

The difference between the early and mainstream market can also be determined by the ‘psychology of influence’. The primary influence on purchasing decisions for the early market is triggered by ‘scarcity’ of products, whereas the influential trigger on the mainstream market is ‘social proof’ of the innovation (Maloney, 2011). Once the chasm has been effectively crossed, the company’s marketing strategy should be shifted towards generating ‘social proof’ in order to overcome uncertainty and alleviate the worries of sceptics. This can be achieved by utilising visionaries as ambassadors for the innovation in communication with pragmatic individuals.

A failure to cross the chasm causes unsuccessful diffusion; this is distinguished by an innovation that fails to exceed 16% of the total available market (Chukwuma-Nwuba, 2013). This is typically because the marketing strategy did not adapt to the new types of consumers, defined as the transition from ‘scarcity’ to ‘social proof’ (Maloney, 2011).

In addition, it is also suggested that there are five underlying factors which instigates the success or failure of an innovation: Marketing Performance, Efficiency of Development, Favourable Management Characteristics, Effectiveness of Communication and Understanding of User Needs (Braun, 1992). In summary, Braun noticed that it is the inability to look at the market and user needs which are the primary causes of diffusion failure.
2.3.2 Criticisms of Crossing the Chasm Framework

Despite being referred to as a timeless strategy (Gudema, 2014), the ‘crossing the chasm’ framework was released in 1991 and despite several updated editions, critics state the model is outdated. For example, new distribution channels have been developed since 1991; previously the emphasis of diffusion was on word-of-mouth, which was a social influence that instigated slow growth. New channels that have emerged during the age of the internet, such as social media, allow for free-flowing information and much faster dissemination of new innovations.

The fact the framework is not an academically supported theory gives uncertainty regarding the validity of the chasm’s existence. Everett Rogers identified that the technology adoption life cycle formed a continuum despite varying interests and needs, with no suggestion of any gaps between the segments. However, this is a reason why Moore states the chasm specifically applies to high-tech B2B markets, as the rate of adoption in B2C markets can be completely different. Such companies as Facebook, Google or Instagram appeared to show no evident signs of the chasm; they experienced rapid adoption by delivering straight to consumers and cutting out traditional distribution channels through effectively utilising emerging digital services.

Marketplaces are always dynamic, therefore mainstream market companies are creating hybrid versions of Moore’s five segments to maintain market leadership and develop new innovations in reaction to their competition. Additionally, market segments are not one-dimensional; individuals will behave in different ways with new products and therefore not match their given ‘personality’ defined by Moore.

Additionally, there is a tendency to over-simplify and suggest there is only one way in which new innovations can be introduced to the market. Critics state the real world doesn’t work this way; there are alternative methods depending on the innovation and the target market itself.

The researcher’s primary critique is that only market share is taken into account within the model, actual growth patterns are not displayed which can be misleading. Trajectory is currently shown on the same level pre-chasm as post-chasm, which could be a contributing factor as to why start-up founders are unaware of the ‘chasm’ and misattribute declining revenue as a fault with the product or marketing efforts. Growth needs to be taken into account so that start-up founders are aware of when to adapt their strategy, which can be linked to the creation of the ‘whole product’.

2.3.3 The Whole Product Concept

“There is a gap between the marketing promise made to the customer – the compelling value proposition – and the ability of the shipped product to fulfil that promise” (Moore, 1991, p. 80).

The ‘whole product’ is defined as “the minimum set of products and services needed to fulfil the compelling reason to buy for the target customer” (Moore, 1991, p. 88).

As mentioned in the section above, the mainstream market requires a ‘whole product’ that is easy to adopt and provides value, meanwhile causing minimal disruption to the lives of the individual. It is necessary for companies to take the ‘whole product’ concept into account in order to create a compelling reason for potential adopters to purchase, especially for the mainstream market.
**Figure 3** displays the ‘whole product’ model, which shows four different levels of a product that must be addressed in order to overcome the gap between customer expectations and the final product. The perception of an innovation is a key determinant of adoption and is found to vary across adopters categories and different technologies, which is why it is necessary to apply the ‘whole product’ approach to each of the five market segments (Fichman, 1999).

1. **Generic Product:** This is what is actually shipped to the customer, and includes what is covered in the purchasing contract.
2. **Expected Product:** This describes the product that the customer thinks they are buying when purchasing the generic product. There is potential for a mismatch between expectations and reality. It is referred to as “the minimum configuration of products and services necessary to have any chance of achieving the buying objective” (Moore, 1991, p. 80).
3. **Augmented Product:** This product provides the maximum opportunity of achieving the buying objective; therefore, it includes additional products and/or services to make a full package (e.g. customer service, additional hardware).
4. **Potential Product:** This is the representation of the product’s potential for future growth throughout the continual development of the market. It is the product functionality that a company should aspire to develop.

The introduction of new innovations, according to Moore, takes place in the centre of the circle, the generic product level, and expands to the outer circles as the diffusion moves along the technology adoption life cycle. The levels in the outer circle gradually become of increasing importance to companies; as markets develop, products in the centre become more alike and competition increases. As mentioned above, technology enthusiasts least require a ‘whole product’, but are rather satisfied with adopting a radical innovation. However, “pragmatists evaluate and buy whole products” (Moore, 1991, p. 82) throughout the ‘expected’ and ‘augmented’ product phases. Once competition increases, it is necessary to invest in research and development (R&D) to augment and reposition the product offering.

The notion of the ‘Minimum Viable Product’ (MVP), suggested in ‘The Lean Startup’, states that companies can release early-stage products with just enough features to satisfy the needs of the early market (Ries, 2011). The MVP is the opposite of a fully developed ‘whole product’; it is typically full of bugs, experiences stability problems and is shipped to consumers before it
is ready. This product instils an early customer base to build upon (i.e. the innovators) and by shipping regular updates, provides the opportunity to act quickly upon feedback from the early market. This method of product development can be typically used for proof of concept and is important to recognise it will not instigate pragmatist adoption. These early versions of the product will in no way meet the expectations of the mainstream market and will not meet the criteria to be classed as an expected product. The potential product however, can be pitched towards early adopters and the MVP will encounter rapid continual development.

To be able to understand the market’s attitudes and behavioural intent towards using the products developed, the technology acceptance model is analysed.

2.4 Technology Acceptance Model (TAM)

“The manner in which beliefs (perceived consequences) are specified, modelled and measured differs from the recommended Fishbein approach” (Davis, 1985, p. 26).

Figure 4 displays the original Technology Acceptance Model (Davis, 1985), an extension of the Ajzen and Fishbein’s Theory of Reasoned Action. The purpose of the model is to predict or explain usage behaviour and suggests a person’s actual behaviour could be determined by prior intentions and personal beliefs (Ajzen & Fishbein, 1980). This model also explains the process of how potential adopters accept and use new technologies, based on user motivation that is influenced by external variables.

This model suggests that the potential adopter’s behavioural intent can be explained by three primary factors: ‘perceived ease of use’, ‘perceived usefulness’ and ‘attitude towards using’. Determining the attitude of a potential adopter provides an indicator as to whether they will adopt or reject the new innovation. The attitude in turn is impacted by the two prior beliefs: perceived ease of use and perceived usefulness. The ultimate behavioural intent, also known as the ‘affective response’, is a major determinant of whether or not the user in question will actually use the innovation, which is referred to as the ‘behavioural response’.

The ‘perceived ease of use’ is a significant variable in the model, impacting upon the perceived usefulness and ultimately in the formulation of the resulting attitude towards the innovation. It is hypothesised that innovations that are easier to use will result in increased job performance (greater usefulness) and if the user becomes more productive, will positively attribute the perception towards the product. Davis also suggested the dependency between the perceived usefulness of the innovation and the potential adopter’s actual intention to adopt the innovation. The ‘perceived usefulness’ is defined as “the degree to which an individual believes that using
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*a particular system would enhance his or her job performance*” (Davis, 1985, p. 26). This factor influences both the attitude towards a product and the intention to use and is therefore determined to be one of the most important factors for companies to focus on when developing a new innovation.

The external variables have a direct relation to both perceived usefulness and perceived ease of use and include factors not represented in the model, such as demographic or personality characteristics, the nature of the particular behaviour under consideration and persuasive communication. These are also referred to as ‘design variables’ and are not theorised to have any direct implication on attitudes or behaviours (Davis, 1985).

It should be noted that this theory applies better to ‘consumers in marketing settings’, as opposed to ‘people in work settings’, as the market may have a broader range of purchasing decisions and are not effected by management intervention (Lin et al., 2007). For the basis of this thesis, the original TAM is relevant; the validity of the model has been proven through studies on successful predictions of acceptance behaviour for different technologies and within different situations (Lee et al., 2003). The strength of the model is supported by Bagozzi (2007), who states that the linkage between behavioural influences and intentions to use technology ensures the TAM model surpasses the Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) models.

However, as Trafimow (2009) criticises, just because the theory has been influential on the field of psychology, it does not necessarily mean that it is a good theory. There are therefore adaptations and extensions to the model, most notably the TAM2 model which includes social influence processes and cognitive influence processes that impact upon intentions and beliefs (Venkatesh & Davis, 2000).

3. **Methodology**

The following chapter presents a thorough analysis into the chosen paradigm, methods, approaches to data collection as well as a view towards the ethics, sustainability and feasibility of the research study.

It must be understood by the reader that at the time of writing, the researcher is conducting an internship at Furhat Robotics AB. This brings several advantages, such as access to a wider network of contacts, availability of support from social robotics experts, familiarity with social robots and knowledge regarding the existing issues that start-ups in this industry are experiencing. However, there are potential implications impacting upon the research. Firstly, there is the inherent potential biases in the research findings, which impacts upon the prediction of success for both the social robotics industry and Furhat Robotics. There also lies the risk that the findings could be swayed towards Furhat Robotics’ current position, which is not respective of other social robotics start-ups. Additionally, due to the interpretivist paradigm (addressed below), potential objectivity issues may arise as the researcher’s personal perspective may be brought into the findings. However, it is hoped the transparency of this information and the outlined steps taken to purposely avoid such biases ensures the validity of the research.
3.1 Research Approach

To briefly define the primary project objective; this research analyses the diffusion of innovations theory and the notion of crossing the chasm, combined with related academic theories in order to formulate findings applicable to the social robotics industry. The research findings are designed to be relevant to the majority of, if not all, start-ups in the social robotics industry.

Firstly, there are two types of research methodologies available to researchers: qualitative and quantitative. Qualitative research is not in numeric form; it is a systematic and subjective approach that provides more in-depth exploration into people’s feelings, perceptions, decision-making processes etc. and is not derived by statistical procedures (Yilmaz, 2013). Quantitative research utilises numerical data that is analysed by mathematically-based methods and reported through statistical analysis. More conclusive findings can be provided with supporting statistical evidence and is therefore typically easier to analyse than qualitative data. For this research paper, purely qualitative data is a better fit to answer the research questions, as it is hypothetical suggestions that will form the research findings. Heavy usage of quantitative research will impose constraints on the findings and may disregard relevant detail in justifying decisions, therefore it is avoided in this thesis.

Research approaches can be classified as ‘inductive’ and ‘deductive’. The inductive approach is generally associated with qualitative research and utilises a research question to narrow the focus. On the other hand, deductive research emphasises causality and begins with a hypothesis (Gabriel, 2013). This research can be argued as adopting an inductive approach, which is closely related to the interpretivism paradigm (addressed below). There is a requirement to collate primary findings in order to formulate qualitative results. This is unlike a deductive approach, that is based on the positivism paradigm which begins with a body of theoretical knowledge (Collis & Hussey, 2009).

Research can be defined as ‘exploratory’ or ‘conclusive’ research. The intention of exploratory research is to explore the research question without providing “conclusive solutions to existing problems”. Alternatively, conclusive research identifies a definitive solution to the research problem (Dudovskiy, 2016). This thesis is exploratory research, due to the fact that open suggestions are provided in order to analyse the issues that social robotics start-ups may face in the future; no definitive solutions based on quantitative analysis are provided.

Additionally, two types of research are ‘basic’ and ‘applied’. Basic research is defined as experimental work with the aim of acquiring new knowledge without any particular application, driven by curiosity. Applied research is defined as an investigation with the aim of acquiring knowledge directed towards solving a practical objective for application in the real world (Kowalczyk, n.d.). This thesis can be classified as applied research. The primary objective of the research is designed to apply findings to formulate suggestions tailored to the social robotics industry.

3.2 Research Paradigm

“A research paradigm is a framework that guides how research should be conducted, based on people’s philosophies and their assumptions about the world and the nature of knowledge” (Collis & Hussey, 2009). There are two main research paradigms which guide how scientific research should be conducted: Interpretivism and Positivism paradigms.
The positivism paradigm originated in the natural sciences and relies on the assumption that reality is independent of us, where knowledge is derived from scientifically verified findings. This paradigm involves a deductive approach and provides mathematical or logical proof to support empirical findings (Walliman, 2011). The interpretivism paradigm resulted due to the perceived inadequacies of the positivism paradigm and is “underpinned by the belief that social reality is not objective but highly subjective because it is shaped by our perceptions” (Collis & Hussey, 2009, p. 45). Reality is highly subjective and is therefore affected by the act of investigating it. This paradigm involves an inductive approach, which leads to broader conclusions that are not derived from statistical analysis of quantitative data (Corbin & Strauss, 1990).

This research relies primarily on the interpretivism paradigm, which is a better fit in order to answer the research questions, as the findings are derived from qualitative analysis with an inductive approach. The findings are subjective, as the suggestions are to be based on hypotheses and opinions of interviewees. The researcher is of the belief that reality is constantly redefined; with the opinion that the best method to use is the one which solves the problem.

3.3 Data Collection and Analysis Method
Primary and secondary research is utilised in order to formulate the findings of this research. The results are purely qualitative, as there is no scope for quantitative research in this paper.

Primary research was conducted in the form of interviews, via telecommunication calls, e-mail and face-to-face, depending on the preference of the interviewees. Three types of interviewees have been identified in order to contribute knowledge based on varying experiences; these are academics, practitioners and social robotics experts. Each interview was conducted in accordance with the ethical considerations outlined below. Interview questions were tailored to each unique interviewee based on their experiences and expertise. The face-to-face interviews were conducted in a semi-structured format and all questions were open-ended with the objective of gaining the full perspective of each candidate.

It should also be noted that each of the interview candidates were aware of the researcher’s employment at Furhat Robotics and agreed to participate with the aim of applying the findings to the social robotics industry as a whole.

The first interview was conducted with Geoffrey Moore, who is renowned for his research in diffusion practices. Geoffrey is the chairman of the Chasm Institute, as well as an organisational theorist, management consultant, speaker and author of ‘Crossing the Chasm’ amongst other business framework books. His research and knowledge into high-tech marketing, and ultimate creation of ‘the chasm’ framework made Geoffrey an extremely relevant interviewee with useful input towards this research.

The second interview was conducted with Samer Al Moubayed, CEO and co-founder of Furhat Robotics. Samer holds a keen interest in the diffusion of innovations, and at the time of writing is currently in the early stages of taking an innovative start-up along the technology adoption life cycle.

The third interview was conducted with Emrah Karakaya, Postdoctoral Researcher at KTH Royal Institute of Technology. Emrah’s previous academic research into the diffusion of dynamic innovations provided the opportunity for relevant feedback based on the results of alternative industries.
The fourth interview was conducted with Flash Robotics, with Michal Dziergwa (CEO & Co-founder) and Jan Kędzierski (CTO & Co-founder). Flash Robotics are in a similar position to Furhat Robotics, in that they are in the very early stages of development and are seeking to diffuse their social robot into society, however are targeting education as a specific niche market. Extracting knowledge and opinions from practitioners and social robotics experts in the same industry provides a better understanding of the potential options available for these high-tech start-ups.

The fifth and final interview was conducted with Ross Mead, CEO and Founder of Semio Robotics. Semio Robotics are a purely software based company, offering a cloud-based platform for conversational AI in social robotics. The nature of a software start-up is different to that of a combined hardware/software company, therefore Ross’ experience of diffusing this software-only offering will add a completely different dimension to the primary research.

Additionally, secondary research will be utilised to support or oppose claims from the interviewees and to determine how existing literature can apply to the early stages of the social robotics industry.

3.4 Ethics and Sustainability
This research fully acknowledges the existing work of other authors, avoiding potential plagiarism by using the Harvard referencing system.

Prior to conducting this research, the ten principles of ethical considerations (Bryman & Bell, 2007) were followed for primary data collection. Interview participants were not subject to harm in any way and all involvement was completely voluntary. Full consent was obtained prior to the study and permission has been granted to record, transcribe and include relevant input into the research findings. Privacy protection is paramount and if requested, anonymity of individuals would be ensured. Communication between participants was conducted with complete honesty and transparency, making sure to avoid misleading or biased information. Offensive, discriminatory or language deemed unacceptable was intentionally avoided throughout the interview process. The interviews were planned in such a way to avoid potential risks in questioning, such as emotional distress or jeopardising the dignity of participants.

This research is conducted with an impartial mindset, however there is the possibility of bias in the findings due to the researcher’s internship at Furhat Robotics and current involvement in the social robotics industry. However, steps have been taken to ensure the findings apply to the social robotics industry as a whole, and all considerations have been taken into account upon formulating the research findings.

There are very limited sustainability issues in conducting this research. All interviews are conducted either face-to-face, via email or teleconference calls, eliminating the need to travel and reducing the researcher’s carbon footprint in the process. There are no requirements to utilise social robots to contribute to the research findings, therefore reducing electricity usage. However, there are sustainability concerns with increased usage of technology such as social robots, as it is likely a constant power supply is needed for each that is installed. Sustainable methods of energy generation must therefore be considered during the production process.
3.5 Feasibility Study

Preliminary analysis was conducted prior to initiation in order to determine feasibility of the research, in terms of analysing scope and length of the project period. Factors potentially impacting upon project success were considered and reduced in the delimitations section. Approval was granted by the thesis supervisor, concluding that the research project is feasible.

It is assumed that all necessary information and required networks can be easily accessed via Furhat Robotics, therefore ensuring feasibility of data access. The existing networks of Furhat Robotics’ employees provides a basis for interviewing social robotics experts across the world. The number of interviews are limited in order to ensure feasibility in line with the project scope. Significant consideration was taken to allow time for analysis of interview material and the formulation of findings, therefore ensuring the scope is not too broad. A more focussed scope was applied by reducing the number of interview questions, therefore limiting the amount of data collection required.

4. Empirical Findings and Discussion

_The following chapter presents both the discussion and the analysis of the research findings, which have been derived from primary interviews and secondary research data. Theoretical models and concepts stated in the literature review (Chapter 3) are referred to throughout each segment._

4.1 Early-stage Barriers to Social Robot Diffusion:

It has been discovered that the major barrier to diffusing social robots into society is due to a high risk of adoption for the customer. According to interview feedback, there is a necessity to reduce risk and uncertainty to be able to diffuse this new technology, which is difficult during this period of development. “Social robots are inherently expensive, there’s no way around that” (Flash Robotics Interview, 2017). Particularly for social robotics start-ups that are building hardware components alongside software platforms, there is a very high cost during development and production stages. Strained economies across the globe are likely to have a reduced interest in social robots if they are expensive, therefore it is necessary to lower the cost of production to achieve successful mass diffusion. It is likely that the cost of producing social robots will not change until the rate of adoption is high enough to warrant mass production.

Additionally, feedback gained from social robotics founders suggested another cause behind the high risk of adoption is that the products are not yet fully developed enough to justify purchasing by the mainstream market. The early majority seek a product that is fully developed and meets their needs; this is the ‘whole product’ concept that is analysed in Chapter 4.4. “You can’t give social robots to the early majority. The products simply are not mature enough” (Samer Al Moubayed Interview, 2017).

The consensus from the interview candidates is that there also is a misalignment between the potential adopters’ expectations of social robots and the actual functionality of these technologies. Whether this is due to the inadequacy of the current state of technology is yet to be seen. Jan Kędzierski (Interview, 2017) stated it is simply public expectations which is the issue, however Ross Mead (Interview, 2017) believes there are technical challenges with technological advancements that are yet to make it out of the lab and prove they can work in real-world settings at production-level quality. The argument confirming technological barriers is supported by Hayes-Roth (2006), who claims that this technology is not developed enough
and will not diffuse into the mainstream market until it is capable of adapting, learning and evolving of its own full accord.

It is important to note that the high risk of adoption identified above will vary between different markets. “Many companies have confused the era of globalisation with an era of homogenisation” (Haig & Page, 2003, p. 153). Social robotics start-ups need to be aware of cultural barriers; products will naturally be incompatible in certain regions or amongst some adopters, especially late adopters. The cultural differences between countries have enormous impacts to the rate of adoption and therefore the success of product diffusion. This may not necessarily mean the product has to physically change, however the marketing strategies are likely to differ greatly. It is not a one-size fits all approach to selling internationally. Accommodating to cultural differences, especially when targetting the mainstream market, results in greater perceived product-market fit. An effective, tailored marketing campaign that educates specific customer segments which are sceptical of this new technology is likely to change the mindset of the relative markets, and in turn, achieve wider adoption.

An additional early-stage barrier to diffusion that causes high risk of adoption is the uncertainty of the social robotics industry. At the time of writing, the social robotics industry is very much in its infancy. “With this being an early stage market, in the infancy of social robotics space, there is scepticism as to whether to market will truly exist” (Ross Mead Interview, 2017). Social robots are new innovations, which are yet to have major impacts upon social systems across the globe. There are currently no companies, start-ups or organisations alike that have crossed the chasm and diffused these products into society; something which is agreed upon by experts around the globe. This point makes it difficult to determine whether the mainstream market is ready for social robots; the only true way to anticipate future performance is via thorough market analysis and ongoing communication with the potential adopters, bearing in mind the possibility that the markets do not yet realise they have a need for social robots. “Markets that don’t exist, can’t be analysed” (Christensen, 1997, p. 15). Additionally, there is the notion that “where there is no competition, there is no market” (Moore, 1991, p. 97), which creates uncertainty regarding the future success. However, there is existing ‘credible competition’ in the form of substitutes, such as non-technological methods and human labour, which proves there is a market need.

It has also been noted that a large percentage of social robotics founders have a background in academia as opposed to business; this ensures relevant technical expertise and is beneficial for product development, however there can be a deficiency in business development expertise. Therefore, there is the risk that the needs of customers at different stages of the technology adoption life cycle will not be served correctly. The lack of financial stability or hiring experience may hinder these start-ups in gaining the relevant expertise required. Miller & Garnsey (2000, p. 460), identified that it is the entrepreneurs that significantly impact the speed at which their technology diffuses. They state “the diffusion of a technological innovation can be strongly influenced by the capacities of the early entrepreneurs to match resources and opportunities”, suggesting that it is vitally important to secure an effective team in the early stages of growth.

It has been found that insufficient and inappropriate management is a major barrier affecting the diffusion of innovations (Karakaya & Srijannawit, 2015). Business strategies used by management that are not effective or appropriate cause slow diffusion amongst market segments. Furthermore, ineffective marketing campaigns and incorrect approaches to educating the market causes barriers to diffusion; these strategies are vital for the social robotics industry in order to overcome any misconceptions the public hold towards this new
technology. Weak after-sales service is also a factor which negatively influences the diffusion of innovation (Karakaya & Sriwannawit, 2015), as there is a tendency to apply resources to making sales but not serving existing customers, therefore causing high churn and low customer retention rates for repeat purchases or continual recurring revenue.

The final and somewhat major barrier to diffusing social robots into society is the task of crossing the chasm.

4.2 Crossing the Chasm in Social Robotics

Industry analysis has shown that AI has previously fallen into the chasm, in a similar fashion to virtual reality. Specifically, there were multiple barriers to adoption which caused a failure in crossing the chasm; primarily a “lack of support for mainstream hardware, inability to integrate it easily into existing systems, no established design methodology, and a lack of people trained in how to implement it” (Moore, 1991, p. 17). The attempt to break through to the mainstream market failed, and ultimately became another casualty to the chasm. It is advised that social robotics start-ups learn from these mistakes and apply them during the development stages. However, advancements in technology have provided stronger foundations for the higher quality of products produced. It has also been noted that the chasm does not exist as prominently in incremental innovations as disruptive innovations (Nilsson & Tutor, 2009), which may benefit some companies. Social robotics start-ups will find introducing this emerging technology to society the most difficult process, however if adopted on a mass scale, future incremental updates to the products will experience a much smaller chasm.

In order to increase the chances of crossing the chasm successfully, it has been found that social robotics start-ups should identify their unique ‘pragmatists in pain’. These are the very first adopters within the mainstream market, those which are willing to take more risk in order to solve an existing problem. They ultimately become references for the innovation, by acting as an influencer for the majority of the pragmatists segment. “A lot of diffusion processes are driven by imitation. We imitate people we like.” (Emrah Karakaya Interview, 2017). It is important to specifically identify the most likely adopters to increase the chances of successfully crossing the chasm; “You cannot focus on convincing the people that don’t believe in the product to believe in it. You have to focus on the people who do” (Flash Robotics Interview, 2017). Geoffrey Moore stated that social robots are likely to be attractive to Technology Enthusiasts as well as differentiating for the Visionaries segment, therefore providing the capability of targeting multiple markets simultaneously (Interview, 2017). (The descriptions for the redefined segments can be found in the Appendices, Chapter 7.1). Social robotics start-ups need to focus on these adopters and cater for their needs; ultimately, they become influencers for the innovations and become a major catalyst for rapid expansion in the mainstream market.

Therefore, targeting the pragmatists in pain requires a different approach to that of the early market. It is important to recognise the differences between the two segments. “Visionaries are attracted to a high-risk, high-reward opportunity that involves them being first and getting a competitive advantage by so doing” (Geoffrey Moore Interview, 2017). On the other hand, the pragmatists in pain are likely to take risk purely to solve a problem, instead of achieving a specific social status. “They will take more risk if the promise is to directly address their painful problem in a comprehensive way” (Geoffrey Moore Interview, 2017). The timing of adapting to cater for the needs of the early majority segment has to be efficient, preferably earlier as opposed to later. However, here lies an issue for social robotics start-ups; based on interview
feedback, it appears the founders are not able to identify the chasm or understand when to adapt their strategy to attract the pragmatists in pain. Firstly, it is imperative to understand where the company lies on the technology adoption life cycle (TALC), which helps to determine the current growth trajectory. Secondly, companies that become victims to the chasm may be under the assumption it is a product issue that is prohibiting sales. This is in fact not the case, but rather a focus shift is required to target the next market segment. Social robots therefore need to be developed with the ‘whole product’ in mind in order to meet the needs of the early market, which is discussed below.

In order to cross the chasm and attract ‘pragmatists in pain’, it is advised that start-ups should focus on collaborators and complementors, and not only on the competition (Shapiro & Varian, 1999). “Unfortunately for start-ups, if your market is not there, you need to join forces and work on it” (Flash Robotics Interview, 2017). Forming partnerships in order to create a superior product can have many positive influences upon a successful crossing of the chasm, particularly with well-known tech companies in the industry. This strategy may allow for the diminishing of certain barriers to adoption for social robotics start-ups, such as high production costs or lack of trust in the brand. This will become evident in the process of integrating products of both hardware and software platforms. An additional benefit of working with collaborators is achieving ‘reinvention’; success depends on how well the product evolves to meet the needs of the more demanding and ever-changing markets. Especially for platform product innovations, partners can develop upon and contribute to the product and become active partners in ensuring the product has the functionality that is needed the most. This is especially useful for tailoring the product towards niche markets. These collaborators become an ambassador of the brand, who grow a high sense of loyalty and ownership of the features they have developed. This way, the company can ensure the product is continually more aligned with the users’ needs and expectations.

A final finding relating to crossing the chasm, is that social robotics founders and academics alike hold differing opinions when it comes to defining market segments of the technology adoption life cycle (TALC), which severely impacts upon recognising and preparing for crossing the chasm. Consequently, this makes it extremely difficult to determine the progress of product diffusion into society. The interview findings suggest there are two common methods to determine a company’s current positioning along the TALC; the first approach is analysing the current market share attained, whilst the second approach identifies the types of customers which are currently adopting the innovation. Those with former opinion, calculate the ‘Total Available Market’ and then determine from there the percentage of the market already achieved. The latter view disregards the quantity of sales achieved, but focusses on the types of adopters to determine where an innovation is positioned along the TALC. For example, adopters that take on risk and are eager to test new technology will always be innovators, regardless of the number of sales achieved. There is no suggested method which is correct, however it is something which start-ups should take into account during market analysis.

It should also be noted that Geoffrey Moore believes the five psychographic categories still apply to today’s tech industry and social robotics, despite new digital methods of disseminating information; “I still think all five categories are alive and well. I do not believe that more digital offers skew the categories, just that more digital products are making the grade with pragmatists at greater speed” (Geoffrey Moore Interview, 2017). This argument makes it easier for social robotics start-ups to identify their target segments in the market.

It was noted during the interviews that social robotics start-up founders suggest there is no real way of determining whether a company is approaching or indeed crossing the chasm. However,
the researcher has identified an adaptation to the traditional model which provides a solution in clarifying signs which helps to identify the chasm.

4.3 The Double-Bell Curve and the ‘V’ in the Chasm

Based upon interview feedback and secondary research analysis, a flaw has been discovered with the existing technology adoption life cycle. The current model takes into account progress based on market share achieved and depicts progress on the same trajectory post-chasm as pre-chasm. This is a major reason why start-up founders find it difficult to identify the chasm; the model does not take into account actual growth patterns. Start-ups generally find that sales and revenue drop, or at least slows whilst crossing the chasm. It is not until the innovation has crossed the chasm that it will scale to its full potential. This is where the researcher’s notion of the ‘double-bell curve’ comes into play. Assuming that technology adoption works from left to right along the life cycle, start-ups will find their growth trajectory on more of a double-bell curve, as opposed to the classic bell curve, as depicted in Figure 5 below. Start-ups generally presume that the product is failing, or that they are not offering a product with high enough value. In fact, the issue is that they are simply marketing and positioning their offering incorrectly to the new pragmatist segment. No longer do the adopters want to hear how much of an innovative and new product it is, but instead how established it is and what value the ‘whole product’ can offer them to improve their lives with ‘references’ from their peers.

![The Double-Bell Curve](image)

Figure 5 - The Double-Bell Curve

The blue growth curve depicts two possible trajectories which start-ups in general could follow, which is something social robotics start-ups need to be aware of. At the peak of the early market, the visionaries segment will begin to saturate and sales will begin to fall. If no action is taken, sales will dramatically plunge and this will ultimately be the cause of death. Unless if a change in strategy is undertaken, the pragmatists in pain will not adopt the innovation. However, if social robotics start-ups adapt their approach, they will follow along the ‘V’ in the chasm. After an initial dip in sales and consequently growth, the pragmatists in pain will begin to adopt the innovation and eventually the rest of the pragmatist segment will follow, instigating mass adoption amongst the mainstream market. One example of an innovation that failed to cross the chasm is Google Glass. The product was simply not attractive to the mainstream market, resulting in low appeal and little added value for the potential adopters. The attempt to cross the chasm failed, due to the fact the mass market did not see any need for the product, consequently failing to follow the ‘V’ in the chasm and ultimately experienced reducing sales. As mentioned in the literature review (Chapter 2), a classic example of an innovation successfully crossing the chasm is the Apple iPod. At the time, existing MP3 players such products as Diamond’s Rio had great initial success in the early market, but seemed to stagnate at the edge of the chasm due to high product complexity; hence saturating the early
adopter segment and not adapting their strategy. By reviewing the market needs and ultimately developing a platform that served as a media player, library and store application, Apple met the demands of the pragmatists in pain and eventually the mainstream market who required a better solution to managing their music and listening ‘on the go’. The innovation very much followed the ‘V’ in the chasm, as Apple adapted their marketing strategy to attract those potential adopters that required a real problem to be solved. The product was consequently superior to the existing competition and achieved rapid adoption in the mainstream market, allowing for a long-standing market leadership position.

These two new potential growth curves are something that social robotics start-ups should be aware of and can be a defining factor in determining where they lie on the technology adoption curve. Declining sales could be a positive factor, in that the innovation is maturing to a stage where it is ready to be introduced to the mainstream market, but simply positioned towards the pragmatists as a ‘whole product’, described below in Chapter 4.4.

It is important to note however, analysing adjacent markets to learn from their mistakes and adopt successful strategies can be a useful but risky approach. Due to the fact no social robotics product has crossed the chasm, taking influence from adjacent markets can contribute towards learning from other companies’ mistakes. However, the social robotics industry is unique and is not likely to develop in the same way as other industries, therefore strategies that previously worked elsewhere might not be relevant for social robotics start-ups.

4.4 Delivering the ‘Whole Product’

It is advised that social robots are tailored to cater for individualised needs of the differing customer segments. Adopters of radical innovations generally have widely differing requirements and expectations of delivered products; therefore, there are differing versions of what the ‘whole product’ should be. The innovators and early adopters generally require a product or platform to develop upon, whereas those in the mainstream market require a fully developed social robot to serve their specific purpose. Underdeveloped products targeted at pragmatists will not satisfy their needs and will consequently achieve low rates of adoption; this market segment will choose substitutes with better functionality to serve the purpose.

Below, Figure 6 displays the technology adoption life cycle place on top of the ‘whole product’ model. The purpose behind this combined model is that start-ups can identify what type of product they should be offering to the different market segments. It can be seen that the ‘generic product’ should be offered to the early market and the pragmatists in pain, the ‘expected’ and ‘augmented’ products are targeted at the pragmatist market (early majority) and the fully developed ‘potential product’ caters for the needs of the conservatives (late majority).
It is suggested that the outer circles of the ‘whole product’ model become of greater importance to social robotics start-ups as the technology adoption life cycle progresses. As the majority of, if not all, start-ups are delivering to the innovators and potentially early adopters, the current focus should be heavily on creating a ‘generic product’ to be shipped out. Once the chasm has been crossed, a heavier focus should be placed upon developing social robots in line with mainstream market’s expectations and improving the product based on the ‘potential product’.

It must also be noted that the ‘whole product’ must be made in accordance with consumers’ expectations, which may change over time. A primary barrier to creating an effective ‘whole product’ is the prolonged periods between market research and product introduction. This has been found to be the cause of failure for innovations; for example, long product development lead times can result in a product that no longer meets the requirements of the target audience (Chukwuma-Nwuba, 2013). If the production time of a social robot is extensive, social robotics start-ups should maintain communication with potential adopters in order to ensure the product is in line with changing customer needs. This argument is supported by Karakaya (2015, p. 20), who states that characteristics of adopters are dynamic and “change can be so continuous that the innovation gets modified in every adoption that takes place”. Social robotics founders also identify the need for communication in order to understand what the market believes is a social robot. This is essential knowledge so that a marketing strategy can be created with the aim of aligning customer expectations with the actual performance of the product delivered. Thus, the requirements can be gathered for the expected product and is likely to meet the needs of the early majority market.

For social robotics start-ups that have an initial focus on the B2B market, the ‘generic product’ needs to be well established to provide foundations to build the ‘expected product’ upon. The ‘expected product’ is the focus for attracting the early stages of the mainstream market. The requirements for this product should be fully understood via recurring communication with potential adopters. If it is unfeasible to develop the product to meet the requirements of the target market, there should be an attempt to realign unrealistic expectations. In order to cater for the needs of each market, the products should be specialised to directly serve customer needs, by making small tweaks to innovations that will increase relevance, talk-ability and memorability and are likely to have hugely successful outcomes’ creating products that are considered as ‘sticky’ (Gladwell, 2000). It is advised that products are made in mind with this
‘sticky’ profile, especially for the mainstream market, as these critical factors can have a big impact upon future adoption. Social robotics start-ups that are prioritising the B2C market, particularly for the mainstream sections of the TALC, are recommended to have a heavy focus on the ‘augmented product’. Meeting the expectations of the buyers is vital for product satisfaction, and therefore creating a strong reference base.

4.5 Split in the road: Mass or Niche?
Social robotics start-ups are faced with two options in terms of their target markets; niche or mass market approaches. It appears that platform product innovations are allowing start-ups to create an offering for the masses; specifically, for developers to build upon the existing architecture to deliver tailored products to their own niche market space. Whereas, start-ups targeting their own niche market to suit a specific purpose have greater control over product development and the specific end-use of the product. However, as identified by multiple interviewees, we cannot be sure at the stage of market development of which is the best long-term strategy to utilise.

“The consequences of being sales-driven during the chasm period are, to put it simply, fatal” (Moore, 1991, p. 50). There is the risk that start-ups attempt to fulfil every potential sale on a wide target segment, despite actually developing a specific, niche product. If the first set of customers are not completely satisfied and their needs are not correctly served, these adopters are not referenceable and will impact heavily upon the chances of success for crossing the chasm. Existing literature recommends that start-ups target ‘beachhead markets’ in order to become the market leader and ensure there is a strong customer base that will act as evangelists to instigate further mainstream prospects. “Dominate a small niche and scale up from there, towards your ambitious long-term vision” (Thiel & Masters, 2014, p. 58). Targeting a niche can prevent the risk of spreading innovations too thin and consequently experiencing slow diffusion/ adoption rates and lack of rapid growth. “The chances of success are going to be higher if you focus on a particular vertical and you go into a niche market where you own it” (Ross Mead Interview, 2017). This method will also increase the likelihood of attracting the targeted ‘pragmatists in pain’, those who will become an effective reference base. From an academic standpoint, Emrah Karakaya stated, “Usually companies that have been successful chose one innovation with the potential to be adopted globally, but start from somewhere to diffuse it first. Then it automatically diffuses into other markets” (Emrah Karakaya Interview, 2017).

However, despite a higher risk of failure, mass market products have the opportunity to gain first mover advantage and achieve the majority of the market share. In a similar way that mobile phones and personal computers became adopted by the masses, social robots have the potential to replicate this scale of adoption. This is likely to work when simultaneously targeting differing types of consumers; from technology enthusiasts to pragmatists, albeit requiring a fully developed ‘whole product’. Additionally, this will provide the opportunity for rapid growth and increased adoption rates.

A great example of a product defying the ‘beachhead market’ approach is the iPhone, which simultaneously attracted technology enthusiast, visionaries and pragmatists alike post-launch, albeit a fully-developed ‘whole product’ that catered to customer needs. However, there lies an inherent risk of first mover disadvantage, in that those who attempt to cross the chasm first have a higher risk of failure and imitators will learn from previous mistakes. Peter Thiel termed this as ‘last mover advantage’, urging that more important than the first mover is the last mover. (Thiel & Masters, 2014). The idea is that the last mover, a.k.a. the fast follower, with a great innovation, will enjoy a prolonged period of monopoly profits. Therefore, targeting a niche
market and incrementally improving the product has the potential to become a successful strategy.

It should be noted that achieving dominance in multiple markets simultaneously is a difficult task, especially for start-ups struggling for resources, funding and experience. Post-chasm pragmatists prefer to buy from market leaders, which is why it is generally recommended by the interviewees as a ‘safe’ option to target a niche market first. The ‘big-bang approach theory’ suggests methods of multiple-market dominance and does not follow the traditional continuum of the technology adoption life cycle. Instead, the products are embraced rapidly by the mainstream market, therefore disregarding the five traditional primary segments (Downes & Nunes, 2013). However, as Al Moubayed stated (Interview, 2017), this is only possible with a ‘whole product’ and not an innovation that has long development cycles. Start-ups also need to be aware that there needs to be significant levels of word-of-mouth between the five market segments in order to generate required traction. Pragmatists, especially with such a disruptive innovation as social robots, seek references from their peers prior to making purchase decisions. The early stage customers will not, where a completely different focus is required, particularly when focusing on a specific niche market with a tailored product.

Based on interview feedback and secondary research/market analysis, the researcher suggests that the most effective strategy is the ‘go big, or go home’ approach by targeting the mass market. Such an innovation is believed by many to eventually cause mass societal change and the forerunner within the industry is likely to reap the rewards. Despite the inherent risk of adopting such an approach, if correctly managed with an experienced team and a well-developed ‘whole product’, the results will be market leadership in multiple industries, ranging from education to healthcare or public services. Rapid adoption is key, similar to adjacent markets such as the mobile phone industry, and social robotics founders should target this approach if their desires are to build such a company. Additionally, building a platform product innovation for the masses provides the opportunity for unique customisation; the product should be personalised in order to create the most value for the consumer (Shapiro & Varian, 1999). If the customer has the option to customise their social robot and personalise the product to directly suit their needs, there is likely to be a much higher chance of customer satisfaction and is a major factor in differentiating products from competition.

The researcher also urges social robotics start-ups to be wary of overadoption in markets that are not yet ready to adopt social robots. Thorough market analysis needs to be completed in order to determine whether there is a willingness to adopt; simply pushing this kind of disruptive innovation into markets that are not yet ready could cause long-term consequences. Even when implementing a mass market approach, resources shouldn’t be wasted on pushing such a disruptive innovation when the potential adopters are not willing to adopt. This may create barriers to future diffusion due to a prior negative perception towards the product. As described below, it may be worth investing over a more prolonged period of time for markets that are not yet ready in relation to the technology acceptance model.

4.6 Customer Attitudes in Technology Adoption

It has been found that there is a misconception between the potential adopters’ perceptions towards AI and social robots, and the actual products that are currently being developed. It is suggested that public perceptions are influenced by Hollywood and sci-fi novels; new innovations that are released to the markets are not meeting expectations and people may have incorrect preconceptions of the functionality that can be delivered with today’s technology. This is confirmed by Kennedy et al. (2015), who suggests there is a discrepancy between
expectations and the products, which accounts for ‘negative cognitive reactions’. “It is not always clear to people what a social robot is. You need to make sure you are on a level playing field in terms of what this technology is” (Ross Mead Interview, 2017). It is recommended that rather than striving to create products to meet these levels, it is much more efficient to re-align potential adopters’ opinions towards this technology. “People should understand the benefits of social robots and the value they bring, but it might be difficult to communicate this to the customers” (Emrah Karakaya Interview, 2017).

Additionally, social robots that are sold to users such as health care providers, will be doing what has always been done, yet cheaper and more efficiently. Therefore, social robots will “put real people out of work, which is creating a social backlash that in the short term is bound to get worse” (Geoffrey Moore Interview, 2017). However, it has been proven that society adapts to the new norm and “any good innovation that solves lots of problems will experience some resistance” (Samer Al Moubayed Interview, 2017). It is vital to change negative perceptions to reduce barriers to diffusion, but also to gain more references in the pragmatists segment to make it easier to cross the chasm. In order to change people’s attitudes towards adopting social robots, the Technology Adoption Model (TAM) must be analysed.

The model suggests that the ‘attitude towards using’ the product will directly impact the ‘behavioural intention to use’, therefore actions (purchasing decisions) are formed through prior attitudes of the innovation. Each of the factors of the TAM have been analysed based on feedback from social robotics experts and secondary research. The primary finding is that social robotics start-ups must focus heavily on increasing the ‘perceived ease of use’ and ‘perceived usefulness’ of social robots. Each of these factors currently have a low rating, mainly due to the lack of awareness and knowledge regarding social robots on behalf of the potential adopters. Such a technology is perceived as highly complex, which lowers the ‘perceived ease of use’, consequently impacting upon the ‘perceived usefulness’ and ultimately creates a barrier to adoption. It is the lack of awareness of social robots in the markets that reduces the perceived usefulness, as the potential adopters are unable to understand the value that social robots can offer them.

It is advised that in order to increase the ‘perceived ease of use’, potential adopters should interact with social robots first-hand. It is only once that users experience the interaction with social robots, as opposed to watching videos online for example, that they realise the true value that can be delivered. It is also suggested that social robotics start-ups must focus on the ‘whole product’ concept (described in Chapter 4.4), to realign customer perceptions and influence their behavioural intent to use. To deliver the ‘whole product’ and remove adoption complexity, social robots must reach a stage where consumers can purchase them off-the-shelf, and simply plug-and-play without any training necessary; it appears that the industry has not yet reached this stage. In terms of changing ‘perceived usefulness’, the use cases for potential verticals must be made visible in order to overcome the potential ‘novelty effect’ which naturally comes with these types of technological innovations.

It is understood that there has been a recent shift in consumer attitudes; the purchasing decision now heavily weighs on the branding as opposed to the physical product itself (Haig & Page, 2003). This is reinforced by Hetet et al. (2014), who emphasises the importance of innovation in brand development, ultimately influencing customer perceptions and brand recognition. There are many examples of re-branding campaigns that have had huge success in terms of sales without alteration of products, such as Apple and Microsoft. High quality products alone cannot be relied upon to succeed; advertising provides the foundations for strong brands and
will significantly influence consumer attitudes towards technology adoption. It is therefore recommended that social robotics start-ups can influence the perceptions and behavioural intentions of potential adopters through effective marketing strategies. Social media and alternative ‘push marketing’ efforts must be made in order to change people’s attitudes towards this technology. Individuals in the mainstream market segment will not automatically seek to learn more about the products; there must be an effort made on behalf of the social robotics industry in educating the public about the current capabilities of this technology. Posting content to social media platforms, with humility and humbleness, will set the correct levels of expectations and hopefully change the attitudes of those that are reluctant to adopt these new innovations.

4.7 Improving the Rate of Technology Adoption

Increasingly digitally mediated lives of the general public are lowering the resistance to the adoption of new innovations. Rapid technological advancements are making the life cycle of innovations much shorter, therefore younger generations in particular are become used to the continually increasing turnover of new products. Consequently, the younger audience is likely to have a lower resistance in adopting new innovations and are also more likely to see the value and perceived usefulness over those that are not technologically comfortable. This is of great importance to social robotics start-ups as the success of new technologies can heavily depend upon the “motivation and success of the people who directly benefit from an innovation... in learning about their technology” (Douthwaite et al., 2001, p. 834). It is proposed that higher perceived usefulness and ease of use can result in increased motivation to learn how new tech can add value to people’s lives. Additionally, it is suggested that it used to take 10 years for an innovation to fully diffuse into society and attain 50% of the market share, however new communication channels and increased willingness to adopt new technology has decreased this time rapidly (Mahajan, 2014). However, the prediction of a successful product is not centred around market share, but instead of the market potential, how fast it will reach 50% market share and the rate of growth of the market. Social robotics start-ups should consider these facts when identifying niche markets or target verticals. It is important to select the right communication and distribution channels in order to target specific potential adopters, as Godin (2009, p. 30) mentioned, there is an increasing amount of ‘noise’ impacting upon consumer attention, therefore “everyone will not listen to everything”.

Social robotics start-ups can utilise the five attributes of innovations defined by Rogers (2003) in order to create a strategy that can help increase the rate of adoption amongst the emerging mainstream market. By increasing the relative speed in which social robots are adopted by the target markets, start-ups can reduce the barriers to diffusion and contribute to crossing the chasm. As described in the literature review (Chapter 2), the five attributes are: Relative Advantage, Compatibility, Complexity, Trialability and Observability.

It is understood that perceptions towards AI and social robots are mixed; inherent preconceptions cause an inconsistency between the actual product and adopters’ existing perception. Therefore, ‘relative advantage’ and ‘compatibility’ differs greatly between the technology enthusiasts with a high willingness to adopt and pragmatists who may be averse to technological change. This can be overcome through sufficiently educating potential adopters regarding the possible value that social robots may be able to contribute; such as reduced costs, unlimited working hours, high customisability and continually improved upgrades. Compatibility is key in ensuring rapid diffusion into society; however, due to the nature of the technology, it is likely that a change in the value system will be required in order to achieve rapid mass adoption.
A similar factor applies in the form of perceived ‘complexity’. Social robots are generally built upon conversational AI and therefore the human-robot interaction is very simple; it is based on normal conversational interchanges. However, to purchase and install a social robot can be perceived complex for non-technical people and as mentioned in Chapter 4.6, the perceived ease of use is low which forms another argument to ensure the creation of a ‘whole product’ prior to shipping. This is a defining factor in predicting the rate of adoption; if marketed correctly, buying a social robot should be as simple as purchasing a mobile phone.

‘Trialability’ is perhaps one of the most important of the five factors. The value of social robots is in the experience; physically interacting with the product is what provides the value. It is recommended that in order to increase the likelihood of adoption, social robotics start-ups should increase the visibility of the robot and allow the public to interact and engage with the products, with the aim of educating and informing the market prior to pushing for sales. However, it is currently too expensive and unfeasible to purchase, trial the product and then return if it doesn’t meet expectations. It is hoped that by attending events, installing robots in public spaces or building online awareness, this will increase the level of ‘observability’ so the value of adopting a social robot will be easily displayed.

Overall, it has been found that ‘trialability’ and ‘observability’ are the most influential aspects in improving the rate of adoption for social robots. These two aspects have a heavy influence in improving the ‘perceived ease of use’ and ‘perceived usefulness’ as described above (Chapter 4.6). The greater the exposure and awareness the potential adopters have of social robots, the more likely they are to adopt and become avid influencers for the rest of the market. “One way of overcoming barriers to diffusion is by running demonstration projects, so potential adopters can understand the offered value of the products” (Emrah Karakaya Interview, 2017). Specifically, this is extremely useful for attracting the ‘pragmatists in pain’. As this target segment are more risk-averse than the early market, the opportunity to view the product and its potential benefits can influence behavioural intention and purchasing decisions. Both of these aspects can also have a positive impact upon the ‘complexity’ of social robots, by aligning customers’ understanding of the products through greater exposure.

It is understood that there should be different strategies used for social robotics start-ups that are targeting either B2B or B2C markets. Hughes & Perrott (n.d.), argue that in addition to analysing the process of speeding up adoption in B2B markets, there are additional factors that impact upon organisational adoption decisions; perception or risk, organisation variables, innovation characteristics and individual variables. The adoption decision can also be influenced by the individuals within the organisation. It is advised that these factors are heavily focussed upon when advertising/selling in the B2B market. In the B2C market, social media and virality in particular are important factors in determining success. New digital communication channels help in reaching a much broader audience, enhancing ‘observability’ of the innovations. A product that is popular, easy to understand and attractive has a greater chance at become viral; this is an extremely efficient method of disseminating information directly to the target audience. Nilsson & Tutor (2009), support this statement by finding that the development of information technology in general has made it easier for the early market to acquire information about new innovations.
5. Conclusions

This chapter concludes the empirical findings and provides summarised answers to the research questions. Additionally, limitations and recommendations for further research are presented.

5.1 Conclusions of Findings

There is huge potential for social robotics and artificial intelligence to impact upon the future world. In the future, today’s jobs will no longer exist and new roles will be created. Automation is predicted to transform industries and everyone from children in schools to the elderly in care homes could be interacting with social robots. At this stage of the industry, it is very difficult to determine the correct approach that social robotics start-ups should take to ensure success, or indeed if the market is even going to exist.

The purpose behind this research is to provide strong foundations regarding the foreseeable future of the social robotics industries. The findings focused on answering the following research questions: What are the barriers to the early stages of the diffusion of innovation for social robotics start-ups? How can these innovative companies cross the chasm?

The primary aim of this thesis was to delve into the potential barriers that the social robotics industry as a whole is likely to face in the future. In addition, several theories and models were applied to support the findings, such as ‘crossing the chasm’, the technology acceptance model and the ‘whole product’ concept. It was hoped that the research will discover connections between these theories and models, to understand how they can affect each other so that a cohesive business strategy can be built to increase the likelihood of successful innovation diffusion.

The findings show that there are significant barriers currently preventing social robots from being diffused into society and successfully ‘crossing the chasm’. Robots are inherently expensive to build and this will not change until the rate of adoption is high enough to warrant mass production. In addition to misaligned customer expectations, particularly in the early majority (pragmatist) segment, social robots are not yet considered a ‘whole product’. The development of the ‘expected product’ is necessary in order to effectively cross the chasm from the early adopters (visionaries) to the early majority (pragmatists). However, the early market (B2B) is currently being served well, as the requirements for a platform product which can be developed upon by customers to serve the needs of their niche market can be offered. Due to the infancy of the market, there is a lack of available comparisons of social robotics start-ups attempting to cross the chasm to learn from; this makes it difficult to know what the most effective strategies are or indeed if the market will prove to exist. Additionally, the researcher urges social robotics start-ups to prepare themselves for not only crossing the chasm, but the post-chasm phase too. The potential scale of mass adoption needs to be effectively managed, therefore a strategic plan needs to be created to be able to successfully withstand this period of rapid growth.

It has been found that an effective strategy in crossing the chasm is to partner with collaborators, particularly those that are popular with the mainstream market segments. This contributes in increasing trustworthiness and improving the brand image, something which has proved to be a necessity in changing the perceptions towards this new technology and influencing the rate of adoption. However, there is risk of overadoption if the market is not ready or fully educated regarding the potential benefits of adopting this technology.
An adaptation to the traditional technology adoption life cycle continuum has been made in the form of the ‘double-bell curve’, identifying a ‘V’ in the chasm which start-ups will experience if they are to successfully cross into the pragmatists segment. Declining sales revenue may be a positive phase if handled well, as it could be the transition period between the early and mainstream market. A change in focus towards the new market segment will provide a better chance of social robotics start-ups following the path of the ‘V’ and overcoming the chasm.

It is suggested that social robotics start-ups can target either a niche or mass market. Platform product innovations are more likely to serve the needs of the mass market, however there is inherent risk in this approach due to the lack of experience these start-ups hold along with the uncertain capability of implementing a product on such a large scale. Serving a niche market is likely to attract more ‘pragmatists in pain’, increasing the likelihood of crossing the chasm in their chosen market, however causing slower growth trajectory along the technology adoption life cycle.

Additionally, in accordance with Rogers’ five attributes of innovation (Rogers, 1995) and Davis’ technology acceptance model (Davis, 1985), customer attitudes can be influenced and the rate of adoption increased. In particular, by educating the potential adopters (primarily via increasing the ‘trialability’ and ‘observability’ attributes) and utilising effective communication/distribution channels tailored to the specific target audience, it is predicted there will be an increase in the rate of adoption.

The researcher’s point of view is that social robotics start-ups should follow up these findings with greater in-depth research in order to formulate effective strategies to ensure these products are successfully diffused into multiple industries. There is great initial potential, however the process of integrating these products into society needs to be closely monitored to avoid suffering the same fate in failing to cross the chasm as many other innovations have experienced.

5.2 Limitations
Several limitations were faced affecting the research and resulting findings. Firstly, limited time constraints restricted the number of interviews and reduced the depth of secondary research. The limited scope set by the INDEK department at KTH (Royal Institute of Technology), 15 credits as opposed to a full 30 credits, also restricted the overall quantity of in-depth analysis into the research areas.

There are potentially limitations to the findings due to potential biases from the researcher, such as the ‘curse of knowledge’ and ‘confirmation bias’. There is the potential of bias results towards the success of the industry and Furhat Robotics, where the researcher is an intern at the time of writing, however steps have been taken in attempting to eliminate these biases.

Only qualitative research has been conducted in this thesis, therefore the findings are not supported with quantitative data analysis. Therefore, the conclusions are predictive, highly subjective and based upon theories, opinions and suggestions. In addition, there is a lack of case studies into adjacent industries, which would help determine strategies based upon experiences of companies previously attempting to diffuse innovations and cross the chasm (which has not yet occurred in the social robotics industry due to its infancy).
There were no interactions with end users of the products, therefore the reference to customer expectations, attitudes and perceptions towards AI and social robots are based purely on secondary research and opinions of interviewees. The researcher was limited to the network of colleagues at Furhat Robotics and could not expand further; it would have been beneficial interview more academics and practitioners for further in-depth analysis. On top of this, not all of the initial planned interviews were undertaken and some had to be conducted via email, therefore limiting the detail of the supplied answers.

5.3 Recommendations for Further Research

The research in this thesis is focused specifically regarding the diffusion of innovation, crossing the chasm and technology adoption in the social robotics industry. Naturally, such an industry in its infancy requires greater in-depth analysis in order to formulate sufficient strategies. It is therefore recommended that academics and social robotics start-ups alike use these findings as a basis for future research regarding these topics on a much broader scale.

The social robotics industry as a whole appears to be primarily concerned with the early market. This research analyses the methods of entering the mainstream market, however it also recommended that start-ups at least consider researching into the needs of the later adopters, as they may have a negative influence on adoption rates if not properly considered. It may be helpful to conduct interviews with practitioners in adjacent industries in the mainstream market to understand their experiences of attempting to cross the chasm and avoid committing the same mistakes.

Further research is required to confirm the theory of the ‘double-bell curve’ and the ‘V’ in the chasm. These notions were suggested based on qualitative data gathered via interview material and secondary sources. Deeper analysis into the causes of failure and the path that start-ups follow in successfully crossing the chasm will contribute to either confirming or denying the theory.

There is a requirement for more in-depth research regarding the positioning of disruptive, high-tech innovations such as social robots in relation to the diffusion of innovation; especially for targeting the early majority (pragmatic) market segment. It is apparent there is a lack of research into the recommended strategies, especially for the social robotics industry, in order to increase the likelihood of crossing the chasm. From these findings, it is important to fully understand how the public perceives social robots and artificial intelligence prior to introducing into the mainstream market as there may be preconceived notions towards these products. Additional research should be considered into measuring adopters’ ‘willingness to pay’ for each segment of the technology adoption life cycle, which will be a contributing factor in determining how to influence customer attitudes and predicted adoption rates.

It is recommended that further research is conducted into the cultural barriers of social robotics adoption. It is understood some cultures are more willing to adopt this new type of technology than others. Therefore, product diffusion and such strategies as marketing or customer acquisition is likely to be different in alternative geographical markets.

Communication should be made with the likely end users of the products, to determine their actual expectations and perceptions of social robots. Simultaneously, findings should be made according to the technology acceptance model (TAM), to determine how potential adopters perceive social robots. In addition, the TAM2 model (Venkatesh & Davis, 2000) should be
considered to also take into account social influence processes, which is likely to have an impact upon the adoption rate of social robots.

The ‘Novelty Effect’ is a topic which should be researched into further. Social robots may possibly be perceived as novelties or as toys, therefore impacting upon the perceived usefulness of the innovation. Social robotics start-ups need adjust their positioning in order to market the product effectively in order to overcome the ‘novelty effect’, but these strategies have yet to be fully discovered. If the ‘novelty effect’ is inherent in the market, there needs to be strategies which can shift this to the ‘bandwagon effect’; where product adoption occurs more rapidly once it is adopted by consumers’ peers.

Finally, it is recommended that the social robotics industry as a whole should consider the ‘Big-bang Disruption’ framework (Downes & Nunes, 2013), where product diffusion doesn’t follow a continuum, but can be sold into each of the five market segments simultaneously with a ‘whole product’. This may be a possibility for those companies who have developed a product that is capable of delivering enough value in the mainstream (mass) market.

Exciting times lie ahead for the social robotics industry and the development of artificial intelligence and it is hoped academics and practitioners alike can utilise this thesis as a foundation for future research.

6. References


Chan, S., 2017. Crossing the AI chasm. [Online] Available at: https://techcrunch.com/2017/01/05/crossing-the-ai-chasm/


7. Appendices

7.1 Redefined segments of Crossing the Chasm

Geoffrey Moore redefined the original market segments of the diffusion of innovations theory. The new terms and full descriptions can be seen below:

1. Technology Enthusiasts (Innovators): These individuals are ‘techies’; they are eager to acquire new technology and appreciate the innovation for what it is. They are extremely eager to be the first people to adopt new technology and often pursue these products aggressively. This market seeks the truth, require access to technically knowledgeable people to solve any issues, be the first people to acquire new technology and want everything cheap (Moore, 1991).

2. Visionaries (Early Adopters): In the high-tech industry, the visionaries dominate the early market buying decisions. They are a “rare breed of people who have the insight to match an emerging technology to a strategic opportunity” (Moore, 1991, p. 25). Similar to the ‘techies’, visionaries seek breakthrough products as opposed to incremental improvements, however are inherently more difficult to satisfy. If the innovation meets the requirements of this market, there will be a burst of revenue and excellent visibility for the proceeding market segments. Without the influence of these individuals, high-tech products cannot make it to the mainstream market.

3. Pragmatists (Early Majority): Despite adopting innovations later in the process, pragmatists often become leaders for the late majority, in which the two segments make up the bulk (68%) of the market. Once 16% of the market share has been achieved, this is referred to as the ‘tipping point’ (Maloney, 2011); companies must begin to adapt their offering in order to meet the changing market needs. Therefore, it is vitally important for any company to transition their marketing and communication efforts for this market segment. If an innovation is offered in the same manner as the visionaries, adoption will simply not occur. These individuals sit in the beginning phase of the mainstream market, therefore have a heavy influence regarding the diffusion amongst the masses. They tend to be risk-averse, reasonably price-sensitive, yet loyal once the innovation has been adopted. These individuals are ‘vertically oriented’, meaning they...
communicate at a great rate than those in the early market, whether this is to gather information or disseminate to others as influencers for the innovation.

4. Conservatives (Late Majority): “For every pragmatist there is a conservative” (Moore, 1991, p. 33). Despite making up approximately one third of the total available market, the potential of this segment is rarely developed due to the lack of attention from high-tech companies. These individuals are inherently traditional, are against discontinuous innovations and can be fearful of high-tech products. However, they can offer excellent rewards to companies if they are served appropriately. Price is a sensitive issue and this segment seeks as little disruption as possible, meaning products must be the full package in serving their needs.

5. Sceptics (Laggards): Sceptics do not participate in the high-tech market. Purchase decisions are made out of necessity and they are very critical in identifying discrepancies between sales claims and the delivered product. Despite making up only 16% of the market, companies can target this segment in order to extend the life of the product, but also learn from these individuals’ feedback, to provide the foundations for future improvement and more effective diffusion of new innovations.