RESEARCHING BUSINESS & MANAGEMENT ISSUES

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Executive summary

The researcher conducted a study to understand the management issues that could occur in the 3d printing industry. The researcher was able to get a detailed understanding into the research questions by doing an in-depth literature

review. Further, to enhance the data collection with respect to the topic, the researcher used secondary and primary data for better analysis in the 3d printing industry.

This particular research topic was selected as the researcher has her startup business in 3d printing and wanted to conduct a study with respect to the scope of growth within this industry. The market share for 3d printed products and services will reach INR 3.7 billion by 2015 and INR 6.5 billion by 2019. **(Weller, Kleer and Piller, 2015).** The researcher will be using this research paper to improve her business growth and understand the management issues which could be faced with the 3d printing industry.

Introduction

This dissertation report analyzes the various factors that are curbing the growth of the 3D Printing industry. This report concentrates on the various marketing techniques that could be used to improve the long-term growth of this rapid prototyping industry in the Indian market.

The author selected this particular topic as the author currently has a startup business of 3D printed products and is facing management issues to understand the long-term commercial viability due to dependency of technology. Although, the issues have been identified this report will also identify the solutions to overcome the problems related to the rapid prototyping industry.

Current academic literature

Addictive manufacturing (AM) or 3D Printing allows customizing products without incurring any cost penalties in manufacturing as neither molds or tools are required **(Wohler's Report 2013)**. The author was able to link the usability of 3d printing in a variety of industries with the emphasis of creating something quickly and that the output is a prototype from which further models can be derived (**Gibson, Rosen and Stocker, 2017)**

The author was able to locate the disadvantages of 3d printing as in competitive markets, AM may lower barriers to market entry which results in lower prices for consumers **(Weller, Klee and Pillar, 2015).** Lastly, users of rapid prototyping find the term inadequate as improvements in the quality of the output from the machines has a much closer link to the final product instead of a prototype **(Gibson, Rosen and Stucker, 2017)**

Non-academic literature

According to **(comsol.com, 2013)** "if you can think it, you can print it". The author located the functionality of 3d products consisting of moving parts can be printed in one go, without having to manufacture the individual parts and then assemble them after the fact. **(3yourmind.com, 2015),** Beginning in 2020, metal 3D printing revenue w within the healthcare industry will consistently grow at a rate of more than double its revenue in automotive applications.

Lastly, the author was able to locate the disadvantages of 3d printing as it can only consist of a single material; for example, you cannot print an object containing both polymer and metal pieces **(comsol.com, 2013)**. Moreover, according to **(comsol.com, 2013)** larger the piece, the longer the printing time. As the object is created layer-by-layer, one object per printer it's much quicker than crafting and assembling your object piece-by-piece, 3D printing does still take time.

Contemporary nature of study

The researcher has selected this particular topic to demonstrate the impact innovative technology has made in the business. The longstanding method of creating the mold with labor efforts would reduce the quality and accuracy of the model, which has now improved with the modern technology of 3D printing. The newness of this particular technology will help sculpting models at a faster rate with better accuracy and ensure a higher customer satisfaction rate for customized products.

Key Research Questions

What is decision-making process with reference to the attitude of customers towards 3d products?

1. Understanding the benefits of 3d printed products
2. Using the concept of the event/ conference to manufacture 100% customized gifting
3. Price variations between retail and customized trophies
4. Timeline in hand to incorporate a new idea

What is the decision making process with linkage to the action taken by customers while purchasing 3D products?

1. Require 3-4 variations in the 3d designs for the decided concept
2. Making changes in the artwork of the selected design
3. Creating a prototype/ sample using the 3d printer
4. Getting the sample approved by the corporate team
5. Making a mold from the sample created on the 3d printer
6. Getting the fiber/ metal mold approved
7. Starting production of the customized model

How can a conversion be conducted from potential customer – lapse or new to an actual customer with new marketing techniques?

1. Conduct a market research to understand the various industries in which 3d printing can benefit
2. Take part in more exhibitions to ensure people are aware of the business model
3. Increasing the networking channels
4. Taking part in more conferences to increase brand name and awareness
5. Emailing and cold-calling people from these industries
6. Increase digital marketing budgets
7. Increasing the number of sales calls and meetings
8. Tapping into the industries of automobile, construction, defense and consumer products

How does an increase in the pricing trends overtime affect the decision making of customers?

1. Price variations between retail and customized trophies
2. Scale of the event
3. Restricted by corporate budgets
4. Corporates normally would pay a higher rate if quality and differentiation is observed in the product
5. Timeline in hand to incorporate a new idea

In summary, this particular topic was selected by the researcher to understand the long-term commercial business viability of the 3d printing business as it is completely based on technology. By stating the various research objectives and questions the researcher was able to narrow her focus for in-depth analysis. This research topic was selected as the researcher has her startup business for 3d printing and wants to understand the long-term viability of this business model.

Next, the researcher to validate the importance of 3d printing will be doing literature reviews to understand the various aspects, which could help, increase the growth and affect the business model in the future. The researcher for clear justifications will do academic and non-academic citations.

Literature review

In this chapter, the researcher would be demonstrating an in-depth grasp of the topic selected. The researcher would be critically reviewing the available literature to answer the research questions stated by the author.

The researcher has majorly used academic sources but due to the limited information available, the researcher also made use of market-linked data, which had strong and relevant information to justify the research topic.

The traditional method of manufacturing used various clay materials as a medium to create the objects to get similar looking objects **(CG Cookie, 2018).** Whereas, in 3d printing, there are various types of digital clays, which are used, in 3d software's to create the models digitally **(Archicgi.com, 2018)**. 3D printing is a technology by which a digital model in a computer file is converted into a physical object **(3D Printing For Dummies, 2018).** The researcher has been able to identify the strength of 3d printing as creating 3d designs and making changes is quicker on a computer than sculpting a new model by hand. Further, there is lesser consumption of clay material which helps save cost and time for the organisation.

The term "3d printing" misguides people into thinking it is a printing process whereas it is Addictive manufacturing (AM) and a prototyping process. The process followed is taking a 3d designed file of a model which is stored on the computer, translating it into a mechanism of printing very thin layers until the object is manufactured on the machine and ready for use. **(3D Printing For Dummies, 2018).** The researcher has demonstrated knowledge in analyzing the lack of marketing, which is causing a gap between customer's imagination for products and

how organizations are able to fulfill this demand without customers having the knowledge about this technology.

Attitude of customers is defined by understanding customers beliefs, feelings and behavioral intentions towards a product. This can have a negative or positive influence on the purchase **(Dean, 2018)**. Customers need to be aware of the benefits of 3d like it is a cost reduction process where in complex objects and integrated functional designs are created in a single step **(Weller, Kleer and Piller, 2018)**. The cost of assembly reduces and it is a quicker method to create customized molds **(Rayna and Striukova, 2018)**. Certain core competences within the business might become non-core due to 100% personalization and certain non-core competencies might gain more importance **(Rayna and Striukova, 2018).** According to the researcher both the authors have a strong point about 3d printing technology reducing the costs of production but, 3d printing is still a time consuming process. If the object is relatively easy to manufacture, it will be easier for the organisation to use the traditional approach with different materials rather than 3d designing, 3d printing the model and then making a mold.

Furthermore, customers have the flexibility to make single products, which would still be economically viable due to the affordability of 3d printers. **(Kietzmann, Pitt and Berthon, 2018).** There is an increase in the value received for end users due to the aspect of 100% personalization **(Power and Bernabei, 2018)**. The researcher finds these debates interesting for single prototypes demanded by customers. But, from the business standpoint creating single prototypes is less profitable than mass produced products due to limited budgets from clients and no benefits of economies of scale.

Manufacturing companies have started using 3d printing to manufacture molds. The first mold is created on the machine and then the traditional process of manufacturing is followed. **(Rayna and Striukova, 2018). (Rayna and Striukova, 2018),** Stratasys, a leading 3d printing organisation, previously used the traditional manufacturing process which took 30 days and $1400 to build an aluminum mold enabling to mass manufacture a set of six ice-cream spoons by injection molding. Instead, the exact same mold can be 3D printed in less than seven hours and about half the cost ($785) using 3d printing. The researcher has identified a key contribution of how 3d printing helps in manufacturing molds. To benefit from economies of scale and faster production, companies have invested heavily in 3d printers, which can manufacture molds and mass outputs on the machine itself. But, on the downside, these machines are very expensive and not all organizations have the capital to follow this process.

Organizations using 3d printing also benefit from using a wider range of materials, which are supported by 3d printers. Stratasys Objet500 (sold at $250,000) can already print more than 100 materials (up to 14 simultaneously) **(Rayna and Striukova, 2018).** Research on conductive materials forecast that wires could directly be installed in the object while 3d printing **(3D Printing For Dummies, 2018).** Furthermore, 3D printing has the advantage of printing custom sensing devices, which can be integrated while 3d printing the object itself **(Journals.plos.org, 2018)**. According to the researcher this is a clear advantage of 3d printing. Currently, businesses create the object on the machine but there is a high assembly cost attached. But, once the range of materials improve, and wires and installations can be directly printed, the costs would reduce drastically for the organizations.

The AM segment has low barriers to entry and caters to different markets simultaneously **(Weller, Kleer and Piller, 2018).** Markets such as production of replacement parts, dental and artificial limbs are a few examples of the markets being catered towards **(Berman, 2018).** The researcher has reviewed the statements and identified an increase in the significance of 3d printing in the various markets. This technology is booming and is identified as a key strength for this market.

With the use of 3d printing, every process would be automated**. (Berman, 2018)**. Firms will be able to increase profit margins by producing customized products **(Weller, Kleer and Piller, 2018).** As the process of 3d printing involves personalization, customers would incur lesser costs even for smaller quantities **(Berman, 2018).** The researcher analyzed that these organizations would be creating personalized outputs for each customer and the business could invest lesser in warehousing and could follow just in time methods of inventory due to the high levels of personalization.

As 3d printing is relatively a new technology, the audience base is unaware of the functionality and the way this technology functions. Recently, there is an increase in knowledge regarding the benefits of personalization using 3d printing to customers. **(Hu, 2018),** this has paved the way for 'do-it-yourself' production among individuals. Customers can personally design the objects using AM. The audience could either invest in their personal desktop 3d printers or use service bureaus, which are cost effective. According to the researcher, the author makes a strong point about 'do-it-yourself' productions but a disadvantage would be the lack of awareness regarding the benefits of 3d printing. This will be achieved with an increase in marketing, which would help increase the growth for this segment, and therefore this is the topic selected by the researcher.

The attitude of customers would favor towards the 3d printing sector if the environments were characterized by demand for personalization, flexibility and design complexity **(Pdfs.semanticscholar.org, 2018).** Customers can fabricate their personalized designs through various types of AM systems **(Dspace.lboro.ac.uk, 2018)**. Also, this technology would help customers follow product personalization, and would be able to modify the design of the product according to their own preferences **(Hu, 2018)**. According to the researcher, the advantages of 3d printing have a major role in the corporate segment. If the customer has an event/ conference, the client would be able to benefit from the 3d printing service bureaus, as they would be able to use AM to personalize product design shapes**.**

(Dspace.lboro.ac.uk, 2018) it is economically viable to create a personalized model as per the imagination of the customer using 3d printing. The highest use of AM with 17% is for consumer goods, **(Semantic Scholar, 2018).** Consumer personalized products such as gadgets, home and personal accessories, jewelry, toys and artistic sculptures would have the highest end-users' reflections on the value of 3d printed personalized products based on product value and experiential value **(Dspace.lboro.ac.uk, 2018).** According to the researchers understanding, 3d printing consumer products are most beneficial in the short term in comparison to product functionality.

For example, Jewelry startups are letting customers 3d design models in plastic to try on before a final casting in metal **(Fortune, 2018).** This process of AM is helping reduce costs and giving more options to customers**.** For large companies like General Electric and Ford, 3D printing has proved to be a useful tool for prototyping new designs **(Forbes.com, 2018)**. In the researcher's perspective, this is an advantage as it is a cost saving process and is an easy method for modifications. But, to debate this analysis, customers should be willing to pay a premium to get a product personalized compared to the traditional manufacturing which would be cheaper and quicker to purchase.

If the product printed is personalized and small in size, it will be cost effective to use AM compared to the traditional methods. An example of the use of 3d printing would be for consumer goods like custom-fitted plastic earphones based on 3D files made from photos of customers' ears **(Fortune, 2018).** According to the researcher, this would have a positive outlook to overcome the problem of ear size differences between customers. It would become more convenient for consumers to have personalized earphones compared to the mass produced earphones. But, to critically analyze this statement, customers need to become aware and a market research would have to be conducted to know if customers would be willing to take the additional effort to get scanned and wait for a longer duration to receive something personalized instead of purchasing the earphones instantly from a store.

Research has proven that participants definitely had a higher opinion of 3D printed personalized products compared to their standard mass production counterparts **(Dspace.lboro.ac.uk, 2018).** Visibility has a real cost and a real value **(EngineerDog, 2018).** The researcher acknowledges the authors and considers the advantages of 3d printing. Once the customers are aware of the benefits 3d printed products bring to them, the purchasing would drastically increase compared to the mass produced products.

But, on the contrary, it is clear that the machines are somewhat difficult to use and this will impact people's ability to make an investment in these machines **(Fortune, 2018)**. Manufactures of the 3d printers are still having trouble selling the machines. Using the technology is still too complicated to reach the mainstream **(Fortune, 2018).** For example, 3D printing companies Stratasys and 3D Systems showcased the business earlier this month by reporting declining revenue in the latest quarter, **(Fortune, 2018).** This is mainly due to the lack of knowledge about the 3d machine. Also there is increased competition, most notably HP Inc., which is expected to start shipping its own line of 3D printer **(Fortune, 2018).** According to the researcher, there is a problem of internal consistency. Customers who could purchase the machine are not willing to risk changing the processes. This is the typical problem of change management and the human phycology. This is a disadvantage of the 3d printing technology as major 3d printing companies have declining revenues due to the weakness of poor marketing and change resistance.

Lastly, not only are the manufacturers finding it hard to sell the machines, but also are suffering from problems of creating a machine with an instant 3d prints which is what customers are demanding, **(Fortune, 2018).** Further, according to the researcher, the weakness of this technology is it isn't an instant "print". Creating the 3d model on the machine still is time consuming depending on the complexity of the model. Customers would still purchase a mass produced model if it was quicker for them and readily available. This is a major drawback for 3d printing according to the researcher.

The major use of 3d printing will be for mass-producing parts rather than only prototyping **(Fortune, 2018).** According to the researcher, even though 3d printing is new technology with a lot of advantages for end users, critically this technology is facing various problems to create a positive attitude for customers to purchase the 3d printers as it is still a time consuming process with a relatively high investment cost. Businesses are still reluctant to

change processes which is impacting the end user's attitude towards the decision making process of purchasing 3d printed products due to less supply.

To take an **action**, the customers would have to follow a decision-making process by comparing a number of options and selecting the most appropriate action **(The Happy Manager, 2018).** The **actions of customers** before purchasing a 3d printed product would be various. The most important is to understand that there is a thin line between the terms "customization" and "personalization". **(Campbell et al, Ltu.diva-portal.org, 2018).** The researcher required this basic knowledge to understand the basic difference to judge the actions of the customers while purchasing 3d printed products.

Customization is selecting from a range of products and modifying the product. 3d printing on the other hand, offers the customers to use their own creativity and receive an output, which they personally desire. End-users have more positive attitude and higher purchase intentions due to a higher degree of design authority **(Ieeexplore.ieee.org, 2018).** Personalization involves designing from the outset with only one customer in mind **(Ltu.diva-portal.org, 2018).** Personalization ensures positive experiences, increases satisfaction with the product and meet both functional and hedonistic needs **(Dspace.lboro.ac.uk, 2018)**. According to the researcher, 3D printing is based on personalization as it gives the client the ability to create something from their imagination rather than the existing options. The researcher was able to analyze this factor more clearly and identify the advantages this process has for 100% uniqueness for the customers.

The actions customers take to purchase 3d printed products is based on the level of personalization and value driven from the design process **(Sinclair, 2018).** Evidence proves that end-users' involvement in the fabrication of products can in itself provide value **(Researchgate, 2018).** According to the researchers understanding, the actions of the customers have a positive influence depending on the level of personalization. But, to critically analyze this situation, customers should be willing to test the internal consistency of the new methods compared to the traditional approach of receiving the product.

(Mugge et al., Iim.ftn.uns.ac.rs, 2018) suggest that product personalization is a long-term strategy with unlimited options for individualization. The actions of customers would require the customers to create various digital options; make variations and once satisfied can create the object using the 3d printing process **(Tandonline, 2018).** The researchers perspective on 3d printed products could be based on the analysis of whether the customers are willing to take the extra time to communicate the idea to the 3d designer to receive something unique. The researcher critically evaluated this, as many customers do not want to take the additional effort for experimenting, as time is a valuable resource.

Individuals do not need to own a 3d printer to create personalized models.
(Schreier, 2018) individuals may also turn to service bureaus or online retailers that enable them to purchase 3D printed items and receive them by mail. This is a very convenient manner to use the digital technology by creating personalized designs and receiving the object at the doorstep. This is a major advantage for the 3d printing segment according to the researcher. Due to the high likelihood of convenience and doorstep delivery there is a higher positive reaction towards 3d printing.

Value is what end-users get from the purchase and use of a product (i.e. benefits, quality, worth, utility) versus what they pay (i.e. price, costs, sacrifices), resulting in a positive or negative attitude towards the product **(Researchgate, 2018).** This is very crucial in the industry, as there is a shift in technology from the traditional to the modern methods of manufacturing. According to the researcher, value is crucial from the customer standpoint. If the business is able to create a 3d model but the quality does not match the customers expectations, there will be a negative value impact and customers would not shift in their buying behavior.

Research has shown, that personalization and high concentration on aesthetic attributes, means it is possible to achieve a high degree of uniqueness with a relatively small differentiation of design features compared to the standard product **(Research gate, 2018).** This shows that customer's would prefer something with a high aesthetic value (4.7/5 score) to be personalized compared product functionality object (3.4/5). Aesthetic value would be in terms of creation of shapes, colors, attractive materials, and impressive surface finish **(Science, 2018).** The ability to personalize is a means of establishing a closer connection between users and products, as it enables them to determine relevant product attributes for themselves **(Nurkka, 2018)**. For example, Argos, the retailer, is running a 3d printing trial that lets shoppers customize jewelry **(Deloitte.com, 2018).** The researcher agrees with the authors to a certain extent. But, to critically analyze this statement, the researcher feels in the long term, 3d printing will be more useful and profit making with product functionality especially in the medical field where the usage of 3d printing is essential.

To **identify potential customers**, businesses need to define their target audience carefully and understand what resources need to be exploited to create a special value in the minds of these potential customers who could be lapsed customers or new customers for the business **(Jstor.org, 2018)**. Research has suggested trust is one of the

main factors that affect the purchasing decision of potential customers **(Aisel.aisnet.org, 2018).** Since the technology is still very new and modern, the amazing designs and logo printing will attract many **(Lai et al., 2018)**. Personalization is the key to the 3d printing segment. Potential customers would show a willingness to use their creativity to design something completely unique to enhance the value of the object **(Science, 2018)**. when users create the design on their own, there is a higher experimental value achieved (**Elizabeth B. -N. Sanders & Pieter Jan Stappers, 2014),.** The researcher agrees with the authors with regards about personalization becoming the key aspect. But, to critically evaluate this situation, a market research would have to be conducted to understand how many customers are willing to take the effort to create the designs on their own and taking that additional effort.

Companies can achieve business growth by using AM for commercialization of new products with economies of scope that can help get products to market faster and cheaper **(Deloitte Insights, 2018).** Potential customers can use 3d printing for highly complex forms, its flexibility for part fabrication, **(Elizabeth B. -N. Sanders & Pieter Jan Stappers, 2014)**. Businesses can now test and launch new ideas quickly, which will help them survey the markets to understand the market potential in various fields. For example, **(Manufacturing.net, 2018)** In aerospace, Boeing is a big user of 3D printing. It flies 3D printed parts. To benefit from economies of scale, Local motors launched the latest version of their Strati, the world's first 3D-printed car **(Deloitte Insights, 2018).** According to the researcher, this functionality aspect in the long term would be more profitable and useful compared to product aesthetics value received from 3d printing.

To **achieve business expansion and conversion of customers**, the business would have to increase its percentage of users who take the desired action **(Nielsen Norman Group, 2018).** To achieve this goal, the business would have convert browsing customers into actual buyers **(Winer, 2018).** Businesses would have to use 3d printing to lower costs of production and increase the accuracy for large-scale operations. Marketing techniques can also be used to increase business growth, Coca-Cola created miniature statues using 3d scanning of consumers to promote smaller Coke bottles, **(Lai et al., 2018).** According to the researcher, many FMCG companies are using 3d printing to their advantage as a strong marketing technique to increase the purchasing and brand recall value.

According to **(Allied Market Research, 2018)** consumer products industry has been the highest revenue-generating segment and is expected to be the highest generating segment even during forecasted period. Large scale organizations like Nokia, Volkswagen eBay, Selfridges are also experimenting the use of 3d printing to develop prototypes for the testing phase. This has increased the efficiency of product development, **(Lai et al., 2018).** In the researchers understanding, many large-scale organizations have invested in 3d printers to capture the market at the earliest. As 3d printing is able to deliver to unlimited markets using various machines, consumer products industry has seen the most rapid growth due to a lesser investment and faster output.

(Curran, 2018), speaks about how the 3d printing industry should pivot to printing more fully functional and finished products or components in volumes, whereas, according to the researchers readings, many contradicting articles by different authors justify saying personalized consumer products would be more profitable compared to fully functional products and mass produced outputs.

The business, which would boom with the 3d printing at a rise, would be for the chemical markets. **(Frost.com, 2018),** the chemicals market is held back to some extent because most chemical manufacturers supplying raw materials and formulations do not have a dedicated supply strategy. The researcher acknowledges the author and once the suppliers are able to make the processes systematic and efficient, the overall market for 3d printing will boom.

Following **business expansion**, the business could benefit from internalization such as economies of scale, scope and learning's between business segments. The company could use its internal core competences to use the **Ansoff matrix** to increase profitability **(Luo, 2018).** For expansion the business could follow digital marketing methods like Facebook promotions **(Morph Blog, 2018)**. The businesses could also give promo materials to the customers for brand recall. The business should find their niche to ensure the business does not deviate from the core vision **(Palacios, 2018).** The researcher agrees with the author to a certain extent. But, to critically analyze this situation, the business could also have live demos in public places, exhibitions and various events to help the customers gain knowledge about how the process of 3d printing occurs and the benefits the process brings to them.

According to **(Allied Market Research, 2018)** The fastest growing markets for the industry would be North America. It was the largest revenue-generating region in the industrial products market in 2014. Europe would be the largest revenue-generating region by 2020. The chance to achieve business growth and expansion using this technology would help increase the profitability and increase the efficiency of the business. **(Allied Market Research, 2018)**. In the perspective of the researcher, the key positive factor for these regions to benefit would be lower costs as the current traditional method involves high labor force whereas, in 3d printing the costs would be minimum and this would work positively in the favor of the organizations.

Pricing strategies requires businesses to look beneath the demand curve to manage the monetary and physiological value of the product to determine the purchasing decision **(Tangle, 2018)**. Pricing is a crucial element for the profitability growth strategy rather than only concentrating on increasing sales and market share **(Ailawadi, 2018)**. Survey has showed that fabricating a product using AM technology requires a higher financial investment from users. The study showed that end-users were not willing to pay a premium for a personalized AM product compared to a mass-produced product **(Dspace.lboro.ac.uk, 2018).** Only the Jewelry category indicated a value increment with an added value of 17.09%. The researcher critically evaluated this situation, as customers would only pay a high premium if the model were very expensive. This demonstrates the actions of the customers and the buying intent would be majorly positive towards consumer goods especially jewelry. But, if the organizations were able to develop machines, which are able to match the price of the traditional mass-produced objects, customers would be willing to purchase 3d printed products

(Dspace.lboro.ac.uk, 2018), research has shown that end users are most willing to pay a premium for personalized consumer goods which have a high incremental value. Further, the unique value is seen to have highest average score of 5.00, closely followed by Co-design Value at 4.75 and Hedonic Value at 4.60 **(Dspace.lboro.ac.uk, 2018).** According to the knowledge of the researcher, these results prove the customers are willing to pay the price variation between the 3d printed products and the traditional mass productions for co-design valued products like jewelry due to a sense of personalization with an aesthetic value. Product functionality is receiving negative and lesser scores in terms of value and purchasing intent.

To finally summarize, the researcher gained knowledge that 3D-printing services and consumer devices are becoming more affordable which is making it easier for consumers to purchase their own personal 3d printers to make personalized objects for functionality aspect or an aesthetic value. But, the printing time is still very long and the layers are visible on the object. **(Chabaud, 2018)**. According to analysis by the researcher, this shows that various post processing operations will have to be conducted to ensure the object is finished and ready for dispatch negating the entire purpose of an immediate finished 3d output.

Research Methodology

The researcher wanted to conduct a research to have a logical and systematic search for additional relevant data regarding 3d printing. This way the researcher will be able to discover new facts and be able to overcome the current issues, which the industry is facing.

The researcher will make use of various types of research methodologies to conduct this study.

Qualitative research is a non – numeric method, which involves interpretation and subjectivity. This research approach aims to study the social reality of people in their natural setting **(McLeod, 2018).** Whereas, quantitative research is based on a numerical, non-descriptive which uses numbers to make a conclusive statement **(Arxiv.org, 2018)**

Applied research on the other hand, speaks about finding an immediate solution for a current problem in the society. This research considers the external validity for external solutions to current business problems **(Research-Methodology, 2018).** Whereas, causal research identifies the extent and nature of the cause - affect relationship. This is normally used to assess the impact of specific changes in norms and processes within organizations **(Rszarf.ips.uw.edu.pl, 2018)**

Lastly, inferential research is where a sample is collected and studied to understand the characteristics and then inferred to the current population for a logically understanding for the future situation **(Modares.ac.ir, 2018)**

The researcher decided to choose inferential research to understand how previously organizations would use traditional approaches of manufacturing and wanted to infer it to the current business scenario and study if organizations are willing to switch to a new method of manufacturing using 3d printing.

The advantage of inferential research is it is a secondary data so data is readily available. It is cheap and less time consuming to analyze the data. It is clear to observe the patterns and can be used to check different variables like switching to 3d printing technology from the traditional approach. But, the disadvantage of this research method is it can easily be misinterpreted. Also, there is a high degree of uncertainty as the population is not fully measured and only a sample is selected to infer to the current scenario changing business manufacturing processes.

Secondary research is the collection of data from second hand sources, which helps to interpret the consumer demand at an earlier stage

Secondary data sources are broken up into internal and external sources of data. The secondary sources include accounting resources, sales force reports, government and non-government publications and syndicate services.

The researcher would make use of syndicate services as these organizations have tabulated information that suits the requirements of the researcher and therefore there is a higher chance of receiving less bias information. These organizations would have previously collected data using surveys from wholesalers, retailers and industrial firms **(Development, 2018).** But, the disadvantage is this is published data and therefore is not exclusive for the researcher, which creates the problem of relevancy in regards to understanding the growth and customer's perception in purchasing 3d printed products

Primary research is defined as factual, firsthand accounts of the study written by a person who was part of the study **(Crabtree, B.F. and Miller, W.L. eds. 1999)**. The data collected through primary research is raw data, which helps the business get accurate information while conducting the business survey.

Primary data will be required to further enhance the authenticity of the data collection. There are various types of primary data, which includes observations, interviews, experiments and questionnaires.

The researcher would use questionnaires to collect the data. This is an inexpensive form of data collection. Further, questionnaires can be submitted to a vast audience through Google forms and results could be achieved easily **(Data, 2018)**. But, a disadvantage of choosing questionnaires would be there is low feedback and it is difficult to know the true accurate response of the customer.

Sampling technique can be classified into two categories – probability and non- probability sampling. Probability sampling is based on the concept of selection based on the principle of random chance. This technique is more complex and more time consuming than non- probability sampling but the accuracy of probability sampling is higher as there is lesser bias and more detailed estimates to make accurate business decisions.

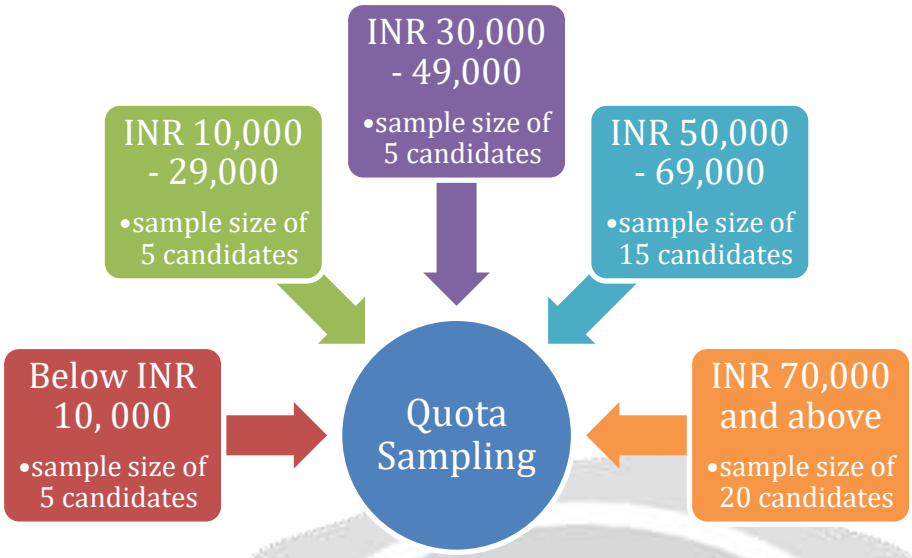
Probability sampling includes random sampling, systematic sampling whereas, non- probability sampling includes convenience sampling, snowball sampling and quota sampling

The researcher will be selecting quota sampling, as the sampling technique to understand if the target audience for 3d printed products would be categorized with income (INR) with below 10,000, 10,000 –29000, 30,000 –49,000, 50,000 –69,000 and 70,000 and above. The researcher therefore plans to conduct quota sampling by selecting few candidates from each category and collecting the responses to analyze if the customers are willing to purchase 3d printed products compared to the mass-produced objects.

The sample size being selected would be in the range of 45 – 50 respondents, as it will help in validating the results for future hypothesis. The researcher would be selecting this particular sample size, as it would not be too large to collect and analyze the data to get an accurate response.

By using quota sampling the researcher would be able to make better comparisons between all the groups on the basis of income for effective judgments on the possibility for customers to switch in their buying behavior. Further, quota sampling would help the researcher as it would be an easier and quicker to do collect the sample and derive a conclusion.

But, on the other hand, quota sampling may be biased as only certain candidates are selected to represent the entire population of that quota. This could be a misrepresentation of the quota and could create errors in the research



(Figure 1, quota sampling used for primary research)

Source: fieldwork

The limitation faced by the researcher was based on the sample size chosen. The researcher selected a sample size of 45 - 50 respondents, which was a small scale of responses. As the researcher would use this research in the future in his startup business, if time were not a limiting factor, the researcher would be able to analyze a larger sample of approximately 200 – 300 respondents.

As the sample size was relatively less, there could be a problem of having an inaccurate measure of the overall responses.

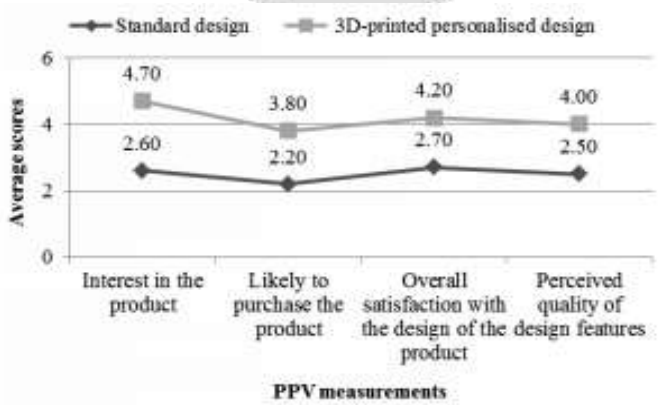
In summary, after conducting a study on all the types of research, the researcher was able to choose the most accurate research type to draw valid conclusions. Furthermore, the researcher had a clear focus on the type of primary and secondary research, which would have to be conducted for the next chapter keeping in mind the sampling technique, and framework that needed to be followed.

Data Presentation and Analysis

The researcher conducted a study to future analyze the data collected for the research questions. To increase the validity of the research, the researcher conducted secondary and primary research.

For secondary data collection, the researcher used syndicate services as mentioned in the research methodology chapter. This data received was found in journal articles to answers for the research questions mentioned by the researcher.

Secondary data presentation:



(Figure 2; purchase trend of standard v/s 3d printed products)

Source: Dspace.lboro.ac.uk, 2018

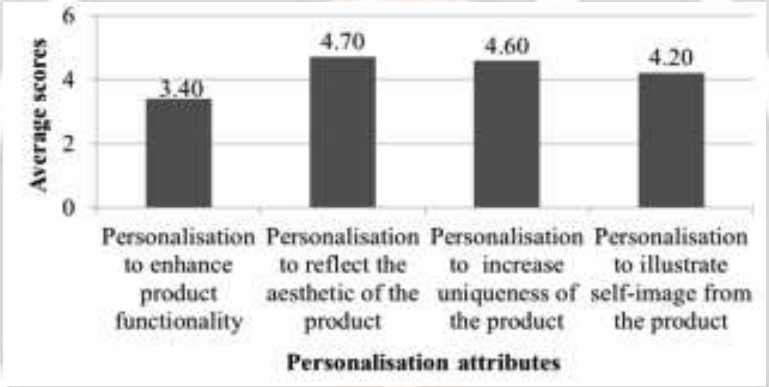
The above graph clearly shows the difference between the traditional manufacturing and 3d printed manufacturing. According to the study conducted by **(Dspace.lboro.ac.uk, 2018)**, the author had taken 4 factors into consideration to understand the buying behavior of customers. The highest score received was a 4.70 rating for interest in the product followed by the overall satisfaction recorded from receiving a 3d printed product.

According to the researcher's understanding, the overall average score for 3d printed personalized designs received a higher score compared to the traditional mass manufactured products.

The researcher further analyzed these findings to understand that customers should a very high interest in the product but showed a low likelihood to purchase a 3d printed product. Whereas, customers did not show a very high score of having an interest in the traditional mass manufactured product with a rating of 2.60/6, but the likelihood was comparatively higher with a rating of 2.20/6.

According to the interpretations of the researcher, customers would be willing to take interest in the product, but as there is less marketing and poor knowledge about this new technology, customers may be hesitant to make a purchase. Customers are more willing to take a tried and tested product using mass manufacturing even though they have a lower interest level in the product.

This helps the researcher analyze that customers have to become more aware of the benefits 3d printing brings to them. Organizations have to ensure the marketing budgets improve and customers become more willing to purchase 3d printed products. Using various marketing techniques, organizations would have to change the customers perception towards purchasing 3d printed items and build confidence in the minds of the customers regarding higher quality outputs, time saving and cost reductions which would finally work in the benefit of the customers.



(Figure 3, scores received for personalization attributes)

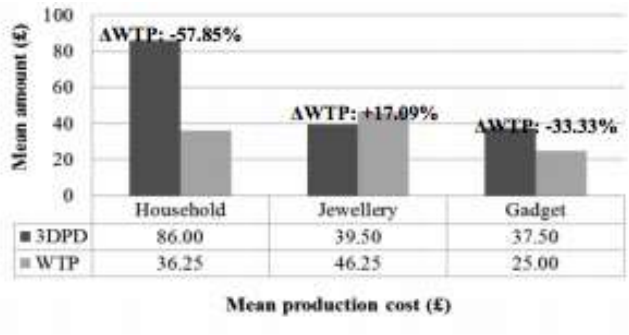
Source: fieldwork

According to **(Dspace.lboro.ac.uk, 2018),** the graph concluded by the author shows the highest average score of 78% for a higher aesthetic value. Followed by a 77% rating for an increase in the uniqueness received from 3d printed products.

According to the researcher's findings, the data collected by this author matches the researcher's literature review conclusions derived by the other authors. The highest use of 3d printing is in terms of aesthetic value like color, shape, design; quality etc. customers are willing to pay an additional premium for consumer goods, which involve a high aesthetic value.

This is followed by the ranking of 76% which shows that customers are also willing to purchase and pay a premium for consumer goods which have a higher unique value compared to the mass produced products. 3d printing gives the customers the option to create an object from their imagination and bring it into a physical model for personal use.

But, on the other hand, the researcher has been able to further analyze that customers are not willing to pay an additional amount for product functionality, which is also another major use of 3d printing. Only a 57% rating was received for this function. According to the researchers evaluation, customers may not be willing to incur a very large investment for a functionality product like a 3d printed house but would be willing to pay a premium for a unique consumer good which could be used on a daily basis.



(Figure 4, consumer purchase of 3d printed products)

Source: fieldwork

Using secondary data, the researcher wanted to further understand within consumer goods, which product would have the highest likelihood of purchasing from the customers.

According to **(Dspace.lboro.ac.uk, 2018),** the only positive mean amount resulted from jewelry with a +17.09% rating. This was followed by -33.33% mean result for gadgets as consumer goods.

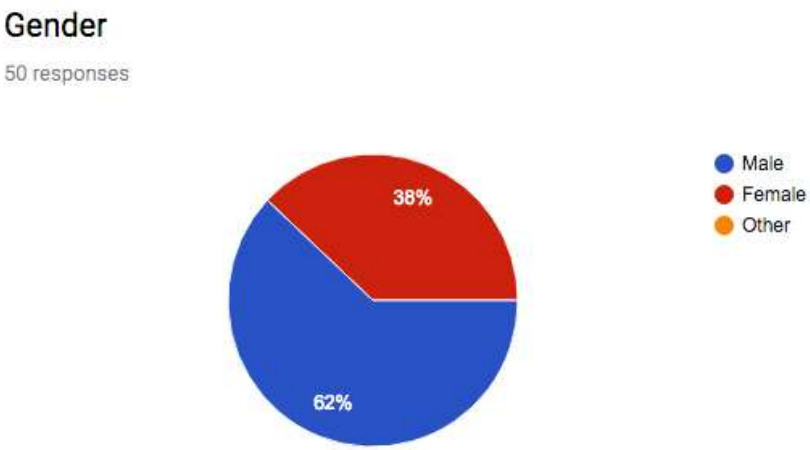
According to the researcher's analysis, customers felt the unique value received from personalizing jewelry was worth the additional cost; effort and time spent using 3d printing. This shows that customers would not be willing to take the additional effort or spend extra time to personalize a household product. Customers may be more willing to purchase a mass-produced household item, as it is easier and more convenient for the customer.

To finally draw from the secondary data collected; the researcher interprets that customers would be willing to purchase consumer goods over functionality aspects using 3d printing. But, as 3d printing ensures customers 100% uniqueness, customers would be willing to pay the additional premium for something which is more expensive and has a high aesthetic value like jewelry compared to a household product.

Primary data presentation:

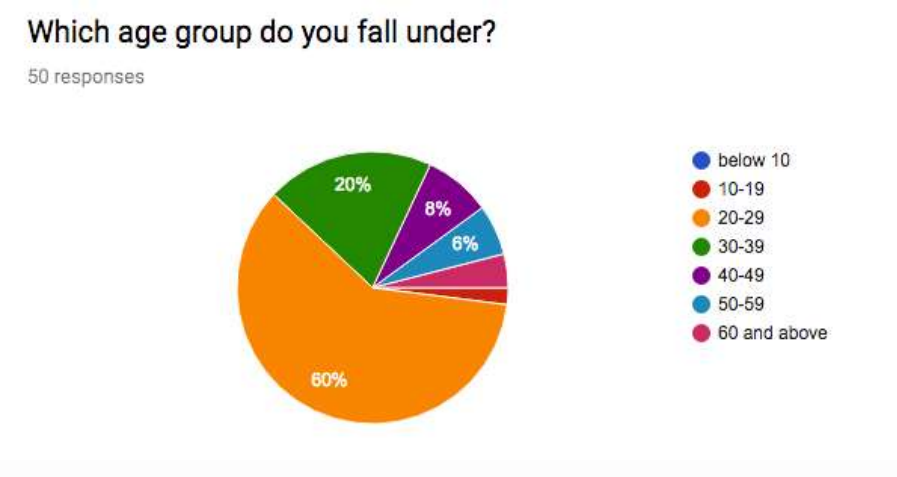
For primary data collection, the researcher made use of questionnaires, which were circulated through Google forms to young adults, mature adults, senior citizens, previous customers and current customers. The questionnaire was only circulated to people who had knowledge regarding 3d printing. Primary research was conducted to ensure accuracy and quality responses.

Before starting the analysis, the researcher conducted the **Chi Test, Sign Test and Spearman's correlation test** to justify the conclusions derived with the data collected from the questionnaires.



(Figure 6, gender)

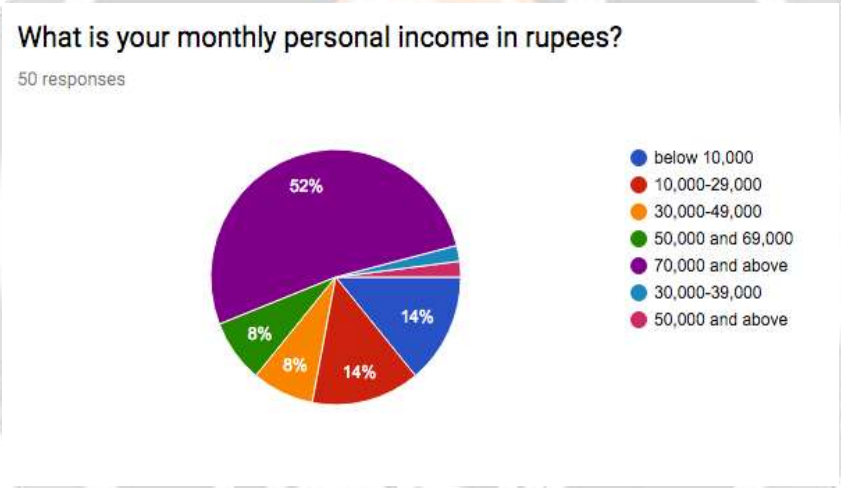
Source: fieldwork



(Figure 7, age)

Source: fieldwork

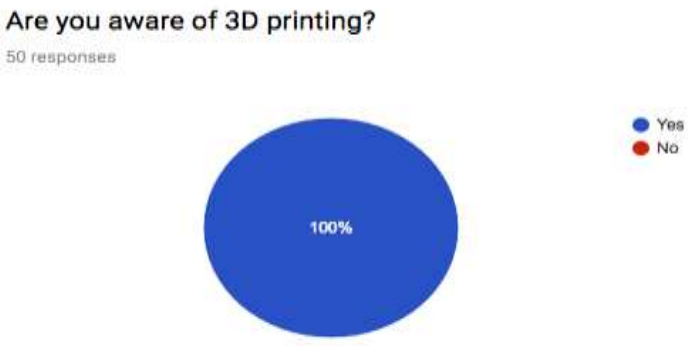
62% of the respondents were male whereas, 38% were female. Young adults between the ages of 20-29 years had the maximum responses. Followed by a response of 20% from between the age of 30-39 years. According to the researcher, the responses were the highest from these age groups as younger audiences are always more willing to experiment with new technology compared to older generations.



(Figure 8, income)

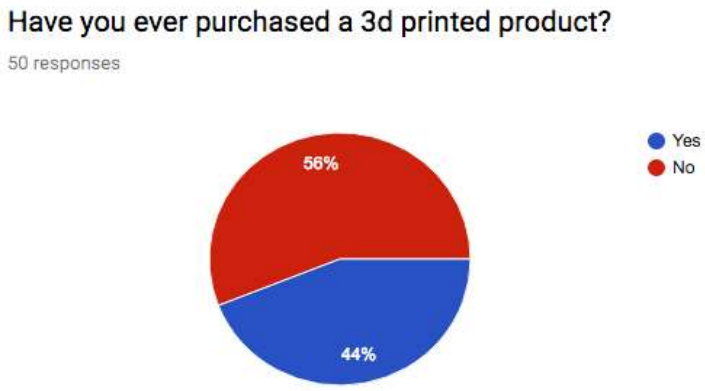
Source: fieldwork

52% of the respondents claimed they received a monthly personal income of INR 70,000 above. This ensures the researchers target audience was accurate as 3d printing is an expensive technology, and the researcher wanted to target customers with a higher personal income.



(Figure 9, awareness)

Source: fieldwork



(Figure 10, purchasing of 3d products)

Source: fieldwork

100% of the respondents had the knowledge regarding 3d printing. All the responses received worked in the favor of the researcher as the target audience needed to be knowledgeable regarding the technology or the responses would be invalid. According to the researchers analysis, from the 100 respondents who were aware of the technology only 44% of the audience had purchased a 3d printed product.

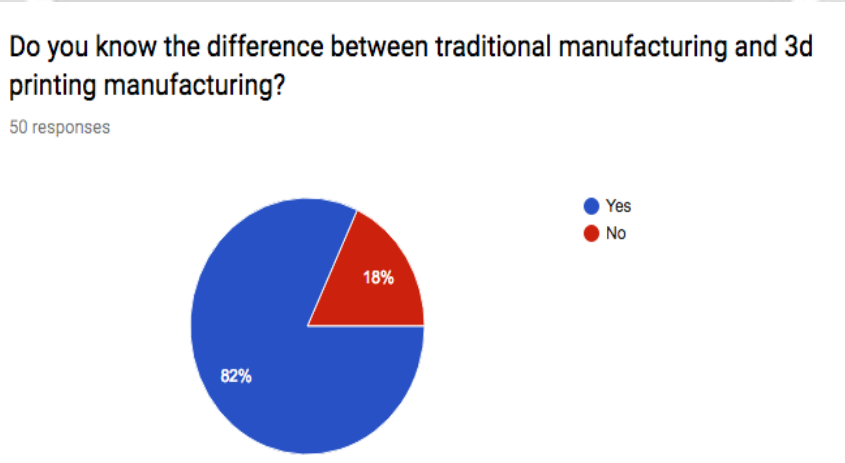
This shows that even though people are aware of the 3d printing technology, customers have not purchased 3d printed products because of factors like poor marketing in terms of product knowledge, price factors, product availability and different methods of promotions, which could increase the buying behavior of the customers.

This is the reason the researcher selected this particular topic, to create a solution for this research problem.

The researcher conducted a **Chi Square Test** on this data to reach a conclusion **(Annexure 1).**

Null hypothesis - As income increases, chances of purchasing a 3d printed product increase proportionally.
Alternative hypothesis – there is no interrelation between both the variables.

The researcher wanted to analyze if there was a correlation between income and purchasing of 3d printed products. **The null hypothesis was accepted**, as there is a positive correlation between an increase in income and increase in purchasing for 3d products. **The correlation value is 0.65**, which helps the researcher to narrow the target audience to individuals only with a higher income.



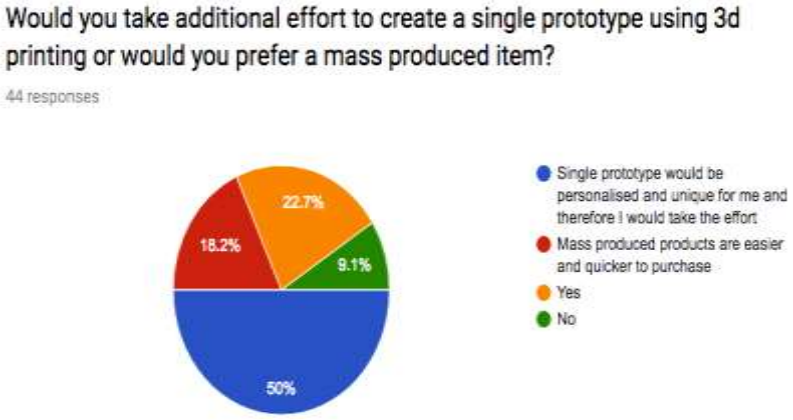
(Figure 11, difference in manufacturing methods)

Source: fieldwork

82% of the respondents knew the difference between traditional manufacturing and 3d printing manufacturing. This analysis shows that respondents have the knowledge between both the processes.

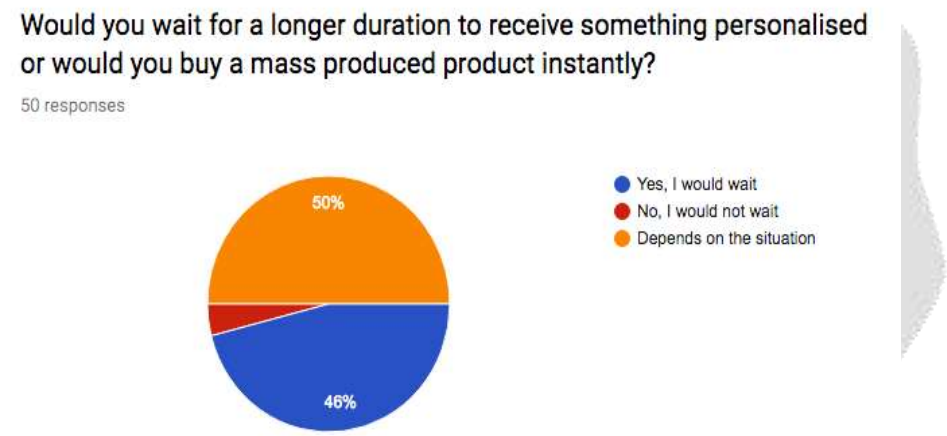
The researcher critically analyzed this response, as in the literature review; authors have claimed that customers only assume 3d printing as a single prototyping process whereas, according to the researchers study, customers are aware

of the usability of the technology. Further, this research shows that customers are aware of the automated process followed using 3d printing versus the traditional manufacturing, which would be created by the labor force.



(Figure 12, effort levels)

Source: fieldwork



(Figure 13, waiting period)

Source: fieldwork

Respondents in the previous analysis have shown that they have knowledge regarding the difference between the old methods of production compared to the new production method using 3d printing.

77% of 44 respondents stated they would be willing to take the additional effort to purchase a 3d printed product which would be 100% unique compared to a retail product. This shows a positive attitude from the customers, which answers the research question stated by the researcher.

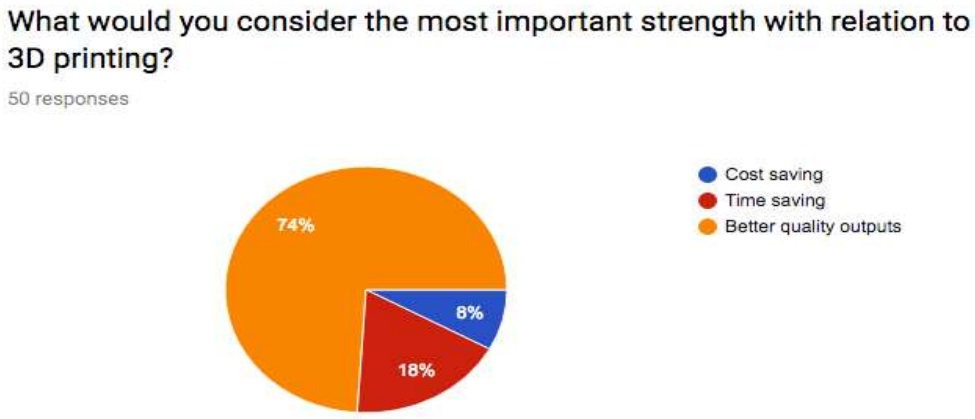
But, at the same time when the researcher wanted to understand if the customers would wait for a longer duration to receive a product personalized, 50% of the respondents said it would be dependent on the situation. The researcher's evaluation shows that if it is an urgent purchase and time is the crucial element, customers would prefer a mass-produced easy purchase. But, if the customers have the time, they would prefer to take the additional effort and communicate their imagined ideas to create a product that would be 100% unique to them.

The researcher conducted a **Sign test** on this data **(Annexure 2).**

Null hypothesis – younger generations have a higher chance of purchasing a 3d printed product over a mass manufactured product
Alternative hypothesis – there is no relation between age and purchasing of 3d products

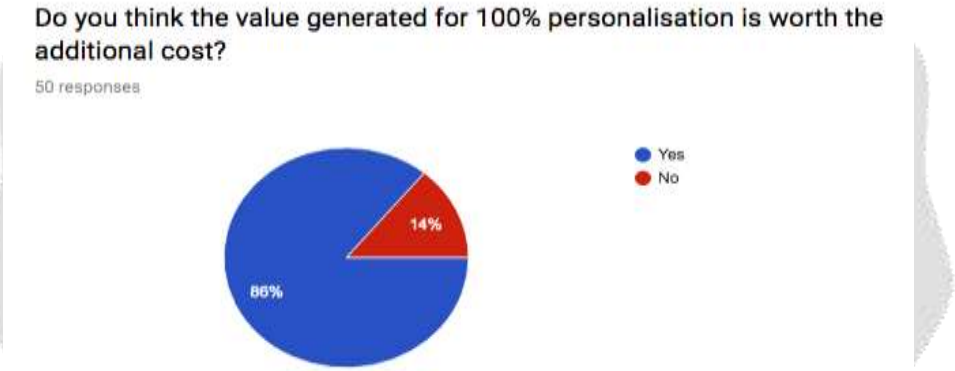
The researcher wanted to understand if age factors affect the purchasing of 3d printed products over mass manufactured products. **The null hypothesis was accepted,** as the P>N. Majority of the respondents were between

the ages of 20-29 who would be willing to use innovative technology to create something personalized rather than purchasing a mass-produced item. This helps the researcher understand that there is a market for 3d products and the target audience should be young adults.



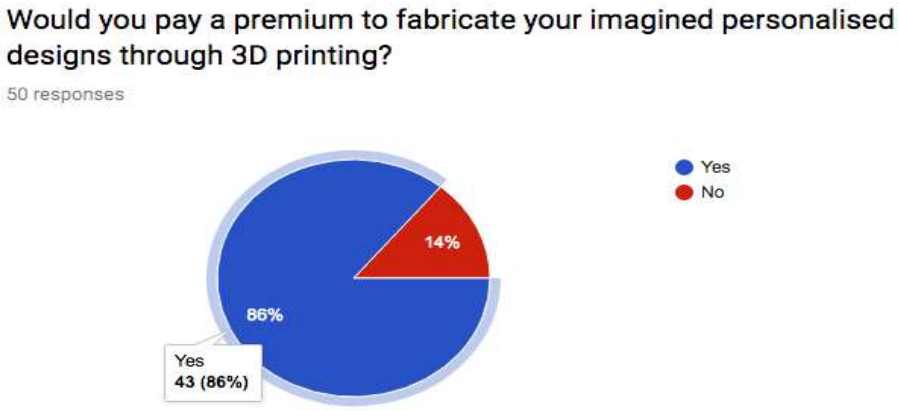
(Figure 14, strength of 3d printing)

Source: fieldwork



(Figure 15,value generation)

Source: fieldwork



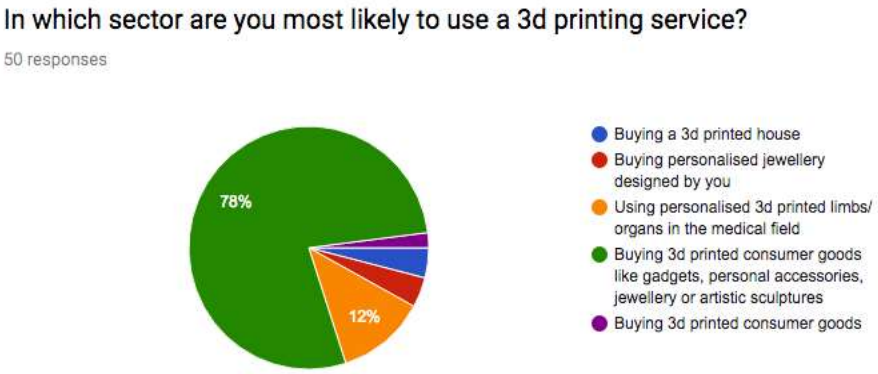
(Figure 16, premium amount)

Source: fieldwork

74% of the respondents stated that quality was the most essential strength with relation to 3d printing. The researcher finds a positive correlation between quality received and value expected as 86% respondents feel 100% personalization is worth the additional cost if the value received is greater than mass produced products.

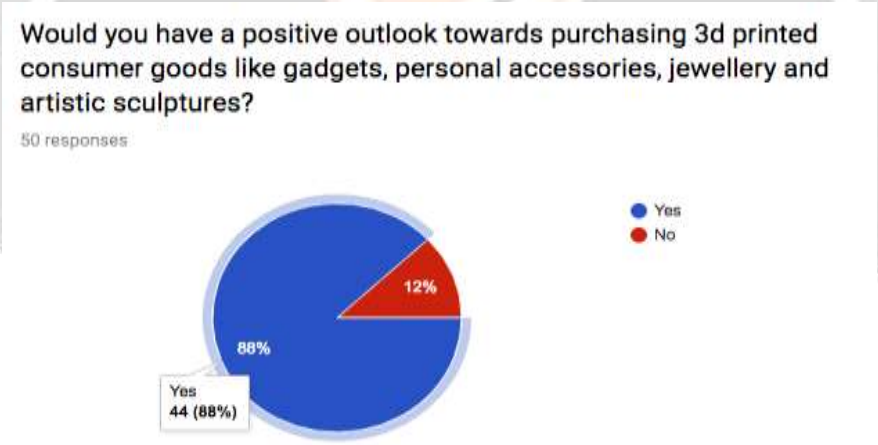
The researcher further analyzed both the charts to find that customers would be willing to pay an additional premium for the value of the product and therefore cost saving as a strength for 3d printing has received only a 8% vote from the customers.

The researcher also asked a double question regarding if they would pay a premium versus if they would pay additional for a higher value to check if the respondents were being accurate with their responses. This proves to the researcher that the respondents have thoroughly gone through the questions are there is a lesser likelihood of flawed/bias answers.



(Figure 17, 3d printing usage)

Source: fieldwork



(Figure 18, outlook towards purchase)

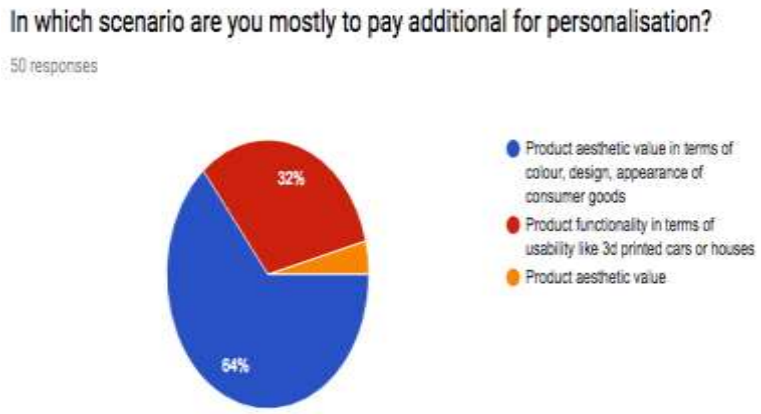
Source: fieldwork

78% of the respondents said they would purchase 3d printed consumer goods like gadgets, sculptures etc. As an end user, customers would be more willing to purchase an personalized version of their daily goods they use rather than purchasing a 3d printed house which is more of a functionality aspect and requires a very large investment cost from the customer.

88% of the respondents also claimed they had a positive outlook towards purchasing 3d printed consumer goods which answers the research question regarding if customers would have a positive attitude towards purchasing 3d printed products

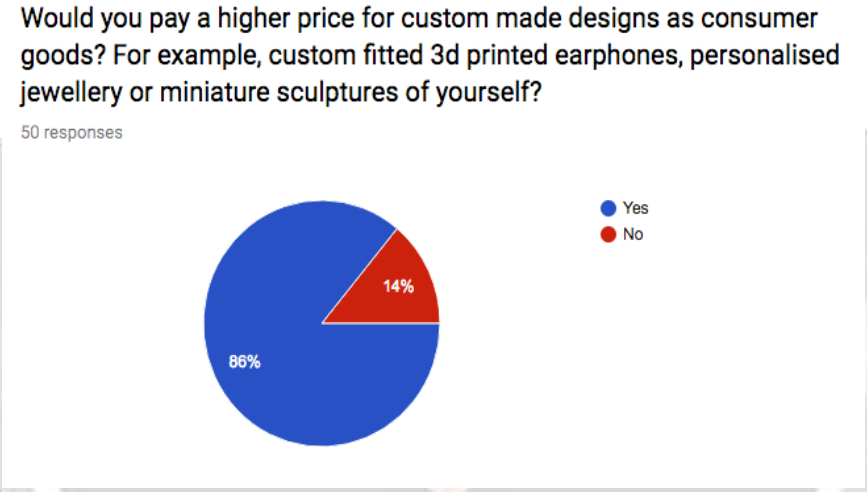
The above data collected matches the literature reviews which the researcher had collected and further justifies the conclusions various authors had driven with regards to 3d printed aesthetic consumer goods have a higher market than 3d printed functionality products.

Further, these findings have also been justified with the secondary data collected by the researcher, which favors consumers purchasing higher 3d printed consumer goods with a high aesthetic value.



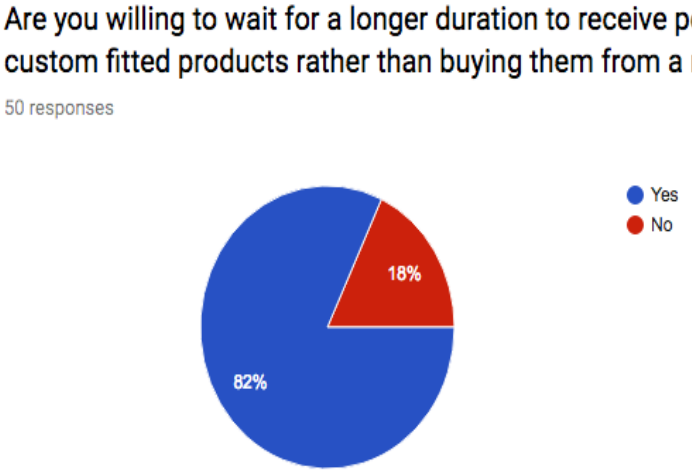
(Figure 19, pay for personalization)

Source: fieldwork



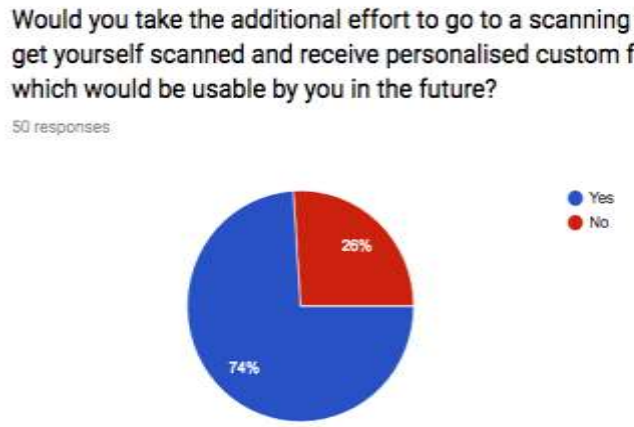
(Figure 20, pay for customized products)

Source: fieldwork



(Figure 21, wait for customized products)

Source: fieldwork



(Figure 22, effort for customized products)

Source: fieldwork

To investigate further, the researcher used the 3 most important factors – price, effort and time to further analyze the buying behavior in customer goods.

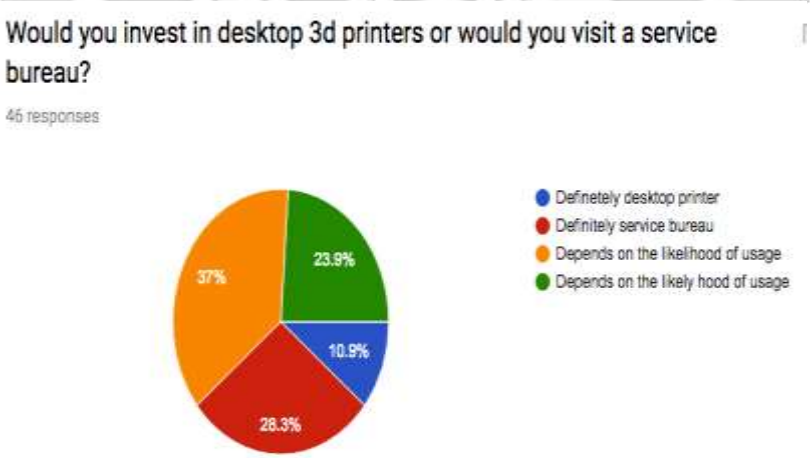
86% of the respondents were willing to pay a higher price for consumer goods. 64% of the respondents claimed they would be willing to pay a premium for asthetic consumer goods which therefore suggests price is not a limiting factor for 3d printed consumer goods

From those respondents, 82% of the respondents said they were willing to wait a longer duration to receive something which would be 100% unique to them. Unless, time was very crucial in that particular situation.

Finally, 74% respondents said they were willing to take the additional effort to go to a scanning laboratory to get themselves scanned if the product would be usable by them in the future.

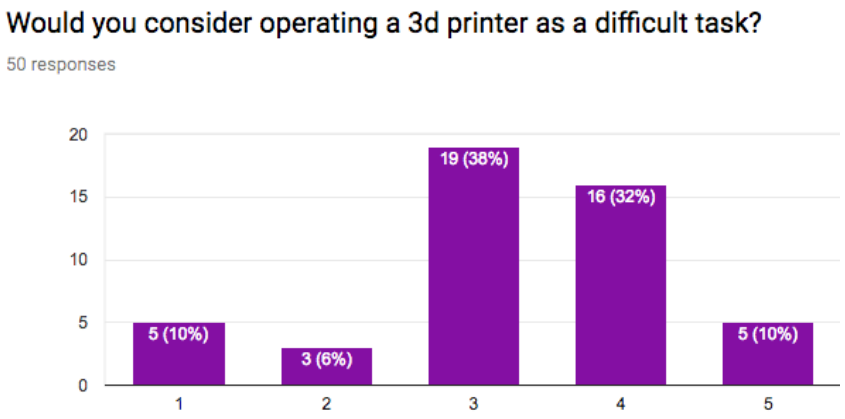
According to the researcher's findings, the main drawback faced by customers is taking the additional effort to receive a product which they can use like personalised earphones or miniature statues of themselves. These processes involves the scanning of the person.

According to the researcher's knowledge there are portable scanners which could be used to take scans of the customers. This would overcome the problem of willingness of customers taking the additional efforts. But, to critically analyse this, the researcher feels like it would become more expensive for organisation to conduct this task. Furthermore, the scans taken from the portable scanner and the scanning laboratorys have a major diference in output which could finally have an effect on the quality of the finished product.



(Figure 23, investment in technology)

Source: fieldwork



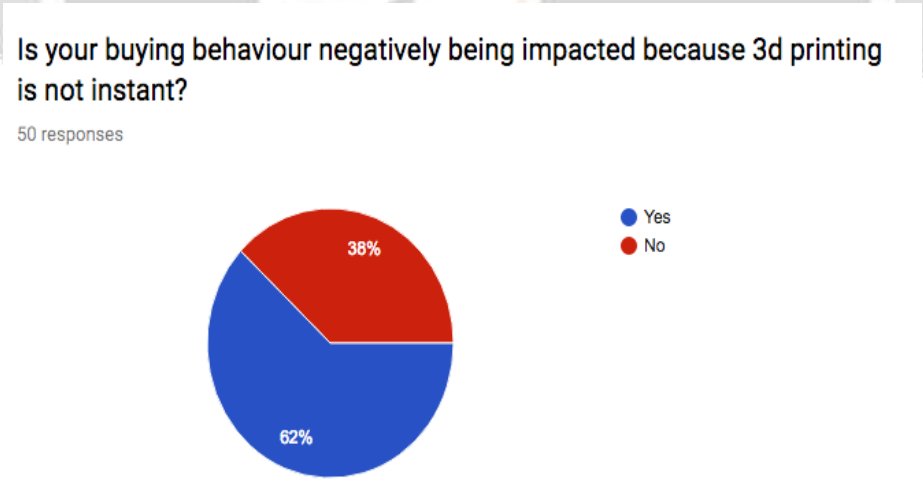
(Figure 24, difficulty of task)

Source: fieldwork

The above Likert scale showed, 61% of the 46 respondents claimed it would depend on the likelihood of the usage. According to the researcher, this simply means that if the customer feels the purchase would be very regular, it would make more sense to invest in a personal desktop 3d printer. But, if it would only be a few purchases, then there would be a higher likelihood of the customer visiting a service bureau.

But, to further critically analyze this, the researcher feels that 28% of the respondents still preferred service bureau over investing in their own desktop 3d printers which shows a probability those customers may consider this as a difficult task.

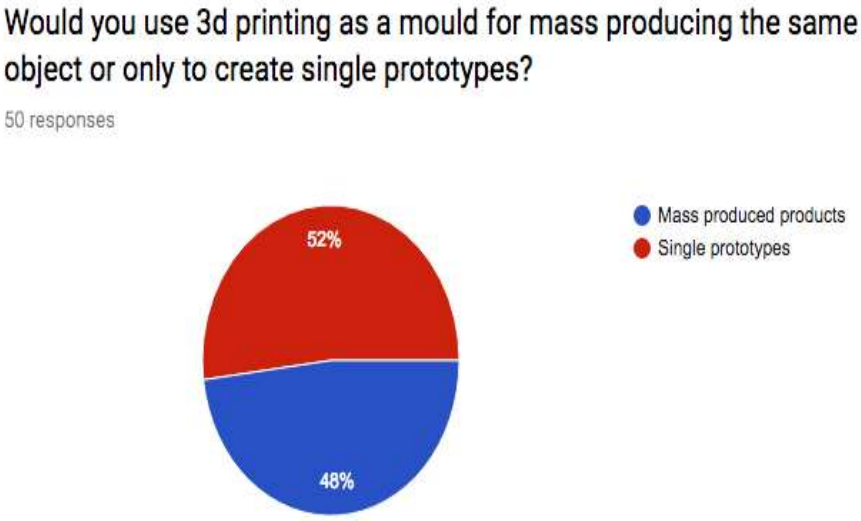
The researcher further evaluated this and realized 32% of the respondents do find it "somewhat difficult" to understand the operations of using a 3d printer. According to the researcher, this may justify the research question of the actions taken by the customers while purchasing a 3d printed product.



(Figure 25, buying behavior)

Source: fieldwork

62% of the respondents claimed that their purchasing is being affected because 3d printing is not an instant output. The buying behavior would improve if the organisation would "instantly 3d print" outputs for a faster process. The researcher feels like the purchasing would increase drastically if 3d printing would become instant or less time consuming than it currently is.

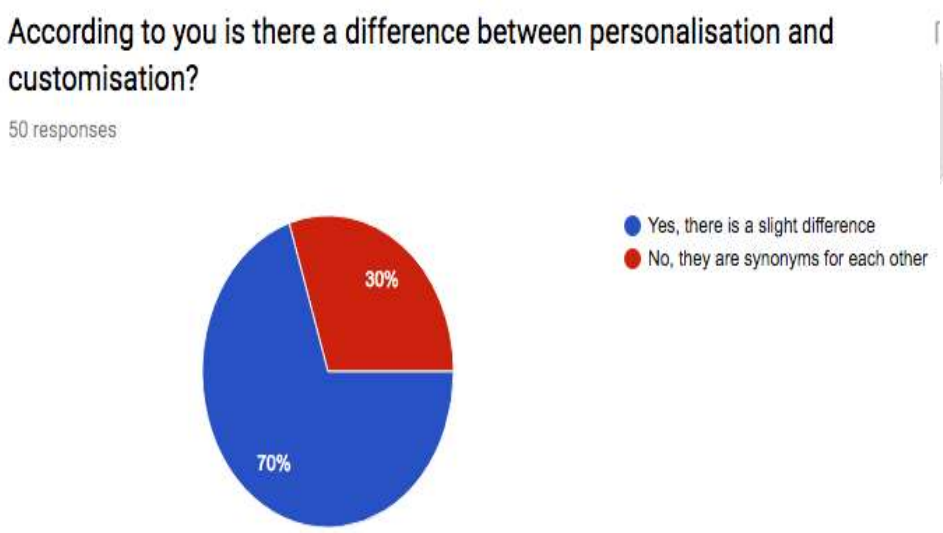


(Figure 26, mass v/s single prototypes)

Source: fieldwork

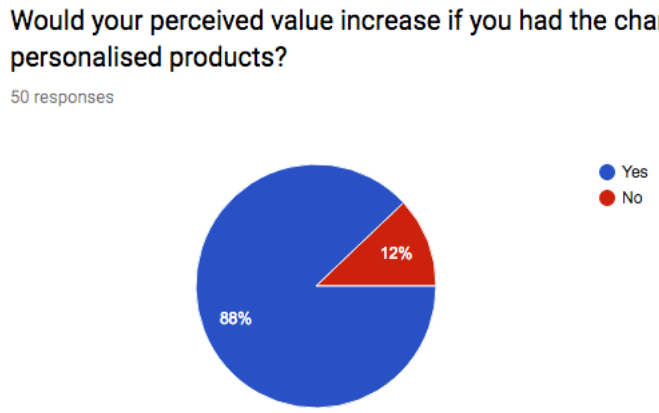
According to the researcher's analysis, 52% of the respondents would use 3d printing for single prototypes. This shows that customers want to maintain the 100% personalized product value aspect for themselves instead of creating multiples of the same.

But, to critically evaluate this situation, corporate clients who have limited budgets would use 3d printing to create the 1st mold and then to reduce costs and save time would use 3d printing to mass manufacture multiple pieces.

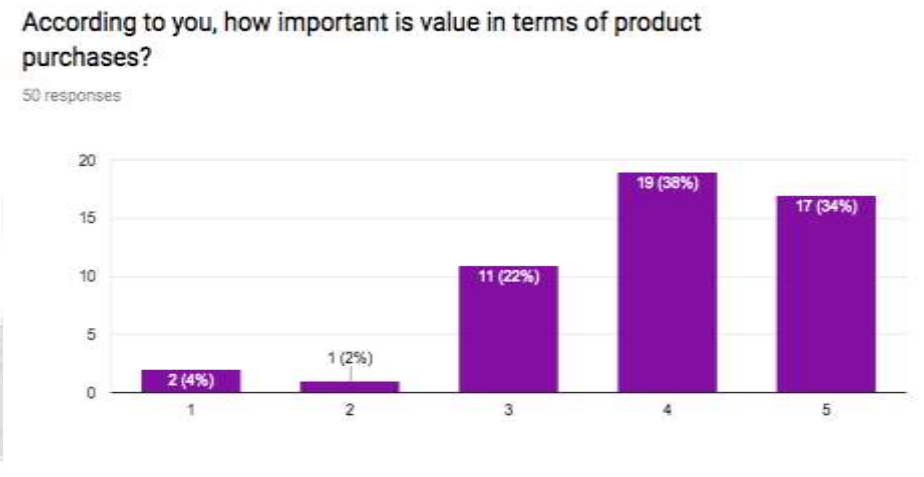


(Figure 27, difference between personalization and customization)
Source: fieldwork

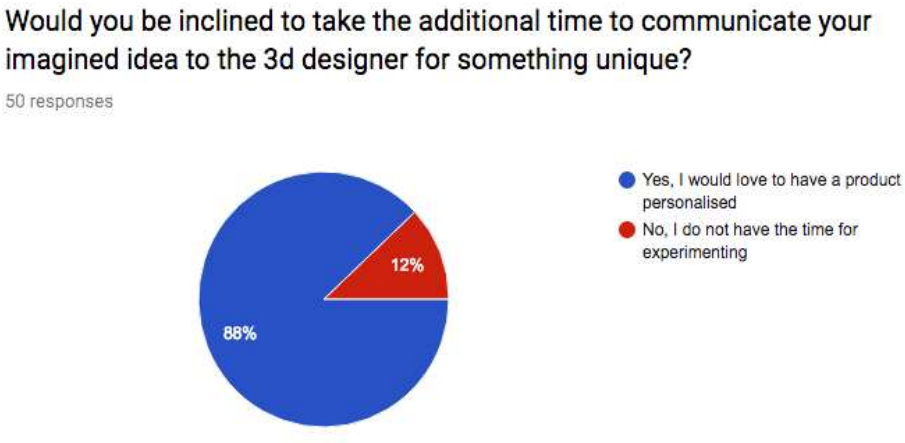
According to the researcher's findings, 70% of the respondents agree there is a difference between both the terms. This negates the literature review collected as the authors claimed customers are unaware of the difference and therefore do not understand how 3d printing is different with regards to 100% personalization.



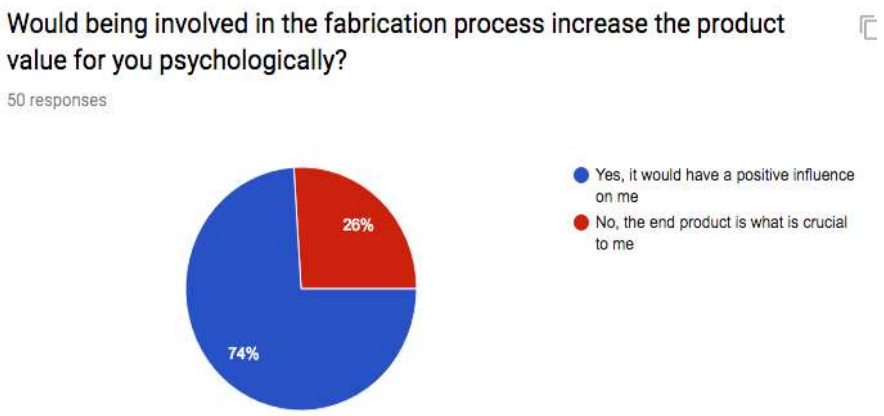
(Figure 28, value of personalization)
Source: fieldwork



(Figure 29, value in terms of purchase)
Source: fieldwork



(Figure 30, time value)
Source: fieldwork



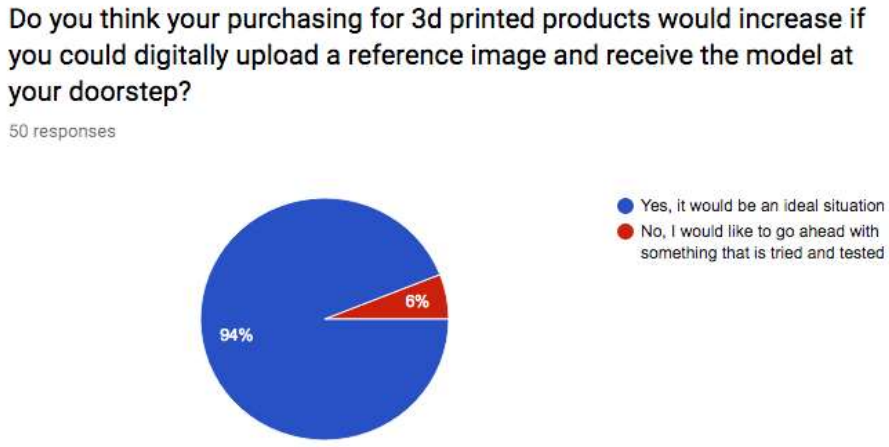
(Figure 31, involvement)
Source: fieldwork

In terms of product value, the researcher wanted to understand the customer perception of 3d printed products.

88% of the respondents reacted positively towards receiving a 3d printed product. In terms of product purchase, 38% said somewhat important and 34% said extremely important. This shows that customers would purchase 3d printed products as it provides a higher value than mass produced items.

88% of the respondents have said they would be very keen to communicate their ideas to the 3d designer to receive something unique. But, only 74% would be willing to take the additional effort to be involved in the fabrication process of creating a personalized product.

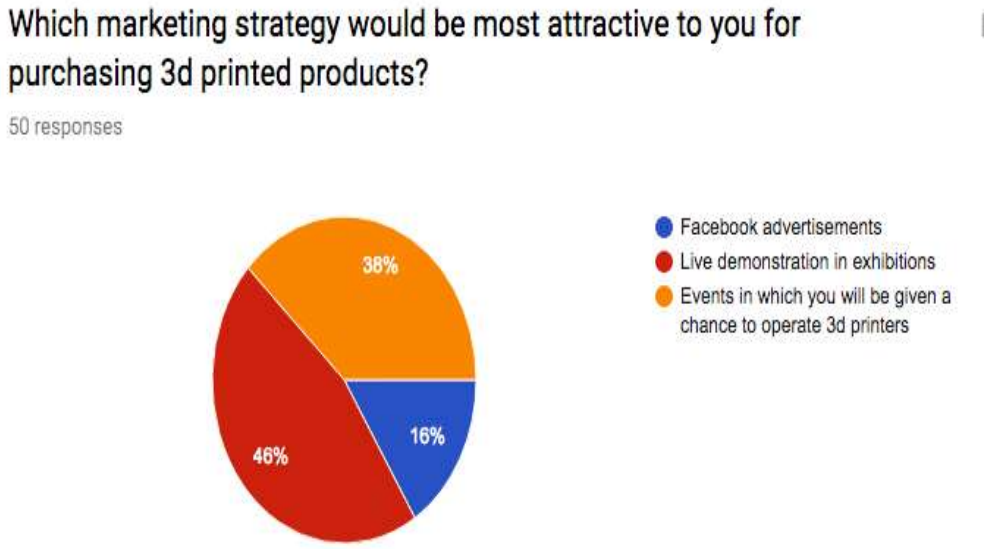
The researcher's analysis of these graphs shows that customers would be willing to purchase 3d printed products and communicate their ideas once or twice maximum to the 3d designers. But, customers would not be willing to spend their time fabricating the product and it involves a lot of time and effort by the customer.



(Figure 32, convenience)
Source: fieldwork

According to researcher's analysis, the data of 94% responses clearly show that the consumer buying behavior would drastically increase if the convenience improves for the end users. This means that if the customers have the opportunity to receive a product that is 100% personalized to them on their doorstep, even if the price is high, the customers would not mind paying the additional premium if they have to take lesser effort to fulfill this demand.

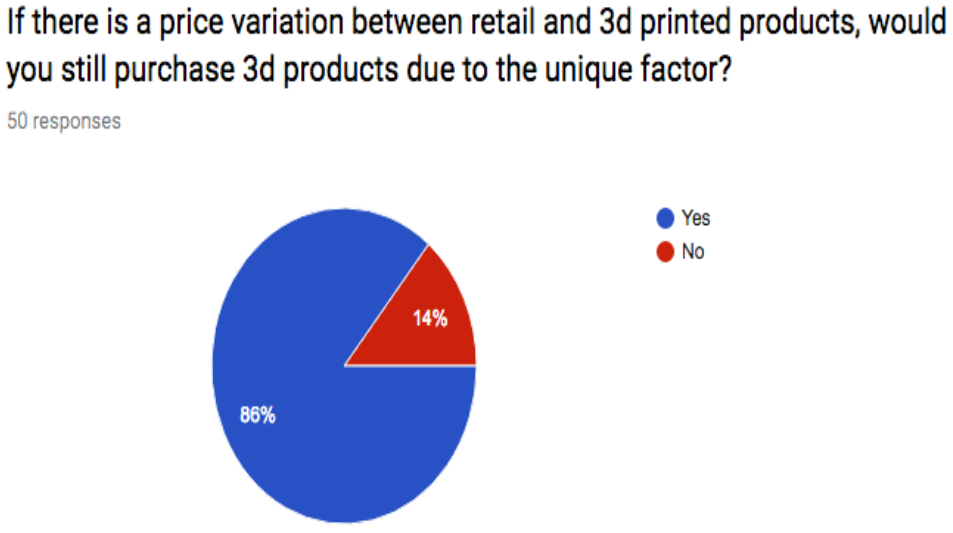
This data collected is in line with the other research findings, which proves the data is accurate.



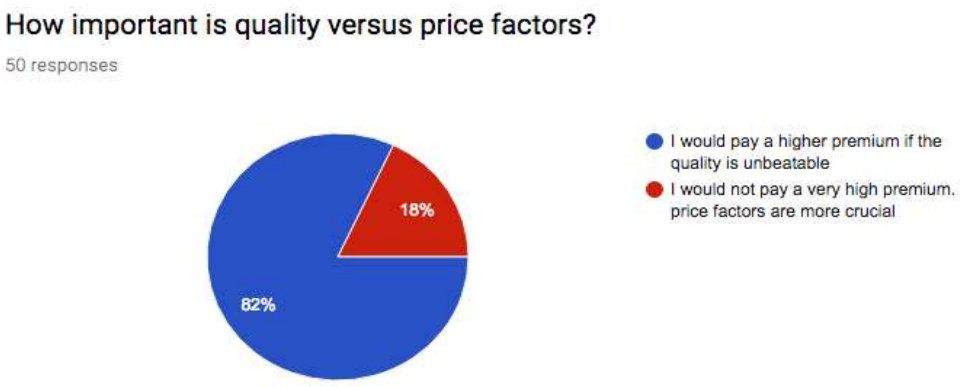
(Figure 33, marketing strategies)
Source: fieldwork

The largest response collected was 46% for live demonstrations in exhibitions. According to the researchers analysis, customers want to visually see how the process takes place and how the layers form the 3d object so they could in the future have knowledge about the process and contact service bureaus to fulfill their demand.

The researcher further evaluated this marketing strategy, as customers would want to gain experience in live events- 38% response rate. Customers are later assured with the quality output and the process that is followed for 3d printing. This ensures lesser confusion and a more clear understanding of this new technology.



(Figure 34, unique factor)
Source: fieldwork



(Figure 35, quality vs. price)
Source: fieldwork

86% of the respondents mentioned that price variations between 3d printed products and mass-produced products would not be the deciding factor for their purchase. 82% of the respondents mentioned they were willing to pay an additional premium if the quality was unbeatable.

According to the researcher's analysis, this shows that customers are willing to pay a premium and switch from the traditional manufacturing to 3d printing manufacturing if the quality is remarkable and the level of effort is minimized from the standpoint of the customers.

The researcher used **Spearman's correlation test** to check if customers consider quality over price with relation to their income levels **(annexure 2).**

Null hypothesis - customers would pay a premium for quality over price
Alternative hypothesis – customers would not pay a premium, as price would be the deciding factor.

The researcher wanted to understand the consumer buying behavior in terms of quality and price. **The null hypothesis was accepted**, as customers would have a higher disposable income as willing to pay an additional premium if the quality is unbeatable. This is helpful to the researcher as now there is a clear indication that price for 3d printed products is not the deciding factor whereas quality would be.

Conclusions And Discussions

Finally the researcher will now draw a conclusion for this research topic. This particular topic was selected by the researcher to understand the challenges, which could affect the growth of the 3d printing industry.

By conducting this study, the researcher was able to identify the limitations, which was affecting the growth of the business. Furthermore, as the researcher currently has a startup business of 3d printing, this study has benefited the researcher to identify the different marketing techniques, which can be used to increase the long-term revenues for the business.

The researcher introduced the topic of 3d printing and mentioned why the researcher selected this particular topic. The researcher's was able to create a logical sequence of questions within the research questions stated by the researcher. According to the conclusion driven in the introduction, the researcher was fully aware and had a logical method of finding detailed answers to these research questions mentioned in the introduction.

Using the logical sequence of research questions created in the introduction, the researcher was able to draw clear conclusions while doing the literature review. But, to ensure high level of accuracy and quality responses the researcher conducted primary research.

The conclusion derived from the research methodology, helped the researcher be focused on the type of research, target audience and the sampling design that would be taken into consideration. This helped the researcher in terms of the secondary and primary data collection that helped the researcher in the next chapter for a more detailed analysis of the research topic.

For secondary data collection, the researcher made use of different bar charts that were found in journal articles that answered a few research questions stated by the researcher.

But, as the data collected from secondary research was limited, the research made use of a questionnaire as primary research for further analysis and to help increase the accuracy and quality of responses.

After following secondary and primary research, the conclusion driven from data presentation cleared showed that the gap for the 3d printing market is because of lack of marketing **(3D Printing For Dummies, 2018)**. Also, the data collected from the literature review and the primary research clearly concludes that 64% would pay a premium for aesthetic consumer goods compared to 32% for 3d printed functionality products **(Science, 2018)**.

Furthermore, 62% of the respondents claimed the reason the buying behavior is low is due to the fact that 3d printing is not an instant process which a limitation of this industry. Moreover, 86% respondents claimed they do not mind paying a premium amount but are not willing to take the additional effort to become a part of the fabrication process. 94% of customers would prefer an online platform wherein they can communicate their ideas and receive the product delivered to their doorstep.

The scope of the study in the future would be to identify how organizations would be able to improve the efficiency of the 3d printers and make it less time consuming. 82% of respondents stated price is not the deciding factor. 86% respondents said value is a crucial factor, which will affect their buying behavior.

A clear recommendation would be for organization's to increase their marketing budgets. 46% of responses said marketing at exhibitions and having live demonstrations would solve this market gap. According to the research conducted, 100% of customers are aware of 3d printing but only 44% of them have purchased a 3d printed product. This is mainly because customers have limited knowledge about the product, price factors and product availability that is hampering their buying behavior.

While circulating the questionnaire, a few respondents found the questionnaire lengthy. This may be a drawback in the study of the researcher as quality may have been affected for this survey. Further, limited information that was collected with respect to the research question that spoke about business expansion. This was a limitation observed and this research question needs more emphasis for the next dissertation report.

Moreover, the researcher revisited the research questions stated in the introduction. The researcher was able to get a clear understanding that the attitude of customers would be positive if the customers are able to understand the benefits of 3d printing and the process which takes place. This would lead to a positive action, as 88% of customers claimed they would want to manufacture their imagined personalized designs. To identify potential customers, the business would have to take part in more exhibitions where 46% of customers stated they would want to be able to see live demonstrations instead of social media advertising. Lastly, to answer the question of pricing, 82% of customers claimed quality would get a preference over pricing as a deciding factor. The limitations identified from the research questions was 3d printing still requires post processing functions and still requires longer timelines to manufacture personalized products.

But, to critically review the research questions stated, the research was only done with respect to the B2C market whereas, a separate range of research questions could be circulated to understand the buying behavior of B2B markets.

Finally, in conclusion, the researcher was able to conduct an in-depth analysis into understanding the challenges faced and the scope of the 3d printing business. By conducting the literature review, the research was able to understand the perception of other authors commenting on a similar research topic. This research topic would benefit the researcher in the long term, as the researcher would be able to use this analysis for her business in 3d printing.

The researcher would try to improve the marketing techniques being followed to ensure the buying behavior improves. The researcher would also try to build an online platform which would allow customers to directly upload drawings or reference images of their imagined designs and create a platform where in end users would not have to take the additional effort. The researcher would charge a higher premium, but as price is not a limitation, the researcher would be able to successfully implement this idea.

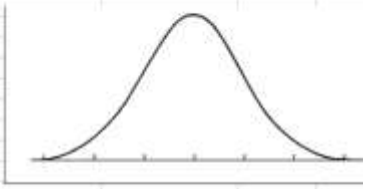
Annexures

Test 1 - Chi Test

Data collected related to income groups and purchasing intent for buying a 3d printed product.

	below 10,000	10,000- 29,000	30,000 - 49,000	50,000 - 69,000	above 70,000	Total
purchased a 3d product	1	0	3	3	15	22
not purchased a 3d product	6	7	2	2	11	28
	7	7	5	5	26	50
correlation value	0.651702316					
p =	0.44					
Expected frequency table						
Total sample	7	7	5	5	26	
purchased a 3d product	3.08	3.08	2.2	2.2	11.44	
not purchased a 3d product	3.92	3.92	2.8	2.8	14.56	

Fo	Fe	Fo - Fe	(Fo- Fe)^2	(Fo-Fe)^2/Fe
1	3.08	-2.08	4.3264	1.404675325
0	3.08	-3.08	9.4864	3.08
3	2.2	0.8	0.64	0.290909091
3	2.2	0.8	0.64	0.290909091
15	11.44	3.56	12.6736	1.107832168
6	3.92	2.08	4.3264	1.103673469
7	3.92	3.08	9.4864	2.42
2	2.8	-0.8	0.64	0.228571429
2	2.8	-0.8	0.64	0.228571429
11	14.56	-3.56	12.6736	0.87043956
				11.02558156



degree of freedom = (5-1)(2-1) = 4	
significance level = 0.05	
value from table = 0.711	
Hence hypothesis is accepted	The researcher concludes there is a correlation between income and purchasing

(Annexure 1, chi test)
Source: fieldwork

Test 2 – Spearman Correlation Test

Spearman Correlation Test

Column1	I would pay higher	I would not pay	rank 1	rank 2	P value
below 10,000	5	2	2	2	0
10,000 - 29,000	6	1	3	1	2
30,000 - 49,000	7	1	4	1	3
50,000 - 69,000	3	1	1	1	0
above 70,000	19	5	5	3	2
					7

Final conclusion	
r	0.530330086
p	0
n	5
df	3
s	0.489472505
t - Stat	1.083472678
a	0.05
t - crit	3.182446305
p value	0.357905889
sig	NO

(Annexure 2, spearman correlation test)
Source: fieldwork

Test 3 – Sign Test

Sign Test			
Age	**purchase a 3d product**	**purchase a mass producted product**	**Sign**
below 10	0	0	same
10-19	1	0	positive
20-29	24	6	positive
30-39	5	3	positive
40-49	1	3	negative
50-59	3	0	positive
above 60	1	0	positive
Frequencies			
negative differences	1		
positive differences	5		
ties	1		
total	7		

(Annexure 3, sign test)
Source: fieldwork

Marketing management in the 3D Printing Industry

The researcher has a startup business of 3D printed manufactured products, but due to dependency on technology the researcher feels that the scope of this business is limited. Thus, the researcher has taken this topic to understand the commercial viability of this business in the long term at an academic level and hence the data will be only used for this study.

* Required

Name *

Your answer

Gender *

- Male
- Female
- Other

Which age group do you fall under? *

- ◯ below 10
- ◯ 10-19
- ◯ 20-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60 and above

What is your monthly personal income in rupees? *

- ◯ below 10,000
- ◯ 10,000-29,000
- ◯ 30,000-49,000
- ◯ 50,000 and 69,000
- ◯ 70,000 and above

Are you aware of 3D printing? *

- ◯ Yes
- ◯ No

Do you know the difference between traditional manufacturing and 3d printing manufacturing? *

- ◯ Yes
- ◯ No

Have you ever purchased a 3d printed product? *

- ◯ Yes
- ◯ No

Would you wait for a longer duration to receive something personalised or would you buy a mass produced product instantly? *

Choose

What would you consider the most important strength with relation to 3D printing? *

Choose

Do you think the value generated for 100% personalisation is worth the additional cost? *

- ◯ Yes
- ◯ No

Would you take additional effort to create a single prototype using 3d printing or would you prefer a mass produced item? *

- ◯ Single prototype would be personalised and unique for me and therefore I would take the effort
- ◯ Mass produced products are easier and quicker to purchase

In which sector are you most likely to use a 3d printing service? *

- ◯ Buying a 3d printed house
- ◯ Buying personalised jewellery designed by you
- ◯ Using personalised 3d printed limbs/ organs in the medical field
- ◯ Buying 3d printed consumer goods like gadgets, personal accessories, jewellery or artistic sculptures

Would you invest in desktop 3d printers or would you visit a service bureau? *

- ◯ Definetely desktop printer
- ◯ Definitely service bureau
- ◯ Depends on the likelihood of usage

Would you pay a premium to fabricate your imagined personalised designs through 3D printing? *

- ◯ Yes
- ◯ No

Would you have a positive outlook towards purchasing 3d printed consumer goods like gadgets, personal accessories, jewellery and artistic sculptures? *

- ○ Yes
- ○ No

Would you pay a higher price for custom made designs as consumer goods? For example, custom fitted 3d printed earphones, personalised jewellery or miniature sculptures of yourself? *

- ○ Yes
- ○ No

Would you take the additional effort to go to a scanning laboratory to get yourself scanned and receive personalised custom fitted objects which would be usable by you in the future? *

- ○ Yes
- ○ No

Are you willing to wait for a longer duration to receive personalised custom fitted products rather than buying them from a retail store? *

- ○ Yes
- ○ No

Would you consider operating a 3d printer as a difficult task? *

	1	2	3	4	5	
Not difficult	○	○	○	○	○	Extremely difficult

Is your buying behaviour negatively being impacted because 3d printing is not instant? *

- ○ Yes
- ○ No

Would you use 3d printing as a mould for mass producing the same object or only to create single prototypes? *

- ○ Mass produced products
- ○ Single prototypes

According to you is there a difference between personalisation and customisation? *

Choose

Would your perceived value increase if you had the chance to receive personalised products? *

- ◯ Yes
- ◯ No

Would being involved in the fabrication process increase the product value for you psychologically? *

- ◯ Yes, it would have a positive influence on me
- ◯ No, the end product is what is crucial to me

Would you be inclined to take the additional time to communicate your imagined idea to the 3d designer for something unique? *

- ◯ Yes, I would love to have a product personalised
- ◯ No, I do not have the time for experimenting

Do you think your purchasing for 3d printed products would increase if you could digitally upload a reference image and receive the model at your doorstep? *

- ◯ Yes, it would be an ideal situation
- ◯ No, I would like to go ahead with something that is tried and tested

According to you, how important is value in terms of product purchases? *

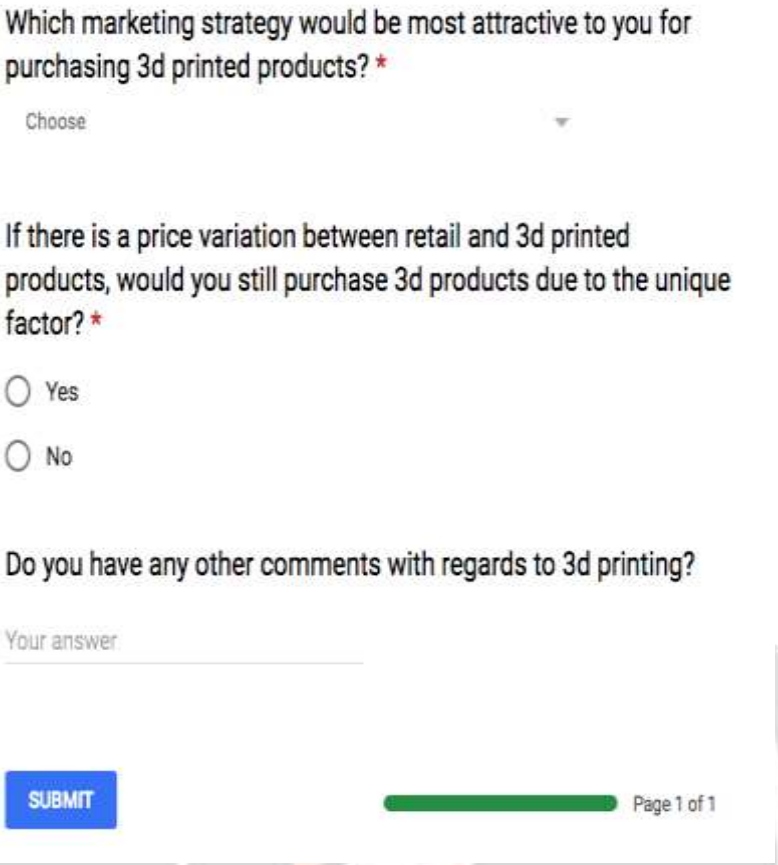
	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Extremely important

In which scenario are you mostly to pay additional for personalisation? *

- ◯ Product aesthetic value in terms of colour, design, appearance of consumer goods
- ◯ Product functionality in terms of usability like 3d printed cars or houses

How important is quality versus price factors? *

Choose


Which marketing strategy would be most attractive to you for purchasing 3d printed products? *

Choose

If there is a price variation between retail and 3d printed products, would you still purchase 3d products due to the unique factor? *

Yes

No

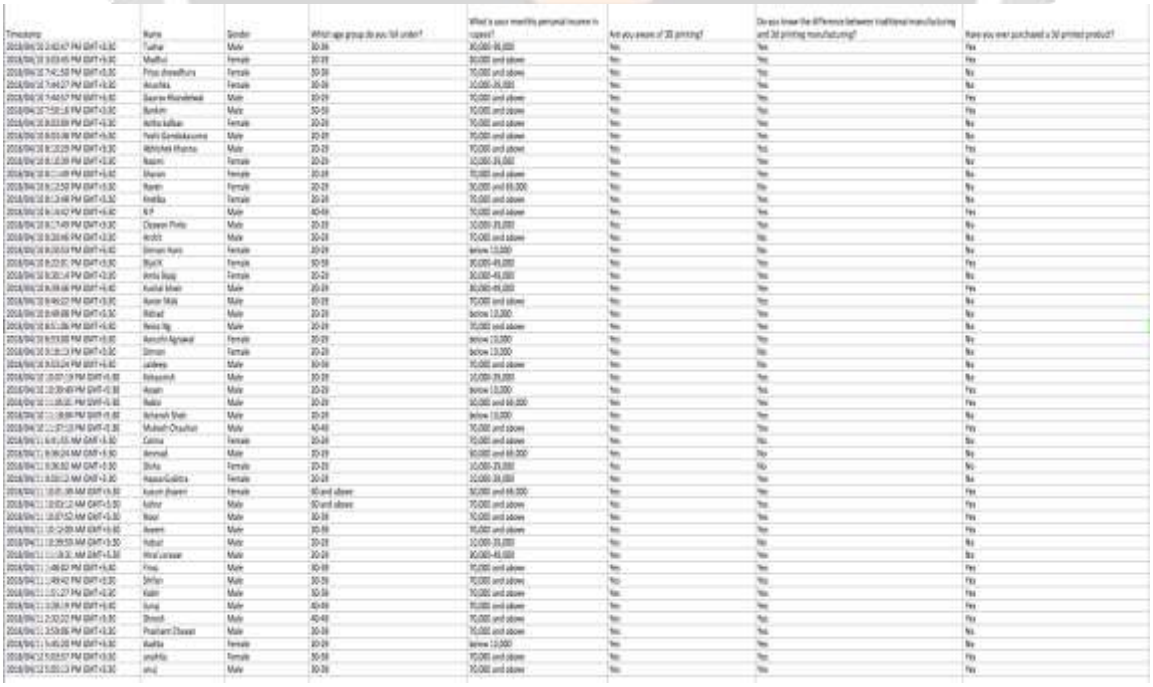
Do you have any other comments with regards to 3d printing?

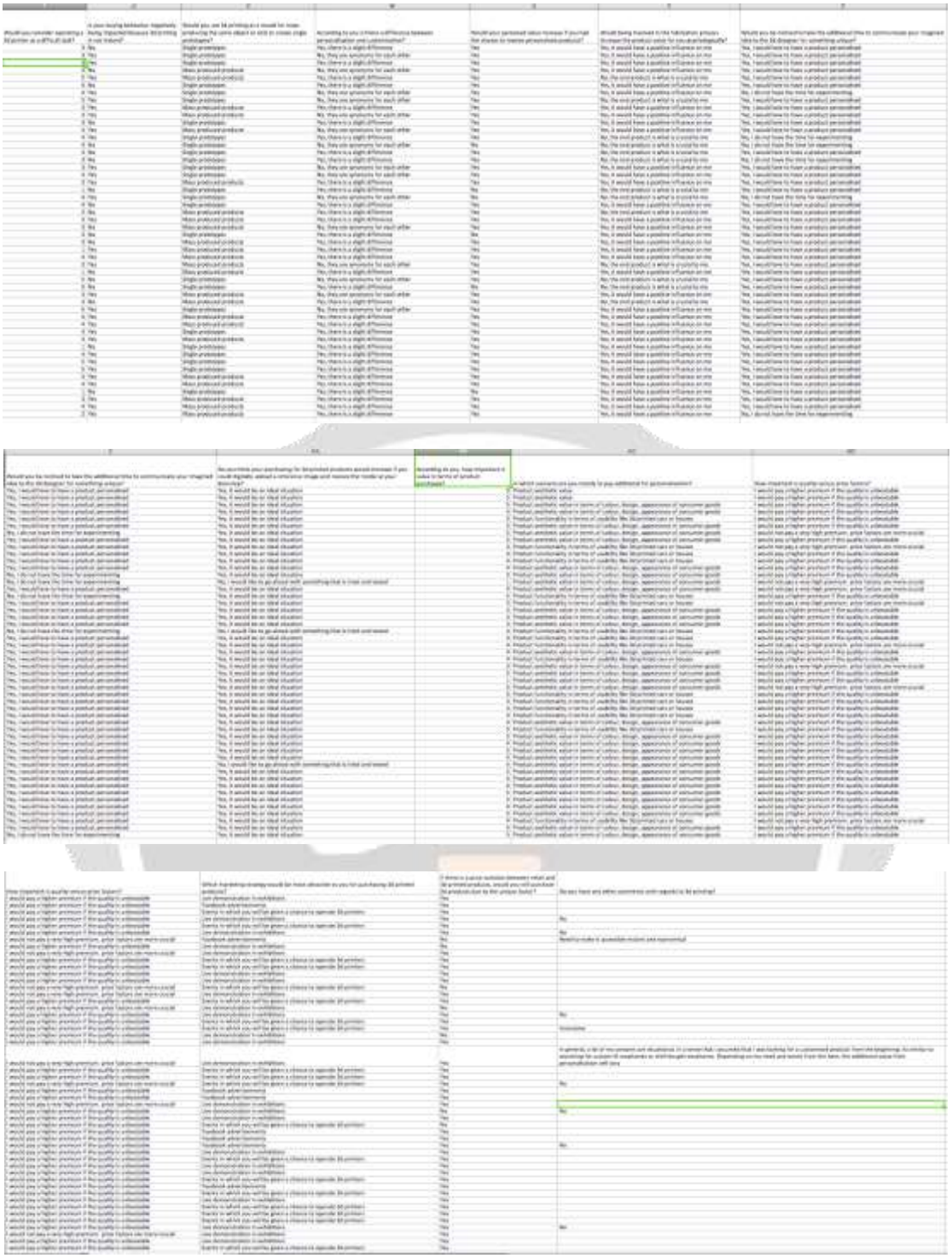
Your answer

SUBMIT

Page 1 of 1

(Annexure 4, questionnaire distributed to respondents)
Source: fieldwork





(Annexure 5, excel sheet of data collected from questionnaire)
Source: fieldwork

The below proposal was created by the researcher before starting the dissertation report on 3d printing.

Topic – Marketing management in the 3D Printing Industry

Title - Analytical study of the challenges faced in the growth of the 3D Printing Industry

The researcher currently has a business of 3D printing and therefore has chosen this topic to understand the different marketing techniques, which can be used to increase the long-term revenues for the business.

Is there a scope of growth in the 3D Printing industry?

The researcher has a startup business of 3D printed manufactured products, but due to dependency on technology the researcher feels that the scope of this business is limited, thus, the researcher has taken this topic to understand the commercial viability of this business in the long term.

To investigate the marketing strategies that will helps drive the market development in the 3D Printing industry.

Research objective

1. To understand the consumer buying behavior for 3D printed products
2. To analyze the demographics of the lapse, current, potential customers
3. To examine various pricing methods that affect the buying behavior of customers
4. To do a comparative study of the old marketing techniques v/s the new marketing techniques

Research questions

1. What is the attitude of customers while deciding to purchase 3D printed products?
2. What is the action of customers while purchasing 3D printed products
3. Who are the potential customers for the 3D printed products?
4. How does the pricing methods affect the decision making of customers?
5. How to achieve business growth and expansion using the new marketing techniques?

Research methodology

The type of research chosen is **quota sampling,** as the author would want to understand which income category could be targeted for purchase of 3d printed products. The researcher will be able to understand how 3D printing will be able to improve the accuracy and quality for future situations.

The author would use secondary data related to 3D printing like journals, books and newspapers. This would be beneficial as the process of collection would be less time consuming for the author.

For primary data the author would be relying on Questionnaires, recordings and surveys. Questionnaires would be circulated among potential customers – lapse, current and potential customers to understand their interest levels to receive something unique using 3d printing technology.

The author would use a sample size of 45 – 50 respondents, which would be customers (B2C markets) to understand if they are willing to purchase products, which are 3d printed.

The techniques which would be used would be non – probability sampling. The author would use quota sampling to analyze each group of individuals and the researcher could analyze who would be most likely to purchase 3d printed items for better targeting.

The author would derive a conclusion as to whether there is scope of growth in the 3D printing industry.

For non- academic research the author will be using newspapers, interviews, discussions, magazine and blogs for example, a blog on consumer 3d printing market trends

For academic research the author will be using books, documents, dissertations and journal for example of an academic research paper. yeh, c.c., 2014.

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