University of Magdeburg

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Master's Thesis

PoSoFiHy - A guided approach towards formulation of problem solution fit hypothesis

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Abstract

The idea of building a startup can be considered as a research activity. Startup founders have to achieve goals, follow a process, analyze, build and proceed. there are so many macro and micro process that needs to be taken care off. Apart from these, startup founders also need to deal with the uncertainties, competition present at that period of time, At any point of time, if any of these aspects are overlooked or there is is a mistake, it can lead to the failure of the startup. The Lean Startup methodology has been a great success and many startup founders have turned their startup ideas into a successful business. Still, we do have problems, there are instances wherein startup do go lean but not able to succeed. As lean startup focuses on breaking down the overall process of building a startup into series of the subprocess. Each of the processes is considered as a state. Once a state is achieved then move to the next. Problem solution fit is considered as the very first and crucial state for startup going lean. Usually, problem solution fit is achieved by formulation hypothesis. The formulated hypothesis is called as problem solution fit hypothesis. This research focuses on the way the problem solution fit hypothesis is being formulated. Formulating a problem solution fit hypothesis means to ensure that the target customer, there need and the solution has to be well described. Also, how do these components relate to each other, their dependencies and any other factors (if needed) as to be well incorporated into the problem solution fit hypothesis? The assumption here is that there is a lack of a process that helps startup founders to do so. Following the current approaches, startup founders do tend to overlook some of the factors related to there target customer, there needs and the solution. This can be one of the reasons for startup failures. As a solution to this, an automated guided approach based on the questionnaire will be designed. This guided approach will be a result of design science approach. Research on the aspects of hypothesis formulation, important components of a hypothesis, lean startup approach will be done. Once developed, the guiding framework will be given to startup founders to use and share feedback through a survey.

Acknowledgements

I would also like to thank Prof. Dr. rer. pol. habil. Hans-Knud Arndt of Institut für Technische und Betriebliche Informationssysteme at Otto von Guericke universität, Magdeburg for his acceptance to be my second supervisor and accessing my work.

I would like to thank my thesis advisor Dr.-Ing. Stefan Knoll of Institut für Simulation und Graphik (ISG) faculty at Otto von Guericke universität, Magdeburg. He was always there to help and guide me during my entire research. He helped me whenever I had any questions or roadblocks during my research. He allowed me to work independently and also kept a tap on me to check the overall progress. I would also like to thank the expert who helped me in coming up with the guided questionnaire based platform. Without their professional guidance and theoretical subject knowledge, it would not have been successfully thought off and designed.

A great thanks to all the startup founders who participated in the experiments and helped me in achieving my goals. Without there help this research would not have been successful.

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1. Introduction

1.0.1 Overview

One of the reasons which add towards startup failure is `"building a product that no one wants"` [ERD11]. Also, in figure 1 the reason that contributes most towards startup failure is no market need. Now, the question arises is why it is happening? Considering any business units, the goal is to make something which will be consumed. There should be a demand then what is the thing that startup is doing wrong. One of the features that segregate startup from a normal business unit is that startup operates in extreme uncertainty. There is a very thin line that results in success or failure of startups. Yes, we do have uncertainty involved but we do have methodologies to be followed as well. The lean startup methodology was brought into the picture by `Eric Ries` in 2008 and later a book was published for the same in 2011 [1]. This methodology was focused on startups. This was an iteration based approach. Hypothesis formulation and validated learning were some of the unique features of this methodology. Following this as well we can see that 42 % of startup failed to build a product that has the demand or a need.

In this scenario, we can define the problem using different problem statements

P1 42 % of the failed startup did not follow the lean startup approach.

P2 42 % of the failed startup did follow the lean startup approach.

As this thesis is focused only on startup following the lean startup approach, the focus of this thesis will be on [P2]. So [P2] can be further broken into

P2.1 42 % of the failed startup did follow the lean startup approach but in a wrong way

[1] https://en.wikipedia.org/wiki/Lean_startup - 04/11/2018

This thesis aims at finding the cause as in what are the ways lean startup is being followed and what can the supporting causes for startup failures. In this thesis the term startup founder is being used for people who plan to have a startup. As the level of uncertainty is more when compared with a normal business unit, startup founder often take extra risks with a vision of having a high profit. This uncertainty factor also has a significant impact on the success of a startup. Dream of having a startup is a fascinating one. Often, startup founder tend to overlook some of the important aspects of there customer, their need and also how the solution adds towards satisfying the need. These reasons do have a big impact on the overall startup idea and when overlooked results in the failure of a startup. To be able to build a product that has demand, the demand and the users need to be well understood. The problem arises when it is not well understood. This problem refrains startup founders towards understanding the relationship between solution, need, and target customer. This results in the uprising of a product which has no demand or we can say no one is ready to accept it or it does not satisfy any need. This thesis is one step towards reducing startup failures by addressing similar causes. The focus is on the factors which are responsible towards negligence of customer, there needs and how the solution will be helpful in addressing the need.

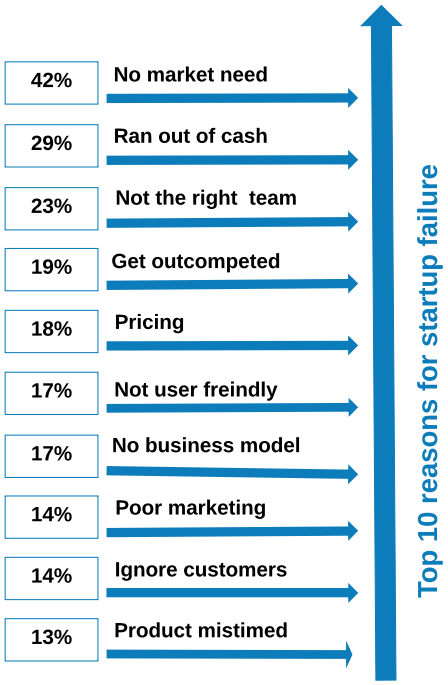

Figure 1.1: Reasons for startup failure adapted from CB Insights- data from 04/12/2018

[2]

The problem solution fit state is the starting and most crucial state for a startup. Problem solution fit indicates that the startup has a good understanding of there target customer, their needs and how does the solution is a fit for the need. Also, it helps in validating customer acceptance towards the solution. Usually this state is achieved via first formulating hypothesis which are also called as problem

solution fit hypothesis. Then these hypothesis are tested and based on the results further steps are taken. Considering the fact that the startup are going lean and achieving problem solution fit. We can still observe that 42% of them are ending up with a problem which is no market need. One of the research objective of this thesis is related towards understanding the general concept related with hypothesis formulation in general. Segregating the hypothesis on the basis of must-have components, how it can be tested, how the quality of formulated hypothesis can be measured falls under the aspects of this research. Once these aspects are well defined and described then using the same for the formulation of problem solution fit hypothesis. Also, designing a guided framework that will be helpful and used by startup founders in order to well understand their target customer segment, their need, and the proposed solution comes under the scope of this thesis.

To be able to develop an information system which adds towards addressing the research problem of this thesis design science approach is used. The general idea of design science approach is towards understanding the existing work or knowledge. Then understanding in specific the problem domain and later designing artifacts that adds towards solving the problem. This helps in defining requirements at each stage which then can be fulfilled and then an innovative artifact can be designed [EHM+04].

1.0.2 Motivation

After attending the lecture "Startup engineering III" during winter semester 17/18 at the faculty of informatics, Otto-von-Guericke University, Magdeburg where concepts related with startup and the best practices to form or startup was taught. It was very clear that students had a tough time understanding the basics related to their target customer, problem definition, and proposed solution. Also when it comes to understanding the concepts of problem solution fit and formulating a problem solution fit hypothesis there were varied unrelated assumptions. Also, following various startup blogs and groups one thing that was clearly visible was that need of innovation towards the operations side of a startup as well. The existing approaches mainly include one to use pen and paper and a brainstorming session which is good but the scope for improvement is also visible. When it came to an individual understanding and applying the knowledge to self-ideas, most of the time the output becomes ambiguous. Also defining the relationship between the target customer, problem definition, and proposed solution and form a problem solution fit hypothesis needed a lot of effort. Searching for some of the basic concepts related to the formulation of a hypothesis, what should be in and what should be out while forming a hypothesis was also not very helpful. Considering this as a challenge, this thesis aims at improving the problem solution fit hypothesis. This includes improving the followed process towards problem solution fit hypothesis formulation and also the formulated problem solution fit hypothesis.

1.0.3 Research problem and research question

- Research problem

The below given research problem has been formulated by addressing the reason that has the highest contribution towards startup failure (figure 1).

- *Startup founders do tend to overlook some of the important aspects related to the target customer, there need and solution while planning for a product*

The given research problem has a very broad research aspect. It also involves research and study from various different disciplines. To be able to address this research problem in a way that it can be related with startup and its failure, following constraints have been used

- Startup going the lean way and following the hypothesis-driven approach.
- Startup focusing on Business to consumer business. Business to consumer (B2C) is business or transactions conducted directly between a company and consumers who are the end-users of its products or services.

- Research questions

The research questions are focused on startup practices. When following lean startup approach, a startup has to first reach problem solution fit state. This state is reached using problem solution fit hypothesis. There has been lack of resources speaking about problem solution fit hypothesis in specific. Also, the ways of formulating the problem solution fit hypothesis are bit ambiguous. The research questions aim at providing clarity towards problem solution fit hypothesis formulation. Also, focus in on justifying the need for a process that can guide users and help in the formulation of problem solution fit hypothesis. Following research questions has been formulated to address the above-mentioned research problem. Also, the research questions have been divided into two section. This is done in order to address the research problem in a very specific way. The first section of the research question focuses on problem solution fit hypothesis. It sets a guideline for the formulation of problem solution fit hypothesis. The second phase focuses on the need for a process. This process takes inputs from the first phase. The aim here is to use these inputs and justify the need for a process that can help users to formulate problem solution fit hypothesis

Research questions

- [**RQ1**] What are the important components of a problem solution fit hypothesis?
- [**RQ2**] What is a good format for representing problem solution fit hypothesis?

- [**RQ3**] How can we represent the relationship between the involved component in a problem solution fit hypothesis?
- [**RQ4**] How can a guided process help startup founders to understand more about problem solution fit state?
- [**RQ5**] Is there a need for a guided framework to formulate problem solution fit hypothesis?

1.0.4 Scope of the thesis

This thesis is focused on startup which is going the lean way and following hypothesis-driven approach. Also, readers can expect information about hypothesis formulation, in general, consisting of information like *how to formulate a hypothesis*, *what are the characteristics of a good hypothesis* etc. The focus is also given to that fact that startup founders should spend time in first understanding the problem then who is having the problem followed by the proposed solution. Based on this ideology a guided framework which helps in the formulation of problem solution fit hypothesis will be the expected output of this thesis. The reason behind a guided questionnaire based framework and the evaluations done are also mentioned in this thesis.

1.0.5 Structure of the thesis

This section ends by giving an overview about the entire flow of this thesis. All the below mentioned sections are formulated in such a way that they answer a question which is then used or supports the research questions related with this thesis.

In Section 3 details about design science research approach has been described. This section starts with an overview followed by an introduction to the information system. The idea here is to show the role of information systems towards the development of the artifact. The questions that are answered in this section are *Why design science research approach?*, *What is design science research?* and *How does it add towards addressing the research questions?*. At the end of this section, a checklist has been introduced. This checklist shows how does the design science research approach will be helping in the development of the artifact.

In Section 4 details about knowledge base has been provided. This section provides related to the information which is present. Readers can get a basic understanding of various terms related to a startup as business models, lean startup approach, and startup. This lays the platform from where the research starts. This section will be answering questions like *What are the existing ways of problem solution fit hypothesis formulation? What is the previous work done in the same research area? What are the challenges being faced in the existing approaches?*. As startup are very much intended to think out of the box and do things which are unexpected. This section ends with details related to a survey. This survey was an effort made to understand the existing ways of doing things.Also, this lays down a platform

from where the next section can start.

The focus of section 5 is on the environment. The environment lays down the requirements for the artifact that has to be developed. There are many aspects in which the problem can see seen. As the focus is on startup going the lean way following hypothesis-driven approach, this section helps in defining requirements specified in this context. The questions that are being answered in this section are *What is the problem with the current approaches? How does this affect the overall startup process?* also *what are the challenges that are being faced by a startup in general?*. This section ends by explaining all the details about the problem. It lays down a platform from where the development of the artifact can start.

A process that can consolidate all the information from prior sections and then help in developing an artifact to address it. In Section 6 readers can expect all the information related to the development of the artifact. The developed artifact aims at resolving the issues discovered in the previous sections. Also, the entire research done in this thesis was based on an iterative process. The information that is being shared in this section is *How does the iterative process help in addressing the research problem? How does the developed artifact evolve during each iteration?* also *How does the developed artifact add towards addressing the research problem?*. This section ends with explaining all the details about the developed artifact. Then start the section which contains details about the experiments.

In section 7 we have the experiments. This section first explains the hypothesis that is being tested in this thesis. All the details related to the experiments and their goals have been described in this section.

In section 8 the focus is on evaluations. Once the experiments are done the results are evaluated. Based on the evaluations the impact of this research towards addressing the research problem will be concluded. This section is followed up by section 9 which gives a conclusion. These conclusions are based on the evaluations results. In this section, the emphasis is given to the research questions. How does the overall research address the discussed research problems? Also, readers can expect an answer to the question *Did this research helped in developing a framework for formulating problem solution fit hypothesis?*.

The focus of section 10 is on future work that can be done. How can the developed framework be scaled to address the similar problem faced by startups? The following section 10 starts with thanking all the involved people in this research. The last section contains references that were used during the overall research.

2. Design science research approach

2.0.1 Overview

This thesis aims at addressing problems related to startup failure. As the term startup and concepts related to it as relatively new, there is a scope for improvement in all the aspects related to it. Design science aims at improvising the process of research and aims at introducing innovative artifacts. An artifact can be a tool, framework, a theory but should be the result of the design science research. These artifacts are dedicated to improving the environment which consists of the people, systems and the area where the problem exists.

This section speaks about the concepts related to design science approach. The deliverable of design science approach is referred as artifacts. So how does the design science approach supports innovation and in turns helps in solving the problem by delivering an innovative artifact.

This section ends with highlighting the facts about the designed artifacts and how does it add towards addressing the research questions.

2.0.2 Information system

The developed artifact aims at addressing a business need. The described business need is to ensure that there is a demand for building a product. One of the important fact that has to be considered here is the involvement of information system in the overall process. To be able to develop an artifact to address a business need, all the aspects related to information science has been taken into consideration as well. Information systems are considered as one of the important components of the business system [PW04]. Information system comprises of five different components which are

- Hardware

  The infrastructure in terms of working devices which can be computer systems, servers, and other devices.

- Software

  To be able to use the hardware we need to feed them with working instructions. This is where software comes into the picture and helps in controlling and giving relevant instructions to the hardware.

- Data

  Data is one of the main assets of an organization. It can be in the form of technologies being used or information related to their customers. Data is used to make decisions and also used for planning about the future advancements of an organization.

- People

  Considering the fact that an organization is run by people along with the technical resources or equipment. People play an important role and is considered as the intellectual property of an organization. People in form of individual effort or in a teamwork towards accomplishing what an organization wants.

- Process

  In order to continue working and achieve the goals, all the above-mentioned components should work on par with each other. The process helps in defining the roles and responsibilities of individual components. The process also helps in better management and keeping a track on the overall progress.

Being such a discrete unit these five components of a information system has to work in par to be able to add value to an organization [PW04]. People, organization and technology together form the foundation and a framework that can incorporate these three aspects can be very helpful in understanding and executing any ideas. One of the main objective is to provide clarity and define requirements for each of the involved components.

To be able to answer the above mentioned research questions, need of an approach which supports innovation is needed. As startup aims for innovation and to first understand the concepts related with it and then to provide a appropriate solution is a challenging task. Design science approach is a model for problem solving and aims at analyzing the problem by defining all its aspects related with the current way of following it and then designing an information system that can address the problem [EHM+04]. Design science approach aims at alignment between the components and how does changes in any one of them can effect other or the described information system as a whole. To be able to do that, at first artifacts are built and then these artifacts goes through a evaluation phase to identify the true business need.

The goal here is to unroll the artifacts that contribute towards the formulation of the information system and then to evaluate whether it is a true business need or not. As information system describes how the components are interrelated and also dependencies. It helps in the overall designing the artifact.

2.0.3 Design science research approach

Design science research approach provides a platform for information science research. It helps in the information science research by providing different perspectives. Also, the problem is being addressed via different analytical techniques. To be able to first understand and then improve aspects related to information science, design science approach has the below given primary activites [KP17]

- Creating new knowledge or innovative artifact
- Recurring use of the knowledge or the artifact

When we speak about an innovative artifact, it does not mean that it is confined to any specific domain or area of study. An artifact can be an algorithm, a method or a framework. An artifact is considered as innovative when it is one of a kind. It has been created using new knowledge. If the knowledge that is required to create an artifact already exists then it called a routine[KP17].

In general, the creation of an artifact using the design science approach is can be described by first defining the environment. On a broader scale, this can be referred as the problem. The activities or factors that are responsible for the problem. Impact of the highlighted problem on people or in any form. Then comes the knowledge. What do we know about it? As the goal is to first understand the concepts related to the mentioned environment. So all the relevant information is gathered. This becomes the base for further research. Followed by design. Once we have the environment described and research done via knowledge base then comes the design. The aim here is to design innovative artifacts. Also, the design process is based on cycles. This enables the creation of an innovative artifact that undergoes continuous feedback and improvisation. More details can be found in below sections.

As shown in fig 2, the design science approach towards answering the research questions which are mentioned above comprises of three segments

- Knowledge base

  The knowledge base comprises of existing knowledge. It serves as a foundation of research. To be able to categorize the existing knowledge in an effective way, it has been divided into theories and methodologies.

- Application domain

  The application domain is focused on business aspects. It is categorized based on the aspects which relate to actual world problem. It describes the people who are being affected or being involved, the problem and that impact of the problem.

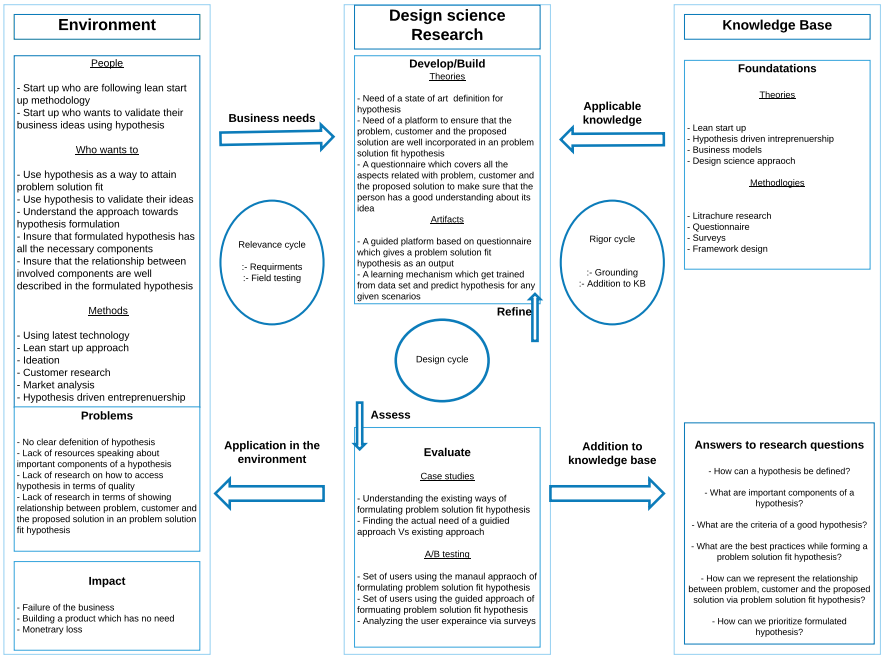

Figure 2.1: Design science approach adapted from [EHM+04]

- Information science research

  Information science research contains the artifacts which when developed or build with the use of described knowledge can be helpful in addressing the problem or the issue. The artifacts are also evaluated to ensure the impact of research towards problem-solving.

Considering the fact that this research is one a kind focusing on a very cruical aspects realted with startup going lean and combining it with the concepts of hypothesis formulation. To be able to achieve this goal, the plan was to understand the core concept behind the lean startup approach by going through the literature and publication related with it. Also, the way lean startup methodology is being understood and followed, what are the benefits and the problems due the way it is being followed. As the focus of this research is towards understanding problem solution fit (which is a very cruical stage for a startup), so all the research aspects will be narrowed down towards understanding that the factors that are affecting problem solution fit. Design science aims at introducing new artifacts by innovation which improve the existing system [Hev07].

Design science approach aims at building innovative artifacts and to be able to do so, it takes into consideration important aspects of knowledge base and application domain. The goal of the artifact is to solve a problem and to do the knowledge about the problem, what has been done prior towards solving the problem and similar details should be known. Also, how does the problem arises, are there any

dependencies, what is lacking in the existing approaches and similar information should be known. Only when considering all these aspects and trying to overcome the factors which when consider can solve the problem. This can also be considered as an innovation as the approach towards first identifying and then analyzing and later solving the problem gives a very good understanding and visibility.

Considering the fact that there is a need for an innovative solution, design science approach can also be seen as a combination of three cyclic approaches which are

- Relevance cycle

  It acts a link between information science research and the application domain. It serves as a requirement list for the information science research to work upon. Also, it includes the practical usage of the artifacts which will be generated via the information science research. Relevance cycle serves the purpose of testing the artifacts as well. Defining the acceptance criteria and initiating the design science research, relevance cycle ensures that the desire for an innovative artifact is to meet. One of the question that is being answered in this cycle is that `How does the artifact improve the environment?` [HC10]

- Rigor cycle

  It bridges the gap between knowledge and the developed artifact via the information science approach. It ensures that the existing knowledge base and the methodologies are taken into consideration while designing or developing the new artifact. Also, to ensure that the developed artifact support innovation all the previous knowledge and information is taken into consideration in rigor cycle.

- Design cycle

  This is considered as the most important cycle as it results in the creation of the artifact. It undergoes frequent changes as the created artifacts go under evaluation and are checked against the requirements and also the intended purpose behind the creation of the artifact. This evaluation and feedback process helps in the frequent refinement of the created artifact.

When planning for an approach such as design science, scientific evaluation of the developed artifacts is the core as the desired output should be able to do what it is intended to do. The above mentioned cycles plays an important role in ensuring that the developed artifact is as per the current requirements and delivers what is being expected from it. Goal behind using design science approach in this research is to develop a artifact that can used used to address the research problem and questions. As per the literature [KP17], design science activities can be broken down into two major activities, which are

- Creation of new and innovative artifacts through design and the existing knowledge base.
- Analysis of the use of the artifacts and continuous feedback which results in the overall improvement of the artifact.

This section concludes by identifying all the research related components for this proposed research questions. Also the components are well integrated in the deign science research diagram. It provides a complete overview of the research activities that will be done during this research. This lays down the base for the research.

2.0.4 Environment of this research

As the aim of this thesis is to develop an artifact which will be used by startup founders. The environment is categorized by factors like people, process, problem, and impact. The environment of this research is defined by first people who are referred to as startup founders. Then comes the approach as in what is the current process that is being followed by the startup founders. As a startup founder, the main goal is to see your startup grow. The success of a startup depends on many factors. One of the most important factors is the process followed. Understanding the process and how does it help startup founders to better understand target customer, there need and how does the solution add towards satisfying the need comes under the scope of the environment.

As startup are meant to grow at a faster rate as compared to the normal business unit. They do tend to think out of the box and follow methods which in turn results in faster growth. These methods and approaches also fall under the scope of the environment. When following a process there are opportunities and there are challenges. The problems that are being originated by following the process and the related impact defines the environment as well. This complete set of factors can also be referred as an application domain.

2.0.5 Knowledge base for this research

Knowledgebase forms the backbone for any research. In this research, knowledge base is referred to as theories, approaches, previous research was done in order to address the similar research problem. When it comes to startup, we do have literature which defines process and methodology so as to how to start with a startup [Hypothesis-Driven Entrepreneurship The Lean Startup [ERD11]]. This paper sets the guideline for this research. In terms of hypothesis and hypothesis formulation Gotelli2004 [GaE04] and a chapter from research method from business [Fra] are used to derive meaningful conclusions for the topic.

Also, questionnaire design, surveys and literature research focusing on the research questions fall under knowledge base. Further, this research focuses on providing an approach which is automated and guided. Research aspects related to framework

design and how to develop such a guided process forms a part of the knowledge base. The lean startup approach adds most of the knowledge to this research. This research is also done following the lean approach in an iterative way. Every deliverable of this research goes through an iterative process. This process helps in the refinement of the deliverable and also helps in understanding the overall system in a better way.

Based on the inputs provided in this section, now we answer for the design science checklist. Design science checklist is a way to identify that the process can serve the purpose or not. The checklist consists of questions which when answered define the overall scope of the research in terms of the process followed.

2.0.6 Design science research checklist

Adapted from Hevner2010 [HC10], design science research checklist helps in providing a clear understanding of the involved research part. This is based on answering some question. These questions serve as a checklist which when answered provides an understanding of the whole research aspect. The checklist comprises of the below-given questions.

Research questions

- [**RQ1**] What are the important components of a problem solution fit hypothesis?
- [**RQ2**] What is a good format for representing problem solution fit hypothesis?
- [**RQ3**] How can we represent the relationship between the involved component in a problem solution fit hypothesis?
- [**RQ4**] How can a guided process help startup founders to understand more about problem solution fit state?
- [**RQ5**] Is there a need for a guided framework to formulated problem solution fit hypothesis?

- What is the artifact?

  To be able to answer the above-mentioned research question, set of guidelines will be formed. These guidelines will be used when formulating a problem solution fit hypothesis. The generated knowledge in the form of guidelines will be considered as artifacts. This is also lay down a format where in the formulated problem solution fit hypothesis can represent relationships. It can also help in filtering out hypothesis which are much more close to the startup founder idea. These guideline will be incorporated in a automated guided platform for problem solution fit hypothesis formulation.

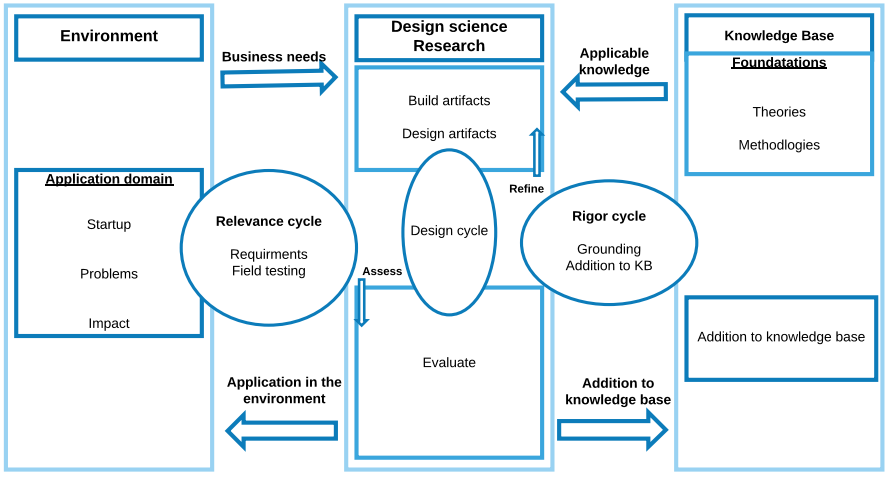

Figure 2.2: Design process adapted from A Three Cycle View of Design Science Research [Hev07]

- What design process will be used to build the artifact?

  Design science research approach is considered as a base for this research. To be able to develop a artifact to be able to answer the research question an iterative process is taken into consideration. This iterative process is based on design science research (figure 3). The iterative process is based on the relevance cycle, design cycle and rigor cycle. These cycles are based on improving the artifact. The idea behind the iterative framework is to ensure that the end product to address the real problem. Also, this process should help in getting more details and understanding about the overall problem. To order to ensure that all the information included in the artifact, the relevance cycle iterates between the environment and the design science research. The rigor cycle iterates between the knowledge base and the design science. The design cycle iterates within the design process ensuring the artifact address the need.

- How are the artifact and the design process grounded in the knowledge base?

  The development of the artifact will go through an iterative process. This will help in refining the artifact. The knowledge base will be the prime source of information.

- What evaluations are performed during the internal design cycles?

  As the goal here was to ensure that the artifact serves its sole purpose of solving the problem. The internal evaluations will be focused on understanding. There will be constant feedback process from experts on the developed artifact. This should helped in developing an artifact which is intuitive and helps users in

achieving its goal. As a part of iterative process, feedback from the expert is the key and will be guiding the overall development process.

- How is the artifact introduced into the application environment and how is it field tested?

  The developed artifact consists of knowledge and a guided questionnaire based tool to formulate problem solution fit hypothesis. This tool will be sent to startup founders and then there feedback will be evaluated to set future goals. The testing will be done by the startup founders. The goal here is to understand the impact of the problem solution fit hypothesis created by the tool when compared to the existing problem solution fit hypothesis.

- What new knowledge is added to the knowledge base and in what form?

  The guidelines that were formed for problem solution fit hypothesis formulation can be considered as an addition of new knowledge to the knowledge base. Also, new knowledge which is the real-time practices or thought that is being used towards hypothesis formulation also adds towards a knowledge base. Also, the tool

- Has the research question been satisfactorily addressed?

  As per the researcher, Yes to a certain extent the research question has been satisfactorily addressed. As the topic is related to a hypothesis which is a very subjective term. Further research can be done by integrating various study domains and research aspects. Also, understanding more about the ways of formulation problem solution fit hypothesis for different business domains needs to be done.

This section justify that design science research process is a good fit for the research problem. The above given checklist provides a overview of how the research activities are aligned with design science research.

3. Knowledge Base

This section starts with defining the requirements for knowledge base. What constitutes a knowledge base and how does it contributes towards providing an answer to the research problem and research questions that are being discussed in this thesis. This sections ends by supporting the need of an artifact by highlighting the research problems. Also, it lays down information that can be used by application domain to support the cause.

3.0.1 Requirements for environment

Design science approach lays it foundation with the help of knowledge base. knowledge base consists of existing knowledge, literature and other aspects that support or adds knowledge towards the focused problem. Knowledge base takes into consideration two types of knowledge sources [Hev07]

- State of the art knowledge towards the problem, which can consist of existing literature or well established studies that support the work.
- Existing artifacts or process established based on the given knowledge. Also some of the supporting knowledge that can be used for building the artifact that support the cause and also adds towards innovation.

To be able to support the discussed research problem, knowledge base should consists of enough information to support it. Focus is also on existing artifacts and understanding the way they work. Below sections describes each knowledge bases in details and also there contribution towards addressing the research problem.

3.0.2 Lecture

During the lecture on the topic **Problem solution fit** by Prof. Dr. Graham horton on 16th February 2018 at Otto von guericke universität, Magdeburg which were focused on highlighting the importance of problem solution fit in the whole startup

scenario.

This lecture was intended for young startup founders who are interested to go the lean way and covert their innovative ideas into a product. As a observer during the lecture, on of the most important aspect that was noticed is the startup founders were finding it difficult to answer some of the important questions which was related with target customer, problem, solution and the benefits and values associated with it. To be able to make them understand more and answer the related questions, a work sheet was provided which categorized target customer, problem, solution and the benefits and values associated with it. Provided worksheet consisted of open questions wherein users can enter their ideas and then brainstorm on it to get more specific details about it. The end goal of this exercise was to formulate problem solution fit hypotheses which can be tested and then further steps can be taken.

Some of the important points in terms of understanding the concepts related with problem solution fit which were noticed during the lecture were

- Problem in defining target customer segment specifically
- How the solution adds towards solving the problem
- Customer benefits and values provided by the solution
- How to define relationships/dependencies between target customer, problem and the solution

These findings helped in discovering the fact that their is a need of guided approach which educates and creates a thinking process leading towards problem solution fit and eventually problem solution fit hypothesis.

3.0.3 Literature research

When compared with the traditional ways of doing business, a startup has a completely different approach. This difference in methodology and the way of perceiving things calls for new process and methodologies. An equilibrium has to be maintained so as to address the changing business requirements. Also, it is not specific to a startup that calls for a change. In order to grow fast or stand out of the crowd, things have to be done differently. Looking back into the 19th century, swift and company took a step forward and re-engineered the meatpacking industry [Por14]. This was a very small step wherein the place of slaughtering of cattle was changed. New ways of transportation were introduced. This change in the regular way of doing thing opens so many new possibilities in the meat industry. One more example focusing on thinking out of the box and doing things in a nontraditional way was done by Malcolm McLean. He introduced a new concept of loading containers in ships [Ebe09]. This changed the current way of loading and unloading the containers by making it much more efficient. The learning here is that to be able to think out

of the box, one should spend time understanding the current ways of doing things and then try to improvise. Knowledge is the key, if you have a good understanding of the current system then you will be able to find the problematical ares and try to solve it with innovative ideas.

The above-given examples are related to a business unit which is already in a functioning state. The idea here was to focus on the concepts of understanding of the business unit, understanding of the problem and out of box thinking to solve the problem. When it comes to startup, the major challenge is that they need to start from scratch. This leaves startup founders with a very less margin for error. A need for a systematic process which can describe the various development phases of a startup was much of need. This approach will be helpful in tracking the progress of each phase. Also, the set of guidelines laid down for each phase helps in understanding and following the process. The term business model was introduced by Osterwalder [OO04]. The concept of business models was to provide a single platform to represent all the components that are involved in a business. To provide clarity to the overall business process. Also, the dependencies between the involved components and how does the components contributes towards the overall development of business can be well described using business model canvas. It also helps in building strategies and thinking way ahead about the business [McG10]. Business models can also be used to keep a track of the overall business. This concept provided a platform to incorporate all the changes that were introduced.

The lean startup approach aims at providing a set of activities. These activities when followed helps a startup to understand more and then plan accordingly. Building a startup is considered a research within itself. Breaking down the startup idea into series of the subsequent process helps in better understanding and also tracking the progress are each stage. The terms introduced like the build-measure-learn loop validated learning, problem solution fit, the minimum viable product provided a way to estimate future aspects related to startup [Rie11] [Bla13]. Customer development is considered as one of the most important aspects of the lean startup approach. Customer development is considered as a front-end activity. The process of customer development can is divided into four different phases as [YD14]

- Customer discovery

  This phase focus on understanding more about the needs of the customer. The problems that are being faced by the customer and all the necessary details related to it.

- Customer validation

  Based on the inputs from the previous phase, this phase focus on a scalable model that can address the need.

- Customer creation

  Identifying the need that has the highest priority. Also, creating new needs and satisfying the demands of the end users.

- Company building

  This is more about laying down a platform with all the previous leaning. Building a process which can operate efficiently and also satisfy the related customer needs.

Customer development is also an active area of research [Bla07] [BD12] [CV13]. As the focus is on the customer so one must go outside the building and speak with real people (customers). This also lies in coordination with the lean methodology. The impact of lean startup has also been mentioned in other research as well [GLM+14]. The lean way is not only for startup, there are well-established business units that do follow the lean way. The idea here is to align the process with the ongoing innovation. The iterative approach mentioned in a lean way helps in understanding more by spending least resources [Koe15]. The hypothesis based approach in the lean startup has a very crucial stand. When followed the expected way, it helps in overcoming the reason "building a product that has no demand". This also helps in saving resources in terms of money and human efforts towards building an unsuccessful product [ERD11].

As problem solution fit is the focus of this thesis and also the most important state for a startup [Bla07]. The problem solution fit state is achieved via first converting the idea into a hypothesis. This formulated hypothesis is called problem solution fit hypothesis. This research also covers the aspects related to hypothesis formulation. As in the context of a startup, there is lack or resources explaining in specific about the problem solution fit hypothesis. Hypothesis formulation is considered as an integral part of a research. The meaning and purpose of hypothesis has to be well understood [Hyp06]. It is a step forward to ensure that the research goals are met. The formulated hypothesis should explain its purpose. The purpose of the research, its goal, and the expected results add more information and makes the formulated hypothesis much more effective [LB05]. A hypothesis can also be considered as a possible explanation for a phenomenon. The formulated hypothesis should be able to describe the cause and effect of a phenomenon. One of the most important aspects of the hypothesis is that it should be testable. This behavior serves the sole purpose. As a hypothesis is meant to approve or disapprove a phenomenon. Forming a hypothesis which can not be tested does not really adds towards doing that [GaE04]. Need of a framework that enables users to think in a systematic way and then helps in formulating hypothesis has also been researched. This framework helps in incorporating all the related components when forming a hypothesis [Fra]. Some of the important aspects that have to be taken into consideration while formulating hypothesis are that the formulated hypothesis should be simple and clear [PRR01]. Also, the hypothesis should be related to any existing knowledge body. The formed hypothesis should also be in a state that it can be verified [Exp15]. Hypothesis serves the various purpose, it helps to define the scope of research. It also defines the focus of the research. Adding all the related components in the hypothesis while formulation makes easier to collect data [Per].

This information will be considered as a basis for the development of the artifact. The idea here is to understand the current ways in which these are being followed. Also, what was the impact of previous research on these aspects?. To be able to do that all the related components will be discussed in specific.

3.0.4 Business model

In this current scenario, the way of doing things are changing. When it comes to business and the approach towards setting up the entire business scene, planning is the key. Setting up a business is never an individual task or is not related to the individual component. As mentioned in the subsection Information systems, we do need involvement from all the related aspects such as people, hardware, software, data and process to set up an information system. Similarly setting up a business needs first identification of related components then assembling them together to function as a single unit.

A business model is supposed to contain all the details related to a business unit. It is a layout of all the involved elements. Also, the relationship between the elements is described in this model. It also shows how does the company plan to make money. What are the values that will be delivered to the customers? How does the product reaches the customer and also how do customers will be made aware of the product. With the way business are changing these business models has to made much scalebale so as to adapt to the new requirements. Also the way these business models are planned need to be improvised. A resaerch done by Alexander Osterwalder on business model has very big impact on the way business units thinks about business models. Osterwalder describes business models [OO04] as

```
"A business model is a conceptual tool that contains a set of ele-
ments and their relationships and allows expressing a company's logic
of earning money.  It is a description of the value a company of-
fers to one or several segments of customers and the architecture
of the firm and its network of partners for creating, marketing and
delivering this value and relationship capital, in order to generate
profitable and sustainable revenue streams."
```

The work by Alexander Osterwalder was one of kind wherein an ontology based solution was provided. This was used to first represent all the involved components and then explain or highlight dependencies between them.

3.0.4.1 Impact of business model

Coming up with a concept of having a business model wherein all the related components and the relationship between them can be represented on a single page was an innovative idea. It was also a step forward to satisfy the changing business needs. Buisness model was able to handle the changes that were happening in the traditional ways of doing business [Tee10]. One of the most important aspects that were brought via the use of business models is that it considers the fact that different

management areas might have different needs. Also, the definition of the term business model changes with context [ZAM11]. Being followed, the concept of business models has been refined and now companies tend to design business models that best suits there requirements. This evolution of business models was an indication that researchers are looking forward to new solutions. Frequently changing business needs have to be supported by a dynamic solution [McG10]. Also, with the changes in the methodology being followed for the business process, new segmentation is being created within the organization. The business model can be also be referred as a tool which speaks a common language. It also helps in improving understanding and communication across the entire organization [OO04].

This information supports the fact that we do need an updated process to support the business changes. Following sections will be explaining one of the processes which aim at supporting the changes especially when it comes to startup.

3.0.5 Lean start up approach

Considering the fact that the traditional ways of doing business is changing. So need of a process that supports these changes is required. The business model canvas was a new way of incorporating the dynamics related with business. Similarly , the lean startup approach is a methodology that helps in executing the plan laid down via business model. Lean startup approach follows a unique way. It prefers going out from the building and perform experiments. Speak with the people and check for there needs. Perform experiments and check how well the solution is satisfying the need. Experiments have more priority than elaborate planning. Once the experiments are done, feedback from real users are taken into consideration and then further planning is done based on that. There is not scope or intuition in lean startup approach. Also, an iterative based approach is implemented which takes into account feedback from target customers. Based on the feedback further refining of the product or business decisions are taken. Lean start up approach is one step forward to support new businesses needs and processes. It supports the dynamic behavior of the business by defining appropriate measures also it prefers customer over all other aspects [Bla13].

Innovation should be supported by a process that understands the dynamics. Also, it can scale up to the level to incorporate all the changes. The need for a methodology to support the growth especially when it comes to cases like a startup is much of a need [YD14]. Lean startup approach was one such solution for this problem. Indeed globalization has boosted the economy. It has created a platform for innovation and new talents to nourish. This has also resulted in a competition, a race of innovation where the focus is mainly given on product [Ahm98]. A need for a process which addresses customer as a priority from the initial phase also keeping a tap on the idea of validating it regularly was much of need [Koe15]. Lean startup emphasizes the fact that customer is always a priority. Startup founders should spend the time to understand their customer and the need. The provided solution will have no use if there is not a real problem.

3.0.5.1 Existing process

Table 3.1: Comparison of different approaches[ERD11]

Comparison of different approaches				
	Build it and they will come	Waterfall planning	Just do it	Hypothesis driven entrepreneurship
Focus on the problem	Yes	Yes	Yes	Yes
Focus on customer	Yes	Yes	Yes	Yes
Validation of customer needs towards the problem	At the end phase	At the end phase	At the end phase	Starts from the initial phase
Feedback from the customer	At the end phase	At the end phase	At the end phase	Starts from the initial phase
Risk factor	Very high	Moderate	Very high	Least

We do have other process available (table 1), such as build they will come, waterfall planning and just do it. As being mentioned in this thesis that the focus is on giving importance to the target customer. To be able to understand more about the customer and there needs. So the process should also be aligned to incorporate these factors. Considered process apart from the hypothesis driven approach which is a part of lean methodology, validations are done at the end. This increases the chances of failure. Also, feedback from the customers are collected at the end. This reduces the chances to adapt the product as per customer requirements. In table 1 three different approaches and only in the case of hypothesis driven entrepreneurship focus is on the customers from the very initial stages. Process should be such that it can help in creating a customer centric product. The target customers are the one who is going to use the product and eventually pay for it. Customer realted checks such as feedback, experiments should always be a priority. It should be included at the beginning phase. There should be a agility involved in the process. Lean start up is also considered as an extreme agile approach [GG12].

As a point, this section gives an overview of the alternatives for the lean startup approach. Considering the fact that customer is always a priority comes first only in hypothesis-based approach. Also learning from customers feedback is a priority. Considering the hypothesis based approach can be an appropriate process to be followed by startup founders. More information about the process can be found in the following sections.

3.0.6 What is so different in the lean start up approach

The lean startup approach can be considered as an experimental process. Learning is the key and to be able to learn startup founders should perform experiments. The aim of these experiments is to remove uncertainty. As discussed above how uncertainties are involved and result towards startup failure. Doing regular experiments and ensuring that there are no intuitions helps in reducing the uncertainty to a greater extent.

The concept of build-measure-learn loop gives a platform where in startup founders can learn. This is also one of the principles of the lean startup approach.

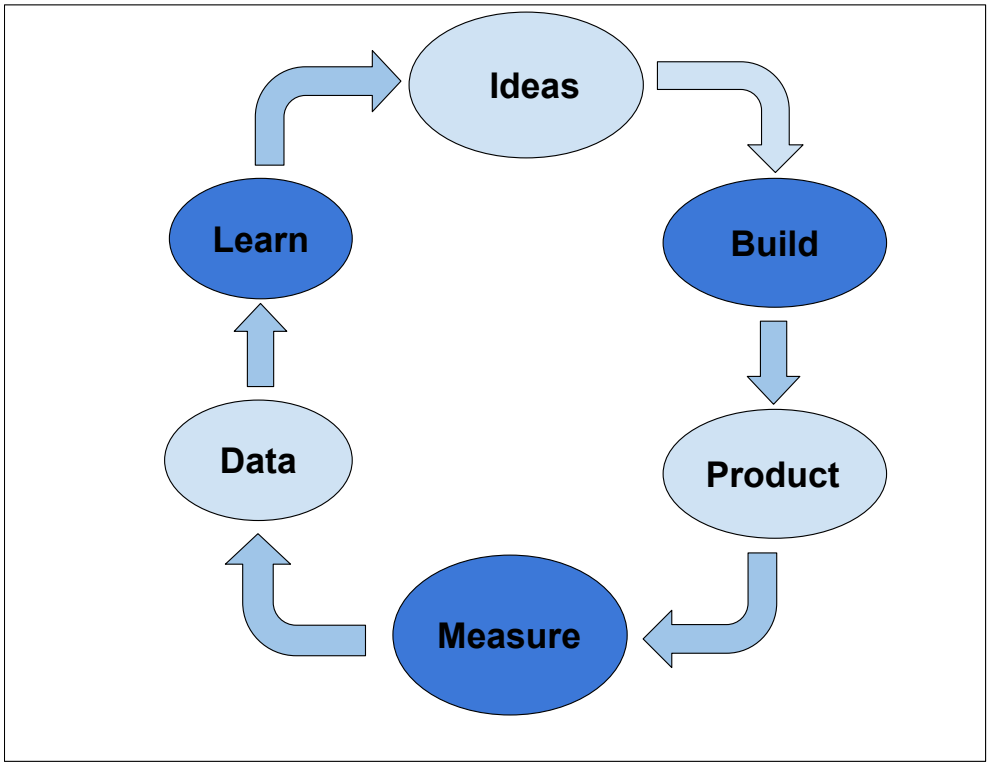

Figure 3.1: Build-measure-learn loop, adapted from Lean customer development [Alv17]

- Principles of lean start up approach [1]
  - Entrepreneurs (startup founders) are everywhere

    Ideas can never be classified as a success or failure unless they are implemented. People do have ideas. These ideas can be dedicated to improving the daily life activities or satisfying a need on a bigger scale. So it does not mean that there is a special classification or skill set required for one to be called as entrepreneurs (startup founders). They can be found everywhere working on there ideas and trying to improve the regular ways of doing things.

  - Entrepreneurship is management

    A process describes guidelines and ways of doing things. When it comes to reality it should be followed. Startup operates in a different way as compared with a normal business unit. It needs to be carefully monitored and steps well executed. It is a new level of management that needs to first well study, understood and then executed.

  - Validated learning

    The startup aims at doing things in a different way. There is a lot of learning involved which help in making decisions. This is being achieved

[1] http://theleanstartup.com/principles

by performing experiments for every intuition. Experiments form the basis of learning. It also helps in providing meaningful insights hence supports positive decision making.

- Build measure learn loop

  The goal of a startup is to convert the business idea into a product. A successful startup first runs experiments to validate the idea before even planning for the product. Build-measure-learn is an iterative process which helps in learning (figure 4). The learning is based on feedback. The feedback is from the experiments. This is a very crucial step as it helps in understanding more about the overall impact of the idea before even spending a huge sum of money.

- Innovation accounting

  A step by step process which helps in setting milestones also helps in tracking the progress of each milestone. Breaking the entire plan into series of smaller plans and then executing each block one by one. Also, maintaining a statistical analysis of the progress done in each block. Then improving the same during the next block

- Other aspects that helps making lean start up unique are
  - Continuous validation and learning
  - Stage by stage progression
  - Visibility
  - Pivoting

3.0.7 Takeaways of the Lean start up approach

- The principles of lean start up approach ensures that customer need is always a priority. Some of the points which are set lean start up approach ahead of the others are [Bla13]
  - Focus is on performing experiments rather than planning
  - Speaking with customer and considering their opinion rather than assuming what a customer might be expecting
  - Idea of minimum viable product
  - Pivoting
- Lean start up also help in planning for the future state of the product.
- Incorporates the dynamics related with the business especially when business units like start up are taken into consideration [Koe15].

3.0.8 Important terms introduced in with the lean start up approach

- Lean start up approach provided a new way of doing things. As mentioned in the above sections about how uncertainties plays an important role towards failure or success of a startup. Lean startup approach has broken down the entire process into series of sub process (figure 5). This helps in better understanding and also refining the idea when and where required. The whole startup scenario has been divided into series of sub process. Lean startup gives emphasis to some terms which are used to describe the various activities performed while following the process

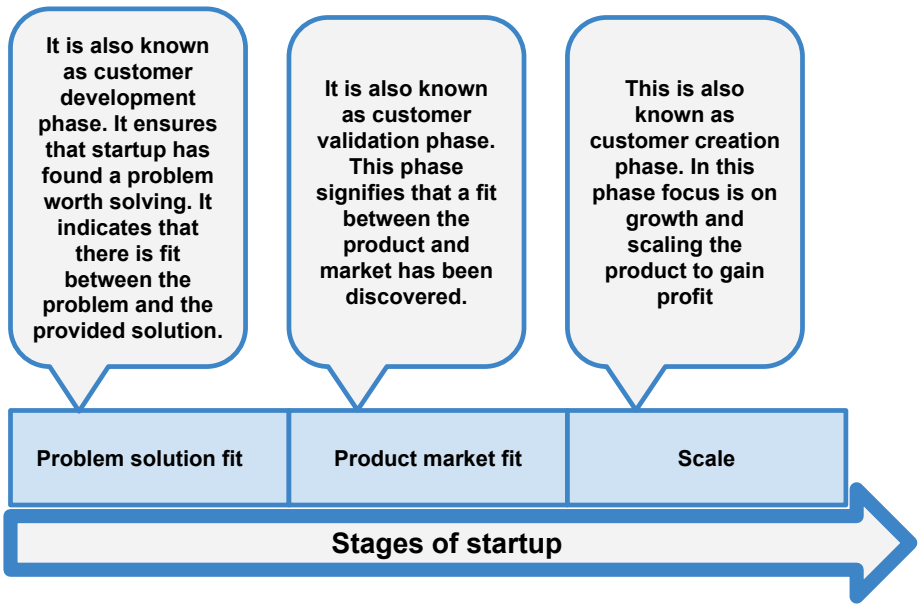

Figure 3.2: Different stages of a startup,adapted from [2]

  - Problem solution fit

    This is considered as the most important phase of a startup. As the name suggests, this phase is all about understanding the target customer and there need (problem). Then comes the solution as to how does it help towards addressing the need. Finally, this phase ends up by ensuring that a valid need has been identified. Also, there is a fit between the need and the solution. Some of the questions that are being answered in this phase are

    * Does the target customer really have a problem?
    * How big is the problem?
    * What are the alternatives to satisfy the need?
    * How will your solution add towards addressing the need?

    * Why will the target customer accept and pay for the solution?
    * Does the target customer needs any special skills to use the solution?

- Product market fit

  This phase is more towards cross-checking your idea with the market. Successful execution of this phase ensures that customers are willing to use the product. This is the phase which adds confidence to the startup founders that their business model is working. Apart from the solution, this phase checks the entire flow of the product and how does it reach to the customer. The main aim is to retain customers and be present in the market.

- Scale

  This phase is more about expansion. Once startup founders has successfully passed problem solution fit and product market fit, product acceptance has been ensured. Now its time to acquire new customers. This phase includes marketing strategy, product demonstration and other related activities.

- Minimum viable product

  This concept helps startup founder to explain their idea in terms of minimum valued product. A prototype can be made from pen and paper but should be able to explain the idea behind it. Using these approach startup founders save a lot of investments as they can refine the idea. For every new feature or idea, a prototype having the minimal feature set is developed and tested. Based on the feedback further steps are taken.

- Techniques that help you in building a strategy [ERD11]

    * Persevere

      The main goal of lean startup approach is to build a product that has acceptance from the target customer. To be able to achieve this, experiments and learning from the experiments is the key. Based on the learning a startup can plan their further steps. The preserve is a positive sign which indicates that the business model layer for the product is working as expected.

    * Pivot

      Pivot is related to changing the strategy. The layout plan is not working as expected so making some adjustments and then coming up with another plan for the same.

    * Perish

      This indicates that the startup idea is not worth going ahead with.

3.0.9 Role of hypothesis in Lean start up approach

- Going through the journal [LM88] which was published in the year 1988, author `Low, M MacMillan,I` highlighted the need of an hypothesis driven approach to cope up with the future challenges.
- Hypothesis plays an important role in lean start up approach as it helps in understanding more about aspects related with
  - Problem being discussed
  - Customer who is having the problem
  - Who does the proposed solution helps the customer in solving the problem

  All the above mentioned points can be tested via hypothesis and based on the results appropriate actions can be taken.
- Time and money are the most important factor that a start up takes into consideration and following hypothesis based approach helps in saving both [ERD11].

3.0.10 Hypothesis

A hypothesis is often used in any kind of research or also in our day to day activities. The fact that the use and context of the term hypothesis changes with the considered perspective often make it hard to cluster it under a single context.

This section is an attempt to explain some of the general contexts of the term hypothesis. Definitions from famous researchers have been used to highlight the core understanding of the term hypothesis. Also, some examples from a perspective of daily life have been used. Research questions such as *What is a good hypothesis? what are the important components of a good hypothesis?* will be answered in this section.

This section concludes by formulating guidelines for a hypothesis. These guidelines will be used when forming the problem solution fit hypothesis.

3.0.11 What is a hypothesis?

To be able to start with a thought process considering it to be a research or any other aspects related with it, there has to be a starting point. Assumptions, ideas are the key which when added with some basic knowledge base of known information makes them more legitimate. These can be considered as hypothesis which form the basis of the research activities. Some of the definitions given by researchers for the term hypothesis are

- Kerlinger defines hypothesis as a `statement of the relation between two or more variables [Ker56].`

- Eric Rogers defines hypotheses as a `tentative guesses, good hunches - assumed for use in devising theory or planning experiments intended to be given a direct experimental test when possible [Rog11].`
- Definition by Bailey which says that `hypothesis is a proposition in testable form and predicts a particular relationship between two or more variables. If a researcher thinks that a relationship exists, he should first state it as a hypothesis and then test the hypothesis in the field [Bai08].`
- Grinnell defines hypothesis as `written in such a way that it can be proven or disproven by valid and reliable data [Gri11].`
- Sarantakos defines hypothesis is a `A hypothesis can be defined as a tentative explanation of the research problem, a possible outcome of the research, or an educated guess about the research outcome [Sar98].`

These definition ensures that hypothesis is a educated guess which has to be tested to proves it validity. The purpose of hypothesis is to bring focus, clarity and direction to a problem or a research.

The definition that will be followed in this thesis for the hypothesis is

`A hypothesis is a statement consisting of known facts but needs to be tested to prove its overall acceptance.`

Hypothesis can be formed based on you day to day observations. It can be an educated guess or an assumption based on partial information but the thing that matters the most is that they should be testable. One of the most important characteristics of hypothesis is it falsifiability . The fact that a hypothesis can be tested makes in much more important from an scientific view point. Hypothesis forms a base when it comes to research, in research scenarios answer to most of the research questions comes in the form of hypothesis. These formulated hypothesis then need to be tested and proved as in accordance with the research questions or topics [Hai07]. As mentioned in the above section that there are many ambiguities when it comes to the definition and understanding of the word hypothesis and also the related synonyms, need of a framework which helps in forming relevant hypothesis is much of a need along with a way to judge the quality of the formulated hypothesis.

The term Hypothesis originated from Greek around 1590-1600 [3]. The definition given for the word hypothesis in the oxford dictionary is `idea or suggestion that is based on known facts and is used as a basis of reasoning or`

[3] http://www.dictionary.com/browse/hypothesis(2/18/2018)

`further conversation` [4]. Hypothesis has been the back bone of major research activities [Sma02]. Hypothesis helps in deeper understanding of a given problem by breaking it into various sub problems. When it comes to research, their are numerous possibilities to deal with the research problem and also the way the research can be proved. If well understood and followed the process of hypothesis and hypothesis formulation then it helps in narrowing down the scope of a research to a very granular level. The basis of forming an hypothesis is observations, more detailed or carefully observed phenomenon results into a good understanding of the problem which in turns helps in formulation of good hypothesis. As hypothesis can act as the base of any research so it is very important to make sure that the components involved in the hypothesis during its formulation are very well thought of. Also one of the most important aspect about hypothesis is that if followed via a iterative process helps in refining the problem to a very granular level and also eliminated not required elements.

3.0.12 Role of hypothesis in day to day life

In our daily life, we do come across scenarios where we use hypothesis based approach to solve a given problem. The approach is so so common that we do without our consensus, going with hypothesis definition that it is based on know facts but it has to be tested to prove it's validity. We do follow hypothesis based approach in your daily life but we really do not understand the way we do it. Taking examples of some common scenarios where in we observe a problem and try to troubleshoot them with our existing knowledge.

Suppose using a remote control to operate your television set. At some point of time the television stops responding to the remote control then the first thought that comes to mind is that it can the be distance, as it too far from the television set (H1). So this is an hypothesis which now has to be tested to ensure its validity. So you try using the remote control from various different distances and still the television does not responds. So now one hypothesis has be falsified. Next hypothesis can be that the battery has lost its power, so now you replace the battery with the new one and try to use the remote control to control your television and still the television does not responds. Now there can be two different set of hypothesis, one can be focused on the battery as they are not good (H2) and the other that the remote control is only not working (H3). So in order to test H2, you try to use the same set of battery in a different remote control and that ones is working as expected to that concludes that your hypothesis H2 failed. Now moving on to H3, which is true as H2 has failed proving that their is some technical problem with the remote control and you should consult the technical people who are well trained to handle these issues. This is an very common example of how we follow a hypothesis based problem solving approach in our daily life

[4] oxford advanced learner's dictionary of current English encyclopedic edition

Following the above given example, it must be noted that observations are very important. Along with observations basic understanding and knowledge also plays a major role. With the observations one can try to understand the phenomenon and then combining it with knowledge or understanding try to perform experiments in order to prove or disprove it. In the above given example, observations were that the remote control is not working and their was basic operational knowledge of the remote control that helped in performing some experiments and then reaching to a conclusion. This can also be seen as a framework where in one first try to make some meaningful assumptions from the observations and with the help of prior knowledge or understanding of the system try to test the assumptions.

As a conclusion from this, observations or prior knowledge is the key. When this is combined with a framework then it gives more clarity and helps in formulating hypothesis which are very specific.

3.0.12.1 What are the important characteristic of a hypothesis?

The goal behind formulation of hypothesis is to serve as a basis for any kind of research activity also it helps in providing an holistic view by specifying the purpose and enhancing the objectivity of the research work. It also helps in breaking down the research into small segments and making it focused and specific. To be able to achieve these characteristics hypothesis must have specific characteristics [Hai07] [PRR01].

- Simple

  The formed hypothesis should be simple and self explanatory. It should not be ambiguous and lead to multiple conclusions. Also there should not be multiple conditions or dependencies in one hypothesis.

- Falsifiable

  The goal of a hypothesis is to check weather the idea or the assumption is correct or not. A hypothesis that can not be tested has no impact or conclusion. There should be criteria or dependencies what can either prove the hypothesis wrong or a idea worth working.

- Should have atleast two variables [5]

  To be able to test and derive meaningful conclusions from a hypothesis their should be atleast two variables involved and relationship or dependencies between them should be stated.

- Should have formed on existing knowledge

  Their should be some known information based on existing knowledge base while formulating a hypothesis. Formulating a hypothesis having without any

[5] Kerlinger, Fried N, Foundations of Behabioural Research , 3rd edition, New York: Holt, Rinehart and Winston, 1986)

knowledge base has higher chances of failure. Adding some knowledge and then testing the impact or dependencies on the other involved components can be a good idea while forming a hypothesis.

This section defines the important characteristics of a hypothesis. These will be used in following sections.

3.0.13 Hypotheses formulation

As discussed in the previous section about the important components of hypothesis the same has to be considered while formulating a hypothesis as well. We do have other approaches for hypothesis formulation. In one of the approach [Ski] the very first step is to collect observations followed by evaluations. Then comes the phase where possible explanations are provided based on the evaluations. The hypothesis is selected from the set of evaluations. Some of the literature [LB05] also argues on hypothesis structure to be in an *IF-ELSE* format. As mentioned in the above sections that the topic hypothesis is very subjective. Also, it differs from different study domains. To be able to address the research problem, the hypothesis formulation approach taken in this thesis is based on research. To be able to incorporate all the features that should be present or considered while formulating a hypothesis, a hour glass approach (figure 6) is being used [PRR01].

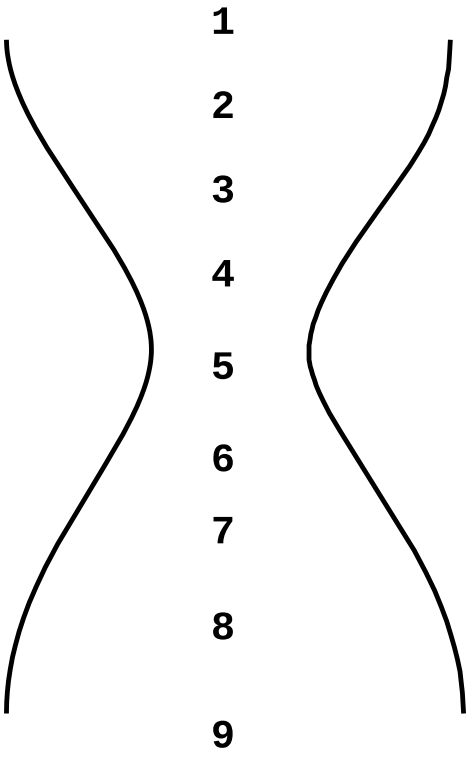

Figure 3.3: hypothesis creation approach

The hour glass approach (fig 4) helps in formulating the hypothesis by narrowing it down via different phases which are denoted by numbers (1-9) in the diagram. These phases are

1. Abstract statement about the problem

   To start with a hypothesis based method, the goal is come up with an abstract idea or a statement. It can be a rough idea or a thought but should be realistic.

2. Adding specific details about the previous experience

   As a second step to it, adding some information. As hypothesis does indicate that it should be formulated based on some previous knowledge or experience. This step helps in adding some information to the hypothesis.

3. Adding any triggers that can be the cause of it

   Now comes the stage where we add some specific information. As mentioned in the above sections that hypothesis should have different components and should have some dependencies between them. This stage adds relational information to the hypothesis.

4. Adding potential problem fields

   The idea behind adding a potential problem field is to ensure that the developed hypothesis is testable. By adding some problem criteria makes the hypothesis falsifiable.

5. Goals and planning

   This can be taken as a step wherein the scope of the hypothesis is defined. As in what is going to happen if things are done in this way.

6. Search, explore and gather more specific information

   If the goal is to drill down the hypothesis to a very specific one then adding more content helps. In case of a startup, this is not a good option as if startup founders add too much specific information then they might turn up ending with only one customer at the end.

7. Check for alternate solutions

   This step too is more focused on adding more dependencies to the hypothesis. There can be different solutions to a problem but to be able to choose the correct one this hypothesis can be helpful.

8. Generate creative solutions

   The hypothesis is all about generating new ideas. Yes, those should be real but coming up with creative solutions is always a choice. This is where hypothesis testing comes into effect and validates if it is a go or no go.

9. Integrate all the aspect to form an educated guess - the hypothesis

   All the above-given points should be followed to come up with a well-formed hypothesis. Also, some of the points are very specific to cases and can be ignored when needed.

A well formed hypothesis shows the level of understanding and research done to formulate it. It also indicates the amount of knowledge the researcher or the person formulating the hypothesis has. A well formulated hypothesis helps in understanding where to search test data, how the the data can be interpreted [SB02].

This section concludes with the approach that will be followed during hypothesis formulation. Also, taking into account the inputs from previous sections which are related to important components and must have characteristics of a hypothesis.

3.0.14 Importance of hypothesis in Lean start up approach

This section will be describing the role of hypothesis in the lean startup approach.

- Hypothesis formulation plays a major role while following the lean start up approach. Continuous iteration to improve the understanding towards problem, solution and proposed solution is achieved by using hypothesis.
- Problem solution fit is a state which implies that the start up has found customers for the product that they are building. It signifies the fact that you are building product for the right people.
- To be able to achieve this state, hypothesis are used. The formulated hypothesis contains the aspects related with problem, customer and the proposed solution which are then tested. These hypothesis are called problem solution fit hypothesis.

As a conclusion, hypothesis has a very important role to play in the lean startup approach.

3.0.15 Hypotheses driven lean start up approach

Failure always gives an opportunity to learn more. Also the more you fail the more you learn. When it comes to hypothesis-driven entrepreneurship, the idea is to convert startup ideas into a hypothesis. This hypothesis that can be tested. Testing the hypothesis at a prior stage helps startup founders to get early results. Consider a scenario wherein a startup founder did the testing of his product once everything was built and ready for launch. failure at that stage would be a pain. So hypothesis formulation and testing it during the early stages gives a chance for a startup where they can think weather to preserve (stick to the plan), pivot (look for an alternative plan) or perish (this is something that has no demand so drop the plan) [ERD11].

Hypothesis-driven hypothesis aims at reducing waste. A concept of a minimum viable product has been introduced. A minimum viable product aims at learning with very minimal resource utilization [Alv17]. A minimum viable product is defined by [minimum] minimum feature set that can define your idea [viable] show how does it

help in addressing customer needs [product] the combination of minimum and viable becomes a product. It can even be a diagram using pen and paper. The idea is to convey the message and show how does it address the needs of the target customer. This is a step wherein a startup founder can validate their ideas even without huge investments.

This section defines the importance of formulating a hypothesis. Also, how can it be helpful for startup founders to validate their ideas and observe results at an early stage? The next section will be explaining more about the different aspects related with the hypothesis formulation.

3.0.16 Problem solution fit hypothesis

Problem solution fit is considered to be a very crucial state. This is the first state to be achieved. Some of the important aspects related with it are [Bla07]

- Considering the key principle of lean start up which is get out the building and test. Your customer are outside and understanding them having a real time experience is very much appreciated. Learn by speaking with real customer and then use the knowledge to formulate problem solution fit hypothesis.
- Problem solution fit hypothesis is used to test ideas. It can also be broken down into customer need hypothesis, need solution hypothesis or solution customer hypothesis. The goal here is to ensure that all the uncertainties have been tested.
- If the formulated problem solution fit hypothesis is not correct then the same is reflected in the developed product and can be one of the contributing factor for business failure.

Major challenges toward formulation of problem solution fit hypothesis is lack of standards or guidelines which leads to ambiguity and in turns adds as a contributing factor towards start up failure [Haa]. The Problem solution fit hypothesis seems to be one word but it comprises of most crucial aspects which plays a major role in any business. The aspects are

- Problem
- Solution
- Customer

Withing these aspects lies many crucial information that has to derived before forming an problem solution fit hypothesis. Use of various other approaches such us design science or use of different ideology to improve the existing scenario is much of a need [Haa].

In Lean start up approach, problem solution fit is considered as a state which indicates that the business has identified the right set of people or so called customer for the product that they are building. Problem solution fit can also be considered as a phase which is focused towards customer discovery. This section shows the importance of problem solution fit hypothesis. Also, more content on the same can be found in the following chapters.

3.0.17 Survey

The survey was the first step for this thesis. We do have process and methodologies available to guide and educate startup about there work flow. Considering the *uncertainty* factor, at times these do not prove to be helpful. As discussed in the subsection *knowledge base - startup* the problems faced by startup are very unique and at times there would not be any solution available. A startup needs to respond in a very short time span and the decisions are taken can affect the overall success and failure of the startup. We do have knowledge as in how should plan and proceed with the startup plan but given the fact about startup failure does not go par with it. It is truth that startup operates with lots of uncertainty which also indicates that they have to do things which are out of book. The intended purpose of this survey was to collect data from startup as in to understand how startup think and approach along with there strategy.

The survey was divided into three sections to capture information as in how does startup operates in real time scenarios. Also, formulation this survey was an iterative process wherein the flow of the questions were of highest priority. To start with, a set of the questionnaire was designed and then was shown to an expert for feedback. After the feedback, the questionnaire went through series of changes. Once done the updated version was sent for feedback as well. The main goal was to collect information which is relevant to this research. Also, ensuring that the participants are able to follow the content and the flow was a priority. Each section of the survey had a specific goal and based on that relevant information was extracted from the survey output. Thinking out of the box is one the major characteristics and also makes startup different from other business units. Also, combining multiple approaches or inventing an approach which works in specific for a kind of startup is a common idea. As the goal of PoSoFiHy is towards providing a guided, automated and questionnaire-based based approach towards problem solution fit hypothesis formulation, information specific to the aspects of the process followed, problem solution fit, hypothesis formulation needs to be captured. This survey was designed to capture general information about the startup then ask process related information followed by or narrowing it down to hypothesis formulation. As the scope of this survey was limited to start who were going the lean way, there was an exit criterion for the participants. The exit criteria ask about the followed process to gain more understanding of the different available process. Then the participant is redirected to a goodbye screen.

This survey was sent to over 300 plus participants. The participants were startup founders, startup accelerators [6] and startup incubators [7] across the globe. In total 113 people had a look on the survey and 24 participants completed the whole survey.

Section I

- General information about startup

  This intended purpose of this section is to collect general information about the startup. The following questions were asked in this section

  1. Your startup is located in which country?
  2. Since when you had a start up idea?
  3. From when did you actually started working on your start up idea?
  4. How many people worked with you on the start up idea?
  5. Which of the following best describes the start up activity that you are in?
  6. What is the current stage of your start up?
  7. How long have you been in the current stage?
  8. Are you familiar with lean start-up approach?

- General introduction
  - Why general introduction?
    - The goal of this section was to basic information about the startup
  - How it will help in this research?
    - Startup which have a long operating history tends to have a stable process and methodology as compared to the ones in seeding phase. Also, startup with long operating history can provide rich information about the ways they evolved. This can be a good way to understand the problems as well as the needs.

  As a conclusion, the majority of the startup that participated in the survey were young (less than 12 months). This can have a positive, as well as a negative effect on the overall results as the startups, are relatively new they do not have a much operating history (figure 7). They would be mostly involved in trying things out to check what suits best for them. Focusing on the positive aspects, new information will be generated. As the startup are new, new and innovative ideas can be captured from there responses.

[6] https://en.wikipedia.org/wiki/Startup_accelerator
[7] https://en.wikipedia.org/wiki/Business_incubator

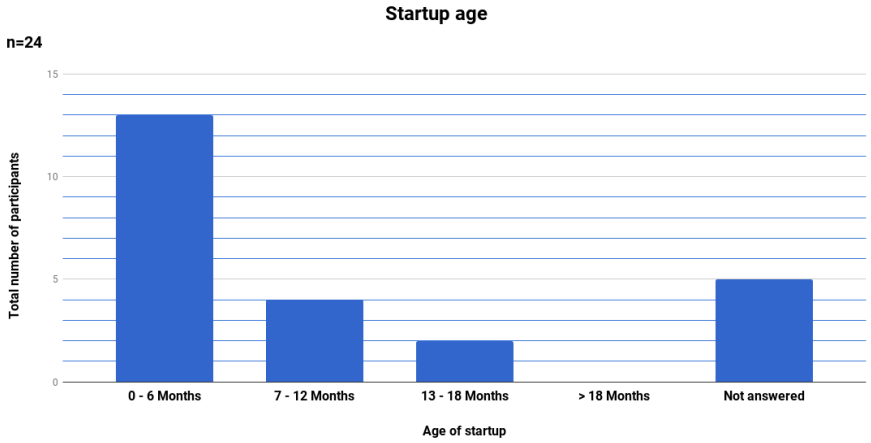

Figure 3.4: Age of participated startup

Section II

– Process followed by the startup

This intended purpose of this section is to collect general information about the process being followed by startup. The following questions were asked in this section

1. What methodology is being used within your start up?
2. What is your level of agreement for the above given statement about Lean start up?
3. Do you follow the Lean start up approach?
4. Are you familiar with the term Problem solution fit?
5. What methodology is being used within your start up?
6. Are you familiar with the term Problem solution fit?
7. Do you use hypothesis driven approach/process to validate your ideas?

- Process followed
  - Why process followed?
    - The goal of this section is to grab information about the existing process. Also, if the participant is not following the lean methodology, this survey asks about what is the process being followed and then Is there any involvement of hypothesis in the followed process?
  - How it will help in this research?
    - As stated above that a startup deal with a lot of uncertainty and they do adapt to new process as and when needed. The question asked

in this section will help in knowing other process available. Also, it would be interesting observation to see if hypothesis based approach are common only to lean methodology or not.

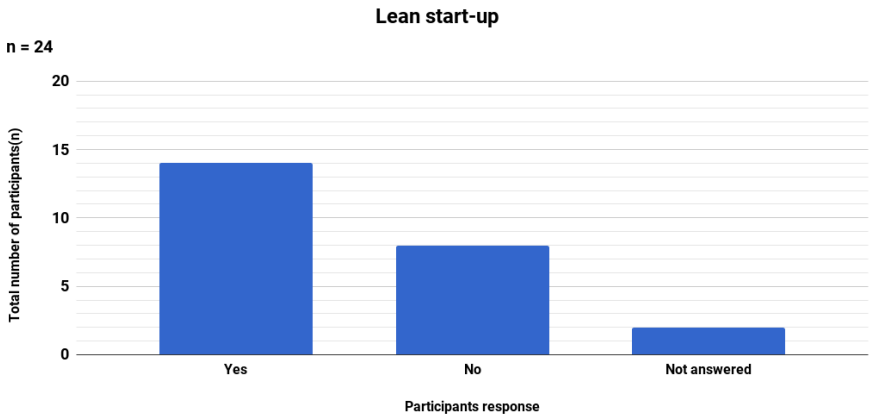

Figure 3.5: Participated startup who follow lean way

As a conclusion, majority of the startup that participated in the survey were following the lean startup approach (figure 8). Also, one thing that has to be taken into consideration is that count for the number of participants for the survey is not static. This is due to the fact that most of the participants did exit from the survey at any point of time.

Section III

- Hypothesis

  This intended purpose of this section is to collect general information about the understanding of hypothesis driven approach in a startup. The following questions were asked in this section

  1. What approach or method is being followed to formulate hypothesis?
  2. How many people are involved in the process of converting ideas/thoughts into hypothesis?
  3. Until now, how many hypotheses has been formulated by your start up?
  4. Which of the following below given points are considered while formulating the hypothesis?
  5. Do the created hypothesis answers any of the below mentioned questions?
  6. As per your personal experience, which of the following templates are good for hypothesis formulation?
  7. In what pattern the hypotheses are validated?
  8. How are the formulated hypotheses prioritized?
  9. Do you follow an iterative process for testing the hypotheses?
  10. Do you follow a process where tested hypothesis is converted into an minimum viable product?
  11. How long does it takes to complete one iteration of hypothesis testing?
  12. Is the iterative testing done based on build measure learn loop?
  13. Would you be interested in using a guided approach towards formulation of problem solution fit hypothesis?

- Hypothesis and hypothesis formulation

For figure 10

[**CASE 1**] Our customer has the problem and would like to use our product
[**CASE 2**] Our customer has the problem when they are in a specific situation would like to use our product
[**CASE 3**] Our product can help people who are in a specific situation
[**CASE 4**] We believe that our customer needs this product as it is better than other available options
[**CASE 5**] Our product can solve a specific problem
[**CASE 5**] Others

  - Why about hypothesis?
    - Hypothesis is a very general term. The context of it can change as per user perspective. Also, as one of the research question of this thesis focuses on setting guidelines for hypothesis and hypothesis

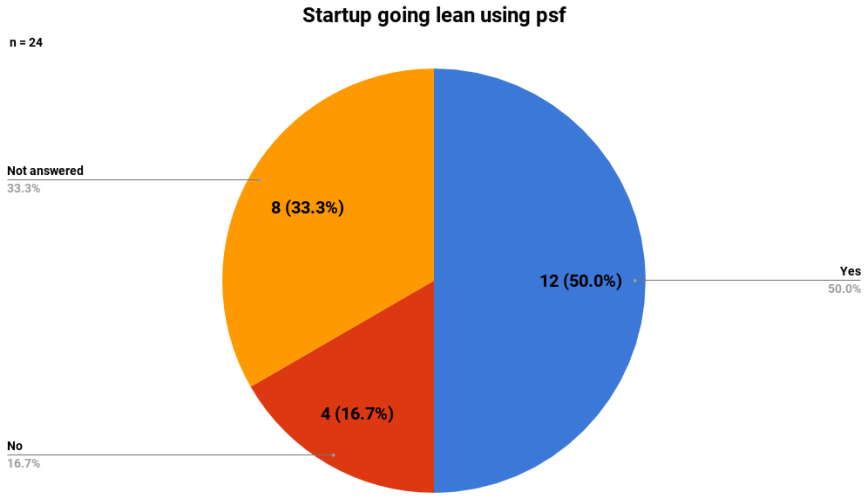

Figure 3.6: Startup going with hypothesis based problem solution fit approach

The figure comprises of three factors related to startup. First being the start following the lean startup approach, then come to the factor which indicates awareness of the concept of problem solution fit hypothesis followed by the fact that does they follow the concepts of the problem solution fit hypothesis. An interesting fact is that participants that most of the participants said yes about following the lean startup approach (figure 9). Also, the majority of participants are aware of problem solution fit hypothesis and do follow the process of problem solution fit hypothesis in their lean startup approach.

formulation. This section will be used to understand the startup prescriptive towards hypothesis.

For figure 11

[**CASE 1**] Hypothesis should be focused,meaning that the concepts are carefully defined
[**CASE 2**] Hypothesis should be testable
[**CASE 3**] Hypothesis should have multiple components
[**CASE 4**] Hypothesis should have different components as well
[**CASE 5**] Hypothesis should have a relationship between the involved components
[**CASE 6**] Hypothesis should be plausible - it should not be defy logic

- How it will help in this research?
  - The information gathered from this section will be used as one of the supporting factor for the development of a automated, guided

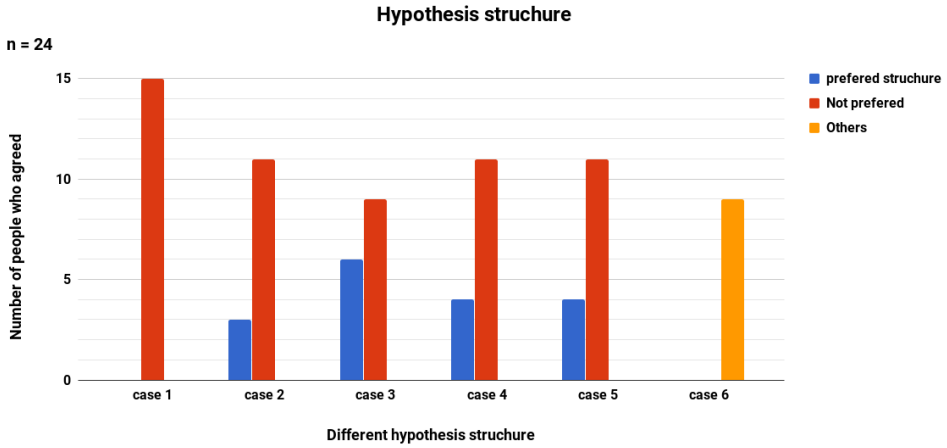

Figure 3.7: Participant response for hypothesis formulation

As a conclusion, we can say that participants do had a mixed opinion on what is the preferred structure for hypothesis formulation (figure 10). This can be expected as majority of the startup that participated had age less that 12 months. Most of the participants had an agreement on the hypothesis formulation format from [CASE3]- Our product can help people who are in a specific situation.

and questionnaire based platform. Also, these inputs will be helpful in supporting the impact of hypothesis based approach on startup failures.

Section IV

- Contact information

  This intended purpose of this section is to collect contact information about the envolved startup. The following questions were asked in this section

  1. In case more detailed information is required, would you be comfortable with further contact via email?
  2. Would you be interested in getting the report of survey analysis?

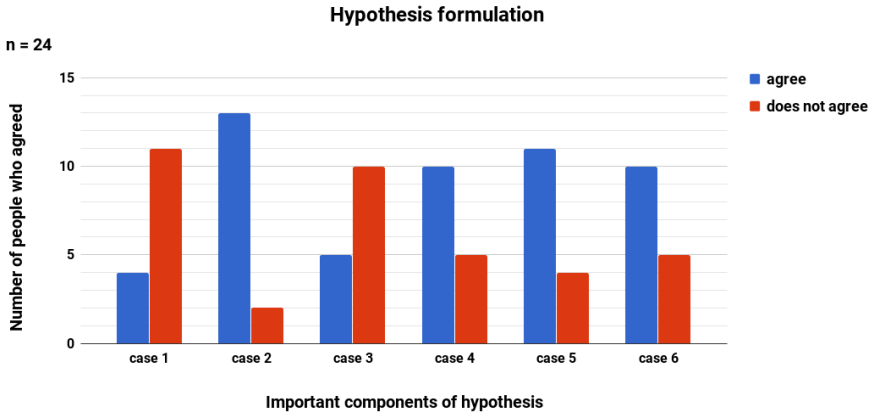

Figure 3.8: Participants response for important components of a hypothesis

For this section where we evaluate the important components of hypothesis the results are almost similar to what we see for hypothesis structure. This can be justified based on the fact that the age of participant software founders were less than 12 months. Going with the statistics, we can say that almost all the participants agreed on the fact that the formed hypothesis should be testable (figure 11). Also, we do have a agreement on the facts such as hypothesis should have a relationship between the involved components . Hypothesis should have different components involved and hypothesis should be plausible - it should not be able to defy logic do have equal number of voting from the participants.

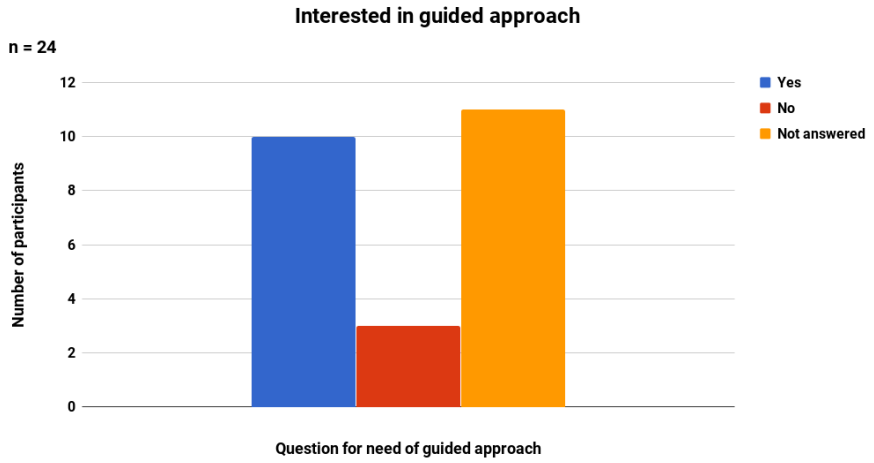

Figure 3.9: Response of participants for the need of guided approach

To be able to justify the need of this research and thesis, this evaluation has the major impact (figure 12). Out of total number of participants that reached the last stage of the survey, 10 agreed for the need of an guided approach.

4. Environment

4.0.1 Overview

This section starts with defining the requirements for environment. What constitutes a environment and how does it contributes towards providing an answer to the research problem and research questions that are being discussed in this thesis. This sections ends by supporting the need of an artifact by highlighting the research problems. Also, it lays down information that can be used by application domain to support the cause.

4.0.2 Requirements for environment

The requirements for the environment can be categorized as startup founders referred as people. The process and approaches that are being followed by them. The existing problem of the process and its impact. The environment speaks about the overall ecosystem that defines the starting point of the problem then comes to the factors followed by the impact.

4.0.3 Startup

Quoting some of the most intuitive definitions that explains the concept behind startup which is

- Steve blank defines the startup as `a startup is an organization formed to search for a repeatable and scalable business model` [1].
- Eric Ries defines the startup as `a human institution designed to deliver a new product or service under conditions of extreme uncertainty` [2].

[1] https://news.ycombinator.com/item?id=10828707-02/25/2018
[2] http://www.startuplessonslearned.com/2010/06/what-is-startup.html-02/25/2018

- Dave McClure of 500 Startups defines startup `a startup is a company that is confused about 1) what its product is, 2) who its customers are, and 3) how to make money. As soon as it figures out all 3 things, it ceases to be a startup and then becomes a real business. Except for most times, that doesn't happen` [3].

These definitions does not give a clear picture of what is a startup but it speaks about what it takes to think about having a startup.

The definition that is being followed in this thesis for startup is

`A business unit which aims at solving a problem. The problem can be new or existing but the solution is innovative`

Globalization can be considered as an important factor that has added towards boosting the startup culture. Especially when we consider that fact that it given an opportunity to do business across the globe and government helping it by levering up the policies to support it [MVW09]. Involving people from different countries and job profile, professionals getting an exposure to travel and work along with people of different culture. Opening up the market and giving leverage to people initiated a wave of innovation which leads to the creation of small business lead by people who were referred as entrepreneurs [VK07]. As startup founders have to deal with the varied amount of challenges and undergo pressure to be able to tackle the challenges. The mindset or we can say the attitude towards approaching the problem has to be different. Below are some of the points that startup founders take into consideration to be able to take effective decisions [4].

- One of the objectives of startup founders is to make a profit in a short period of time. They really do not care much about the long terms goals but mainly focus on profit.
- In some cases profit is considered secondary and focus is given on proposing a solution that can be a game changer. Something that has never been done before or is being done in a much more suitable way.
- Startup founders which aim for long-term goals and try to develop a product in an incremental way often found a start company at the end.

- Some of the characteristics that define a business unit as startup are [5]

[3] http://www.finsmes.com/2013/05/quote-day-dave-McClure-6-startup-definition.html-02/25/2018

[4] https://www.linkedin.com/pulse/20140813173935-8497556-are-entrepreneurs-and-start-up-founders-the-same

[5] http://www.startuplessonslearned.com/2010/06/what-is-startup.html

- Should be working in extreme uncertainty
- The idea or the solution concept should be new
- Plan to grow fast

These are the challenges that a startup founder has to face to be able to have a startup. It can also be seen as building blocks. Understanding the fact, where to keep and when to keep the block is the challenge. One mistake can turn things the other way. We do have challenges but we do have data which says that startup founders are trying there best. Figure 13 shows the rate of startup growth for the year 2106. This growth also supports the need of research which aims at finding inconsistencies in the process followed by startup.

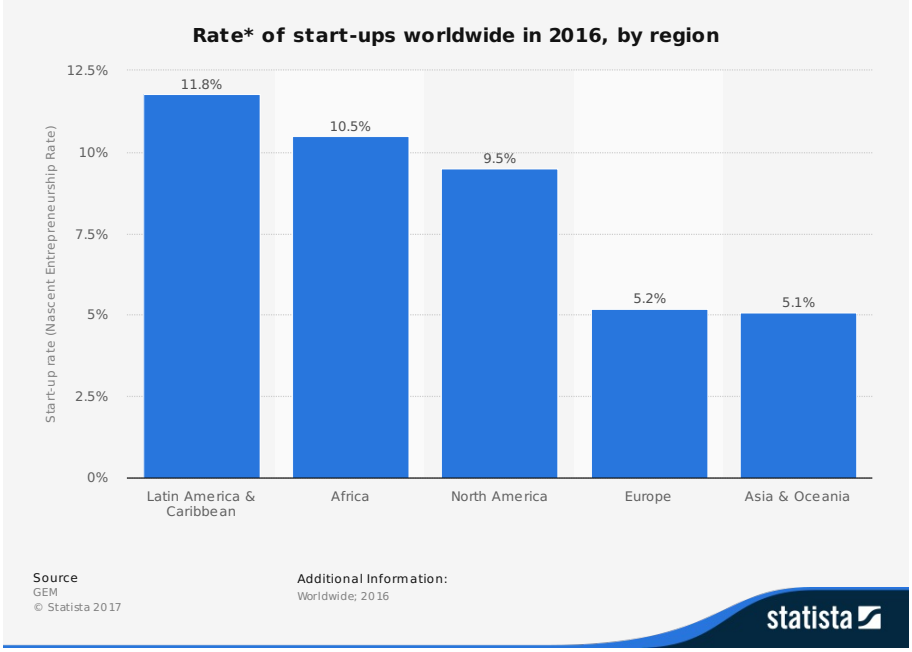

Figure 4.1: start up growth world wide, Ref statista.com

4.0.3.1 What makes start up unique

- Methodology

  As a business unit, a startup can be clearly distinguished. As a business unit, a startup has different goals, objectives, and approaches. Startup operates with extreme uncertainty and this is one of the major fact that makes it unique [TL05].

- Work atmosphere

  The startup aims to do something innovative and in a very short amount of time. This puts the startup team into a great challenge and this is also one of the differentiating factors when compared with traditional business units.

- Need to follow a methodology to support the process

As startup are different from the traditional business units they need to follow a specific methodology to be able to support their working environment. The goal of the followed methodology is also to ensure that the vision of the startup has been or will be achieved.

4.0.3.2 Challenges faced by start up

- Innovative product
  The idea of having an innovative product is one of the unique features of the startup but it increases the complexity as well [Bla07].

- Deliver fast
  To be the first in the market can also be considered as one of the goals of startup and achieving that is a very critical task [Bla07].

- Scalability
  To be able to survive in the market and ensure to the customer that the product is really worth buying there should a factor which speaks about future prospects. What gain or how much gain and till when a customer can avail from the purchased product. [Bla07]

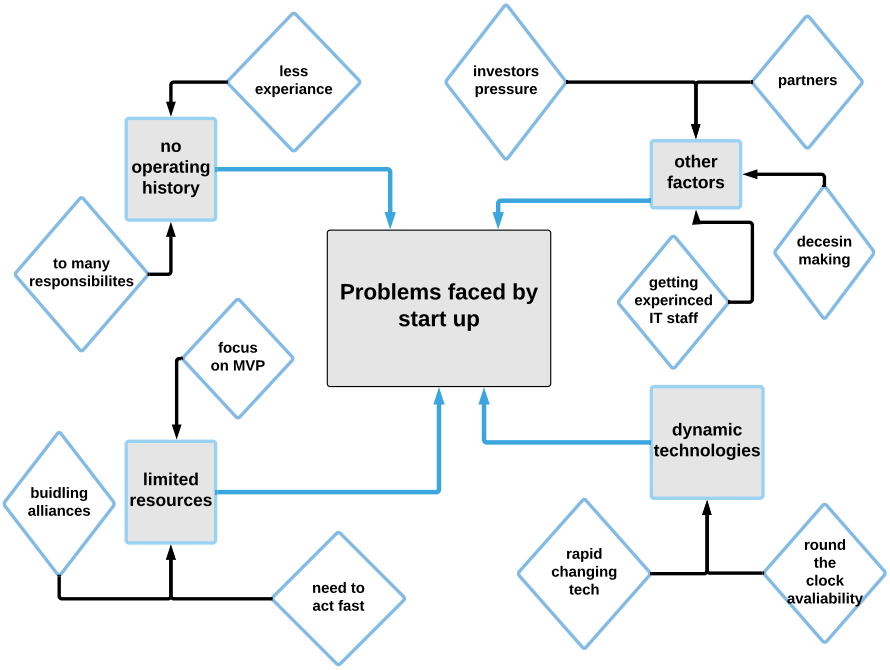

Figure 4.2: Challenges faced by startup - adapted from Software development in startup companies: A systematic mapping study [PGU+14]

`"A startup is a human institution which is designed to deliver new product or service under extreme uncertainty"` definition stated by Eric Ries [6]

[6] http://www.startuplessonslearned.com/2010/06/what-is-startup.html-02/25/2018

gives a clear understanding of what startup is and what it takes to proceed along with a startup idea. An individual who aims for startup are called startup founders and they do have the vision to change the traditional way of doing things. It can be a completely new approach or updating the existing ones. Technological advancement is one of the major contributing factors which helps towards the fulfillment of the goals or vision of an entrepreneur but technology is not the only aspect that has to be considered. One of the most important points that have to consider while speaking about the startup is that it has no prior operating history. Startup starts from level 0 and has to manage all the aspects starting from customer discovery, validating ideas, marketing and many more. If any of these aspects are not well understood or not carried out properly then it might lead to the failure of the startup. Despite the amount of risk and uncertainty evolved the rate at which startup are growing is significant.

Considering this significant growth, researchers from different educational background has shown a lot of interest in understanding the behavior and the way a startup is operated. As startup way is not the traditional way of doing things so it needs new approach or framework wherein it can operate and deliver as intended. Lean startup approach is a step forward to support the dynamics related to the startup. The main motto of the lean startup approach is to get outside the building and do experiments which in turn helps in validating the ideas before even you have started spending money to build it. The focus of this thesis is towards hypothesis-driven entrepreneurship which is a part of lean startup approach. Some of the aspects of hypothesis-driven entrepreneurship are to understand your customer, understand the problem and how the proposed solution can help in solving the problem. This is basically done by formulating the hypothesis, the former hypothesis is then tested and then further planning is done based on the outcomes. We do have success stories of the various startup like Airbnb, Uber, Dropbox but we do have failures as well. The focus is towards hypothesis-driven entrepreneurship considering the customer-centric factors which when ignored adds up towards the failure of the startup.

4.0.3.3 So is failure related only to the startup?

Some discussion about business failures, it can be a startup or not but the idea is to focus on the reasons which relate to a failure of a product and in turn the entire company.

Table 4.1: Business failures

Product	Target customers	Assumptions	Reality	Reason
Volkswagen Phaeton [KA08]	People who are interested in buying an expensive car	Marketing in demographics where people already have luxury cars will boost sales	Failure	High price for a budget car brand Marketing in areas which were dominated by other high end cars
Segway [KA08]	Everyone	Everyone will be interested to buy User friendly	Failure	High product price No clear definition of target customers
Walmart [KA08]	German market	German customers are same as their other customer Stores acquisition	Failure	Less understanding of German market No prior research was done on the needs of customer segment

Considering that startup work with uncertainty and with a high amount of risk evolved but failure is not only associated with them. The main contributing factor for failure is not having a good understanding of the target customer (table 2).

Assuming that a there is a problem and target customers are going to accept the solution without any hesitation is never true. These facts also add towards the need of having a platform wherein startup founders or any other business unit can brainstorm and understand aspects related to the target customer, there need and the solution. As a conclusion, it is clear that customers are always a priority. Irrespective of being a startup or a normal business unit, target customer and there needs have to well understood.

4.0.4 Process followed

The followed process plays a major role in the success or failure of a startup. As mentioned in the knowledge base about the existing process and methodology available for a startup to follow but still, most of the startups do not turn out to be successful. The objective here is to focus on target customer, think more about all the aspect but considering that fact that at the end the person who is going to accept is the target customer. Startup founders often find it difficult to understand the basics related to the process and that gives unexpected results. The problems that related to the unexpected behavior has to be carefully studied and analyzed. As startup founders do tend to think out of the box and approach the best-suited process.

Going with this research, the objective is to concentrate on startup going lean and following hypothesis-driven approach. When it comes to hypothesis-driven approach, the implementation is straightforward. As in turn your ideas into the hypothesis, test it and then proceed. Each hypothesis is being tested in the form of minimum viable product (MVP). Based on the feedback startup founders determine to preserve, perish or pivot [ERD11]. The approach aims at testing each hypothesis and then planning ahead hence reducing wastage of resources. Hypothesis driven approach is based on hypothesis. There is no clear guidelines about how does the hypothesis look like or what forms a good hypothesis?. We have three main components involved which are target customer, there need and the solution. There are several dependencies between these three components. When it comes to formulating a hypothesis, these dependencies have to be incorporated as well. Also, to be able to incorporate these dependencies, these three components have to be well read and understood. As this hypothesis adds towards the overall development of the product it has to well form.

Need of a platform which provides a way to understand in detail about the target customer, there needs and the solution is much of a need. Also, the sequence matters, there can be a different set of hypothesis when you start thinking from target customer and then the need followed by the solution when compared to need, solution and then the target customer (figure 15). Also, startup founders tend to overlook some of the important details or follow there intuitions while following an process. This can be justified based on the fact that startup founders are much passionate than any other business unit. They consider there idea very personal and often tend to mix it up with passion. A platform which can cross question users and enable them to think and can cover all the assumption is required.

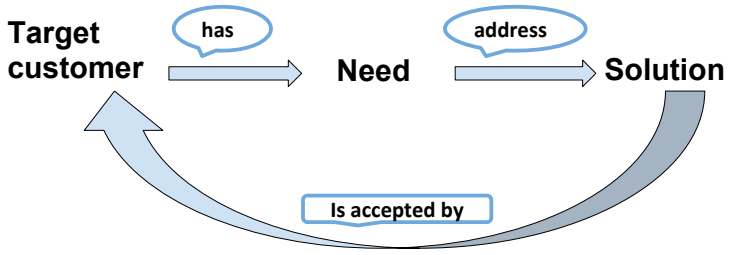

Figure 4.3: Interaction between target customer, need and solution

5. Design science research

5.0.1 Overview

This section contains details about the development of the artifact. It starts with the artifacts that were created from the starting of the research. This research follows an iterative way. So the developed artifacts also went through this process. Also, how did the changes based on the feedback affected the development of the artifacts are mentioned in this section. This section ends with the final version of the artifact followed by the experiments.

5.0.2 Requirements for design science research

The requirements for the design science research are outcome from environment section of the design science approach. The environment section serves a segment which provides business needs. These business needs has to be fulfilled by the developed artifacts. The Knowledge base also provides inputs in terms of previous research work done on the same aspect. It forms a base for the overall planning and development of the artifacts.

5.0.3 Problem solution fit canvas

To begin with the approach of formulating problem solution fit, a canvas was developed. The idea behind this canvas as to provide a common platform wherein startup founders can note down all the related aspects associated with there customer, needs of the customer and the solution. This canvas (fig 16) was a result of literature research and also following a similar approach as the business model canvas.

The inspiration behind developing a canvas for letting the startup founder understand more about the target customer, there need and the solution came from `The business model ontology:A proposition in a design science approach` [OO04]. The idea was to present all the relevant components at one place. Also, how these components are related to each other and their dependencies can be shown on a single

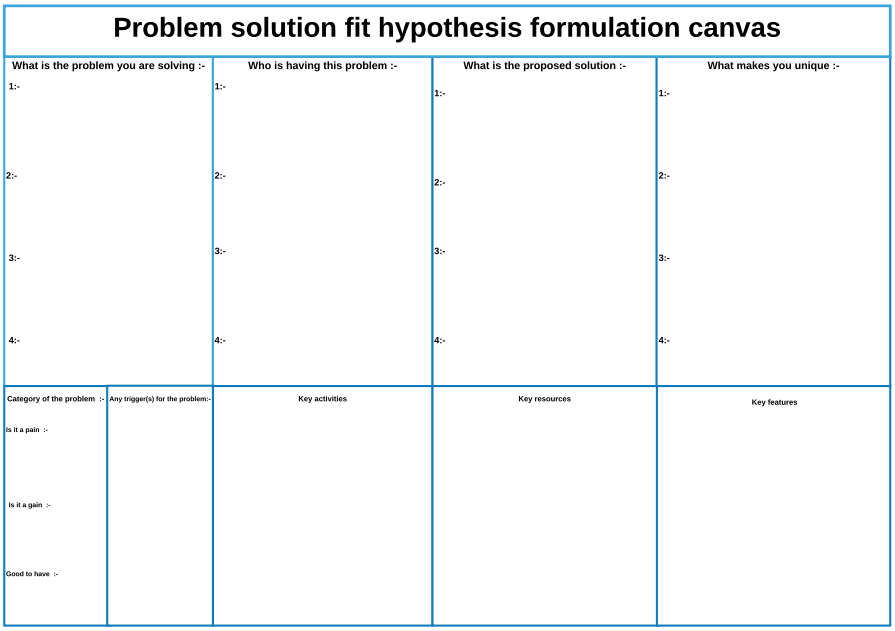

Figure 5.1: Problem solution fit canvas

platform aka canvas. For the contents and the segmentation used in the canvas, ideas were taken from Hypothesis-Driven Entrepreneurship The Lean Startup [ERD11]. This canvas is also a result of an iterative process wherein the initial version of it was given to an expert. Based on experts comments changes were done to this canvas.

This canvas was developed with an understanding that in general startup founders like to work with canvas. They like to spend time brainstorming about ideas using a canvas. As mentioned that this canvas was developed in an iterative way by taking regular feedback from experts. The main problem that still existed was that `How to enable a process that will lead to step by step brainstorming?`. As this canvas had options but there were no process or guidelines. There was also no way to cross verify that the provided information is correct. Also, startup founders had no way to check that they are thinking in a correct way or not. These were the major challenges that were going against problem solution fit canvas. These challenges lead to thinking of a process which consists of a framework. This framework should be able to guide startup founders. Also, the framework should be able to cross check the provided inputs.

5.0.4 Guided framework consisting of questionnaire

Coming up with an idea for developing a framework which can help startup founders in polishing their ideas was a challenging task. Uncertainty and startup go in parallel and an effort to reduce this uncertainty needs a good understanding of the startup scene and also focus on a specific problem. When speaking about startup the problem definition and the goals should be well defined. The problem that is being focused here is that there is a lack of understanding towards understanding target customer, problem, and the proposed solution. Also, a way to represent the

Table 5.1: List of startup that were analyzed

Start up name	Product
Deliveryhero	online food deleviery service
Hellofresh	sends pre-portioned ingredients to users' doorstep each week
Westwing	Westwing is an online platform and company that provides products and services related to interior designing
Auxmoney	Auxmoney is an online peer-to-peer loan marketplace.
Soundcloud	SoundCloud is a social sound platform where anyone can create and share sounds
Home24	Home24 is an online platform that enables consumers to find and purchase home furniture and decor
Kreditech	Kreditech uses machine-learning technologies to provide access to better credit for the underbanked
GoEuro	GoEuro is a multi-mode search tool that compares and combines rail, air, bus, and car for European destinations
Auto1	AUTO1 Group connects buyers and sellers of cars via an online platform.
GetYourGuide	GetYourGuide is a booking platform for tours and activities, offering a variety of travel experiences through their global supplier network
Glossbox	GLOSSYBOX is an online subscription service, delivering high-end beauty products directly to its users' doorstep
egym	eGym makes the gym work for everyone
Outfittery	OUTFITTERY provides an online personal shopping service for men to dress them for success
Dreamlines	Dreamlines is a globally expanding startup specialized in selling cruises and on its way to become the #1 cruise portal in the world
Movinga	Movinga is a Berlin, Germany-based online relocation service provider company.
Blacklane	Blacklane is a Berlin-based global professional driver services company
Azubu	Azubu is a global entertainment network focused on eSports, providing unparalleled gaming, viewing, and interactive experiences
Babbel	Babbel is the market-leading app for language learning
Clue app	Clue uses science and data to provide actionable personal insights into female health
HomeToGo	HomeToGo is the world's leading meta-search engine for vacation rentals
EyeEm	EyeEm is a photography company building computer vision technology to connect its creative community to leading brands and agencies
Simfy	simfy is an online music platform that enables its users to stream, share, and store music
Chrono24.com	Chrono24.com is an online marketplace connecting buyers and sellers of luxury watches
Onefootball	Onefootball is a global football community that connects 20 million football fans in over 200 countries
Studitemps	STUDITEMPS specialized in placing qualified students as temp workers, when necessary even on very short notice
Dubsmash	Dubsmash is a video messaging application
Shopwings	Shopwings is an online platform that provides its users with the ability to receive groceries and delivery services
Spreadshirt	Spreadshirt is an e-commerce platform that lets anyone create, sell, and buy their ideas on tangible products worldwide
Brille24	Brille24 is a retailer of prescription eyeglasses distributed via online channels in German speaking countries
Springlane	Springlane is the category leader for cooking and dining products as well as selected wines and spirits in Germany with the vision to fuel people passion for cooking
Medigo	Medigo is a curated marketplace that simplifies the complex process of booking medical travel.
Cobi	Cobi is an integrated system that connects users' bike with their smartphone new riding experience.
Codecademy	Online learning platform
Dwolla	Dwolla is faster-growing mobile payment solution
ZocDoc	ZocDoc is a way to book doctor appointments online
Chic by Choice	Chic by Choice is one-of-a-kind hire destination which allows women to access designer dresses, straight from the catwalks
Mush	App lets new parents connect with others locally, chat, swap and sell items.
Talmt.io	Online platfrom for software engineers to apply for jobs and companies to post job offers
Agricool	Building a sustainable food system by growing local, tasty and pesticide-free fruits and vegetables for everyone
Infarm	Infarm can personalize its farms to each customer's unique needs, growing different varieties for different supermarket locations or equalizing the flavor of the produce to better suit the taste palate of a customer's clientele
Medium	online content, blogs
Zipline	Builds autonomous drones designed to deliver vaccines, medicine, or blood to clinics located in regions that are difficult to reach
Spotted	Spotted is a hyper local app about making new connections with awesome people from your everyday life
Carmudi	Carmudi is an online marketplace for new and used cars and motorcycles in Mexico, the Middle East and Asia
Watchmaster	Watchmaster.com is the fastest-growing digital marketplace for buying and selling luxury watches
Nestpick	Pick your next home, live anywhere
Smeet	Smeet is an online 3D entertainment platform enabling users to collaborate, play games together, and watch live web streams
Junique	Disrupt the mass art market by making exciting designs of genuine artists accessible to consumers
celonis	Celonis offers the most advanced Process Mining tool for analyzing & visualizing business processes

relationship between target customer, problem and the proposed solution to give a better understanding of the overall product. An iterative process was followed to develop the framework. The goal of this framework was to ensure that users

- Brainstorm about
  - Target customer
  - Problem
  - Proposed solution
- Define
  - Target customer based on their attributes
  - Need based on their dependencies
  - Solution based on the factors that add towards solving the problem
  - Fit between need and solution
  - why the target customer will accept the solution
- Represent
  - Relationship between all defined attributes
  - Dependencies
  - Accepting factor for the solution

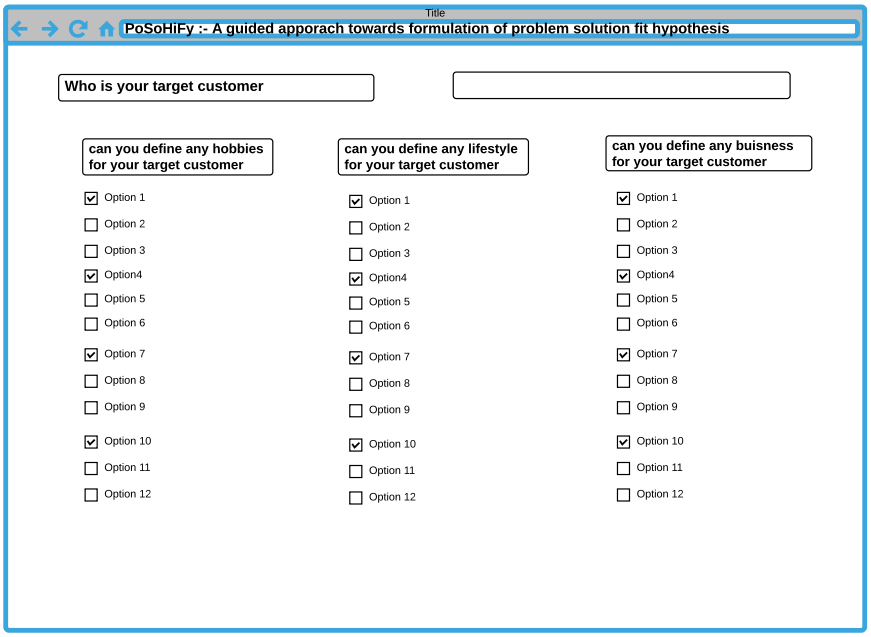

Figure 5.2: First iteration - Customer screen

In the **first iteration**, the approach towards building the framework consisted of the question, answers of which needs to be selected from a list of available answers (figure 17). The idea behind this was to give available options. These options were provided by analyzing 50 startup (table 3) and then segregating them based on their product and customer. This will give more clarity to the users and also help them in the selection process. As all the options will be available, the user would not have to spend more time thinking about the attributes related to the customer. This can also be a motivating factor towards the use of the tool. The similar approach was used for need and solution. In the end, the idea was to collect all the attributes that user as selected and then form a problem solution fit hypothesis. To be able to validate this approach and start working on the details, confirmation from an expert was much needed. This approach was shown to the expert and this approach failed to answer the below-given questions

- How can this model assure that all the customer related attributes have been considered? Theoretically, the list is infinite
- Does this approach works for any kind of startup as in can a startup which works on biomedical research and a startup who aims at improving the customer reach via the internet. Can both be able to use this tool?

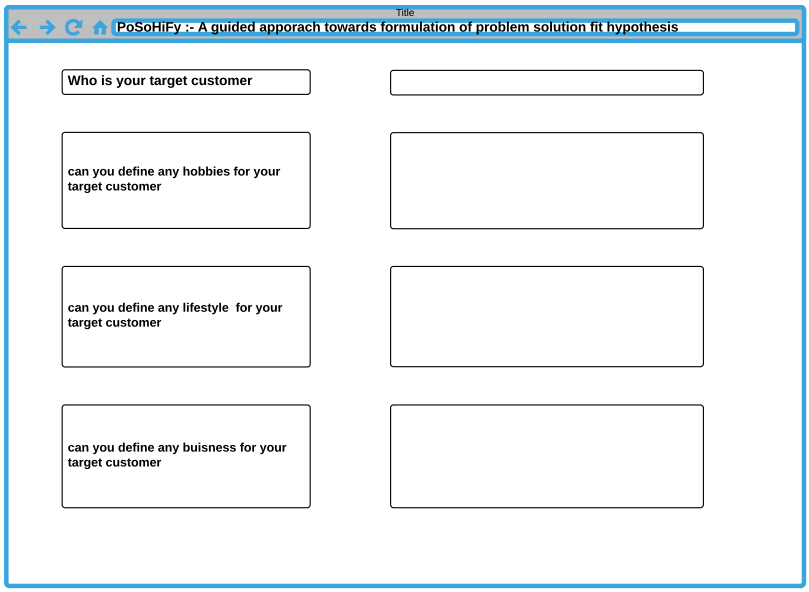

Figure 5.3: second iteration - Customer screen

- How can this approach help me in cross-questioning my idea?

Similarly, these questions were asked for the segment with need and then with a solution. As a whole this approach needed improvement.

In the **second iteration**, the drawbacks of the first iteration were covered. This approach had the open text area where the user can enter free text. This free text was then combined together to form a hypothesis (figure 18). Now, this approach gave the user the freedom for free text and then formulate problem solution fit hypothesis. When consulted with the expert about this approach, the blow given questions were still unanswered

- How does this approach force user to think more about the customer, their need and more about the solution?
- How does user learn about the fit between need and the solution?
- How does user justify the fact that his customer will accept the solution and will be ready to pay for it?
- Cross questioning to ensure that user has thought about all the possible combinations and possibilities were missing

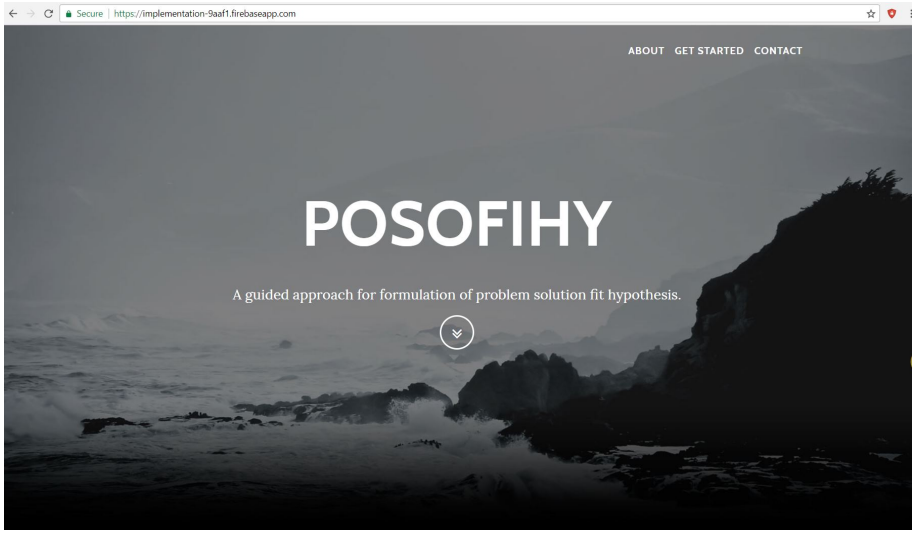

Figure 5.4: Third iteration - Landing page

In the **third iteration**, the drawbacks of the first and second iteration were covered. This approach had the open text area where the user can enter free text. This free text was then combined together to form a hypothesis. Now, this approach gave the user the freedom for free text and then formulate problem solution fit hypothesis. The interesting part of this approach was that it was based on an iterative process. Making the tool iterative enabled user to think again and again about details related to the customer, their need, and the solution.

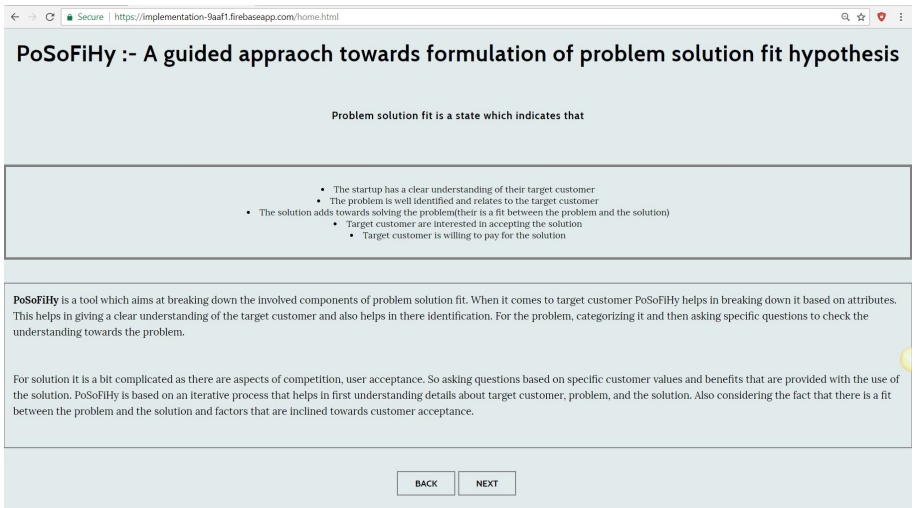

Figure 5.5: Third iteration - Educating the users

As a new approach, educating the customer during the flow was also identified as the need. Taking target customer segment as a topic, the idea of segregating target customer based on their common characteristics has been introduced. This helps in identifying the customers. The reason behind this approach and the way of doing

this has been well described in PoSoFiHy. Same has been followed when it comes to needs and the solution.

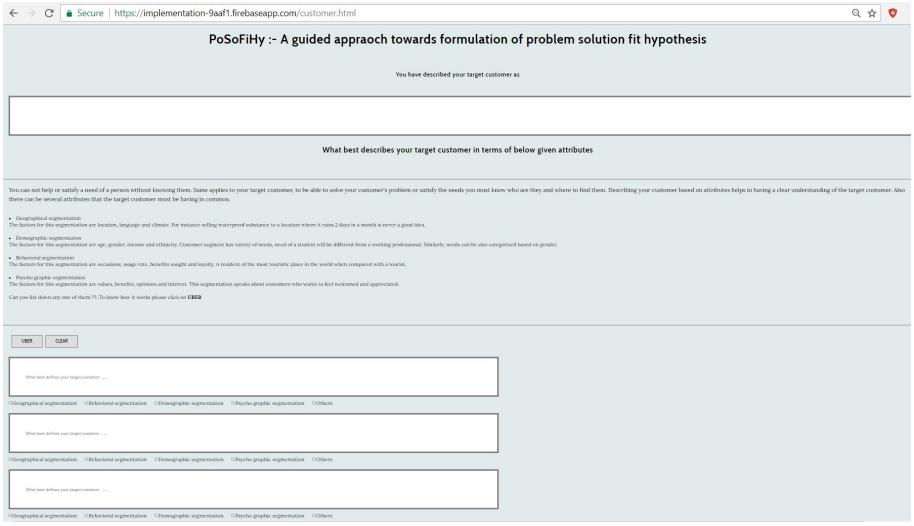

Figure 5.6: Third iteration - Customer screen

Using the approach wherein startup founders can use free text and also use various categorization to well define all the aspects related with target customer, there need and the solution helped in getting more data. The data given by the user increased which helped in formulating more combinations of problem solution fit hypothesis. In this approach, along with the formulation of the problem solution fit hypothesis, a user can get problem solution, solution customer, and customer problem hypothesis. In the end, this tool also provides cross questions which can help the user in a brainstorming session on their startup idea.

At the end, startup founders were asked questions related with the use of the tool. As this is a new approach the feedback was concentrated on the factors like tool usage, knowledge creation and user satisfaction. More details on this will be shared in the next section.

- Following the research methodology discussed in section 4, contribution of the writer towards this thesis consists of three segments
  - Contribution towards literature
    - Adding theoretical knowledge and answering the formulated research questions on hypothesis

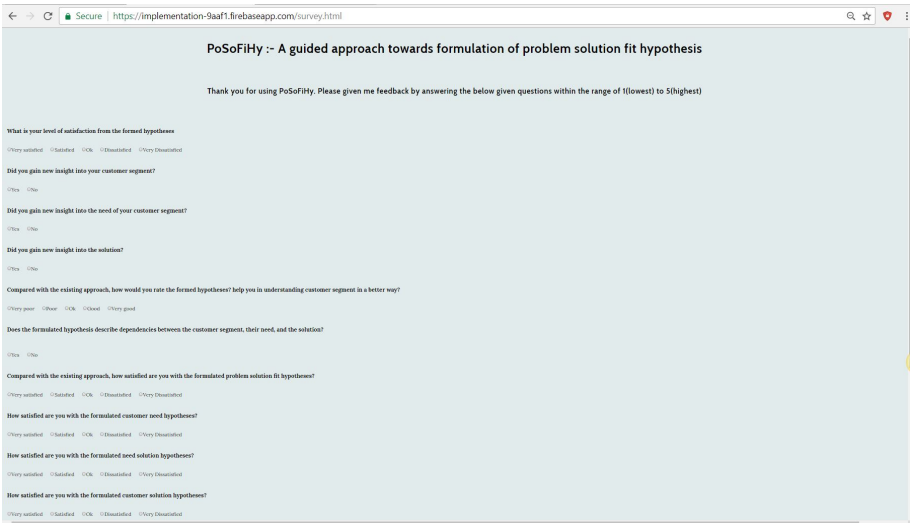

Figure 5.7: Third iteration - feedback page

* Adding theoretical knowledge and highlighting the factors that are responsible to the cause that customer needs are not taken into consideration when planing for a product.
* Adding theoretical knowledge towards the impact of globalization on business and business process and how these has resulted into creation of new process and methodologies.
* Highlighting the impact of lean start up approach focusing on hypothesis driven entrepreneurship on how it helps in saving time and money for dynamic business units such as start up.
* Survey sent to start up to understand the practical implications of lean start up approach focusing on hypothesis driven process. Analysis of the data from the survey will be used during the preparation of the questionnaire which in turn will be implemented in the framework as a guided approach.

– Contribution towards formulation of problem solution fit hypothesis

* Using design science approach, representing an overview of the need of framework which can help in understanding hypothesis formulation.
* Due to not having enough information or clarity for the formulation of problem solution fit hypothesis their is a big impact on the business and this impact can be visualized using the diagram created using the design science approach.
* An ontology that represent the relationship and dependencies between the involved components in a problem solution fit hypothesis.
* A framework which when used can be helpful in understanding more about problem, proposed solution and the target customer. Also it gives a clear picture about any kind off dependencies or relationship between involved components.

  - Contribution towards development of guided framework
    * The guided framework will be a web based tool named *PoSoFiHy*.
    * PoSoFiHy will be having 4 segments. First will be problem then customer followed by proposed solution and then what makes the solution unique.
    * To be able to be a guided framework, set of questionnaire will be provided to the user for all the 4 sections.
    * Once user has completed all the 4 section then the problem solution fit hypothesis will be generated based on user answers to the asked questions.
    * Also, adequate amount of learning information will be provided for each of the section to make it more user friendly.

5.1 Experiments

Design science approach aims at creating new and innovative artifacts. To confirm their utility these artifacts should add towards solving a problem . If the created artifact does not have any utility then it does not serve the design science approach and can not be called as an artifact [EHM+04]. Also, it can be a case that the utility of the artifact is not well demonstrated. This falsifies the claims which support the creation of the artifact. For an information science research, the created artifact should be able to prove its utility. So, to be able to prove the utility of the designed and developed guided questionable based framework below are the experimental approaches

The hypothesis that is being tested in this experiment is

- [**H1**] Often startup founders tend to overlook some of the relevant characteristics of their customer, need of the customer and the solution while forming a problem solution fit hypothesis.
- [**H2**] Existing ways of formulating problem solution fit hypothesis lack in following any scientific approach.
- [**H3**] An automated, guided and questionnaire-based approach towards the formulation of problem solution fit hypothesis can help in better understanding of concepts related with the customer, their need, and the solution.

To be able to test the above given hypothesis, PoSoFiHy asks users to give a feedback at the end of the process. The formulated questions are

- [**Q1**] What is your level of satisfaction from the formed hypotheses.
- [**Q2**] How would you rate PoSoFiHy in terms of time spent to formulate hypotheses?

- [**Q3**] How would you rate PoSoFiHy in terms of content/information provided to understand the concept of problem solution fit?
- [**Q4**] Did you gain new insight into your customer segment?
- [**Q5**] Did you gain new insight into the need of your customer segment?
- [**Q6**] Did you gain new insight into the solution?
- [**Q7**] Does the formulated hypothesis describe dependencies between the customer segment, their need, and the solution?
- [**Q8**] Compared with the existing approach, how satisfied are you with the formulated problem solution fit hypotheses?
- [**Q9**] How satisfied are you with the formulated customer need hypotheses?
- [**Q10**] How satisfied are you with the formulated need solution hypotheses?
- [**Q11**] How satisfied are you with the formulated customer solution hypotheses?
- [**Q12**] How satisfied are you with the formed questionnaire to validate your startup idea?

The experiments goals are to first get a response from the users about the tool. As PoSoFiFy also helps the user in brainstorming about there ideas, new knowledge can be created. Any new attributes about target customer, there need or the solution is considered as knowledge. Also, the satisfaction of the user in terms of the generated problem solution fit hypothesis and also the overall process of doing it will be evaluated in the following section.

6. Evaluation

6.0.1 Overview

This section starts with an introduction about PoSoFiHy. Also, how does the research work done in the previous sections added towards the development of the artifact (PoSoFiHy). Then followed by the data that was generated by users that used PoSoFiHy.

6.0.2 About PoSoFiHy

PoSoFiHy is a guided approach which helps startup founders in formulation problem solution fit hypothesis. The goal of PoSoFiHy is to ensure that startup founders know what they are up to. To be able to formulate a problem solution fit hypothesis, startup founder should have enough information and understanding about there target customer, there need and the solution. As mentioned in figure 1, the most contributing reason for startup failure is no market need. One of the reasons behind this is lack of understanding about the components that are involved while formulating problem solution fit hypothesis. A well-formed problem solution fit hypothesis should have all the components as well there dependencies. PoSoFiHy uses an iterative questionnaire based framework. The idea behind this framework is to give an opportunity to startup founders to think in small steps. Each iteration in PoSoFiHy asks startup founders question based on target customer, there need and the solution.

At the end of each iteration, startup founders can see their inputs and then think more about it. PoSoFiHy also tires to educate startup founders about how to categorize certain aspects of the target customer. This categorization helps in identifying the target customer in a specific way. Also, a way to think in a different way about the need of the customer has been introduced. As a final solution, PoSoFiHy accumulates all the inputs and form multiple problem solution fit hypothesis. The formulated problem solution fit hypothesis has been divided into three segments

- Customer need hypotheses

  Customer need hypotheses consist of target customer and there need. This hypothesis aims to test that the need does really belong to the target customer or not and vice versa.

- Need solution hypotheses

  Need solution hypotheses consists of the need and the solution. This hypothesis answers the question as to how does the solution address the need and are there any dependencies between the need and the solution.

- Customer solution hypotheses

  Customer solution hypothesis consists of target customer and the solution. The focus here is to understand how does the target customer uses the solution. Also are there any special criteria for the target customer to be able to use the solution.

Along with hypothesis formulation, PoSoFiHy also provides a platform to cross verify all the details related to the target customer, there need and the solution. The goal is to ensure that the startup founders have investigated all the possible scenarios. There can be a scenario wherein Startup founders might be biased about there startup idea and tend to overlook some important aspects related to it. This approach of cross verification is a step to overcome this. Also, startup founders have an option to discard any formulated hypothesis or the formulated cross questions. In the end, PoSoFiHy offers a survey wherein users can share their views about the approach and the formulated hypotheses. The details about the survey can be found in the following section.

6.0.3 PoSoFiHy survey data

PoSoFiHy provides a new way of formulating problem solution fit hypothesis. When compared with the existing ways using pen and paper, whiteboards or brainstorming meetings PoSoFiHy is a web-based platform. To be able to evaluate the tool covering all its aspects, the survey questions are divided into three segments

- Feedback on tool (figure 23)

  The set of questions that falls under this category are

  - [**Q1**] What is your level of satisfaction from the formed hypotheses.
  - [**Q2**] How would you rate PoSoFiHy in terms of time spent to formulate hypotheses?
  - [**Q3**] How would you rate PoSoFiHy in terms of content/information provided to understand the concept of problem solution fit?

  The goal here is to find the overall impression of PoSoFiHy.

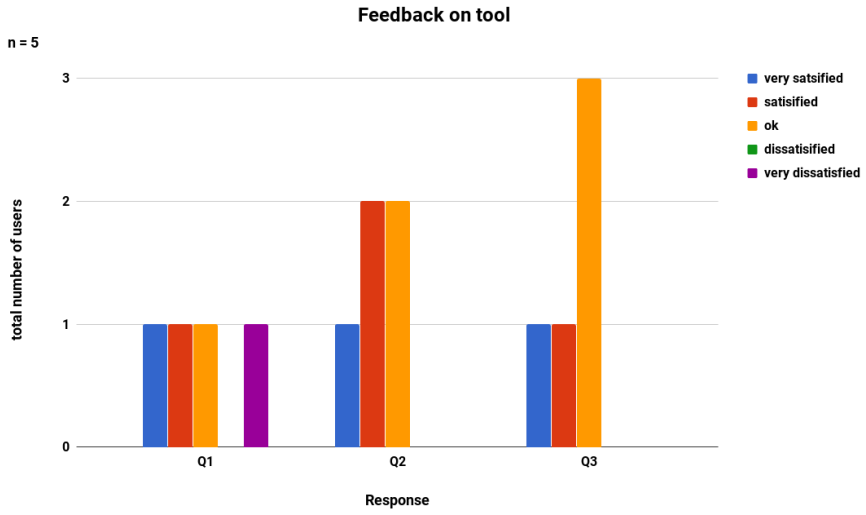

Figure 6.1: Feedback on tool

The total number of participants for the experiments is 5. In terms of level of user satisfaction for the formulated hypothesis, we do have a mix response. 1 out of 5 users was very satisfied and 1 user voted for satisfied and 1 for ok. Also, we do have a user who was very dissatisfied from the formed hypothesis. 1 out for 5 users did not vote for this feedback question.

- Knowledge creation (figure 24)

  The set of questions that falls under this category are

  - [**Q4**] Did you gain new insight into your customer segment?
  - [**Q5**] Did you gain new insight into the need of your customer segment?
  - [**Q6**] Did you gain new insight into the solution?
  - [**Q7**] Does the formulated hypothesis describe dependencies between the customer segment, their need, and the solution?

  The goal here is to get information from the user in terms of new knowledge created. As PoSoFiHy do make the users learn during the overall process. Also, the guided questionnaire based framework is focused on ensuring that the users to discover new things about the target customer there need and the solution. These set of questions defines how much of a learning was generated by PoSoFiHy.

- User satisfaction (figure 25)

  The set of questions that falls under this category are

  - [**Q8**] Compared with the existing approach, how satisfied are you with the formulated problem solution fit hypotheses?

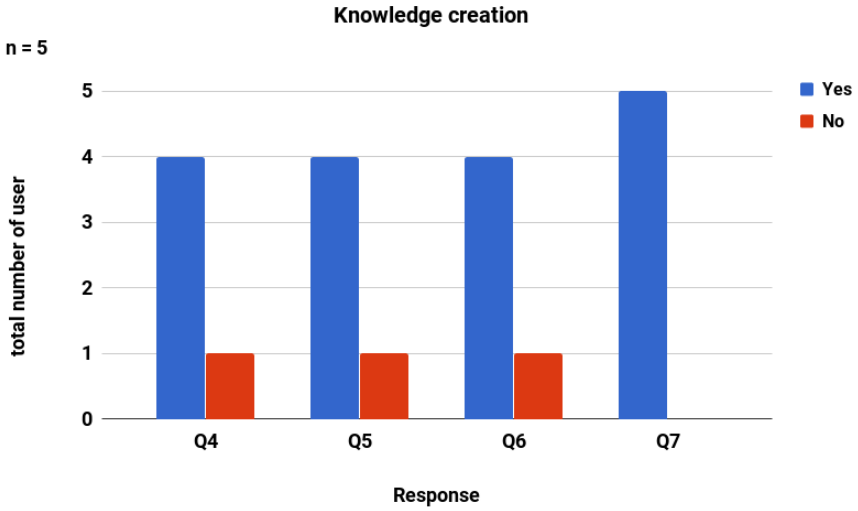

Figure 6.2: Knowledge created by PoSoFiHy

The total number of participants for the experiment is 5. For the section of knowledge creation we do have positive feedback. For the questions related with showing dependencies between the involved components, all the participants said yes. For the question related with gaining insights about target customer, there need and the solution 4 out of 5 participants voted yes.

- [**Q9**] How satisfied are you with the formulated customer need hypotheses?
- [**Q10**] How satisfied are you with the formulated need solution hypotheses?
- [**Q11**] How satisfied are you with the formulated customer solution hypotheses?
- [**Q12**] How satisfied are you with the formed questionnaire to validate your startup idea?

The goal of this section is to get feedback from the users about the level of satisfaction on the formed hypothesis. This is also a feedback on the process followed as in turn the hypothesis are generated through it.

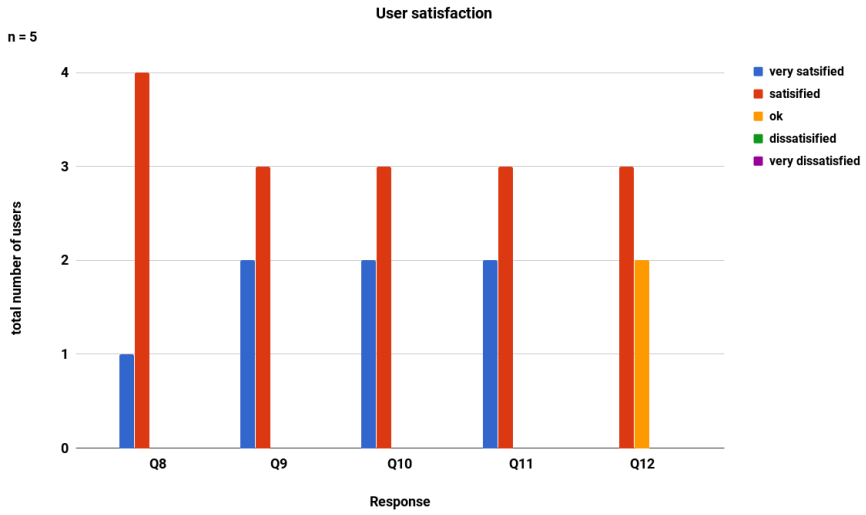

Figure 6.3: User satisfaction after using PoSoFiHy

The total number of participants is 5. The results from user satisfaction do support that there is a need of a new approach which helps startup founders in formulating problem solution fit hypothesis. 4 out of 5 users were satisfied and 1 was very satisfied with the formulated problem solution fit hypothesis. Similar pattern can be observed for the question related with need solution, customer solution and customer need hypothesis. For those 3 were satisfied and 2 were very satisfied. For the questionnaire that were formed to cross verify users input has scope of improvement as 3 were satisfied and 2 were ok with it.

7. Conclusion

Literature research to understand concepts related to startup. Being a new research topic there has to be a lot that has to learn and understand about startup. Previous research is done identifying the challenges and problems faced by a startup. This gives an understanding of the areas which need to be focused and needs improvements. Also, considering startup as an information system which involves people, process, system and technology and how these components affect the overall startup ecosystem. Going with the literature research, it has been clear that process has a major impact on the overall startup ecosystem. We do have a process that aims at improving the startup process but a need for guidelines and defining more about the different aspects of the process has been discovered. As the focus of this thesis is on startup going lean and the research area is related to problem solution fit hypothesis. All the research activities are funneled towards understanding and formulating problem solution fit hypothesis. The goal is to reduce the rate of startup failure. A survey was also included as a part of the research activity. As startup aims at being fast they do tend to think out of the box. The goal of the survey was to understand what startup is doing in real scenarios. Do they really go by the book or follow their intuitions? The survey was sent to startup, below are the derived conclusions.

- Survey was divided into sections to capture relevant information from the participants.
  - Age of the startup (figure 7)
    - When comparing the age of the startup, the majority were less than 12 months
    - This gives an indication that startup at early stages does tend to look for resources. This helps them in understanding new ways of doing things. Also participating in experiments can be helpful in terms of learning and also improvising on their process.

    * In terms of knowledge creation for this research, we can say that less experience can affect the overall understanding of the process. This can also have an effect on the overall survey feedback.

- Lean startup methodology (figure 8)

    * The survey was sent to more than 300 plus people. Also, it was shared on social networking channels like facebook[1] and linkedin[2]. The idea behind was to have the maximum number of participants.
    * When focusing on the process followed in the participated startup, 14 out of 24 did go lean. This is an indication that young startup does follow lean. This is also a positive aspect of the overall research.
    * This also gives an indication that there has to be work done to improvise the overall lean experience. As lean divides the overall process into series of the sub process. More guidance on the sub process might lead to promising results.

- Going lean with problem solution fit state (figure 9)

    * Going lean can have different perceptions. Startup tends to define their own process to be able to stand first. This section was meant to filter out the startup who go lean and do use problem solution fit state.
    * With the available data, it is clear that 12 out of 24 startups do go lean and use problem solution fit.
    * This also gives an indication that startup does tend to follow a process but not might be able to do it in a way it is supposed to be. This can be due to lack of resources or understanding of the process.

- Problem solution fit hypothesis structure (figure 10)

    * Hypothesis, in general, is an ambiguous term. This section was meant to understand if the startup does tend to follow or prefer any structure for the problem solution fit hypothesis.
    * The results prove that yes, startup founders do have different opinions on problem solution fit hypothesis structure. 9 out of 24 voted for others and 6 did agree on a format which says **Our product can help people who are in a specific situation**.
    * This results also show a need for uniformity towards problem solution fit hypothesis. The difference in thinking and structure can also be one of the contributing reasons for startup failure

- Important components of problem solution fit hypothesis (figure 11)

[1] https://www.facebook.com/
[2] https://www.linkedin.com/

    * As per research, the hypothesis is a very important aspect of any research. There are some guidelines that need to be followed when formulating a hypothesis.
    * The same has to be applied while formulating problem solution fit hypothesis. The formulated problem solution fit hypothesis is based on the startup idea. Understanding towards problem solution fit hypothesis formulation is the key.
    * 13 out of 24 accepts that the problem solution fit hypothesis should be testable. This has also been discovered by the literature research. There should be a relation between the different components of a problem solution fit hypothesis has been agreed by 11 participants.
    * The difference in opinion in this result also indicates that there is a need for a platform which can educate startup founders and ensure that everyone has a similar understanding.

- Need of a guided approach (figure 12)

    * This aspect plays an important role in supporting the idea behind this thesis and also to answer **RQ5**.
    * 10 out of 6 participants did say yes towards the need for a guided approach. As a start, this can be considered as a positive response.
    * 11 out of 24 did not answer this question. As most of the startup were new so it might be a case that they were unsure about the concept or need of a guided approach.

As a conclusion, this survey did prove that there is the difference in thinking between startup founders. We do have a process but the way of implementation differs. Also, startup founders do have an accord on problem solution fit hypothesis and do consider that hypothesis should be testable and should have dependencies. The need for a guided approach is also supported by the survey data. These inputs are taken into consideration along with the results from knowledge base to develop the artifact (PoSoFiHy).

PoSiFiHy follows a iterative process throughout its development process. The goal was to follow the lean process of first coming up with a minimum viable product with spending least resources (figure 26). In this case it was the pen and paper prototype which was developed. This prototype was then given to an expert for review. Based on the review new approach was developed. This process went until a approach was finalized. Once the approach was finalized in the pen and paper version then the real development started.

As a conclusion, following this process gave an opportunity to learn more about the overall lean process. This also helped in understanding the problems that a startup founder faces which is finding the right combination. As mentioned in the design science section where the description of how the artifact transitioned from a finite list of selection to free text format. This was the overall

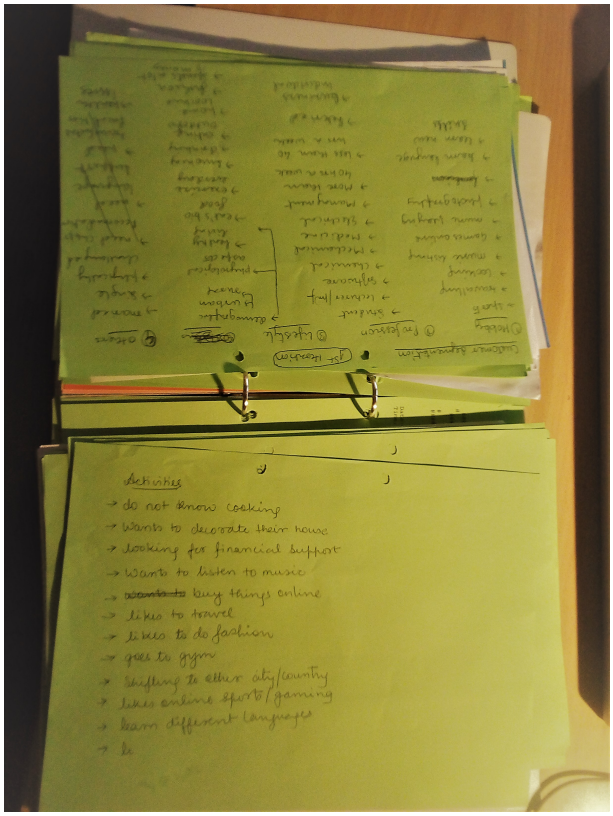

Figure 7.1: Pen and paper process for developing the artifact

result of this iteration based approach.

In relation to the data collected from PoSoFiHy. The total number of participants where 5. Yes, this is a very small number but the development of the artifact took more time than expected. This affected the experimental results for PoSoFiHy. PoSoFiHy was developed based on the information from knowledge base. The goal was to ensure that startup founders do understand and think more about the target customer, there need and the solution. Some of the hypothesis that were created using PoSoFiHy are

- Problem solution fit hypothesis
  - *[WHO] busy people [IN PRESENT STATE] hungry [NEEDS] deliver food on time [TO SATISFY] not hungry*
  - *[WHO] customer doesn'T know how to cook [IN PRESENT STATE] hungry [NEEDS] immediate access to food [TO SATISFY] not hungry*
  - *[WHO] need treatment at affordable price [IN PRESENT STATE] looking for treatment [NEEDS] personal touch by doctors/clinics/attendants [TO SATISFY] treated at nearest clinic at a price s/he could afford*

    * *[WHO] customer looking for medical facilities [IN PRESENT STATE] looking for treatment [NEEDS] clinics should accept payment by card/cheque [TO SATISFY] treated at nearest clinic at a price s/he could afford*

- Customer need hypothesis

    * *people looking for food [CHARACTERIZED BY] busy people [IN PRESENT STATE] hungry [AND WANTS] not hungry [BECAUSE] immediate access to food*
    * *people looking for food [CHARACTERIZED BY] customer doesn'T know how to cook [IN PRESENT STATE] hungry [AND WANTS] not hungry [BECAUSE] no access to food*
    * *customer looking for medical facilities [CHARACTERIZED BY] urban population [IN PRESENT STATE] looking for treatment [AND WANTS] treated at nearest clinic at a price s/he could afford [BECAUSE] getting treated at nearest clinic at cheapest possible price*
    * *customer looking for medical facilities [CHARACTERIZED BY] language issues [IN PRESENT STATE] looking for treatment [AND WANTS] treated at nearest clinic at a price s/he could afford [BECAUSE] treatment not covered by insurance*

- Need solution hypothesis

    * *[THIS] deliver food on time [WILL HELP TO] hungry [BECAUSE IT PROVIDES] not hungry*
    * *[THIS] notify customer about status of food arrival [WILL HELP TO] hungry [BECAUSE IT PROVIDES] not hungry*
    * *[THIS] clinic closest to their location [WILL HELP TO] looking for treatment [BECAUSE IT PROVIDES] treated at nearest clinic at a price s/he could afford*
    * *[THIS] affordable price [WILL HELP TO] looking for treatment [BECAUSE IT PROVIDES] treated at nearest clinic at a price s/he could afford*

- Customer solution hypothesis

    * *[WHO] people looking for food [CHARACTERIZED BY] busy people [WILL USE] deliver food to customer*
    * *[WHO] people looking for food [CHARACTERIZED BY] people looking for food [WILL USE] immediate access to food*
    * *[WHO] people looking for special food or ingredients [CHARACTERIZED BY] unavailability of special food in certain geographical location [WILL USE] provide required food/ingredient to customer at doorstep*
    * *[WHO] customer looking for medical facilities [CHARACTERIZED BY] urban population [WILL USE] providing contact details of clinics and doctors that are nearest to the customer and best in the market*

- Cross verification questions
  - *[DO] people looking for food [CHARACTERIZED BY] busy people [AND] working people [ARE IN STATE] hungry ?*
  - *[DOES] deliver food to customer [WHICH PROVIDES] deliver food hot [AND] deliver food on time [IS A PERFECT SOLUTION FOR] immediate access to food ?*
  - *[DO] customer looking for medical facilities [REALLY NEED] treated at nearest clinic at a price s/he could afford ?*
  - *[DOES] providing contact details of clinics and doctors that are nearest to the customer and best in the market [PROVIDES] clinic closest to their location [TO] customer looking for medical facilities ?*

The idea here was to force startup founders to think. All the possibilities related to the target customer there need and the solution was presented based on the given input. Also, startup founders do have a option to discard the irrelevant options.

In the end, PoSoFiHy asks participants about the overall experience. Going with the overall feedback on the tool 1 out of 5 participants was very dissatisfied with the tool. For the parameters like time spent and content, all the users were satisfied (figure 23). This also shows towards users acceptance towards a new approach. In terms of letting participants brainstorm and learn more about the target customer, there need and the solution PoSoFiHy did a great job. 1 out of 5 participants did say no to the learning aspects related to the target customer, there need and the solution. 5 out of 5 participants were able to find dependencies in the formulated problem solution fit hypothesis. As the concept behind PoSoFiHy was to ensure that the formulated problem solution fit hypothesis do follow the must-have criteria of a hypothesis. It did help in establishing dependencies between the involved components (figure 24).

A concept of formulating different types of hypothesis such as customer need, solution need, and customer solution hypothesis was used in PoSoFiHy. Almost all the participants were satisfied with the approach (figure 25). This is a very positive indication towards this new approach. Also, participants were satisfied with the cross verification questions that were generated by PoSoFiHy.

For the research questions

- [**RQ1**] What are the important components of a problem solution fit hypothesis?

  This research brings various aspects related with the important components of a problem solution fit hypothesis. When it comes for the important components for a problem solution fit hypothesis, target customer, there need and

the solution comes first. PoSoFiHy uses a different way of describing the need. It is based on the concept of current state and the idea state [3]. The current state is described as the existing state where the target customer has a need. Ideal state is the preferred condition where the target customer will be once the need is satisfied.

Also, some of the characteristics that were identified during this research and adds towards answering this research question. The formulated problem solution fit hypothesis should be testable, simple and focused. To be able to do so all the components described above should be present in the formulated problem solution fit hypothesis. Also, one of the important characteristics of hypothesis which is having dependencies. To be able to show dependencies, the formulated problem solution fit hypothesis should have different components. So it is clear that these aspects are interrelated and ignoring one aspect will lead to the formulation of problem solution fit hypothesis which does not serve the intended purpose. Having so many dependencies to make it difficult first to understand and then formulate problem solution fit hypothesis. This also adds towards a need for a framework that can guide startup founders and help them in formulating problem solution fit hypothesis which is able to serve their purpose.

- [**RQ2**] What is a good format for representing problem solution fit hypothesis?

  The survey that was conducted as a part of this thesis had a question about a preferred format for problem solution fit hypothesis. 9 out of 24 participants opted for a format which is our product can help people who are in a specific situation. This can be used to answer the research question but there are other aspects as well. The representation of problem solution fit hypothesis does tend to change based on the type of the startup and also the process used for formulating a problem solution fit hypothesis. After doing this research and going through the ways of problem solution fit hypothesis the answer for the research question will be, if the formulated problem solution fit hypothesis is testable, focused, plausible and is able to show relationship and dependencies between the involved components. Then the used format is a good format for representing problem solution fit hypothesis.

- [**RQ3**] How can we represent the relationship between the involved component in a problem solution fit hypothesis?

  To be able to represent the relationship between the involved components the most important aspect is first understanding the components and how are they related. At present PoSoFiHy asks participants about all the related information about target customer, there need and the solution. Now to represent relationship combinations are used along with some connectors such as

[3] https://medium.com/startupsco/first-step-to-validate-your-business-idea-e24d357768ee

  - WHO component A [IN PRESENT STATE] component C [NEEDS] component D [TO SATISFY] component E
  - component A [CHARACTERIZED BY] component B [IN PRESENT STATE] component C [AND WANTS] component D [BECAUSE] component E
  - THIS component D [WILL HELP TO] component C [BECAUSE IT PROVIDES] component E
  - WHO component A [CHARACTERIZED BY] component B [WILL USE] component D

  The idea here is to use formats and then using the inputs provided by the participants form sentences. Yes, these sentences can be sometimes grammatically incorrect. The dependencies must be visible. From the feedback data from PoSoFiHy, this kind of approach did help participants to understand the dependencies between the involved components. With more research and guidance from language experts, this can be made more perfect.

- **[RQ4]** How can a guided process help startup founders to understand more about problem solution fit state?

  Based on the results from PoSoFiHy, a guided process does help startup founders to think more. Also, different iteration and learning provided during the process helps in creating new knowledge. In general, a process or a framework do help in established a common platform and remove uncertainties. So yes, a guided process does help startup founders to understand more and formulate better problem solution fit hypothesis.

- **[RQ5]** Is there a need for a guided framework to formulate problem solution fit hypothesis?

  Yes, a need has been identified. PoSoFiHy was a very small contribution towards it. More research has to be done covering different aspects and experiments including startup from different sectors. These results can be the true source to identify the exact need.

8. Future Work

PoSoFiHy is a new way of formulating problem solution fit hypothesis. Along with hypothesis formulation, PoSoFiHy aims at ensuring that the created hypothesis does serve the intended purpose. Also, startup founders can cross verify some of the aspects related to the target customer, there needs and the solution. Going with the results, startup founders were satisfied with the approach and the ideology behind it. The developed tool needs more attention in terms of user acceptance. In terms of future work related to the tool, opportunities are numerous.

Going with the initial idea of helping startup founders in formulating problem solution fit hypothesis PoSoFihy was a start. Future aspects of PoSoFiHy consists of first covering all different kinds of a startup business. This startup business includes B2B, C2B, C2C. At present PoSoFiHy takes inputs from users and then form problem solution/customer need/need solution/customer solution hypothesis. Also, the set of the cross verification question is based on the user's input. Future aspect of this can consist of a learning platform that learns from the startup founders inputs. This learning mechanism will be based on specific sectors as e-commerce, fintech, insuretech, and others. The goal here is to reduce uncertainties by asking questions to the startup founders that they would not have thought of.

A platform which can help in prioritizing the formulated hypothesis based on the business requirements. As a startup, you need to be fast. There are various features that a startup product can have. Regular experiments and identifying the most important ones based on user response can help a startup founder to stand out from the race. Also, enabling option wherein multiple users can help in formulating hypothesis and brainstorm on an idea. Collaboration is always good when planning for a product. These aspects can also be considered in the future scope of PoSoFiHy.

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Hiermit erkläre ich, dass ich die vorliegende Arbeit selbständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel verwendet habe.

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