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FACULTY OF COMPUTER SCIENCE

## Why Hardware Startups Fail

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## Acknowledgements

This paper is dedicated to:

My small family my mother, and my Tribes inside and outside Iraq Great City of Baghdad and Mesopotamia who gave me the possibility to pursue my university studies and believed in me all these four years.

To the people of Mesopotamia, the homeland of the apostles and prophets, cradle of civilization, crafters of writing, and home of numeration. Upon our land the first law made by man was passed, and the oldest pact of just governance was inscribed, and upon our soil the saints and companions of the Prophet prayed, philosophers and scientists theorized, and writers and poets excelled.

To my professors, they really only inspired me to be the kind of professor they never were. I can not thank them enough.

*“Fasten the throne [first], then engrave [it].”*

“I love offending people because I think people who get offended should be offended.”

— Heider Jeffer

“Those who are able to see beyond the shadows and lies of their culture will never be understood, let alone believed, by the masses.”

— Plato

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Bolzano, Italy  
2022 March  
Heider Jeffer

## **Abstract**

**Keywords** [hardware] AND [startup OR start-up OR startups]  
AND [Fail OR failure OR fails OR failures OR challenge OR challenges  
OR dead]

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# **1. Introduction**

## **1.1 Problem and Motivation**

## **1.2 Research Question**

The research question addressed in this paper is:

*RQ: Why Do Hardware Startups Fail?*

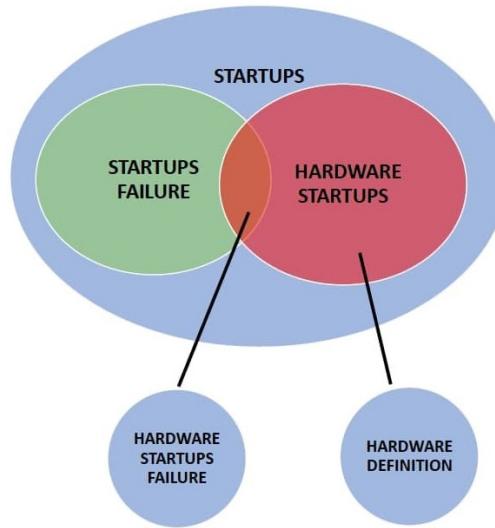
## 2. Background and Related Work

### 2.1 What is Hardware Startup

A Hardware startup is project to create a physical part of computer such as CPU, monitor, mouse motherboard, or ware (such as fittings, cutlery, tools, utensils, or parts of machines) made of metal, or equipment, especially for industrial or military use [1], undertaken by an entrepreneur to seek, develop, and validate a scalable business model for this hardware [2].

Fig.2.1 represent our vision, the phenomena that we study powered by the finding studies and the related work.

Figure 2.1: From startups to hardware startups failure



2018 was the start point, we almost find no publication to cover our research, it was and is still one of many challenges that we faced is to find a scientific paper, publications, related to our research, and our research question, this challenge gave us an idea that the area that we decided to write a paper for it is a new area, but when time pass we started to find a few publications related to our research and they still few, and we can say with confidence that we are the first to walk through this area. We collected the finding studies on Startups to define the Startups in general then we collect finding studies on Startups Failure Hardware and Hardware Startups to have a clear idea of what each of them means and then to go forward in our research to define the Hardware Startups Failure which is the research question of this paper.

## 2.2 Why Startup Fail

According to the European Association of Business Angels (EBAN)<sup>1</sup>, around 300 million founders currently have 150 million businesses worldwide. There are launched about 50 million new projects every year (137,000 per day). CB Insight's research, which analyzed the causes of 101 startup failures, has shown that 9 out of 10 startups fail in 1-3 years, which is a 40% riskier than in standard business models. According to Bloomberg's<sup>2</sup> analysis, 8 out of 10 startups fail over 18 months, mainly due to lack of understanding of customer needs and inadequate revenue generation what also confirms KPMG Startup Survey 2016<sup>3</sup> which define, that only 37% of startups generate revenue (69% up to 50 thousand euros, 23% more than 50 thousand and 8% more than half a million euros) and others do not receive any money yet. Because the primary goal of doing business is to generate finance for covering company costs as well as for shareholders. So every startup should create an ideal revenue model, which describes how a company generates profit and sufficient capital for further investment [3].

Fig 2.2 is the side by side two tables data analysis Why startups fail, the 2018 Top 20 [4] versus the 2021 Top 12 [5]. These two tables published by CB Insights studies and

Figure 2.2: 2018's Top 20 VS 2021's Top 12 Reasons Startups Fail, by CB Insights

TOP 20 Reason Startups Fail (2018)	Top CB Insights 2018		TOP 12 Reason Startups Fail (2021)	Top CB Insights 2021	
<b>No market need</b>	<b>01</b>	<b>42%</b>	Ran out of cash/failed to raise new capital	<b>01</b>	<b>38%</b>
Ran out of cash	<b>02</b>	<b>29%</b>	<b>No market need</b>	<b>02</b>	<b>35%</b>
<b>Not the right team</b>	<b>03</b>	<b>23%</b>	<b>Get outcompeted</b>	<b>03</b>	<b>20%</b>
Get outcompeted	<b>04</b>	<b>19%</b>	Flawed business model	<b>04</b>	<b>19%</b>
<b>Pricing/cost issues</b>	<b>05</b>	<b>18%</b>	Regularity/legal challenges	<b>05</b>	<b>18%</b>
<b>Poor product</b>	<b>06</b>	<b>17%</b>	<b>Pricing/cost issues</b>	<b>06</b>	<b>15%</b>
Need/Lack Business Model	<b>07</b>	<b>17%</b>	<b>Not the right team</b>	<b>07</b>	<b>14%</b>
Poor Marketing	<b>08</b>	<b>14%</b>	<b>Product mistimed</b>	<b>08</b>	<b>10%</b>
Ignore Customers	<b>09</b>	<b>14%</b>	<b>Poor product</b>	<b>09</b>	<b>08%</b>
<b>Product mistimed</b>	<b>10</b>	<b>13%</b>	<b>Disharmony among team/investors</b>	<b>10</b>	<b>07%</b>
Lose Focus	<b>11</b>	<b>13%</b>	<b>Pivot gone bad</b>	<b>11</b>	<b>06%</b>
<b>Disharmony among team/investors</b>	<b>12</b>	<b>13%</b>	<b>Burned out/Lacked of passion</b>	<b>12</b>	<b>05%</b>
Pivot gone bad	<b>13</b>	<b>10%</b>	-----	-----	-----
<b>Lacked of passion</b>	<b>14</b>	<b>09%</b>	-----	-----	-----
Bad location	<b>15</b>	<b>09%</b>	-----	-----	-----
No financing/Investor Interest	<b>16</b>	<b>08%</b>	-----	-----	-----
<b>Legal challenges</b>	<b>17</b>	<b>08%</b>	-----	-----	-----
Don't use Network/Advisors	<b>18</b>	<b>08%</b>	-----	-----	-----
<b>Burn out</b>	<b>19</b>	<b>08%</b>	-----	-----	-----
Failure to Pivot	<b>20</b>	<b>07%</b>	-----	-----	-----
<b>Σ</b>	-----	<b>299</b>	-----	-----	<b>195</b>

data analytic, the 2018 table break down Top 20 reasons why startups fail, while the 2021 table stated Top 12 reason startups fail. CB Insights is a private American company

<sup>1</sup><https://www.eban.org/>

<sup>2</sup><https://www.bloomberg.com/opinion/articles/2015-06-10/>

learning-lessons-from-failures-of-tech-startups

<sup>3</sup><https://assets.kpmg/content/dam/kpmg/pdf/2016/06/startup-ecosystem-survey-slovakia-2016.pdf>

specialized in compiling data about startups. Influential venues like New York Times<sup>4</sup> and The Financial Times<sup>5</sup> have used its reports to illustrate articles. Since 2014, CB Insights compiles notable failure stories, called post-mortems<sup>6</sup>.

In 2018, CB Insights stated the Top 20 reasons for startup failure, by analyzing 101 startup failure post-mortems, CB Insights said that they compiled a list of startup failure post-mortems that they got from startups industries and companies, one of the most frequent requests CB Insights received was if CB Insights could distill the reasons behind the failure down from all these posts that they got. Startups, investors, economic development folks, academics, and corporations all wanted some insight into the question: “Are there a few primary drivers of startup failure?”. Since many startups offered multiple reasons for their failure, we will see that the chart highlighting the top 20 reasons does not add up to 100% (it far exceeds it).

Fig 2.3: We compared the 2021 new CB Insights update with 2018. 2021 update, CB Insights reduced the 2018 Top 20 to Top 12 Reasons Startups Fail ”Why Startups Fail”.

Figure 2.3: Analysis by Heider Jeffer

Reason of Fail	CB Insights 2018	CB Insights 2021
Ran out of cash/failed to raise new capital	29%	38%
No market need	42%	35%
Get outcompeted	19%	20%
Regularity/legal challenges	08%	18%
Pricing/cost issues	18%	15%
Not the right team	23%	14%
Product mistimed	13%	10%
Poor product	17%	08%
Disharmony among team/investors	13%	07%
Pivot gone bad	10%	06%
Burned out/Lacked of passion	08%	05%
$\Sigma$	299	195

Following the chart is an explanation of each reason and relevant examples from the postmortems.

By comparing the 2018’s Top 20 table with the 2021’s Top 12 table, we break down these factors and questions as following:

- **Increased:** Ran out of cash/failed to raise new capital and Regularity/legal challenges, increased rapidly from 29% to 38%, and 08% to 18% respectively.
- **Question:** Is the increase happen because the startups companies and industries fail to increase the failing reasons of their startups product?
- **Decreased:** Not the right team, Poor product, and Disharmony among team/ investors decreased rapidly from 23% to 14%, 17% to 08% , 13% to 07% respectively.

<sup>4</sup><https://www.nytimes.com/2019/02/10/technology/new-wave-unicorn-start-ups.html>

<sup>5</sup><https://www.ft.com/content/65f08660-a762-11e9-984c-fac8325aaa04>

<sup>6</sup><https://www.cbinsights.com/research/startup-failure-post-mortem/>

**Question:** Is 2021 CB Insights decreased these reasons from 2018, because the startups companies and industries they success to decrease the failures factors of their startups product, and they modified the business model to improve the startups product?

- **Added:** 2021 Top 12 CB Insights added the following fail reasons: failed to raise new capital and Flawed business model.

**Question:** Are CB Insights added these two reasons because they are new problems appear in startups products line?

- **Removed:** 2021 Top 12 CB Insights removed the following fail reasons: Need/Lack Business Model, Poor Marketing, Ignore Customers, Lose Focus, Bad location, No financing/Investor Interest, Don't use Network/Advisors, and Failure to Pivot.

**Question:** Are CB Insights removed these reasons in the 2021 new update, because the startups companies and industries solved the problems in 2021 so CB Insights removed these reasons from the Top 12?

### 2.3 Studies on Hardware Startups

- An advanced materials research by Tim van Erp from University of Southern Denmark stated the following: "Hardware startups address the development of innovative tangible products. The hardware product itself may consist of mechanical, electrical, and software components [6]."
- "A preliminary study of agility in business and production – Cases of early-stage hardware startups, the interesting thing about this study is the involvement of many important players in tech communities such as Internet-of-things (IoT),cyber-physical systems and advanced robots with Hardware Startups, on the other hand, the study involves the important new player Industry 4.0 and the role on Hardware Startups, the study stated the following: "The startup landscape includes not only pure software products, such as web platforms, mobile apps, and desktop applications but also products that are composed of both software and hardware units. With the Industry 4.0 revolution, there is an increasing amount of hardware-related products in the domain of Internet-of-things (IoT),cyber-physical systems, and advanced robots. The entry threshold for starting a business around hardware-related products has never been lower due to the popularity of hardware ecosystems [7]."
- Interesting finding studies focus on how to create a business model to build hardware startups driven by the Linux community. Open Source Hardware Startups and Their Communities, the study integrated a very important Linux Distro (distribution) (Redhat)<sup>7</sup>, and the Redhat community, to help the open-source industries to build an open-source Hardware Startups driven by the Linux community and powered by an open-source software [8].

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<sup>7</sup><https://www.redhat.com/en>

## 2.4 Related Work on Hardware Startups Failure

We found a few studies to help us to answer for our research question "Why Hardware Startups Fail", almost no studies at all. We find an article in Wired<sup>8</sup> that discuss with a reliable, credible, authoritative, and trustworthy resources related to research question "*Why Hardware Startups Fail*", Wired is a monthly American magazine, published in print and online editions, that focuses on how emerging technologies affect culture, the economy, and politics. Erin Griffith is a senior writer writ an article "Why Do Startups Fail? Because Hardware is Hard" published in Wired to investigate companies, industries on their hardware startups failures, the writer provided his article with important researches and studies from CB Insights on the failure of Hardware Startups, the writer stated the following: "Investors have been loath to repeat the mistake ever since. Venture funding for hardware startups hit an eight-year high in 2016, with investors pouring 4.4 billion US dollars into 624 startups, according to data provider CB Insights. Hardware entrepreneurs are eager to use a successful crowdfunding campaign as evidence of customer demand for their products. If tens of thousands of people are willing to donate money or pre-order a product that doesn't yet exist, surely millions will want to buy it in a store, the thinking goes. More than half of gadget startups raised their first funding on a crowdfunding website, according to CB Insights. CB Insights found that the top reason unsuccessful startup founders believe their companies failed is the lack of a market need for their product (See Wired[9])".

Fig 2.4: We created this figure to compare the 2017's Top 9 [10] Reasons Hardware Startups Fail by CB Insights with the 2021's Top 9 Reasons Hardware Startups Fail by Heider Jeffer [11].

Figure 2.4: 2017 TOP 9 Hardware Startups Fail CB Insights VS TOP 9 Hardware Startups Fail Heider

TOP 9 Hardware Startups Fail by CB Insights (2017)	TOP CB Insights 2017		TOP 9 Hardware Startups Fail by Heider Jeffer (2021)	TOP Heider Jeffer 2021		
Lack of consumer demand	1	38%	Product strategy mistakes	1	6/24	25%
High burn rate	2	28%	Lack of consumer demand	2	4/24	≈ 16%
Lack of interest after crowdfunding	3	24%	High burn rate	3	4/24	≈ 16%
Product strategy mistakes	4	21%	Manufacturing setbacks	4	3/24	≈ 12%
Manufacturing setbacks	5	17%	Lack of interest after crowdfunding	5	2/24	≈ 8%
Too much competition	6	14%	Investors/founder misalignment	6	2/24	≈ 8%
Consumer adoption barriers	7	14%	Too much competition	7	1/24	≈ 4%
Investors/founder misalignment	8	10%	Consumer adoption barriers	8	1/24	≈ 4%
Regulatory uncertainty	9	03%	Regulatory uncertainty	9	1/24	≈ 4%
Σ	-----	169%	-----	-----	1	100%

- **TOP 9 Hardware Startups Fail by CB Insights 2017:** CB Insights has found that a staggering 97% of consumer hardware startups ultimately fail or fizzle out without a large exit. This is a much higher rate of failure than is seen by tech startups as a whole. This brutal statistics makes it especially interesting to dig in and look at the reasons for failure, in this paper, we used the CB Insights studies (Top 9 reasons Hardware Fail) for coding the QDA (Qualitative Data Analysis). After sifting through hundreds of consumer hardware failures, CB Insights identified the most common reasons for failure among these startups. Given the fact that there are often several reasons for a startup's demise, CB Insights attributed the

<sup>8</sup><https://www.wired.com/story/why-do-startups-fail-because-hardware-is-hard/>

failure to multiple reasons for several of the companies in our sample, and we will notice that in the chart below. The top reasons for failure don't add up to 100%. They far exceed that percentage. It's worth noting that this type of data-driven analysis would not be possible without several founders being courageous enough to share the stories of their startup's demise with the world. CB Insights was able to look through the data to identify nearly 400 companies that failed or fizzled out, and identify the reasons for the failure of dozens of them thanks to founder post-mortems.

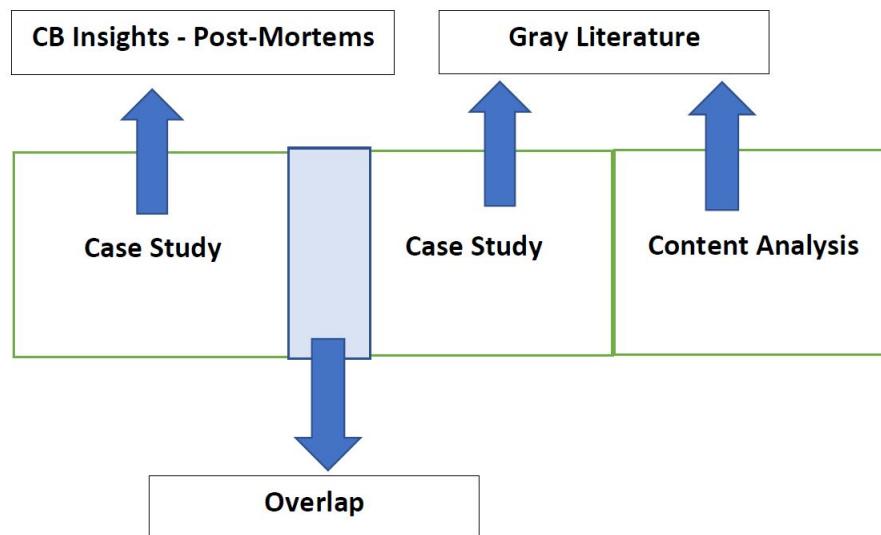
- **TOP 9 Hardware Startups Fail by Heider Jeffer 2021:** By analyzing CB Insights 101 startup failure post-mortems data, these 101 post-mortems are startups in general, and we only need "Hardware Startups Fail", we found 24 Hardware Startups Fail from the 101 Startups, we found the Top 9 reasons that these 24 Hardware Startups Fail and we ranked them (from Top to Bottom) as following: 25% Product strategy mistakes, 16% Lack of consumer demand, 16% High burn rate, 12% Manufacturing setbacks, 0.08% Lack of interest after, 0.08% crowdfunding Investors/founder misalignment, 0.04% Too much competition, 0.04% Consumer adoption barriers, and 0.04% Regulatory uncertainty, respectively, which is a noticeable difference from CB Insights Top 9, on other hand our Top 9 reasons for Hardware Startups Failure do not exceed the 100%, but they stay below the 100% while in CB Insights they scored (169%) far exceed the 100%.
- **Top 9 by CB Insights 2017 and Top 9 by Heider Jeffer 2021 The Differences The Similarities, and what we Learned:** Even when we used the (same) CB Insights Top 9 reasons Hardware Startups Fail in our process and the same CB Insights' companies and industries with their hardware startups fail as input, but our output is deference from CB Insights Output.
- **Lesson to Learn:** The differences between our Data-Analysis and CB-Insights analysis occur, because: We used more than one resource for each Hardware product to study the reasons of Hardware Startups Fail, we make massive research in websites, official interviews, mainstream news, scientific journal, and social media, we gather all these formations and we added them to CB Insights inputs that we already had to code the reason of hardware startups product fail, while CB Insights didn't tell us how many Hardware Startups fail and what is the total number of the hardware startups fail, and how they did analyze their post-mortems from 2004 till latest update in 2021.

### 3. Research Approach

We used NVivo 12 software for qualitative data analysis, , in this chapter we will use the same terms Nvivo 12 used to explain the finding study of our research (e.g. Items, Code, Nodes, Map, Mind Map..etc.)

This study is designed to be exploratory due to the nascent nature of the startup research area and the limited number of previous studies on Hardware Startups failure. In order to quickly obtain useful data and understand the directions of inquiry in future primary research, we decided to use secondary data on the hardware startups fail examples that we could find on different websites, to develop an initial understanding of the phenomenon under the study[12].

Figure 3.1: phases



### **3.1 Phase 1: CB Insights Post-Mortems**

Step 1: case studies from CB Insights post-mortem

We harvest the data on hardware startups failure based on a scientific paper study published by [Usman Rafiq<sup>1</sup>], it is true that the Usman's study focused on software startups failure CB Insights, but the study help us, because in his paper extracted the failed software startups and hardware startups from the startups products in general, these data published by CB Insights,

Step 2: processing the Usman project

we only selected the 24 hardware startups failures, from the CB Insights Top 9 reasons hardware startups fail for coding the reason of failure for all 24 hardware startups to approach the fail of the hardware startup.

#### **3.1.1 Data Collection**

Step 3: The data source used for this study is the CB Insights post-mortem database.

CB Insights is a private American company specialized in compiling data about startups. Influential venues like New York Times and The Financial Times have used its reports to illustrate articles. Since 2014, CB Insights compiles notable failure stories, called post-mortems. These stories contain official communications from startups communicating the failure, founders post on personal blogs, or news in specialized media about the failure.

Step 4: Take only Hardware Startups Product,

These CB Insights Post-Mortems represent product of Startups failures in general (Hardware, Software..etc) we choose only the hardware product that failed. For better understanding the reason(s) of failure, we collect more information about these hardware products from the websites.

Step 5: Code the Failure Factors,

We code the reason(s) of fail for each product, these codes are based on the CB Insights top 9 reasons of failure, then we create a table to store the following information: product name, description, and From "from where the product come, Whether the Hardware came from CB-Insights or from Gray Literature or from Both' (See Table 4.1).

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<sup>1</sup>[https://www.researchgate.net/publication/352462012\\_Analytics\\_Mistakes\\_that\\_Derail\\_Software\\_Startups](https://www.researchgate.net/publication/352462012_Analytics_Mistakes_that_Derail_Software_Startups)

### 3.1.2 Data Analysis

#### Step 6: Thematic Analysis

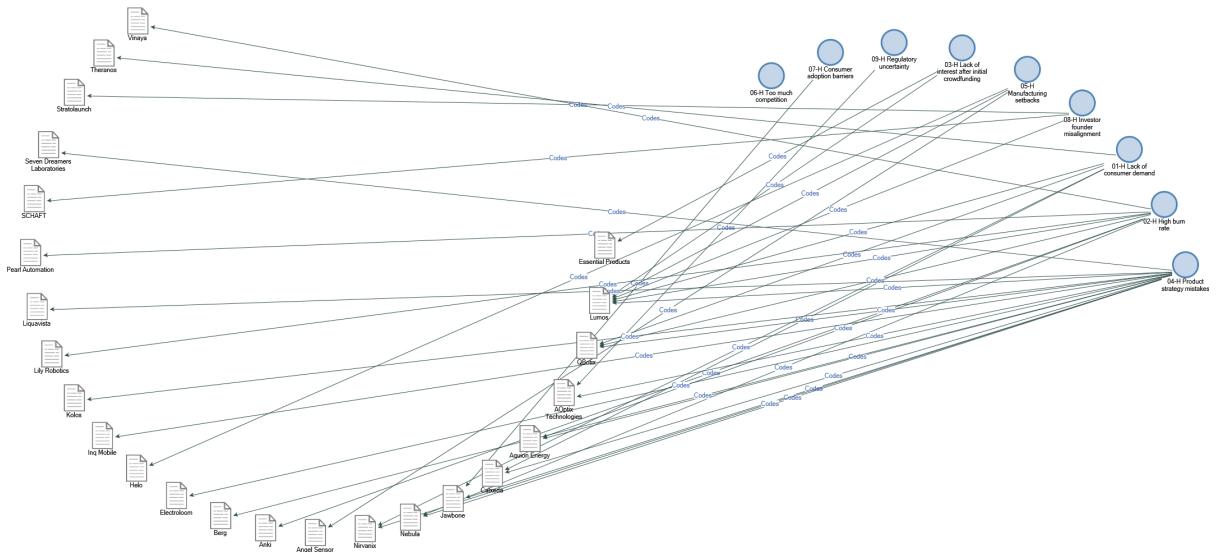
To analyze data, we employed thematic analysis, “a method for identifying, analyzing, and reporting patterns (themes) within data”. looking for crucial information that startups have to deal with and trying figure out the mistakes made by the startups in handling this kind of information.

#### Step 7: Nvivo 12 Software and Qualitative Data Analysis

With Nvivo 12 is a software tools for qualitative data analysis, using the CB Insights (Top-9 Reasons Hardware Startups fail) to analysis CB-Insights Post-Mortems.

#### Step 8: Output: CB Insights 24 Cases Finally we have CB Insights output Fig.3.2 From this phase we have 24 case study from CB Insights (See the 24 hardware startups in the 'left' side of Fig.3.2) we coding them with Top-9 reasons of nodes (see the 9 reasons (9 nodes) in the right side of Fig.3.2) on Why hardware startups fail.

Figure 3.2: Nvivo 12 Project Map:CB Insights post-mortems



## 3.2 Phase 2: Gray Literature

this phase contain content analysis and case study. we used the Grey Literature to harvest more hardware startups failure, Gray Literature is:

'Information produced on all levels of government, academia, business and industry in electronic and print formats not controlled by commercial publishing i.e. where publishing is not the primary activity of the producing body.'

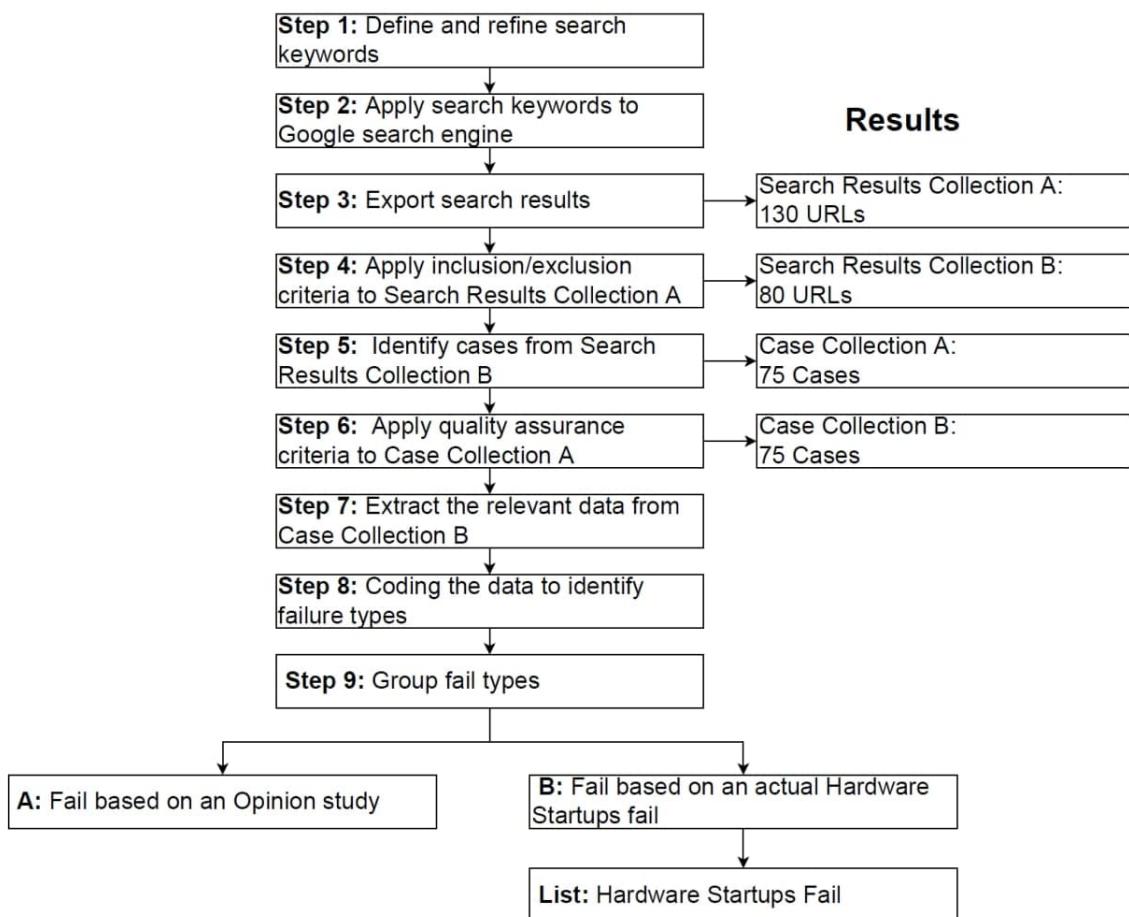
[Grey Literature<sup>2</sup>] to collect our data in Phase 2 we store the content analysis which gave us opinion on with the reason(s) why hardware startups fail we coding them with the publisher(s) own opinion(s), if we find that there is an acutely product(s) in the Gray literature (an actual hardware startups failure) then we store these products to process with our own coding [our own reason(s) 'Why these hardware startups products fail?'], for some cases from the Gray Literature that we harvest, we got an overlap between our coding and the CB Insights. Overall data collection and analysis process employed in the study is illustrated in Fig. 3.3 and explained in detail in the following text.

---

<sup>2</sup><https://guides.lib.monash.edu/grey-literature/what-is-grey-literature>

Figure 3.3: The data collection and analysis process

### Data collection and analysis steps

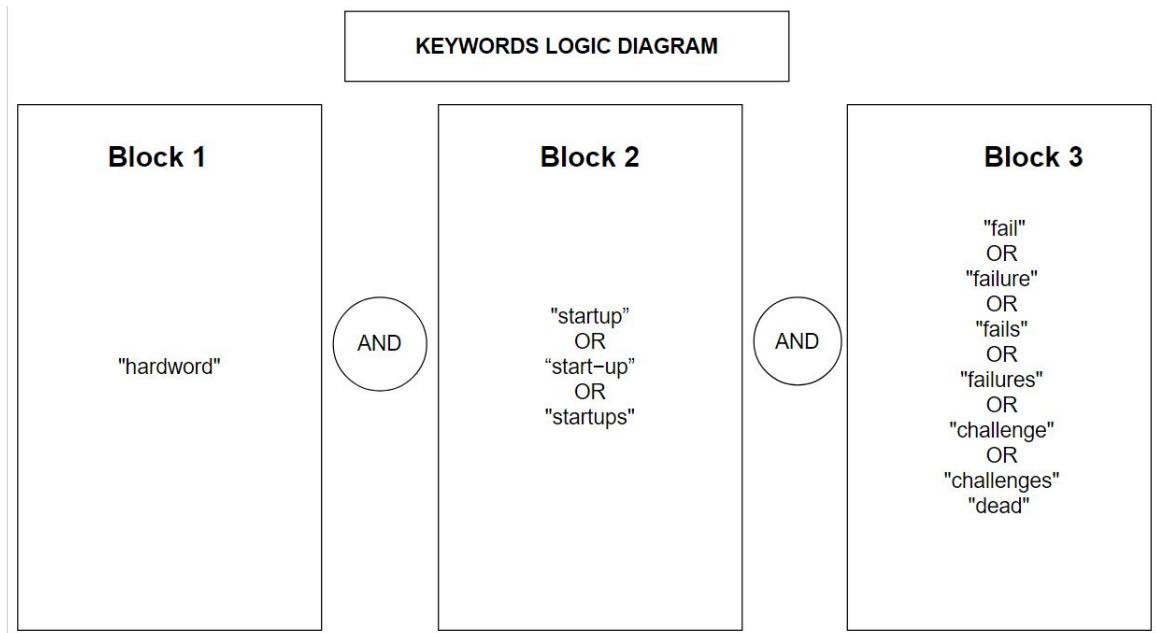


### 3.2.1 Data Collection

Step 1: Define and refine search keywords

The first step of the data collection was to define the search keywords used to search the secondary data. We conducted several trial searches, observed the search results, and refined the search string subsequently. Fig 3.4 As a result, the following 3 items keyword final search string was formulated:

Figure 3.4: Keywords logic diagram



$$\left( \text{"hardware"} \right) \text{ AND } \left( \text{"startup"} \text{ OR } \text{"start-up"} \text{ OR } \text{"startups"} \right) \text{ AND } \left( \text{"Fail"} \text{ OR } \text{"failure"} \text{ OR } \text{"fails"} \text{ OR } \text{"failures"} \text{ OR } \text{"challenge"} \text{ OR } \text{"challenges"} \text{ OR } \text{"dead"} \right)$$

**Step 2:** Apply search keywords to Google search engine

To search online sources, Google search engine was used through Chrome browser. To avoid the influence of geographical location on the search results the website www.google.com was used. Google search engine does show about 14,700,000 results, then, in Google Advanced Search, We narrowed our results by changing the Language Setting to English, choosing language English. As a result, in total 130 results were displayed and eventually accessible.

**Step 3:** Export search results

The search results needed to be exported in order to be analysed by our researchers. We exported the search results manually (in the format of URLs), then we used Google Extension named [Print Friendly & PDF] we used this Google Extension to convert the Web pages into PDFs format, remove from these web pages the adds pictures, web pages headers, footers and unrelated featured to make these web pages clean and light, then we saved these PDFs format in folder in our local machine to use them as a Data base.

**Step 4:** Apply inclusion/exclusion criteria to Search Results Collection A

To select the webpages that contain relevant and reliable content for this study, we applied a set of inclusion/exclusion criteria to Search Results Collection A.

The inclusion criteria are:

- The URL is working, and freely available (or accessible).
- The topic of the webpage is about hardware startup fail context.
- The webpage is in English.
- The webpage must be current, relevant, authoritative, and accurate.

The exclusion criteria are:

- The webpage is non text-based (e.g. videos, audios, or images).
- The webpage on Slideshare, Quora, LinkedIn, Facebook

This step resulted in the Search Results Collection B which contains 80 URLs and represents 80 webpages.

**Step 5:** Identify cases from Search Results Collection B

**Step 6:** Apply quality assurance criteria to Case Collection A

To ensure that we have sufficient and adequate data on the cases for further analysis, we evaluated the quality of data we had on the 85 cases in Case Collection A based on the following quality assurance criteria:

- Does the data about a hardware startup fail, and does the publisher write these data well, to allow the researchers to quote the reason(s) of hardware startup failure and to code these failures from these data?
- Do the researchers have to make excessive guessing in order to understand the hardware startups failures' type and the factors triggering those failures, and/or have to make excessive guessing in order to figure out whether this failure product is hardware startups or startups failure in general?

A case is included if the answer to the first criterion is positive and the answer to the second one is negative. The data regarding these cases are contained in 75 webpages.

### 3.2.2 Data Analysis

Step 7: Extract the relevant data from Case Collection B For each case (hardware startup fail) contained in Case Collection B, we were looking for the following information on the case:

- Background information.
- Reason(s) of the failure.
- Date of the document.

Step 8: Coding the data to identify failure types into Nodes

'Coding means that we attach labels to segments of data that depict what each segment is about. Through coding, we raise analytic questions about our data [...]. Coding distils data, sorts them, and gives us an analytic handle for making comparisons with other segments of data.'(Charmaz, 2014: 4<sup>3</sup>). 'Coding is the strategy that moves data from diffuse and messy text to organized ideas about what is going on.'(Richards and Morse, 2013:167<sup>4</sup>). So coding is the process of gathering related material into a container called a Node. When you open a node, you can see all the references in the project coded to the node.

The data extracted on each case was analysed qualitatively to identify the reason of fail to answer the following question why hardware startups failure. We relied on the explanations given in the case material that we collected from webpages to identify the reason of hardware startups fail.

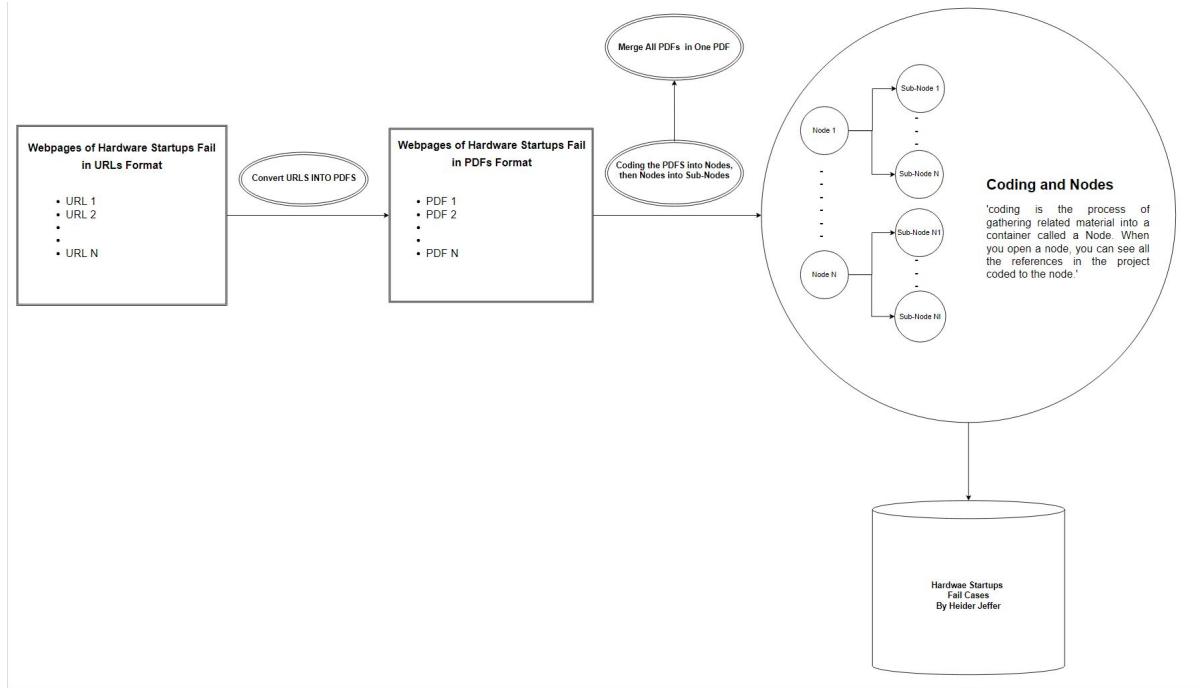
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<sup>3</sup>[https://www.researchgate.net/publication/280609701\\_Grounded\\_Theory\\_and\\_theoretical\\_coding](https://www.researchgate.net/publication/280609701_Grounded_Theory_and_theoretical_coding)

<sup>4</sup><https://us.sagepub.com/en-us/nam/readme-first-for-a-users-guide-to-qualitative-methods/book236735>

Fig. 3.5 Convert the URLs webpages format into PDFs format, clean PDFs from ads, header..etc make the PDFs it friendly PDFs, do the coding for all PDFs to nodes, nodes into sub-nodes, merge all PDFs files into one PDF, finally extract the hardware startups cases from the contents cases and stored them.

Figure 3.5: Coding the data to identify failure types



Now, reorder and refine nodes, remove the duplicated nodes, to keep the project clean, simple with clear cut, usable for users, developers, industries, companies, and the researchers who are welling to use our study and modified our codes, since this study is an open source free software project (Copy Left).

Step 9: Group fail types

To group the reason(s) of Hardware startups fail then do the following:

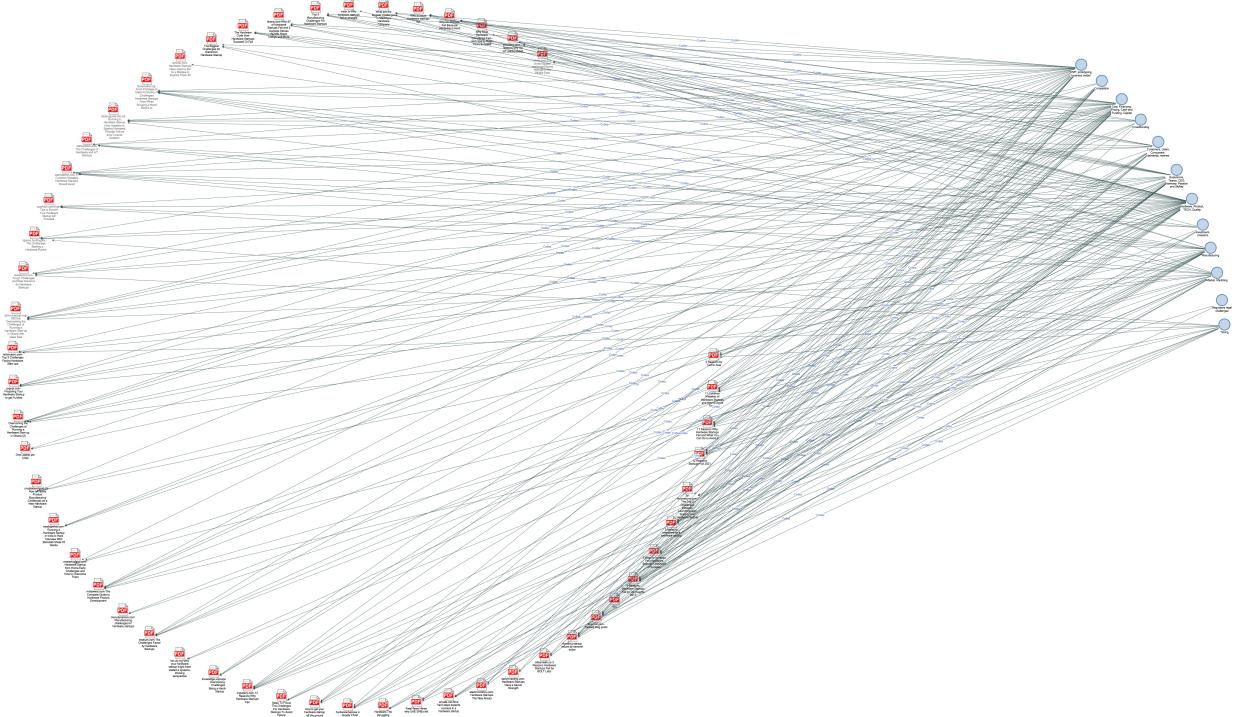
A1 If the fail is based on an opinion study then code the reason of fail.

A2 If the fail is based on an actual Hardware Startups fail (e.g. published by startups industries or startups companies..etc), then repeat [A1], create a table to store the following information: product name, description, and from "from CB-Insights or from Gray Literature or from Both' (See Table 4.1).

As a result, XXX are the total reasons of hardware startups fail, these fails are divided into two parts; based on opinions & based on an actual products fail. We merged all PDFs in one PDF, for better analysis, and understanding to our data, and to put our phenomena in one place, so we have a big picture, this will simplify the study and the check and the balance to correct the error.

Fig.3.6 showing the finding research of our Gray literature, we will explain it in the following text In the left side of Fig.3.6 we have 53 items in total, for the

Figure 3.6: Nvivo 12 Project Map: Gray Literature



sake of simplicity we organised these 53 items into two parts, part A is contents analysis, in which we coding the 288 opinions into nodes, we removed and merged the duplicated nodes then we end up with 12 nodes on why hardware startups fail. In the right side of Fig.3.6 we have 12 nodes for 16 case studies on why hardware startups fail.

Now we complete the two phases, Phase 1 which represent CB Insights with its own case study and Phase 2 which represent the Gray Literature with its case study and content analysis, finally we got the overlap between the two phases. In the next chapter we will show the finding study for our research.

### **3.3 Phase 3: Modelisation, Optimization, and Visualization**

#### **3.3.1 Modelisation: Data**

Data is the case study and content analysis. In Phase 1 and 2 we already optimized our data. In Phase 3 we need to merge these data in one model. Merge the Cases and Content Analysis of Phase 1 with Phase 2. In Nvivo 12 there is a possibility to merge the data, Using this possibility we merged the Cases of CB Insights Post Morterm and and the content analysis of Gray Literature. As a result we got 76 cases and content analysis represent CB Insights Post Morterm and Gray Literature, respectively that that merged in one folder. As a result, all the collected data of Phase 1 and 2 are stored in one model.

#### **3.3.2 Modelisation: Failure Factors**

After merging the data, we need to merge Failures Factors of Phase 1 with Phase 2. By merging the failure factors of CB Insights Post Morterm and the Gray Literature of Phase 1 with Phase 2, We will get 20 failure factors that cause the death hardware startups product that merged in one folder. We have Model for failure factors attached with the data.

#### **3.3.3 Optimization: Data and Failure Factors**

Checking out the initial model that we built in section 3.3.1 and 3.3.2 we noticed that, some of the titles of the failure factors are very similar, and the adjustment is required, In Nvivo 12 it is possible to merge the similar factors into one, by using Nvivo 12 merging possibility we succeed to reduce the 20 failure factors into 4, to speed up the process of understanding the reason behind the failure of the hardware startups product for the future input, and instead of processing the future data with complexity order of 20, 19, 40 keys, we have only complexity of 4 keys to process the future data with [Page 59: Solare Focuses on a Few Key in this stduy 4 keys that merged in one folder. Metrics<sup>5</sup>]. Now we optimized our model. By reducing the factors to 4, we check out the data to see whether these data are attached to any failure factors or not, and we see that all our data are attached to at least to one of these four factors. As a result the model data and the model factors are optimized and functioning as we expected.

#### **3.3.4 Visualization: Data and Failure Factors**

We built a an optimized model for this study with Nvivio 12. The output of this optimized model is data visualization represent the failure factors that reflect content analysis and the hardware startups products that killed by these failure factors. These 4 visualized failure factors are the answer for the research question "Why do Hardware startups fail?", while content analysis and cases are the visualized data playing the evidence part to support the failure factors that answered the research question.

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<sup>5</sup><https://books.google.it/books?id=mIk6x8WNQAwC>

## 4. Research Finding

### 4.1 The Studied Cases of Failed Hardware Startups from CB-Insights and Gray Literature

As we showing in Table 4.1 we find the hardware startups that failed from CB Insights post-mortems and the gray literature that we combined them together, we get 40 cases, the overlapping cases are Jawbone, Lumos, and Theranos, then by merging the overlap cases we will end up with 37 cases in total, as following:

$$\text{Total Case Analysis} = \text{CB Insights} + \text{Gray Literature} - \text{Overlap} = 24 + 13 - 3 = 34$$

Table 4.1: The Studied Cases of failed Hardware Startups from CB-Insights and Gray Literature

Case	Description
<b>Cases from CB Insights</b>	
1 Angel Sensor	A flexible wristband that can be worn 24/7
2 Anki	Harnessing robotics and artificial intelligence (AI) to bring to life consumer products with intellect and interactive capabilities
3 AOptix Technologies	A commercial developer of Adaptive Optics (AO) technology
4 Aquion Energy	Manufacturer of proprietary Aqueous Hybrid Ion (AHI) batteries and battery systems for long-duration stationary energy storage applications
5 Berg	Berg manufactures a complete range of beverage and liquor control systems for liquor, beer, wine, and other beverages
6 Calxeda	formerly Smooth-Stone, brings new performance density to the datacenter on an attractive power foot print by leveraging ultra-low power processors as used on mobile phones as a foundation for its technology
7 Electroloom	is a 3D printer for clothes capable of creating nonwoven fabrics on unique and complex structures
8 Essential Products	is a company focused on creating consumer technology products for the 21st century
9 Helo	is the developer of Sense, a smart sleep sensor. Sense is a sleep tracking device that measures temperature, humidity and ambient light
10 Inq Mobile	is a smartphone-maker, creating a range of devices that included two 'Facebook phones' in 2011
11 Kolos	is the world's first racing wheel for full-sized iPads
12 Lily Robotics	is a technology company that makes flying cameras

Continued on next page

**Table 4.1 – continued from previous page**

Case	Description
13 Liquavista	a spin-out from Dutch electronics Philips, developed and patented an electro-wetting technology for use in electronic display screens
14 Nebula	has developed a technology that can turn backpacks or briefcases to a mobile charger
15 Nirvanix	A provider of enterprise-class cloud storage services designed specifically for customers with expectations of extreme security, reliability and redundancy. Under its Cloud Complete portfolio is focused on advancing the underlying technologies in the autonomous vehicle to improve the experience for every driver on the road today
16 Pearl Automation	employs distributed robotics to significantly increase the economics and improve the capabilities of the solar industry
17 QBotix	providing high-power humanoid robots for dirty dangerous and difficult work, and for research purpose
18 SCHAFT	development of AI, robotics, and healthcare devices
19 Seven-Dreamers-Laboratories	is developing an air-launch platform to make access to space more convenient, reliable, and routine
20 Stratolaunch	is a research and design house that creates lifestyle-enhancing technology products
<b>Cases from Gray Literature</b>	
1 NJOY	was developing electronic cigarette
2 Juicero	is on a mission to invent products, services and experiences that help people consume the fresh foods that manifest true health and longevity
3 Fuhu	a designer, seller and developer of consumer products and services for children
4 Pebble	was developing watches that can display messages from smartphones
5 Zeebo	was the developer of the Zeebo system, a 3G-connected digital entertainment and educational platform
6 Hello	is the developer of Sense, a smart sleep sensor. Sense is a sleep tracking device that measures temperature, humidity and ambient light
7 Coolest Cooler	was a multi-function cooler that was initially funded through the crowdfunding website Kickstarter
8 Zano	project created by Torquing Group to create a remote-control quadcopter drone with a high-definition camera
9 Makerbot	3D printing. Anyone who wanted a desktop 3D printer could buy a MakerBot kit or build a RepRap, MakerBot was the market leader and almost synonymous with desktop 3D printing for many years
10 Pirate3D	3D printer to all its backers and clients but also suspended its operations
11 Novelsys	Reinventing the Mobile Charging Experience

Continued on next page

**Table 4.1 – continued from previous page**

<b>Case</b>	<b>Description</b>
12 Better Place	was a venture-backed international company that developed and sold battery charging
13 One Laptop per Child	was a non-profit initiative established with the goal of transforming education for children around the world; this goal was to be achieved by creating and distributing educational devices for the developing world, and by creating software and content for those devices.
<b>Overlap Cases</b>	
1 Jawbone	formerly Aliph, develops products and services for mobile devices such as headsets and wireless speakers
2 Lumos	a spin-out from Dutch electronics Philips, developed and patented an electro-wetting technology for use in electronic display screens
3 Theranos	is a biomedical device company working on the field of Theranostics, the integration of technology with medical therapies to deliver the RIGHT drug, in the RIGHT dose, to the RIGHT patient at the RIGHT time
<b>CB Insight</b>	24 Case
<b>Gray Literature</b>	+ 13 Case
<b>Overlap</b>	- 3 Case
<b>Total Cases</b>	34 Case

## 4.2 Failure Factors, Cases and Content Analysis

Table 4.2 failure factors that defined by description and proved by the evidence. The first column represent the 4 failure factors of our study, the second column represent the description and how our study define the failure factors, and finally the third column represent the evidence that our study used to prove the definition and the failure factor.

Table 4.2: Failure Factors

Failure Factors	Evidence
<b>1. Industrialisation and Manufacturing Description</b> <ul style="list-style-type: none"> <li>○ Every thing related to the Physical parts of the product and the manufacture that made the product</li> <li>○ Poor product</li> <li>○ Poor execution</li> <li>○ Wrong choice of a manufacturer</li> <li>○ Not considering DFM (Design for Manufacturability)</li> <li>○ Trying to create the next Apple or Tesla</li> <li>○ Product design that ignores technological limitations</li> <li>○ Lack of proper testing</li> <li>○ Lack of Research and Validation</li> <li>○ Wrong Manufacturing Partner</li> <li>○ Lack of Proper Testing</li> <li>○ Product Hardware mistimed</li> <li>○ Manufacturers Capabilities</li> <li>○ Product strategy mistakes</li> <li>○ Product or Service Problems</li> <li>○ Slow technical progress,</li> </ul>	<b>Case Analysis</b> Total = 14 Case <ul style="list-style-type: none"> <li>○ Angel Sensor</li> <li>○ AOptix Technologies</li> <li>○ Aquion Energy</li> <li>○ Berg</li> <li>○ Calxeda</li> <li>○ Helo</li> <li>○ Inq Mobile</li> <li>○ Jawbone</li> <li>○ Kolos</li> <li>○ Liquavista</li> <li>○ Lumos</li> <li>○ Nebula</li> <li>○ Nirvanix</li> <li>○ QBotix</li> </ul> <b>Content Analysis</b> Total = 6 Content
Continued on next page	

**Table 4.2 – continued from previous page**

Failure Factors	Evidence
<p><b>2. Business Model and Economic Description</b></p> <ul style="list-style-type: none"> <li>○ Your business model does not exist</li> <li>○ Scaling</li> <li>○ Prototyping and the MVP</li> <li>○ Sometimes You Just Can not Afford Your Supply Chain</li> <li>○ Funding</li> <li>○ Corporatism</li> <li>○ Communication</li> <li>○ Investor/founder misalignment</li> <li>○ Inaccurate planning or scheduling</li> <li>○ Your bank account is empty</li> <li>○ Underestimating development and production costs</li> <li>○ Pivot gone bad</li> <li>○ Ran out of cash/failed to raise new capital</li> <li>○ Lack of interest after initial crowdfunding</li> <li>○ failed round of financing was reportedly to blame</li> <li>○ Poor Team Management, Requirements Creep</li> </ul>	<p><b>Case Analysis</b> Total = 11 Case</p> <ul style="list-style-type: none"> <li>○ Stratolaunch</li> <li>○ QBotix</li> <li>○ Lily Robotics</li> <li>○ SCHAFT</li> <li>○ Pearl Automation</li> <li>○ Lumos</li> <li>○ Aquion Energy</li> <li>○ Vinaya</li> <li>○ Nebula</li> <li>○ Essential Products</li> <li>○ Anki</li> </ul> <p><b>Content Analysis</b> Total = 9 Content</p>

Continued on next page

**Table 4.2 – continued from previous page**

<b>Failure Factors</b>	<b>Evidence</b>
<p><b>3. Market and Marketing</b></p> <p><b>Description</b></p> <ul style="list-style-type: none"> <li>○ There is no market for your product</li> <li>○ Market risks</li> <li>○ How is your customers</li> <li>○ Market Problems or Lack of Market Demand</li> <li>○ Someone else did it better</li> <li>○ The users do not like it</li> <li>○ Identifying Opportunities</li> <li>○ Meeting Market Demand</li> <li>○ Build your audience before you build your product</li> <li>○ Over Promising to Customers</li> <li>○ Blind trust in customer opinions</li> <li>○ Lack of competitive advantage</li> <li>○ Not Listening to your Customers</li> <li>○ No Competitive Advantage</li> <li>○ Regulatory/legal challenges</li> <li>○ Got out competed</li> <li>○ Trying to do everything for everybody</li> </ul>	<p><b>Case Analysis</b> Total = 7 Case</p> <ul style="list-style-type: none"> <li>○ Theranos</li> <li>○ QBotix</li> <li>○ Nirvanix</li> <li>○ Calxeda</li> <li>○ AOptix</li> <li>○ Jawbone</li> <li>○ Lumos</li> </ul> <p><b>Content Analysis</b> Total = 13 Content</p>
<p><b>4. Teamwork and Expertise</b></p> <p><b>Description</b></p> <ul style="list-style-type: none"> <li>○ Poor Team Management</li> <li>○ Skilled Labor</li> <li>○ Dream-team</li> <li>○ Human Resources</li> <li>○ Experts to Provide Technical Support</li> <li>○ Skills and infrastructure</li> <li>○ The need to hire talent with specialized skills</li> <li>○ Not the right team</li> <li>○ Engineering/technical design issues</li> <li>○ Superiority bias</li> <li>○ Multiple Engineers,</li> <li>○ The team does not work,</li> </ul>	<p><b>Case Analysis</b> Total = Zero Case</p> <p><b>Content Analysis</b> Total = 20 Content</p>

## 5. Discussion

### 5.1 Statement of major finding

The results from the qualitative data analysis of startup analytic for 32 case analysis (hardware startups failures) combined with the 48 content analysis (opinion studies on hardware startups failure) supported the expectation of this paper. The finding show that four significant failure factors that caused the death of the hardware startups product. These four failure factors are:

Industrialisation and Manufacturing, Business Model and Economic, Market and Marketing, and Teamwork and Expertise.

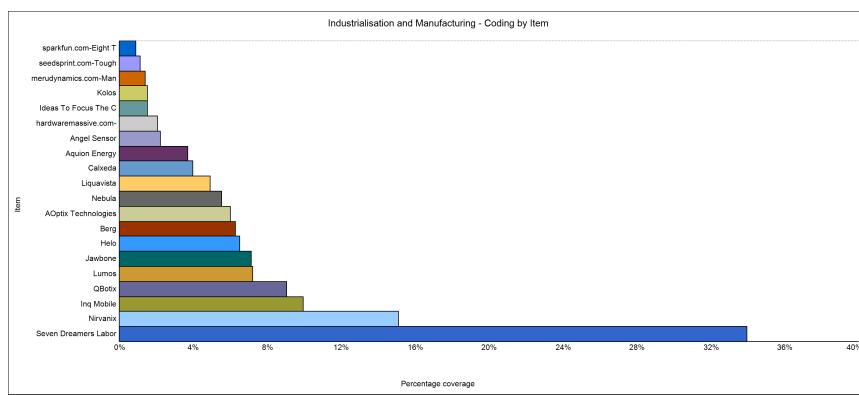
It was found that these four factors are more significantly attached to the failure of the hardware startups products. Beside, base on these four failure factors, there was also significant differences found in the level of attachment in case analysis (hardware startups failure) and the content analysis (opinion studies on why hardware startups fail).

### 5.2 Major Failure Factors

#### 5.2.1 Industrialisation and Manufacturing failure factor

Fig. 5.1 This failure factor caused the death of 14 Cases [Hardware Startups] as following: Angel Sensor , AOptix Technologies ,Aquion Energy , Berg, Calxeda, Helo,Inq Mobile, Jawbone , Kolos , Liqua-vista , Lumos , Nebula , Nirvanix , and QBotix. This failure factors founded in 6 content analysis [Opinion Studies on why hardware startups fail]. The Industrialisation and Manufacturing failure factor is a function of 14 Case Analysis + 6 Content Analysis = 20 as showing in Fig. 5.1

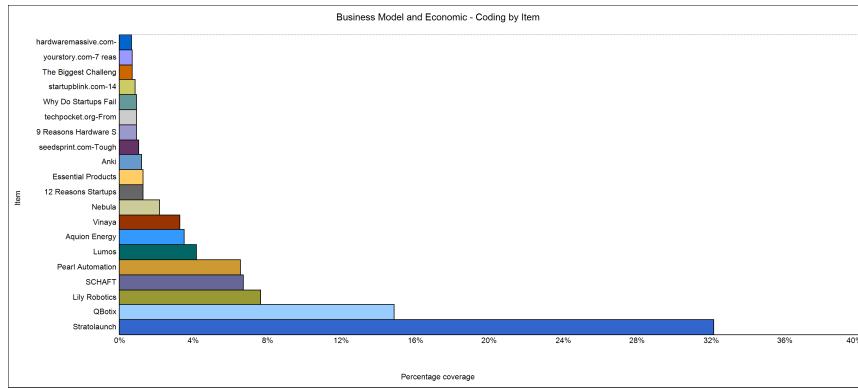
Figure 5.1: Nvivo 12: Industrialisation and Manufacturing - Coding by Item



### 5.2.2 Business Model and Economic failure factor

Fig. 5.2. This failure factor caused the death of 11 cases [Hardware Startups] as following: Stratolaunch , QBotix , Lily Robotics,SCHAFT, Pearl Automation, Lumos ,Aqion Energy, Vinaya, Nebula, Es-sential Products, and Anki. This failure factors founded in 9 content analysis [Opinion Studies on why hardware startups fail]. The Business Model and Economic failure factor is a function of 11 Case Analysis + 9 Content Analysis = 20 as showing in Fig.5.2.

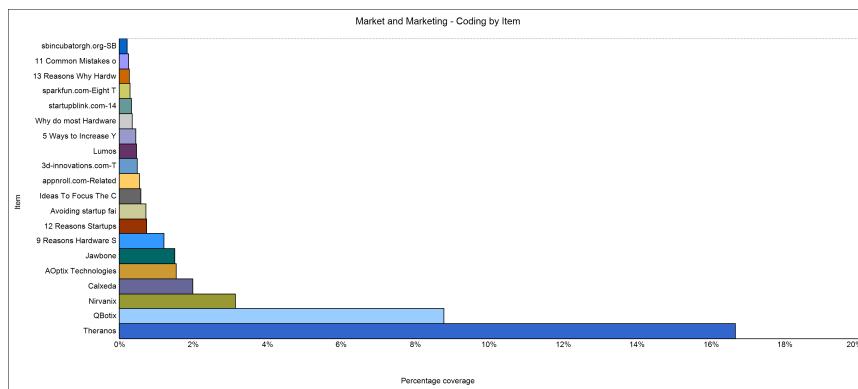
Figure 5.2: Nvivo 12: Business Model and Economic - Coding by Item



### 5.2.3 Market and Marketing failure factor

Fig. 5.3 This failure factor caused the death of 7 cases [Hardware Startups] as following: Theranos, QBotix, Nirvanix, Calxeda,AOptix, Jawbone, Lumos. This failure factors founded in 9 content analysis [Opinion Studies on why hardware startups fail]. This failure factors founded in 13 content analysis [Opinion Studies on why hardware startups fail].The Market and Marketing failure factor is a function of 7 Case Analysis + 13 Content Analysis = 20 as showing in Fig. 5.3.

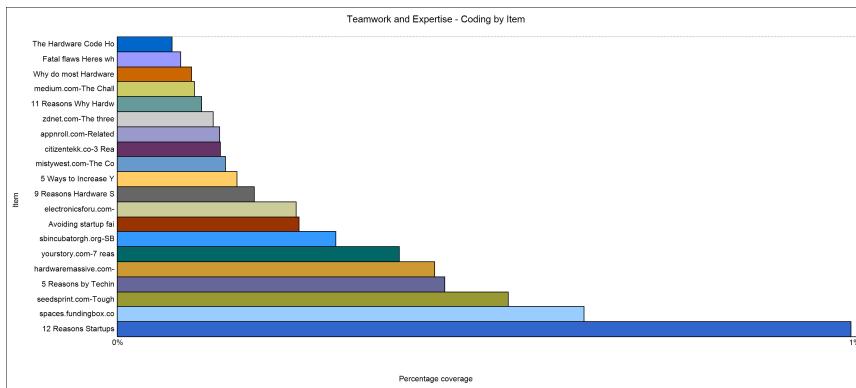
Figure 5.3: Nvivo 12: Market and Marketing - Coding by Item



### 5.2.4 Teamwork and Expertise failure factor

Fig. 5.4 In our study we mentioned the Teamwork and Expertise as fourth failure factor, even when we did not find any evidence support that, we find that failure factors did not cause the death of the [Hardware Startups product] that we collect and attached with it, but since we find this failure factors appear in 20 content analysis [Opinion Studies on why hardware startups fail] we consider it to be the fourth failure factors. The Teamwork and Expertise failure factor = Zero Case Analysis + 20 Content Analysis = 20 as showing in Fig. 5.4.

Figure 5.4: Nvivo 12: Teamwork and Expertise - Coding by Item



## 5.3 Failure Factors Formula

From subsection 5.2.1, 5.2.2, 5.2.3 and 5.2.4, we can provide a formula for the failure factors, as following:

$$\text{The Failure Factor} = \text{Case Analysis} + \text{Content Analysis} = 20 \text{ Case analysis and content analysis.}$$

This formula will help us to establish the relation ship between the failure factors with case and content analysis, in another word this formula showing the relation between the Qualitative data Analysis which is the reflection of the failure factors and Quantitative data analysis which is the reflection of case and content analysis.

## 5.4 Compression with relevant literature and previous finding with significance contribution

In a study done by CB-Insights<sup>1</sup> it found that there are 9 failure factors behind the failure Hardware Startups. In a study done by Industery<sup>2</sup> for an online manufacturing platform for engineers & designer On demand Manufacturing & Prototyping Services On demand Manufacturing and Prototyping Services. The study shows 13 failure factors behind the

<sup>1</sup><https://www.scribd.com/document/411970038/CB-Insights-Hardware-Startups-Fail-pdf>

<sup>2</sup><https://www.industery.com/blog/reasons-why-hardware-startups-fail/>

death of the Hardware Startups. In a study done by Outdesign <sup>3</sup>, the study shows that 12 failure factors cause the death of hardware startup.

Industry, Outdesign and CB-Insights they did not showing the methodology that they used to drive these failure factors. Here we will compare our study with CB Insights and this Comparison is the same with Industry and Outdesig, so for simplicity we will compare our study with CB-Insights.

At CB Insights Website, they publish the entire failing startups in one basket, without classification or categorising, either these startups are software startups, hardware startups, as researchers focusing on startups analytic ,we found that is a kind of a messy process for qualitative data analysis, because we have no idea if these post mortem is a software product or Hardware Startups product , we have no idea which failure factors caused the death of hardware startup, CB-Insights study only mentioned the failure factors that cause the hardware startups to fail without attaching, or naming the hardware startups that killed by that factor(s). What we learned during our work in this study is to speed up rather than slowing down the startups analytic process, speed up is an important point that recommended by startups experts and startups founding father [Page 59: Lean Analytics: Use Data to Build a Better Startup Faster Book by Alistair Croll and Benjamin Yoskovitz <sup>4</sup>] the 9, 13, and 12 failure factors that mentioned by Industry, Outdesign and CB-Insights could slow down the analytic startup process, and causing a misleading, for example, the CB Insights failure factors had high numbers of factors for hardware startups which is 9 which is a high number for hardware startup, CB-Insights named the CEO of the but not the product and let the readers and the website visitors to guess the name of the failing product that produced by that CEO, other time CB Insights mention the failing product but without attaching the failure factor that caused the death of that product. In our study we grouped, categorized, classified the data, then we stated the failure factor and hardware product the died because of that factor, in our study, we take advantage from the opinion studies that relative to that failure factors. In Industry, Outdesign and CB-Insights we find a similarity between these failure factors, for example in CB-Insights study some of these factors can be merged in one factors in sake of simplicity, and speed up the analytic process, in our study we can go ahead with 20 failure factors but we decided to spend more time to merged these 20 failure factors into 4 failure factors to keep our study simple and clear with clean cut. Finally CB-Insights did not use and take advantage from the Gray Literature, in our study we open the door for Gray Literature for more data analytic and expand the knowledge and the expert studies opinion about the reason(s) behind the failure of the hardware startups, so anyone who read this study can understand which cause which and why this cause that and the evidence behind them.

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<sup>3</sup><https://www.outdesign.co/single-post/11-reasons-why-hardware-startups-fail-and-what-you-can-do-to>

<sup>4</sup><https://books.google.it/books?id=mIk6x8WNQAwC>

## 6. Conclusion and Future Work

### 6.1 Conclusion

The purpose of this research was to identify the failure factors that cause the death of hardware startups product. Based on the startups data analytic it can be concluded that there are four factors that cause the failure of the hardware startup. It could be useful to finding the solution to prevent the failures to help the startups industrial companies to improve the hardware startups product.

In this study we have clearly and concisely answered the main research question 'Why Hardware Startups Fail'.

We have summarized my overall argument and key takeaways. Through my analysis from CB-Insights Failure Post Mortem and Gray Literature it's been proven that the following 4 failure fractures:

1. Industrialisation and Manufacturing
2. Business Model and Economic
3. Market and Marketing, and
4. Teamwork and Expertise

These four failure factors they caused the death of Hardware Startups, these failure factors that we mentioned are clearly explained what our research has contributed to knowledge.

This project challenged conventional ideas for the industrial startups companies about Hardware Startups process and the failure factors that caused the fail of the hardware startup.

### 6.2 Future Work

We have to mention important limitations of the research with a given relevant recommendations for future work.

- o Exceed the keywords

Exceeding the study keywords and adding to the current keywords the following: IOT, Electronic devices.

- o Gray Literature

We work hard on the current Gray Literature, the deadline to publish this paper is a challenge, we think that we need to improve current Gray Literature, simply by using the current Gray Literature that we used in this study, and including the new keywords to expand the search engine and include more information, by saying (more information) this we will improve the data analytic qualitative and quantitative levels.

- o The Model

During writing the introduction of this study We found that we built a great model reflecting the research question, but forgot to assign to appointed a chapter to describe such important model with details, in the current paper the model that

we built is distributed and lost in different chapters, sections, and subsection of this study which make us feel so sad that we miss nerves of our study (the model and the formula) that we built and help us to answer the research question, we did not mention a chapter to describe it, beside, improve the model that we built in this study, to make it more close to represent any hardware that fail and the failure factors that caused the death of that hardware. Using the current model that we built in this study and improve it, modify it than build on it more sufficient model to collect the hardware failure.

- The way this study is written, reflect, the target of this study.

Is this study for elite and elitism or is it for average user?

Every time we work and writing this paper, we think about that question "Who is our target?" answering this question will reflect the way and the word we used to write this paper, if our target is the elite and elitism then our study will be less popular, if our target is the average user then this paper will become more popular, there is no secret we can not stand the elite and elitism at all. Therefore we put more effort to simplify the complexity of the scientific sources that we used and explained them in a simple way, and I know this will ruined the way of life of elite and elitism in UNIBZ , and, yes, indeed, we are so glad to do it, and I wish to write the study more simpler as we can to ruined the elite and elitism harder, beside, it is a good sign when the study ruined elite and elitism .

- Failure Factors

Re-read the Data that we used in this study, and the 20 failure factors that we reduced to 4 failure factors that we build. caused the death of hardware startups. Merging and reducing the 20 failure factors into 4 is still debatable between us and our supervisor, have been saying that we still believe that keeping the failure factors small numbers is better for speed up the process of collecting the hardware startups that fail and the failure factors that cause the fail, is this perfect no, but from our side at the time we write this paper we believe there is not a better or alternative way then the 4 factors that we recommended in this paper

- Accuracy and Precision

We believe accuracy and precision is so important, it is the sign of honesty. In this study we work hard to reach accuracy and precision as much as we can, we debate each section with our supervisor, reading, watching, listening to the CEO interviewed in the mainstream media to reach that goal, for every chapter in this study we always keep asking ourselves is our study accrue and precise?

- Racism and Discrimination in Bolzano, Challenges.

"Those who cannot remember the past are condemned to repeat it."

George Santayana

One of many reasons that we have so much Discrimination in the first place in Bolzano or in USA. Matter and fact that, Bolzano becomes a place led by bunch of adult children of alcoholics, fake scientists live in bubbles, they don't get mad on racists people who are destroying them over and over again, but they get mad at the people like me who pointed out the third stage cancer of racism and antisemitism who are killing this city like they did in 1940s. By gas-lighting the honest people in favor of the racism and antisemitism.

Systematic racism, lack of decent home to leave like a human is a challenge ,finding a single room for people who looks like us to study in Bolzano is a challenge, the racists renters in Bolzano that cover up and back up by UNIBZ, fake professors of UNIBZ and the sellout to silence us is not only great challenge but it is a great challenge with very low bar and lack of morality, a lack of decent place in UNIBZ

to study is a challenge after they kicked us from our old building and let our old building empty and full of dust is sad before Covid-19 is challenge, the COVID-19 is a challenge.

In spite of these challenges we determine to go throw them to complete this study, to make it as perfect as we could.In spite of all these challenges, just publishing this study is a prove that we won, humanity won, and racists thugs lost and ruined the racists ways of life, and if I do nothing in my entire life only this, then I can calmly say, this will make me die of an overdose of satisfaction, and if racists believe our work our codes and our moral ruined the way of their life then they did not see things yet.



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## A. Appendix

### A.1 Paper-prototype

Figure A.1: Paper-prototype - first activity

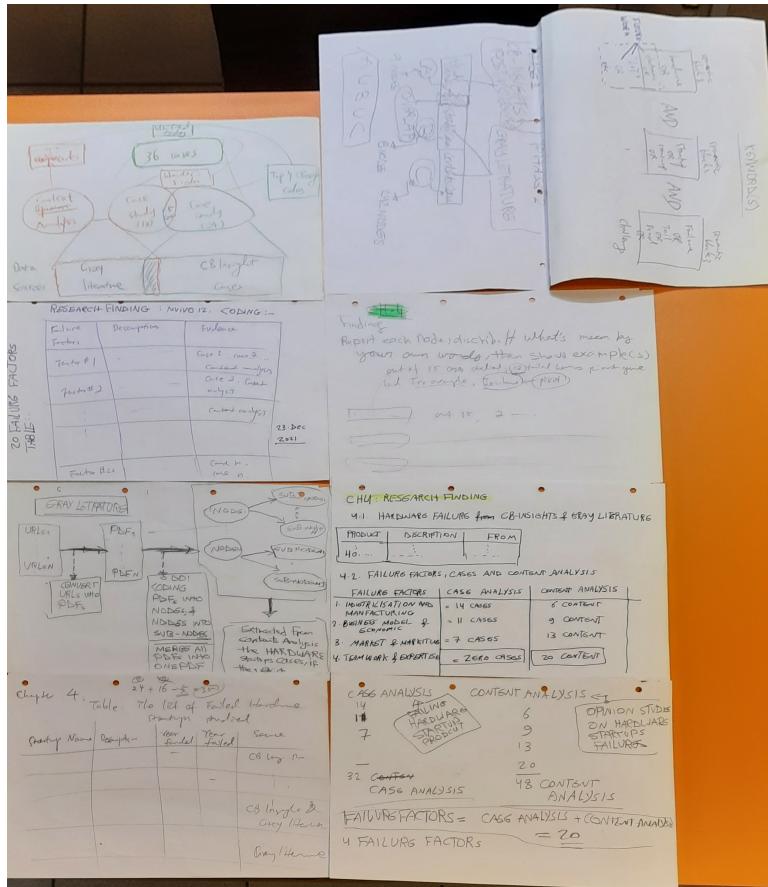


Figure A.2: Paper-prototype - second activity

## A.2 Quantitative Data Analysis

### A.2.1 Case Analysis

The screenshot shows the Nvivo 12 Pro interface with the project title "QDA8.nvp - Nvivo 12 Pro" at the top. The left sidebar contains a "Quick Access" section with icons for Files, Memos, and Nodes; a "Data" section with sub-options like Files, Phase 2 and 3, File Classifications, and Externals; a "Codes" section with sub-options like Codes, Nodes, Failure Factors, Relationships, and Relationship Types; a "Cases" section; a "Notes" section; a "Search" section; a "Maps" section; and an "Output" section. The main workspace displays a tree view under "Phase 2 and 3" with nodes such as Angel Sensor, Anki, AOptix Technologies, Aquion Energy, Berg, Calxeda, Electroloom, Essential Products, Helo, Inq Mobile, Jawbone, Kolos, Lily Robotics, Liquavista, Lumos, Nebula, Nirvanix, Pearl Automation, QBotix, SCHAFIT, Seven Dreamers Laboratories, Stratolaunch, Theranos, and Vinaya. To the right of the tree view is a search bar labeled "Search Project" and a table titled "Search Results". The table has columns: Name, Codes, Referer, Modified On, Modified, and Classification. The table lists 21 rows corresponding to the nodes in the tree view, with the last row being highlighted.

Name	Codes	Referer	Modified On	Modified	Classification
Angel Sensor	1	1	03-Jul-21 11:30 A	HEIDER	
Anki	1	1	02-Jul-21 8:14 P	HEIDER	
AOptix Technologies	2	2	03-Jul-21 11:52 A	HEIDER	
Aquion Energy	2	2	02-Jul-21 9:20 P	HEIDER	
Berg	1	1	02-Jul-21 9:30 P	HEIDER	
Calxeda	2	2	02-Jul-21 8:14 P	HEIDER	
Electroloom	1	1	02-Jul-21 9:45 P	HEIDER	
Essential Products	1	1	02-Jul-21 9:54 P	HEIDER	
Helo	1	2	02-Jul-21 10:01 P	HEIDER	
Inq Mobile	1	1	02-Jul-21 8:14 P	HEIDER	
Jawbone	2	3	08-Dec-21 7:37 P	HEIDER	
Kolos	1	1	02-Jul-21 8:14 P	HEIDER	
Lily Robotics	1	1	02-Jul-21 11:02 P	HEIDER	
Liquavista	1	1	08-Dec-21 7:41 P	HEIDER	
Lumos	3	6	02-Jul-21 8:14 P	HEIDER	
Nebula	2	3	08-Dec-21 7:51 P	HEIDER	
Nirvanix	2	3	08-Dec-21 7:58 P	HEIDER	
Pearl Automation	1	2	02-Jul-21 8:14 P	HEIDER	
QBotix	3	3	02-Jul-21 8:14 P	HEIDER	
SCHAFT	1	1	03-Jul-21 9:58 A	HEIDER	
Seven Dreamers Laboratories	1	2	08-Dec-21 8:00 P	HEIDER	
Stratolaunch	1	2	08-Dec-21 8:05 P	HEIDER	
Theranos	1	1	03-Jul-21 12:36 P	HEIDER	
Vinaya	1	1	03-Jul-21 11:17 A	HEIDER	

Figure A.3: Nvivo 12 - CB Insights Post Mortem

## A.2.2 Content Analysis

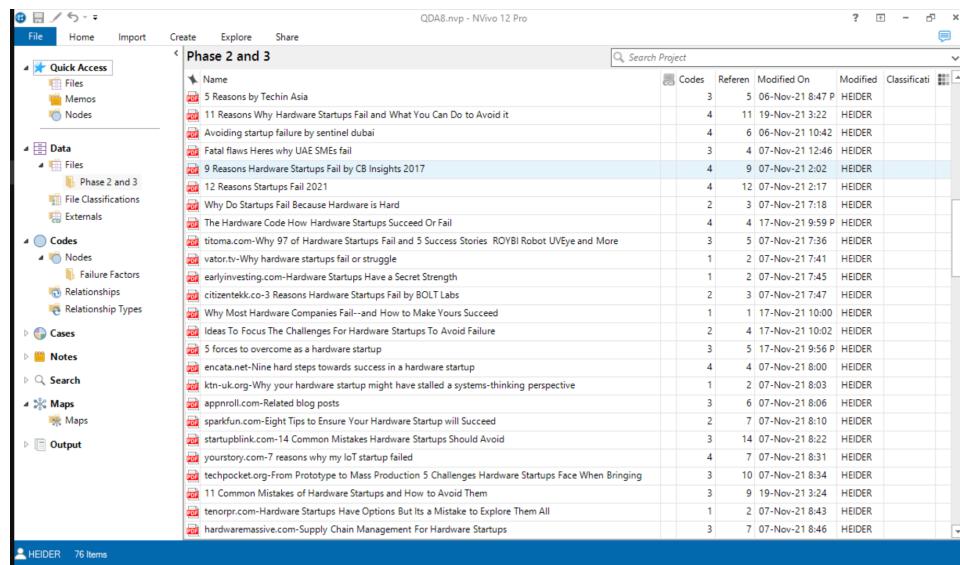


Figure A.4: Nvivo 12 - Content Analysis

## A.3 Qualitative Data Analysis

### A.3.1 Failure Factors

The screenshot shows the Nvivo 12 Pro software interface. The left sidebar contains a navigation tree with categories like Quick Access, Data, Codes, Cases, Notes, Search, Maps, and Output. Under the 'Nodes' section of the 'Codes' category, the 'Failure Factors' node is selected. The main workspace displays a table titled 'Failure Factors' with the following data:

Name	Files	References	Created On	Created By	Modified On	Modified By
Industrialisation and Manufacturing	60	120	07-Nov-21 9:55 AM	HEIDER	24-Dec-21 7:28 PM	HEIDER
Business Model and Economic	53	112	07-Nov-21 10:15 AM	HEIDER	24-Dec-21 7:14 PM	HEIDER
Market and Marketing	38	60	07-Nov-21 9:55 AM	HEIDER	24-Dec-21 7:29 PM	HEIDER
Teamwork and Expertise	25	30	07-Nov-21 10:32 AM	HEIDER	24-Dec-21 7:34 PM	HEIDER

The status bar at the bottom indicates 'HEIDER 4 items'.

Figure A.5: Nvivo 12 - Failure Factors

### A.3.2 Hierarchy chart of Failure Factor - Coding by Item

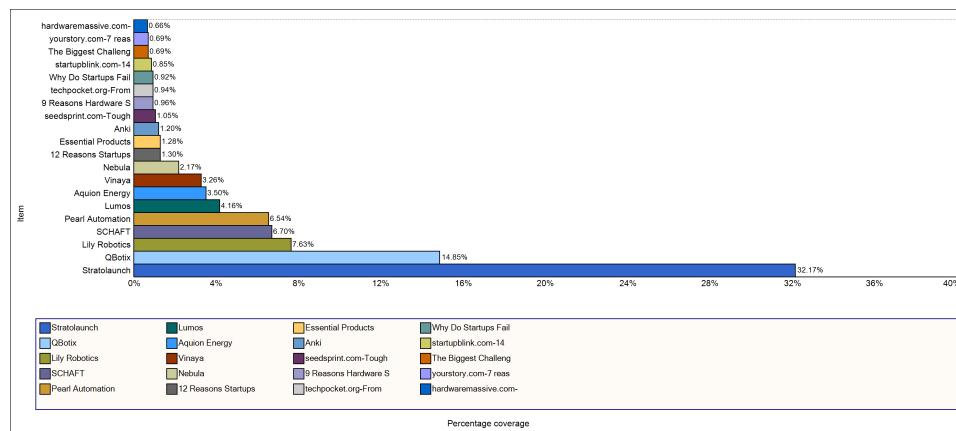


Figure A.6: Nvivo 12 - Hierarchy chart of Business Model and Economic Failure Factor - Coding by Item

### A.3.3 World Cloud



Figure A.7: Nvivo 12 - World Cloud

### A.3.4 Tree Map



Figure A.8: Nvivo 12 - Tree Map

### A.3.5 Cluster Analysis

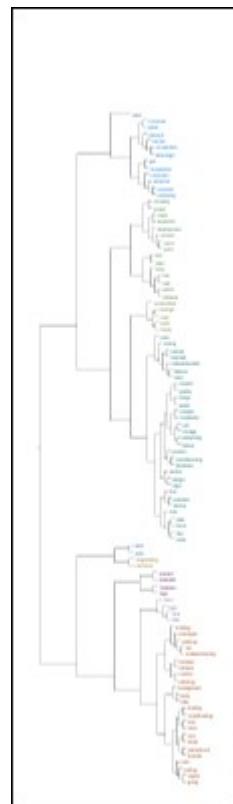


Figure A.9: Nvivo 12 - Cluster Analysis