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MASTER'S THESIS

ANALYZING FRUGAL INNOVATION INTRODUCED BY CROWDFUNDING: A CASE STUDY OF 3D PRINTING AND APPLICATION

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ABSTRACT

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Keywords: Frugal innovation, Reverse innovation, 3D printing, Crowdfunding, Funding, Investment, Crowdfunding platform.

The problem of entering frugal innovative products into market occurs from limited resource constraint. The thesis aims to find an alternative business strategy to ease introducing frugal innovative products into the market. In theoretical part of the study, a review data on frugal innovation and reverse innovation led to identify the problem of introducing frugal innovative products into the market. In research part of the study, a review data of adaptive concept from open innovation to crowdsourcing and 3D printing were shown crowdfunding is the suitable strategy for gathering investment for the frugal innovative product. The study is searching for the possibility to introduce a frugal innovative product by crowdfunding as an alternative business strategy by concentrating on two main topics. Firstly, to identify factors that support the feasibility of introducing frugal innovative product within a crowdfunding platform. Secondly, find successive technique to introduce frugal innovative products within crowdfunding platform.

In the first research analysis indicate that the concerns of real environment, do more with less for more, and three constraints concept of frugal innovation help to support the feasibility of use crowdfunding platform for introducing frugal innovative products into the market. In the second research analysis the data set of 12 and 20 cases studies of 3D printing's crowdfunding platform were indicate the successive technique to introduce frugal innovative product concerning on type of crowdfunding base on product/project purpose, adoption of nine main characteristic contents into platform topic and apply the suitable platform pattern for offering more convenient and effective platform for users by integrate similarity share interesting/ equipment/ program of frugal innovative product.

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I would like to thanks for opportunities that I accepted to study in GMIT program. I have learned new things, get new knowledge and experience, and know friends around the world. I can say this program is changing my life that is leading me to know more what I want to be what I am interested in. This master thesis comes to finalize my GMIT master's program.

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Veerada Auamnuaychai

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1. INTRODUCTION

1.1 Background

In recent years there have been a plethora of new products released in the market. This causes high competitiveness in the market which results in new, more and higher innovative products to be rapidly introduced in the world market. Innovative products have been developed to help people to live more easily, comfortably and fashionably. The innovative products have been attractive mostly to consumers in developed countries where people have more income and better access to the marketplace, while the situation and opportunity in developing countries are dramatically different due to different cost of living and facilities. Therefore, introducing the innovative products to the market and consumers in developing countries is a challenging issue.

To this end, there have been innovations and methodologies developed to overcome this above-mentioned challenges (i.e. Frugal and/or reverse innovation). *Frugal innovation* has been introduced aiming to provide innovative product and technology to the consumers in developing country with low-cost products, by removing some components/parts while the main and necessary responsibilities are still functional. The frugal innovation was originally invented in India and further developed in other developing countries (i.e. ASEAN countries, China, and African countries, etc.). (Bhatti and Ventresca, 2013) Moreover, this concept can also be applied reversely to developed countries using reverse innovation. *Reverse innovation* is a strategic process applying frugal innovation reversely with a modification and re-construction for developed countries with a similar concept (i.e. Low production cost, wide varieties, and sustainability). In particular, low-cost innovative products that have been developed in developing countries are then sold to developed countries resulting in new markets and consumers. (Hossain, 2013b) *Crowdfunding* has been introduced as an innovative platform and/or facility allowing a flexible and easy approach between entrepreneur, investors and target markets. (Schweissguth, 2015) Crowdfunding has been rapidly attractive and growth, which is also beneficial to the growth of frugal innovative products, in particular, the well know frugal innovative concepts, 3D printing. In this study 3D printing is reviewed, analyzed and used to verify

the feasibility of methodology of integrating frugal innovation in crowdfunding platform which is the scope of this thesis topic.

Analyzing crowdfunding platform with 3D-printing innovative product highlights the relationship between frugal innovation, reverse innovation, and crowdfunding. This will result in depth understanding and key to success (a successive technique), in particular, a successive strategy and platform pattern in introducing frugal innovative product by crowdfunding platform. This development and analysis provides a robust guidance to support the development of future business strategy of frugal innovative product within crowdfunding platform.

1.2 Objectives, research question and limitations

1.2.1 Objective:

The purpose of this research is to (i) understand and (ii) develop the methodology to enhance the development of the concept of introducing the frugal innovative products produced by the small enterprises and startups with crowdfunding platform to get more attractions from investors. In particular, the identification of the method for approval the feasibility of introducing frugal innovation within crowdfunding platform is studied and presented. To achieve the first objective, the concept of frugal innovation and crowdfunding were found and introduced with relevant information. And the second objective, the application of the developed frugal innovative products, 3D Printing within crowdfunding platform is highlighted and analyzed through relevant case studies. The successful techniques to introduce frugal innovative products within crowdfunding platform are introduced. In particular, the development of the methodology to evaluate and approve the feasibility and the potential of introducing frugal innovative products within crowdfunding platform is also introduced/proposed to support the future development of business strategy for frugal innovative product.

1.2.2 Research Questions:

The main searching of this study is to evaluate the feasibility of frugal innovative product introduced within crowdfunding platform and to identify the key factors to success. These could be answered by the study of the following research questions:

1. Which factors support the feasibility of introducing frugal innovative products within crowdfunding platform?

2. How to succeed the introducing frugal innovative products within crowdfunding platform? (Techniques: in case of 3D printing)

    2.1. Which type of crowdfunding platform should be provided for introducing frugal innovative product? (Strategy)

    2.2. What is important content that founder need to provide in crowdfunding platform? (Characteristic)

    2.3. What kind of development should be provided for introducing platform pattern of 3D printing's crowdfunding? (Platform pattern)

1.2.3 Scope and Limitations:

The scope of this study is to identify the feasibility of introducing frugal innovation within Crowdfunding platform. At this stage of the study, information collected and reviewed of frugal innovation, investment method for frugal innovative product, grounded framework of frugal innovation (reverse innovation, open innovation, crowdsourcing), crowdfunding, and 3D printing to provide fundamental knowledge is genuinely limited and therefore, the reasonable assumptions and notes will be provided. In particular, the scope of this study and the identification of successive factors and methods will be implemented as follows:

1. Comparing and matching definition, characteristics, and properties between frugal innovative product and crowdsourcing concept to identify feasibility of introducing frugal innovation within crowdfunding platform.

2. Comparing 12 cases studies of 3D printing concept from different type crowdfunding platforms and analyzing deep detail of 20 case studies of 3D printing introduced by crowdfunding platform to identify the techniques (Type of crowdfunding platform, content in crowdfunding platform and the platform pattern of crowdfunding platform) to successfully introduce frugal innovative products within crowdfunding platform.

1.3 Research approach and methodology

In this study, Qualitative research method is used to identify the basis for this research study. In particular, the research approach method contains two sources of data collected using qualitative research and case studies analysis. This thesis has been introduced with four phases (as figure 1)

Phase I, Theoretical data review of Frugal innovation and Reverse innovation are studied for identifying of problems. After the data are reviewed, ideas and questions are then generated for introducing frugal innovative products into the market that is lack of market attraction leading to the difficulty to find the investors and introduce products to market.

Phase II, To overcome this challenge, one of well know frugal innovative concept, 3D printing, which is the integration product concept of reverse innovation and frugal innovation, is reviewed in theoretical data. While theoretical data of the adaptive conceptual framework of frugal innovation is also reviewed at the same time to find best solution/business strategy for introducing frugal innovative products into market.

Phase III, Data collected, knowledge base, and resulting keys to success are integrated in this stage to evaluate the feasibility of frugal innovative product introduced within crowdfunding platform and the identification of key factors to success.

1) Find a supportive reason that enables the feasibility of introducing frugal innovative products within crowdfunding platform by analyzing and comparing definition, characteristic, and properties between frugal innovation and crowdsourcing help to support the use of crowdfunding platform for introducing frugal innovation product into developing market. Assuming frugal innovation as initial cause or motivation and crowdsourcing as solution has proved the approval of suitability to introduce frugal innovative product by crowdfunding.

2) The data and Information on case studies of 3D printing introduced within crowdfunding platform are collected, reviewed, and analyzed to identify the optimal solution for introducing frugal innovative product within crowdfunding platform. This stage contains two types of data collection: 12 cases studies of 3D printing from different types of crowdfunding platform and deep detail of 20

successive cases of 3D printing introduced by crowdfunding platform, which are reviewed and analyzed, and result in finding successful strategy.

Phase IV, discussion, conclusion and recommendation are then reported.

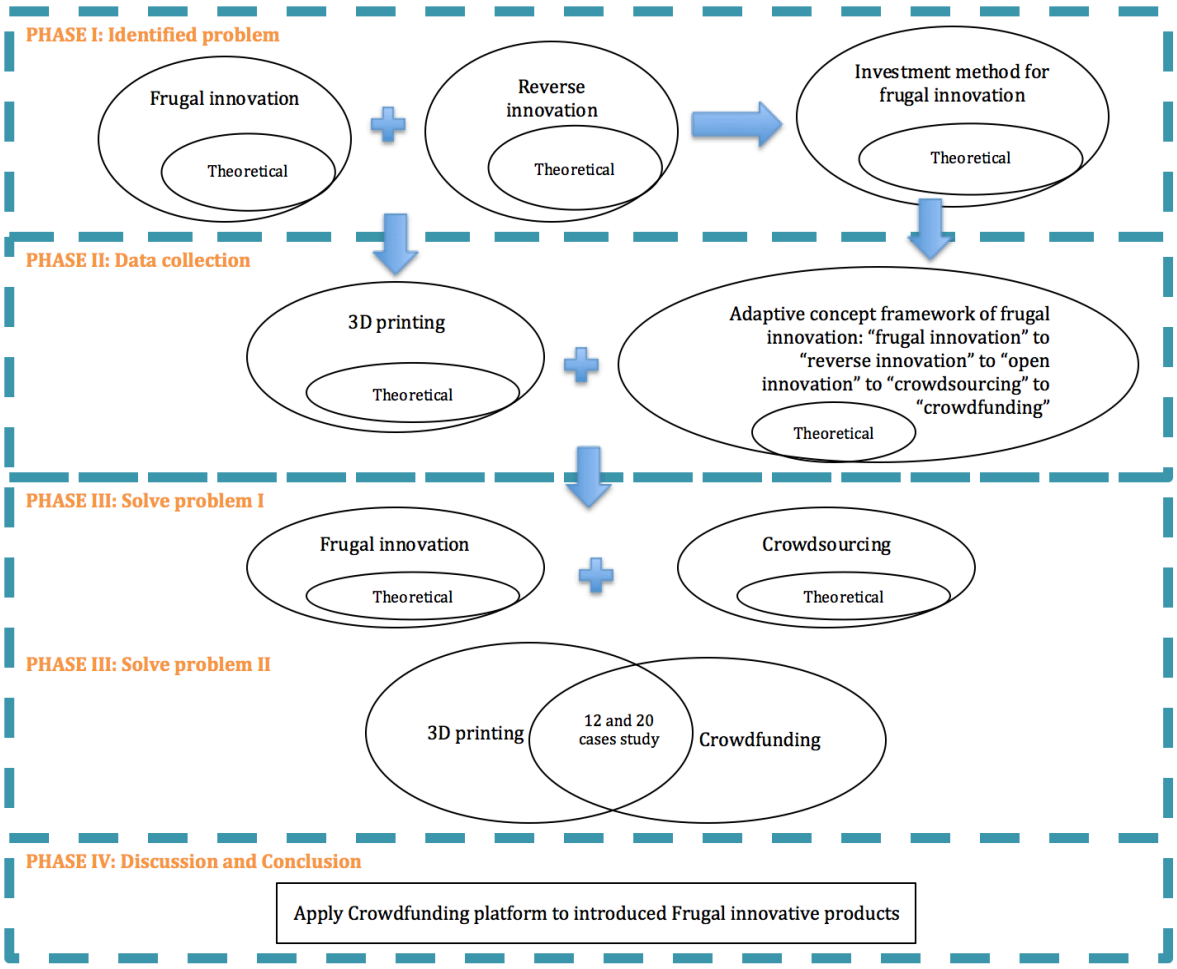


Figure 1. Methodology: 4 phases

1.4 Structure of the thesis

This thesis structure consists of eight chapters and is arranged as in figure 2.

Chapter 1: is a brief introduction to the study, which is mainly about the relevant challenges and motivation of frugal innovation introduced by crowdfunding, which is the main topic involved in this project. The research question, objective and limitation are also explained in this chapter. The Methodology and structure of the thesis are also briefly presented.

Chapter 2: is a literature review, general information and background concepts and relations on frugal innovation, reverse innovation, and analysis situation of frugal innovation product in developed and developing countries.

Chapter 3: presents the framework of the related concept of frugal innovative and 3D printing.

Chapter 4: Explain research strategy & collection of research method and presents the detail data and Information of 12 cases of 3D printing by different types of crowdfunding platform and in deep detail 20 successive cases of 3D printing introduced by crowdfunding platform.

Chapter 5: is the identification of rationality to apply Crowdfunding for introducing frugal innovation. The analysis presents

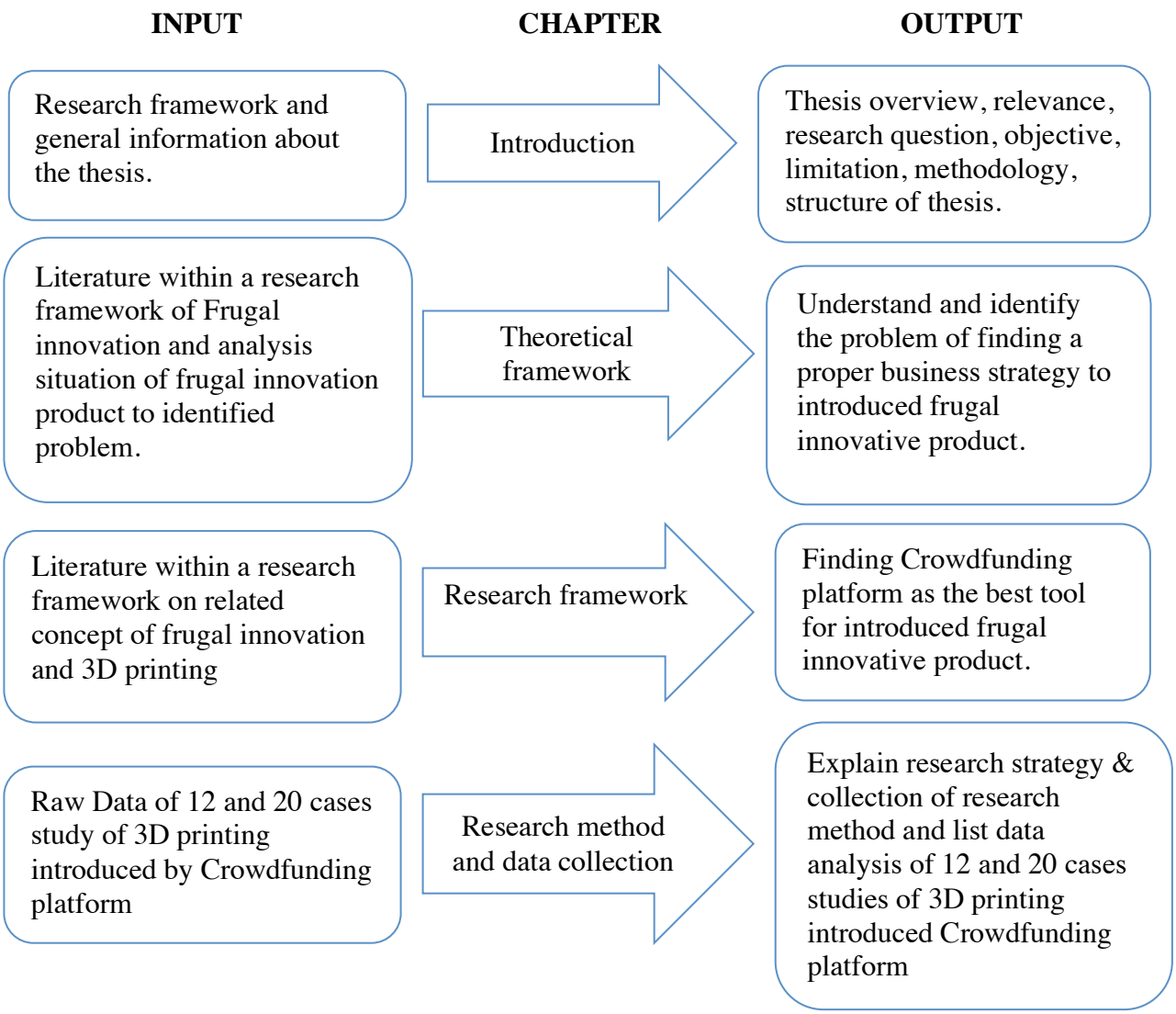
(i) Supportive reason that enable the feasibility of introducing frugal innovative products within crowdfunding platform by analyzing and comparing definition, characteristic, and properties between frugal innovation and crowdsourcing concept to help to support the use of "crowdfunding" platform for introducing frugal innovation products into developing market.

(ii) The most effective techniques to successive introduce frugal innovative product by crowdfunding from collected, reviewed, and analyzed information of:

- 12 cases of 3D printing from different type of crowdfunding platform to find the best crowdfunding type for introducing 3D printing concept which is one of the frugal innovative product.
- In depth 20 successive cases of 3D printing introduced by crowdfunding platform to find the important content and information that founder need to provide and concern to successive introduce frugal innovative products by crowdfunding platform (in case of 3D printing)
- In depth 20 successive cases of 3D printing introduced by crowdfunding platform to find the problem of existing platforms and develop the pattern of crowdfunding platform for suitable introducing 3D printing concept,

which is one category and can develop concept to create successive way to introduce a frugal innovative product by crowdfunding.

Chapter 6: Discussion and conclusion of overall topics that have been studied in this thesis and show the application of obtaining results from integration concept between frugal innovation and Crowdfunding. And also recommendation for further research.



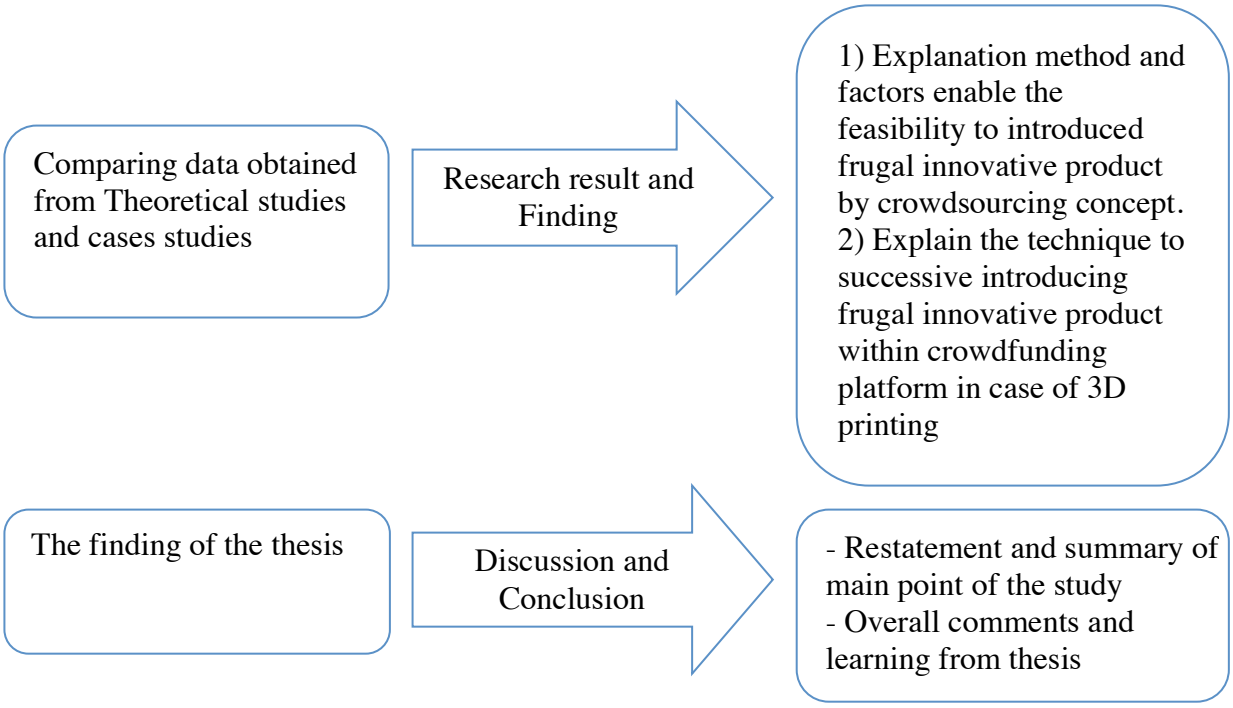


Figure 2. Structure of the Thesis: Input – Output.

2. THEORETICAL FRAMEWORK

2.1 Frugal innovation

This section provides a theoretical discussion of the concepts of frugal innovation. Which presents a definition of frugal innovation, concept of frugal innovation, characteristic and function of frugal innovation, process of frugal innovation, case example of frugal innovation, and finally framework related topic of frugal innovation.

2.1.1 Definition of Frugal innovation

Frugal innovation means affordable and sustainability oriented innovation. (Busa et al., 2013) Sometimes it is called " Bottom of pyramid innovation", "Grassroot innovation", "Jugaad innovation", "Inclusive innovation", "Reverse innovation", and "Shanzhai innovation". Frugal innovation begun from developments for low purchasing power markets by reducing unnecessary part, using low-cost manufacturing and optimizing efficiency as per the principle "do more with less for more people". (Bhatti and Ventresca, 2013: Bhaduri, 2015) It is one of the five types of innovation management, which include customer-based innovation, high speed/ low risk innovation, integrated innovation, Proactive business model, and Frugal innovation. (Eagar et al., 2011)

To understand Frugal innovation, one has to consider separately the meaning of Frugal and Innovation.

Frugal

Frugal means "economical" and "sufficient" refers to high quality, efficiency, affordability, and accessible design of products to people. It explains economic characteristics of resource used with basic and low cost concept. Frugal activity presents doing more (functional) for less (cost). The definition of "Frugality", "Frugal consumers", "Frugal of social science and humanities" perspective, and "consumers and firm" perspective need to be understood by studying marketing literature and consumer research. (Bhatti, 2012)
Frugality refers to "need satisfaction" and "simple search", which mean minimizing and limiting resource constraints (Bhaduri, 2015) and "economically" means careful use of

resources to avoidance of wastes. ((Mark) Lee, 2016) Frugality is the restraint of consumption behavior, acquiring and resourcefully constraint, of economic goods and services to achieve long-term goals using existing resources rather than wasting money on short-term goals. ((Mark) Lee, 2016); Todd and Lawson, 2003; Bhatti, 2012)

Frugality can be viewed as personality trait and lifestyle and as consumption behavior desires to get maximum value out of products and services. (Todd and Lawson, 2003) Frugal consumers, who have independent decision making on spending behavior, have discipline and resistance against social influences to spend money. Frugal consumers tend to save money rather than use credit cards and disregard brand, status, and materialism. ((Mark) Lee, 2016)) According to Todd and Lawson (2003) frugal consumer behavior contains "Self-reliance" or "Self-help" or "DIY" type of attitudes.

Frugality can be described though social science and humanities by focusing on three perspectives. Firstly, in the psychological perspective, frugality means the careful use of resources and avoidance (reduce and eliminate) of wastes. Secondly in the economic perspective, relating to the theory of capital growth, frugality represents the personal saving effect of increasing capital growth and wealth of countries' resources. And finally in the religious perspective, the main purpose of social activity is to follow communities' policies and get public acceptance. Frugality represents economic activity under ethical and disciplinary constraints of individuals and society that approach the best effective result. Ethical awareness means being socially and ecologically responsible by avoiding excessive and unfair consumption and production. (Bhatti, 2012)

In consumer perspective, Frugality refers to affordable and costless products or process that occur in resource constraint conditions, in sophisticated and unenthusiastic production, with unchanged or improved functions of product and process, while still retaining the products or processes main function. In firm perspective, frugality refers to an affordable solution for customers by producing designing, producing, transporting, and maintaining products and services under environment constraint (Bhatti, 2012)

All in all, to understand frugality one has to understand product selection and consumption related to environmental conditions. It contains aspects of social marketing, consumer policy and sustainability. Thus, frugal behavior is beneficial to market movement of older technology and self-help customers. (Todd and Lawson, 2013) Frugality can be applied in both developing countries, for reducing cost and reachig more affordable consumers, and developed countries, for reducing cost, increasing product types, and for increasing

movement in economy. (Bhatti, 2012) Frugality is beneficial in managing sustainably plentiful resources by sacrificing short-term goals in production for consumers to be able to achieve long-term goals. (Bhatti and Ventresca, 2013)

Innovation

Innovation comes from "innovate" which means creating new idea's ability to use knowledge, creativity, skill, management, and technology experience to develop new products, processes, and services to respond and approach market needs. In economic perspective, innovation means novel ideas or existing ideas being developed into new ideas for economic and social purpose, to get more business opportunities. The outcome of innovation is new products, processes, and services, which lead to new features or methods that developed to improve efficiency of previous items. The change of economy, resources, and structures of a population can be caused by innovative activity. (Bhatti, 2012)

There are two views to identifying innovations. First, innovations can come from entirely new ideas, radical innovation, for get acceptation from involve people as new ideas although others consider as imitate from existing ideas. (Nataraajan, 2016) Second, innovation is an innovative solution for getting a better outcome by improving efficiency of products or processes. During the creation of new innovations, old ideas were destroyed by creative destruction. (Bhatti and Ventresca, 2013) However while creating innovations one has to consider many constraints such as environmental, social, and economic, organization structure and skill of workforce etc. (Bhatti, 2012; Greenhalgh and Rogers, 2010)

There are two main ways to create innovations, by R&D organization and by being open to ideas. To get solutions from R&D organization, it needs to have the capacity of humans, resources and investments that are required in developed countries for supporting large companies or firms. However, in developing countries, an SME or small company, can create from ideas that don't need to have large resources and investments, it may come from experienced personal or external knowledge. (Bhatti, 2012)

The results of innovative solutions have both positive and negative effects on the economy and society. Positive innovation will solve problems and improve microfinance by (Bhatti, 2012) creating value to company which also benefits the consumers and society.

(Greenhalgh and Rogers, 2010) Negative innovation will create problems and expenses to people and organizations.

All in all, Innovation is a new method or process to interpret and solve problems according to the selection of the target group. Innovation is responding to market needs constantly, always adjusting to environmental conditions, adapting to respond to a specific group of people by producing new products and processes. Applying innovation helps to improve processes and product's efficiency, which gives competitive advantage to the entrepreneur, organization, firm, start-up, and government etc.

2.1.2 Concept of frugal innovation

According to "Frugal" and "Innovation" meaning, frugal innovation is an innovation or business strategy under environmental constraints and factors such as lack of knowledge-workers, inadequate investment, resource scarcity, and limited materials etc. for delivering affordable products to underserved customers. The purpose of frugal innovation is to remove the unnecessary parts, change and add infrastructure to improve efficiency of the outcome, which includes products, services, and processes. (Bhatti and Ventresca, 2013)

There are two types of innovations; conventional "do more with more" and frugal "do more with less".

In the conventional innovation process, the design will provide new product under an abundant environment which has enough materials, investment, skilled workers, knowledge, know-how etc. for a developed market. The development of outcome, top-down process, comes from the wants and preferences of developed customers, which sometimes desire in excess of their necessary needs. This method improves efficiency by increasing parts, processes and functions with by the "do more with more" concept. (Bhatti, 2012; Bhaduri, 2015)

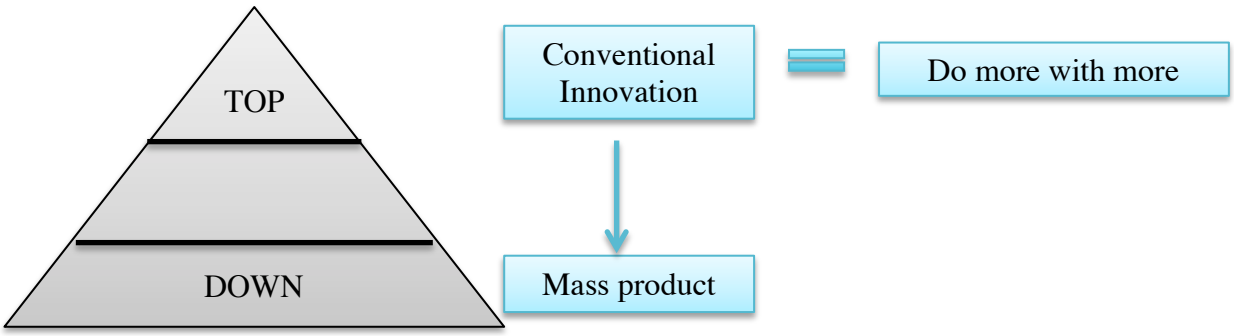


Figure 3. Conventional innovation: do more with more and top-down process.

In the Frugal Innovation process, the designing is done under a limited environment such as lack material, investment, skill worker, knowledge, know-how etc. for developing market. It considers the needs of the developing market by using local knowledge, experiences, and environmental conditions and thus increases efficiency with less loss of assets in both investments and resources. (Bhatti, 2012; Bhaduri, 2015)

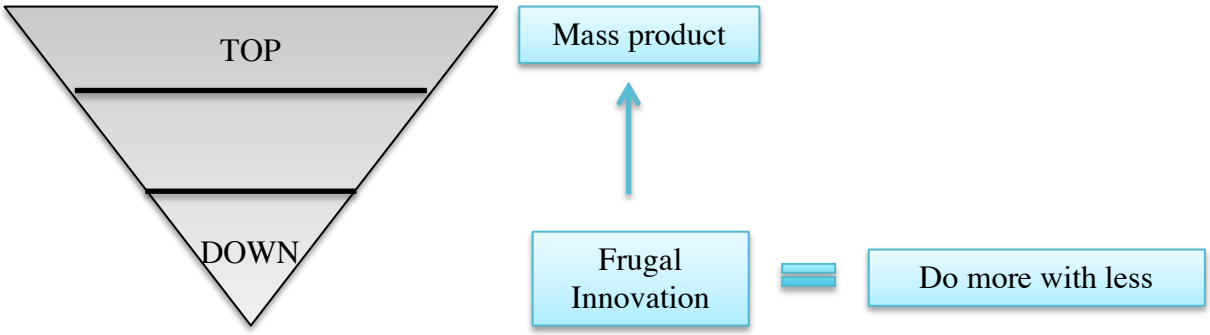


Figure 4. Frugal innovation: do more with less and down-top process

The main purpose of frugal innovation is to provide cheaper products and services with high efficiency to grassroots customers under limited production conditions by "do more with less" concept with innovative thinking and reduced costs. (Bhatti and Ventresca, 2013; Radjou and Phabhu, 2014) Frugal innovation is the best business/ innovation strategy for introducing innovative products to developing markets. In the past, developing countries used conventional innovation to introduce novel products, resulting in disadvantages such as scarcity of resources and money, destroying the environment, and unaffordability etc. to company, people, and society. (Busa et al., 2013)

2.1.3 Characteristic and function of Frugal innovation

Frugal innovation concerns real environment than theory

In a scarce environment, solution orientation, sustainability, economic viability, and motivation to expand firm and company, are leading factors to apply frugal innovations to develop products and processes. (Busa et al., 2013; Bhaduri, 2015)

The outcome of a frugal innovation concerns the real environment rather than a theoretical design. To create frugal innovations one needs to understand and track the interaction of company, supplier, and customers in the supply chain to avoid misunderstanding product

and process development. When a misunderstanding occurs in the supply chain, the main purpose of product and process can be misled and this can slow the innovative processes of the company. (Bhatti, 2012)

Thus, the application of innovative thinking is to analyze the interaction of people in the supply chain though different environments. The ability to analyze and modify outcomes under environmental constraints is required to create frugal innovation. It refers to the creation of products and processes suitable for local industries and building capability. (Bhatti, 2012)

Three constraints of Frugal innovation

Frugal innovation needs to include environmental key factors of business, technology, institutions, and society to create innovation in frugal condition. Intersection of three environment constraints, which are resource constraint, institutional constraint, and social constraint, need to be considered to create the frugal innovation model shown in figure 3. (Bhatti, 2012)

Resource constraint (or resource strategy) is a limiting resource condition, which refers to the lack of money and raw material. Most of the solutions are apply with less expense and process by new technology or materials to suit for the environment (In some cases a new substitute resource is not required when environmental factors are taken into account). The solution can come from business and technology innovations, which may alter the control, procurement and coordination of skill, labor, and material. Thus, problems can be solved and more business opportunities will get benefit after innovator can “access and control” scarce resources. Resource constraint is concerning as a main factor of applying frugal innovation in any size of company. (Bhatti, 2012) In SME perspective, resource constraints is a huge problem because of am lacking environment (raw material and investment) and finding a substitute or new solution (or resource) to offer affordability to low-income customer is the main solution. A large company can benefit from local R&D that finds the proper solution by considering resource constraints and then diffusing into a central R&D that searches for a global solution to get more business opportunities. (Bhatti, 2012)

Institutional constraint (or institution void) is a constraint that is based in the context of human interaction and behavior. It has two categories: a formal constraints are the mandatory control of people to follow constitution, laws, and rules etc. And an informal

constraint is a sense of social cohesion that makes peace in society such as norms, conventions, and codes of conduct etc. This constraint is popular among social organizations to create a solution. The problem can occur from institutional complexity, lack of agreement and intermediaries among company, supplier, and consumer in the supply chain. (Bhatti, 2012; Bhatti and Ventresca, 2013).

Social constraint (or affordable constraint) is a constraint that concerns the approachability and purchasing power of customers to reach their needs. Eliminating social constraints means to create products, processes, and services that are more affordable and accessible to a larger number of underserved customers. (Bhatti, 2012)

According to the three constraints, resource constraint (strategy), institution (void), and social constraints (affordability), we can identify, understand, and position frugal innovation to businesses, institutions, and social innovation. It will allow innovators to overcome barriers of resources, institutions, and society to easily apply frugal innovation to a product, process, and service for low income customers through the processes of "creative destruction", "diffusion of innovation", and "disruptive innovation" to get resource dependency, competitive advantage, and institutional entrepreneurship. (Bhatti, 2012)

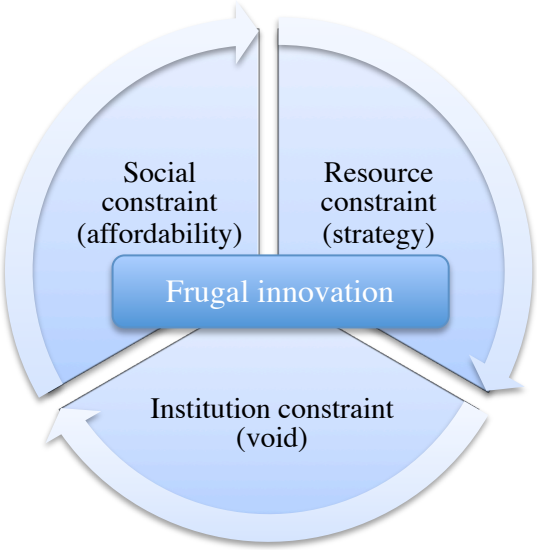


Figure 5. Three constraints of frugal innovation: resource constraint, institution constraint, and social constraint.

10-core characteristics of frugal innovation

According to Basu et al. (2013) Frugal innovation can be described by 10 characteristics: Ruggedization, Light weight, Mobility, human centric design, simplification, new distribution model, adaptation, use local resource, green technology, and affordability. These characteristics help guide problem solving and entering the market by maintaining sustainability and social equity that satisfy needs and support long term use in both developed and developing markets.

1. Ruggedization: developing a product able to withstand extremely harsh environments by increasing the reliability and performance of basic design (such as protection against water, vibration, temperature, chemicals etc.)

2. Light weight: developing a product design that is easy to carry with any type of transportation and being portable everywhere for easy accessibility.

3. Mobile enables solution: developing product that can be connected worldwide and being reachable and accessible to customers.

4. Human centric design: developing intuitive product which is easy to use without any skill, knowledge or training.

5. Simplification: developing product with less parts and functions to be DIY or to be self-reliant.

6. New distribution model: make the accessibility of product and publishing product by a different way than before to increase users' interest. For example, by reduce gender gap or inequity as strategy to approach the market.

7. Adaptation: can be developed or evolved with better designs and functions from existing product to get a better product solution and accessibility.

8. Use local resources: using raw material and equipment from local area without importing to reduce costs and support local business.

9. Green technology: using renewable resources to produce product and process for maintaining sustainability.

10. Affordability: producing by low cost of whole supply chain process (production cost and transportation cost) for low income customers.

2.1.4 Originated concept of Frugal innovation

"Do more with less for more"

The main purpose of applying frugal innovation is not only to reduce costs and improve efficiency for low income customers, but also to do so regarding social sustainability. (Bhatti, 2012 and Eagar et al., 2011) claims by using "do more with less" of Frugal innovation concept help to use less resources, production and supply chain processes for getting high efficiency by self-reliance and social benefit concepts.

According to Basu et al. (2013) a sustainable solution helps to bring adaptable, affordable, appropriate, and accessible solutions from the needs and context of base of pyramid (BOP) users (by concerning social, environment, and economic) to create a frugal innovative solution.

Frugal innovation solution designs that support global sustainability can expect to create an equity solution for the whole world market, which means making it equally approachable and affordable to any level of users. It aimed for more people can reach to the frugal innovation product and process which extended originated of "do more (efficiency) with less (cost)" to "do more (efficiency) with less (cost) for more (people)" concept. (Bhatti and Ventresca, 2013)

In the past, creating frugal innovation had to consider only resource and social constraints with "do more with less" concept. However, nowadays a successive frugal innovation has to consider more variables, like institutional constraints and low income customers, have to take into account to improve and add value during the supply chain. From the shift of "cost efficiency" to "for more people", the sustainability thinking and cooperation among stakeholder in the supply chain was required by focusing on global production, consumption, and sustainable process with "do more with less for more people" concept for applying innovative product and process into the world market. (Bhatti and Ventresca, 2013)

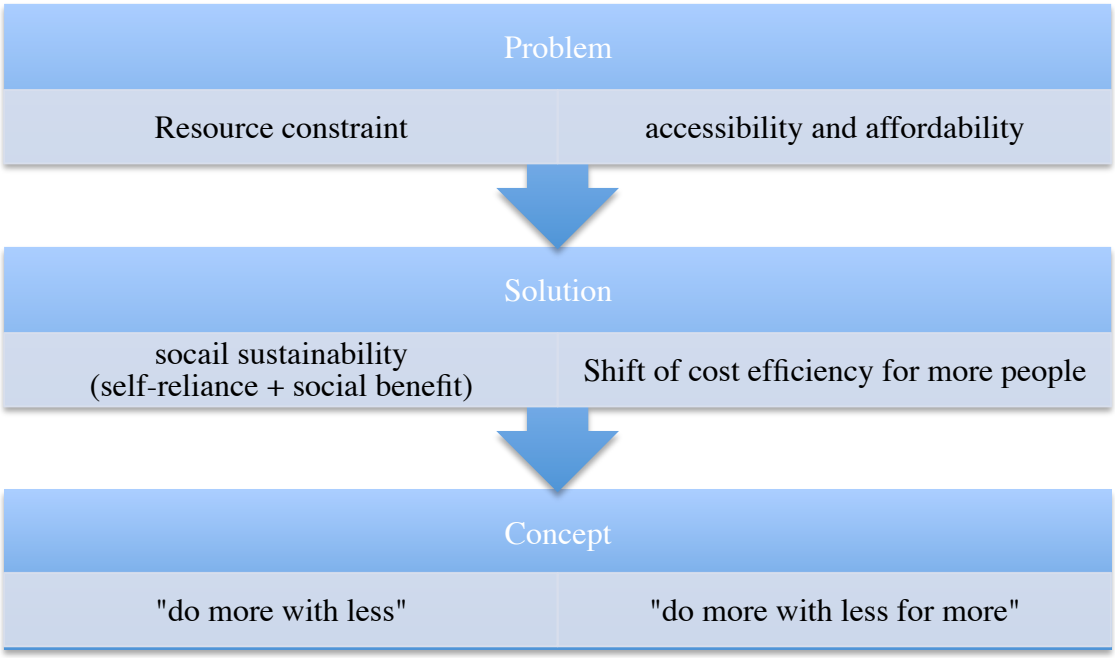


Figure 6. Frugal innovation concept: shift from “do more with less” to “do more with less for more”

Creative destruction and Disruptive innovation

Frugal innovation is the result of “creative destruction” and “disruptive innovation”. The concept of creative destruction is the process of destroying the outdated idea by using new innovative products and processes instead of solving problems. In the process, the new product will create new value to destroy old value for approaching more needs by using less resources, less cost by cut down unnecessary parts and functions leading to increased accessibility and affordability. (Bhatti and Ventresca, 2013) According to Georgantzas et al. (2005) the concept of disruptive innovation derived from the diffusion of creative destruction by changing outdated products into new products, which grew new markets, change competitors and customer targets, and disturbed former companies in a new market by offering new value propositions and affordability. Disruptive innovation is an ideal concept in a developing country. It is suitable for low-income business models that can easily expand and spread products into the wider market, and bring a positive market response by introducing new products to a new market that has unexperienced, low-income users. (Ostraszewska and Tylec, 2015) All in all, the frugal innovation is grounded from disruptive innovation which comes from diffusion of creative destruction.

2.1.5. Challenge to successive frugal innovation

Frugal innovation is used to improve efficiency of both product and process that operate in a lacking resource environment. It restructures the products, creates value chains, and builds sustainability into the system. The product will provide only mandatory functions, use less materials and set the price to be more economical than previously and include only the essential and eliminate the unnecessary. (Zeschky et al., 2011; Bhatti and Ventresca, 2013)

The aim of frugal innovation is to consider "the way to achieve" rather than the "outcome after achieving". It tends to change the criteria's of the standard product, consider environmental factors, and consumer consciousness. (Bhaduri, 2015) According to Zeschky et al., (2011) successive Frugal innovation has 2 main challenges to overcome; Understanding the value architecture of frugal innovation and building a local organization structure for enabling frugal innovation. First, understanding the value architecture of frugal innovation as said "Frugal innovations are the result of unique value architecture that is grounded in the drive to meet basic requirements at the lowest possible cost" means understanding the needs of customers to create and develop products and processes to reach the basic requirements with high value and low supply chain cost by focusing mainly on developing main functions, cutting unnecessary parts, and using low-cost processes. The innovative solution was presented in a unique form of product and process to show good enough product to meet local requirements by focusing on 3 constraints: resource constraint (need), cost (affordability), institution void (lack of business medium).

Second, Establishing a local organization structure for enabling frugal innovations as said "Building effective capabilities for frugal innovation depends largely on the ability of the R&D team to sense local need and translate them into effective, low-cost product" means building separate supporting R&D sections to increase understanding, translating, and development of needs from local knowledge and resources (environments) to create suitable and affordable innovative product and process. Additional local R&D sectors should be made fully responsible and made to assist decision making to acquire fast and efficient solutions to develop innovation product and process. (Zeschky et al., 2011)

In R&D the section, the solution of frugal innovation can occur through both formal and informal innovation. In formal innovation, innovative thinking is done by a scientist, all of the information regarding the solution is presented logically in a theoretical frame which

makes it easy to control information and activities. Thus, formal innovation brings easiness to communicate the solution's information among people in supply chain processes, which is smooths learning processes. It also decreases corporation cost and provides a clear timeline. However, formal innovators have problems to create new innovative solutions because of the limited thinking enabled by a logical and theoretical framework, which causes less creative solutions. In informal innovation, innovative thinking launched by the innovator, creates an innovative solution based on local environment conditions without boundary and knowledge limits. All information presented regarding the solution is in according to the real environment. Informal innovation brings lack the ease of communication of a framework model and has limitations in knowledge thinking which can become obstacles to the learning process. It is also more expensive and a lack of timeline occurs when using informal conditions. However, the creativity of the solution from informal thinking is more various and reliable because of considering the real environment without thinking boundary than formal innovation. Frugal innovation relies on analyzing customer needs from the "real environment" rather than the "theoretical". Even though the learning process and cost of formal innovation are lower than informal innovation, solving the frugal innovative problem is designed for directly adapting to environmental constraints. (Bhaduri, 2015)

2.1.6 Maked of Frugal innovation

Frugal innovation is used as mainstream of business strategy for developing market (India, China, and other emerging countries etc.) and also expanded to developed market (EU and USA). (Eager et al., 2011; Bhatti and Ventresca, 2013)

In developing market frugal innovation used for introducing market in small to medium enterprise (SME) by receiving and applying frugal innovation from the resource constraint environment from low purchasing power customer for bringing self-reliance and sustainability to the local area. In developed market frugal innovation used for introducing in a large company or Multinational Corporation (MNC) by received and applied frugal innovation from original equipment manufacturer (OEM) for incremental economic growth. (Basu et al., 2013)

For example General Electric (GE), Nestle, Huawei, Cisco, Ryan air, Philip, Siemen, Logitech, IKEA, etc. (Zeschky et al., 2011; Eager et al., 2011; Basu et al., 2013; Bhatti and

Ventresca, 2013) which can classify according to business types such as medication, telecommunication, banking, education, energy, training, housing, automobile, device etc. For example:

- ***Medication*:** GE with portable electrocardiograph (ECG) machine which is light weight, long life battery operated, cheap, reliable, easy for use and repair, and affordable. Due to the problem of rural patient in India can't afford to pay for the test, physician, and small clinics. It leads GE to develop portable and costless ECG machine by introduced bus and movie theater ticket printers to use instead of monitor with long life rechargeable battery for eliminating weight, portability, power consumption, and battery life cycle problem. In addition, GE makes ECG machine easy to use for skill-less users by using basic operation pattern from traffic signal to start (green button) and stop (red button) machine. The design comes from combination of know-how and existing device maintain and adapt main parts and functions, and cut unnecessary parts and functions. It is developed to reduce 60% of previous cost (from $2000 to $800). The expansion of ECG machine from India have been widespread into other emerging market (China, ASEAN, Africa) and developed market (USA, and Europe) for introduce alternative cheap and portable option of ECG machine which effect to reshape health care in world market. (Eager et al., 2011; Basu et al., 2013; Govingarajan, 2012)
- ***Telecommunication*:** Cisco and Nethope with Emergency Net Relief Kit (NRK) which is functional boxing of communication hub of satellite phone and satellite laptop including by voice communication device with analog mobile phone and universal charger; Bluetooth handset with base and charger; broadband global area network (BGAN) satellite Internet via 492 Kbps WI-FI link with 8 hr. spare battery, power pack, and car battery adapter; fold-flat 48 watt. Solar power kit with connection cable; small laptop with mouse, controller, various cable and power adapter; USB memory stick. It's a high functioning box set with all-purpose and convenience for communication with small suitcase size, lightweight within 4-pound, and portability. It provides both data interfaces, via Ethernet, Bluetooth, and ISDN though USB, and phone interfaces, via RJ-11 and Bluetooth. Also support IP, VOIP, VPN, and encryption standard. The originate ideas was developed for help to contact and coordinate to move the victim during disaster in remote areas to safety area such as cyclone in Bangladesh, earthquakes in Pakistan, Haiti and Chile.

NRK developed by 2 companies; Cisco in purpose of make contact for ensuring safety of the employee in disconnected place and Nethope, nonprofit organization such as the red cross, world vision, Mercy corp., for contact victim during disaster. With this innovation make world can connect without any limited of unconnected network areas. (Basu et al., 2013; Musich, 2007)

- ***Banking*:** Kopo Kopo with mobile money platform. It is a mobile network that customer load money into mobile device for sends money, pays bills, withdraws money, and buys goods. Kopo Kopo make money transactions which help reduce wasted time and get more opportunities to do other activity by using local resources, mobile phone to transfer money instead of spending the whole day doing transaction in bank. The corporate of Hope micro and Splash mobile make easier to approach the mobile transaction platform of Kopo Kopo. In addition, Kopo Kopo can analyst buying trends of customer and send interaction SMS to customers. Kopo Kopo have used in Kenya, Leone, Kenya, East Africa, and widespread in other countries. From this make the disruption among transaction from traditional to mobile money service. (Basu et al., 2013)

2.1.7 Grounded framework of Frugal innovation

Frugal innovation model

Frugal innovation comes from the mixture of Jugaad innovation, Gandhian innovation, and reverses innovation as show in figure 7. The main purpose of frugal innovation is launching strategic suitable for universal customer, “inclusive innovation”, which was presented innovation for everyone at any level of monetary circumstance can easily approach product and service. (Basu et al., 2013)

Figure 7. Frugal innovation model

Hierarchy of innovation related to Frugal innovation

Innovation knowledge in emerging market was adapted from "one concept to another concept" by transferring from "same for less" to "adapt for less" to "new for less" to construct and become the Frugal innovation framework. There are developing from Cost innovation, Jugaad innovation, Gandhian innovation, Good-enough innovation, Frugal innovation, and Reverse innovation respectively as show in figure 8. (Ostraszewska and Tylec, 2015)

- **Cost innovation**: according to Zeschky et al. (2014) is the solutions by improving on process innovation to propose lower cost product with same function as western. The changed of expensive product into costly product occur by intensive improve R&D in the production process, which allow to use low cost from local resource and labor. Cost reduction done by reduce size, change labor source, change raw material resources without any change of function and quality until reach to the affordability of resource constraint consumers. All in all, cost innovation is a process innovation that offers low cost with same functions of western product in resource constraint environment to consumers.
- **Jugaad innovation**: according to Radjou et al. (2012) refers to "Zizhu" in China, "Gambiarra" in Brazil, "D.I.Y" in U.S.A, "Jua kali" in Africa, and "Système D" in

France. It comes from the concept of "Innovative quick fix", improvised solution from ingenious with limited resource (fund, raw material, skill worker etc.), to provide quick solution to solve difficult problems to reach customer's satisfy in an insufficient environment with low cost. Jugaad innovation may refer to "poor quality of solution to solve problem for BOP" comparable to the conventional innovation concept, it is same as non-finish the process of innovation solution. However, in terms of BOP perspective, the benefit was offered to low-income customers from non-complex solution to solve urgent problems with low cost to get "product innovation". (Ostraszewska and Tylec, 2015)

- **Gandhian innovation**: according to Ostraszewska and Tylec (2015) refers to affordability and sustainability concept, it comes from the idea of "doing more with less for many" which means to enhance performance of products and processes by improving parts and function from reducing unnecessary to maintain only mandatory parts and functions for developing low investment cost to reach more massive number of people. (Basu et al., 2013) as "technology transfer innovation". (Ostraszewska and Tylec, 2015)
- **Good-enough innovation**: according to Zeschky et al. (2014) refer to "process and product innovation" which is introduced adapt or re-engineer low cost product by taking advantage of local resource to reduce cost, same concept as cost innovation. In addition, Intensive improve on simple function and user friendly by maintaining main functions and eliminate unnecessary parts, make the product easy for use, and provide robustness, low maintenance cost and long life-cycle to bring value-add to good-enough products and processes for serving matching with customer requirement in a resource constraint environment.
- **Frugal innovation**: according to Ostraszewska and Tylec (2015) is a strategy to offer a cheaper and simpler product for developing economies. The strategy is not the only concern on produce low cost product, but intense on using available resource and avoiding waste with same or better main product's function to meet customer needs. Frugal innovation offers better product and process than existing solution for developed new applications with the resource constraint environment and low cost product concept to provide a new value proposition with new product's structure and architecture for new customer. Frugal innovation is disruptive innovation. it does not come from re-engineering, but from developing a

specific application of product and process in a resource constraint environment, which may reach entirely new customers or market. The concept refers to “process, product, and application innovation”. (Zeschky et al., 2014)

- **Reverse innovation**: according to Hossain (2013b) refers to adaptation of innovation for serving low-income customers to transfer product and process to create new market for serving high-income customers. It is called as “market innovation” which taking originates an innovative idea from developing countries to scale up and propose new product and process to developed countries by re-organization to create entirely new market demand. After successive test new product and process in developed markets, new innovation will be proposed to the global market. Thus, Apply reverse innovation effected to change in organizational structure, business strategy, product development, and innovation method. In the reverse innovation process, firstly, the less cost product will be beneficial to developing market. After that accepted product will expand and serve to developed market to use. (Basu et al., 2013) All in all, There are benefit to both developing and developed countries to receive new product and process with less cost and maintain only necessary functions and parts which helps to create values in supply chain from simplicity, easy to use, and lowering cost of product and process. Introducing reverse innovation from developing country to developed country is not easy to successful because knowledge (know-how), people (worker), and resource based from developing market environment (Ostraszewska and Tylec, 2015). However, the competitive advantage will be received after successively apply reverse innovation into a developed country, it make opportunities to reach more customer preferable, expand product variance and market. Reverse innovation becomes more important and popular activity to apply in a western company for maintaining position and defending competitor to become a business leader. (Hossain, 2013b)

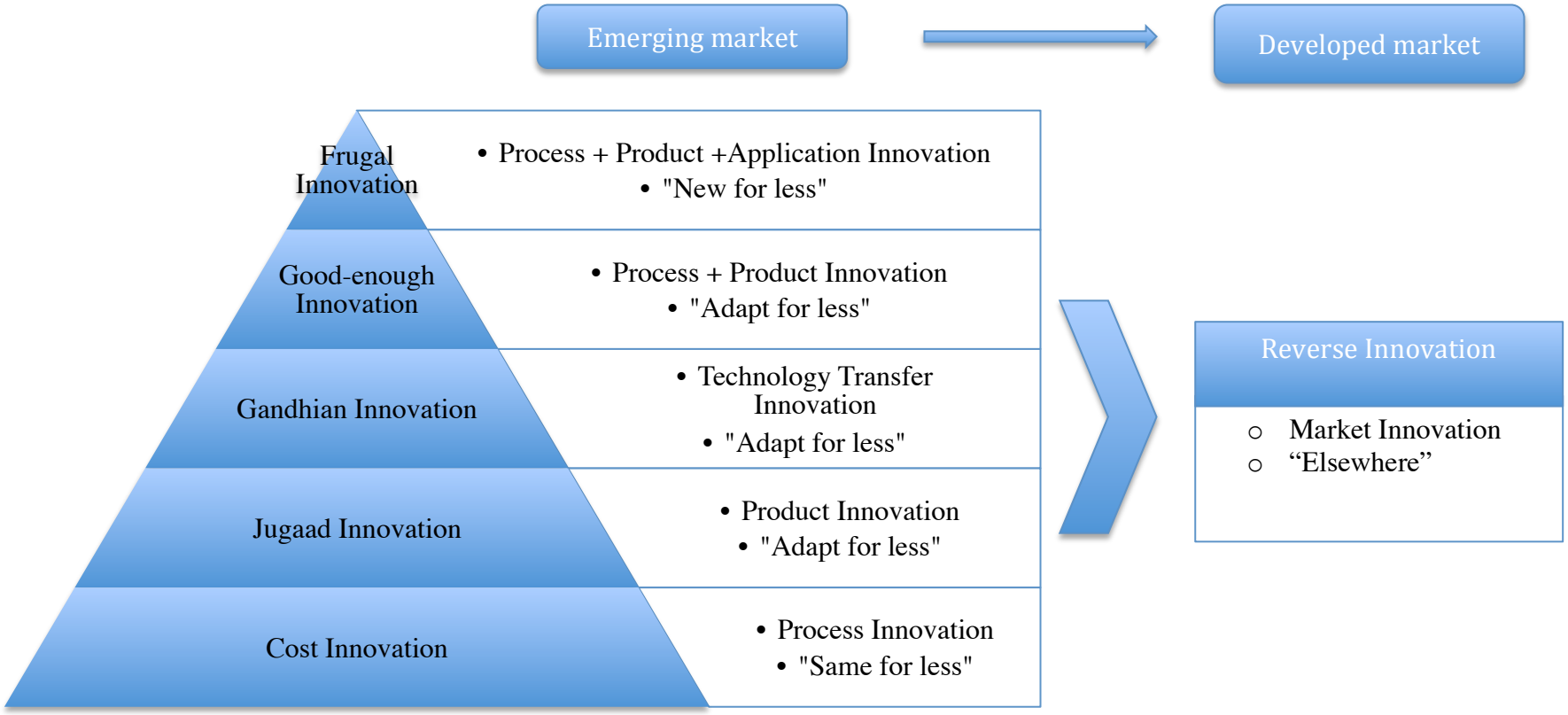


Figure 8. Frugal innovation framework

2.2 Investment method for frugal innovation

In this section, we provide a theoretical discussion of the concept of investment method for frugal innovation. We present financing source, and current investment method for the frugal innovation product.

2.2.1 Financing source

According to Hofstrand (2013) and Schwienbacher and Larralde (2010), There are many financial sources for building start-up companies. Choosing the proper sources for obtaining funds have to concern on many factors. Such as type and size of business, the amount of money needed, and exact time to use money etc. However, Financing source has been divided into two main types: Equity and Debt.

For ***Equity***, the money invested directly to company from property of internal parties, which bring investors have the right to control company's decision, at the same time, investors undertake risk from company. Thus, start-up companies do not have to pay an interest rate for investment as loans. Equity can come from:

- *Entrepreneur and team members*: Investment comes from own capital or personal saving. Which comes as first choice for an entrepreneur to looking for investment. More reliability of a company's investment come from entrepreneur and team members be a part to invest in their own capital.
- *Friends and family*: the second choice for acquiring investment, this source of investment comes from entrepreneur's friends and family. However, problems can occur from an unclear business deal.
- *Business angels*: wealthy individual who invests with small amount of money on small projects or a project come from emerging company.
- *Venture capitalists*: specialized investors gather money from non-specialized investors to create an investment portfolio of big project with long-term investment, around 3-5 years. Firstly, an investor will invest on start-up or initial stage of project that have high growth potential of investment portfolio. After company create investment portfolio, investors will resale investment portfolio in order to receive a high rate of return.

- *Other companies/ strategic investors*: other companies invest on projects that related with their strategic. Which means successive of project affected to successive of company strategic too.
- *Stock markets*: invest in share of IPO (initial public offering) to get the right to held company.

For ***Debt***, the money invested in the form of loans by external parties or people who have related to company through contract, which bring company have the right to control their own decision and not allow investor's to have influence on main decision, in the same time, investors undertake less risk from company. Thus, Start-up Companies have to pay an interest rate for investments that bring difficulty to get loans since company cannot provide stable cash flow evidence to prove affordability to pay an interest rate. Debt can come from:

- *Banks*: short-term and long-term loans offer for lenders after providing business plan, positive track record, and collateral. Rare opportunities to get money for setting Start-up Company.
- *Leasing companies*: providing use of an asset for business by agreeing to rent tangible resource, such as building and equipment, between company and lease organization. When the lease end the asset will return to the owner. Normally, The lease bill will come by annually.
- *Government agencies*: funding loans and provide financial assist with business by federal, state, government support.
- *Customers/ suppliers*: refer to agreement between business-to-business, trade credit that give credit and discount from seller to buyer in order to follow seller's contact.
- *Bootstrapping*: Bootstrapping come in the form of zero coupon bonds. It helps company provide investment money for initial stage to build up company. The entrepreneur will be given little capital and investment money from personal finance or customer financing by operating revenues of the new company. For example money can come from pre-order of product, the initial investment used for hire people to build prototype and sell it to get more investment money.

2.2.2 Frugal innovation product in world market

In this part we discuss on business or market situation in developed and developing countries for more understanding of environment constraint that influence to an investment

method of frugal innovation product. And leading to the problem of introducing frugal innovative product to market.

Business and market situation in developed and developing countries

Nowadays world economic still have discrimination of developed, developing, and undeveloped countries. From this point of view, it is necessary to make differentiate of business strategies to handle with different situation and condition of each area. In a developed country is abundant with resources, institution, and affordable constraint. It is easy for customers to approach product and service in wealth environment. Which mean full of material, human resources and supporting institution for providing product and service to high-income people. On the other hand, in developing country scarcity of resources, institution, and affordable constraints represented which means lack of material, human resources and institution void for less affordable customers. It refers to cut off opportunities for low or middle-income people to use the innovative product. (Bhatti, 2012) According to "Requiring of the need to approach innovative products in a constraint environment with low expenses" in developing countries bring to occur the establishment of frugal innovation. (Eagar et al., 2011) The idea is generated from the motivation of base of the pyramid (BOP) customers to improve efficiency, decrease costs, and reach massive market scale which is referring R&D activity for economic of scale to the mass market of developing market. (Basu et al., 2013; Bhatti and Ventresca, 2013)

Frugal innovation is the concept of "do more with less for more people" to create new innovation solutions for solving the problem of inapplicable, inaccessible, and unaffordable of product and service to support local needs for many people by concerning environment constraints. (Basu et al., 2013; Bhatti and Ventresca, 2013) The main purpose of Frugal innovation is supported to help and serve for low and middle-income people with intensive R&D activity on main parts and functions which mean no need of extravagance and unnecessary feature. (Bhatti, 2012) Thus, It is not only supported to reach the needs of low income customers, but also increasing the competitive advantage of companies in emerging markets by removing excessive parts and functions for only remain major functional and using low cost of resource and production process. However, on the developed view consider Frugal innovation as incomplete R&D processes. (Eagar et al., 2011)

The process of frugal innovation can distribute to worldwide, according to the beginning of "self-use", which is creativity ideas comes from inspiration to produce support self-need product, then "local sale and distribution", which refers to product are useful and expand into "local R&D" then "central R&D", where the acceptable and usability of product from local area bring interesting to international companies for future development to other area to get more competitive advantage in the world market. (Bhaduri, 2015) As the original model of frugal innovation occurs in emerging countries, China and India, after that apply to other developing countries and expand to developed country such as USA and EU countries. (Bhatti and Ventresca, 2013) Successive of frugal innovation derives from emerging market to international market by concerning the complexity of business models and organization from bottom to top of pyramid. (Zeschky et al., 2011) According to Bhatti and Ventresca (2013) The diffusion and adoption from developing market to developed market, Reverse innovation, help company to reach competitive advantage by shift innovation from local to global through "cross learning opportunities" that transfer knowledge and know-how by concerning "infrastructure, performance, sustainability, regular, and preference gap". So frugal innovation is not only strategy to develop product, process, and service for developing market but also for developed market.

Frugal innovation turns to be strategies for companies to get more competitive advantage and business opportunities by "reduce cost, increase efficiency of process and supply chain, control innovation source for emerging markets, adapt to local knowledge, increase way to access technology". The change from developing markets to developed market presents benefit from changing labor source help to reducing labor and R&D cost, increasing wider range of alternative choice for customers such as more choices for unaffordable customers in both developing and developed countries, more various choices for customers who prefer only main function of product. (Eagar et al., 2011)

Problem of introduce frugal innovation product to world market

From Frugal and reverse innovation strategies are serve for low-income customers in developing and developed countries respectively. More focus, Frugal innovation is innovative strategies base on limited resource constraint to create value in supply chain from simplicity, easy to use, lowering cost, high efficiency, and qualitative product and process for serve to huge number of low-income customers in developing countries. Frugal

innovation receives successive acceptance in developing market and after that become to transfer to developed markets, it considers as reverse innovation. To apply reverse innovation, frugal innovation was brought to use in developed countries, require adapting business architecture (organization structure, business strategy, product and innovation method etc.) to suitable with innovative product.

To be the leader of innovation mindset's company has to be first understanding and introducing with Frugal innovative ideas. As faster of the business shift mean more opportunities to get a competitive advantage. (Eagar et al., 2011) In additional, Frugal innovation is a key economic growth to decrease declining of the world market, it helps to slow down economic recession by increase efficiency, decrease costs for getting more affordable customers which bring more competition to companies and effect to stop declining of the world market. (Bhatti and Ventresca, 2013)

To introduce frugal innovation in developing countries and reverse innovation in developed countries need to have new business strategies for easily presented the product to approach the customer's needs and for easily find business investors from all around the world under restrictive environment.

3. RESEARCH FRAMEWORK

3.1 Adaptive concept framework of Frugal innovation: "Open innovation" to "Crowdfunding"

Open innovation (OI), was introduced as a business strategy to get external and internal ideas for improving product and process by using open source. (Hossain, 2013a) It bought the following ideas of crowdsourcing and crowdfunding to introduce frugal and reverse innovative product which offers accessible, applicable, and affordable product and service to customers and investors under environment constraints. This section contains discussion about how frugal innovation and reverse innovation concept turn to adapt with open innovation and crowdsourcing, and crowdfunding concept.

3.1.1 Open innovation

Open innovation is presented in deep detail: Definition of open innovation, Open innovation type, Adopt open innovation for introducing frugal innovation, Open innovation implementation – "open innovation" related to "crowdsourcing".

Definition of Open innovation

Referred from Chesbrough (2003b) open innovation (OI) is explained as "paradigm that assumes that firms can and should use external ideas as well as internal and external path to market, as the firm look to advance their technology" which means open innovation is used as a strategy to share and interchange information of knowledge and experience from external and internal ideas by many difference sections inside and outside organization such as company, industries' partner, research institute, university, and users etc. to generate the best idea for developing product and process though open source software. (Chesbrough, 2003b; Hossain, 2013b) OI benefits by flow valuable ideas to market with time and cost efficiency, which means to use little time and low cost for generating and developing ideas. On the other hand, close innovation refers to strategic for developed ideas from only internal sources, which allows limited ideas generate from the business and R&D department inside company. This means a company has to support on the

development process with their own for every activity such as manufacturing, marketing, service, distribution, finance, and support etc. (Chesbrough, 2003b; Loren, 2011)

Open innovation type

There are two-process types of open innovation: Outside-in process and Inside-out process. Outside-in is open process to receive knowledge, experience, and management ideas by sourcing and acquiring from external sources. In this "gain external knowledge" process is based on intensive with highly collection knowledge by in-licensing and buying patents for creating a new business strategy to approach what customer want. New developed ideas was gained from transfer, integrate, and diffusion of external knowledge among company, supplier, and customer to make valuable intellectual property (IP) licensed patents and technology knowledge to organization. Inside-out is open process to bring and share internal knowledge to market by revealing and selling licensing intellectual property (IP) and enlarging technology transfer to external organization. In this "bring knowledge to market" process is based on intensive research on purpose of out-licensing and sell IP to another organization for get an investment return back to company which help to increase profit and expand organizational survival. (Gassmann and Enkel, 2004)

However, open innovation is a progress from a combined of outside-in and Inside-out process which is called "coupled open innovation". It was integrated of "acquiring external knowledge" and "externalizing own knowledge" to rise up organization efficiency and competitiveness. From coupled open innovation, outside-in process creates spillover ideas. Meanwhile, Inside-out process sells the spillover ideas to other company. (Hossain, 2013b)

Adoption of "Open innovation" for introduce frugal innovation

According to Hossain (2013b), Open innovation adoption helps as another channel to receive and apply new strategic ideas into business by open sourcing with lowing cost and minimizing time of introducing the product and easiest approaching to market. To do open innovation, western companies use online platform to receive innovative ideas from people in anywhere, both developing and developed countries.

In developing market, open innovation will bring benefits in term of providing frugal innovative idea with low cost of product development by reducing R&D cost and conduct

low risky cost in research due to share and interchange of knowledge and experience from many different sources to get the best proper solution.

In developed market, open innovation will bring benefit and work as intermediate to transport frugal innovation from developing markets into developed markets. There will bring and capture proper frugal innovation to apply in developed countries by adoption as reverse innovation. At the same time, new product ideas with low cost from the partnership and outsider in developing countries will be accessed. It has advantage to offer more variety of product options to low-income customers in developed market.

All in all, open innovation is a creative innovation strategy by receiving new personal or organizational idea by open sourcing - both outside and inside sources. Which makes company exchange and translate new innovative ideas without standing alone on R&D activity. The company has to seek and pursue existing ideas that receive from open source, then organization will adapt and add value for getting suitable product and process to the market. Open innovation is used in both developing and developed markets, In developing market it helps to get a new developing idea for reducing development cost, and In developed market it helps to ease finding strategy to adopt reverse innovation from developing market.

Open innovation implementation: "Open innovation" related to "Crowdsourcing"

Crowdsourcing is innovative ideas come from the marketing department than R&D department. The idea comes from open source to receive 'voice of customer' to let customers have 'customer co-creation'. Crowdsourcing provide base on communication technology and information as same as open innovation. (Seltzer and Mahmoudi, 2012) crowdsourcing come from "crowd" which means any large group of people deal things together on same purpose (Sloane, 2011) and "outsourcing" refers process to achieve task by external source instead of only do internal source. Crowdsourcing is a process performed by individual or group to distribute problem solving and produce a business model by gathering a crowd's idea from open source, create reward strategies for making crowd work, and use crowd's ideas to accomplish something. (Seltzer and Mahmoudi, 2012) Thus, a proper application of crowdsourcing will give a lot of benefit to company - less time consumes, less costs, less mistakes, more variant of product types from

successive crowdsourcing, by selection suitable of innovation to apply in system, will be creating value and make disruptive to products. (Sloane, 2011)

3.1.2 Crowdsourcing

Crowdsourcing is presented in deep detail: Definition of crowdsourcing, Crowdsourcing concept, Different of crowdsourcing from close and open innovation, Benefit of crowdsourcing, successive crowdsourcing, crowdsourcing category.

Definition of crowdsourcing

Crowdsourcing comes in the form of participative activity on an online platform, web-based business model, to solve complex problem and create a proper solution for specific purposes from open sourcing or "open call" through Internet. (Schwienbacher and Larralde, 2010) Crowdsourcing uses technical of outsourcing to obtain shared online solution from individual, organization, institution, communities, nonprofit organization, and population to gather various knowledge. And then organization chooses, combines, and processes solution ideas into best innovative products by communicating between sponsor and solver by offering reward as pay for share ideas, work, money, know-how, and knowledge. From crowdsourcing, the satisfaction of need and economically will be provided to users and rewards will be provided for crowdsourcer. (Seltzer and Mahmoudi, 2012; Bramham al. et, 2014) As according, crowdsourcing is not "single strategy", but a combination between "user-driven innovation" and "co-creation" though Internet by crowd-platform to introduce, gather, distribute, and model product from the crowd's ideas. (Sloane, 2011; Seltzer and Mahmoudi, 2012)

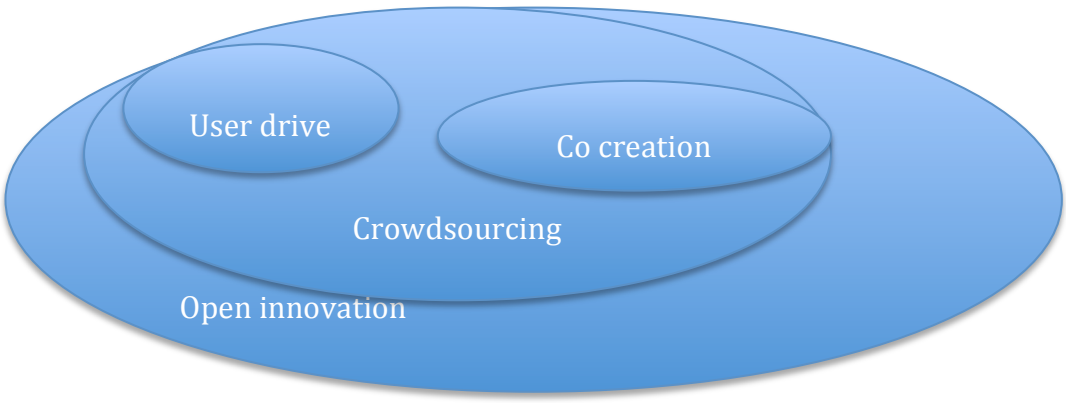


Figure 9. Crowdsourcing: Subset of open innovation.

Crowdsourcing gives organization's opportunities to get more successive and receive various problem solving. Crowdsourcing comes from join principles of open innovation, user innovation, collective intelligence, the wisdom of crowds, and marginality in problem solve. (Braham al et, 2014)

- "Open innovation" and "user innovation" which refers to open source for receiving new innovative ideas from outsiders, users, customers, and organizations to develop product and service's efficiency.
- "Collective intelligence" refers to capability to handle with connection of the large scale of interaction. (Braham al et, 2014)
- "Wisdom of crowd" refers to crowd that provides solution though online platform with democratic participation to outsourcing and create product and service innovation. (Sloane, 2011; Brabham, 2013)
- "Marginality", which refer to organization gaining different experience and out-border knowledge by outsiders or less involve people from organization, who have difference problem-solving environment from insider and organization, to create different and various problem's solution. (Braham al et, 2014)

Crowdsourcing concept: "top-down" and "bottom-up" process.

Crowdsourcing is combinations of "top-down" and "bottom-up" processes which bring organization offer the best solution to customers. The process between "top-down" and "bottom-up" need corporation of organization and public, or crowd, which effect to occur "co-creation". The "bottom-up" process brings open sourcing to share creative solution process by crowd via Internet. The "top-down" process brings management to fit with the organization's strategy.

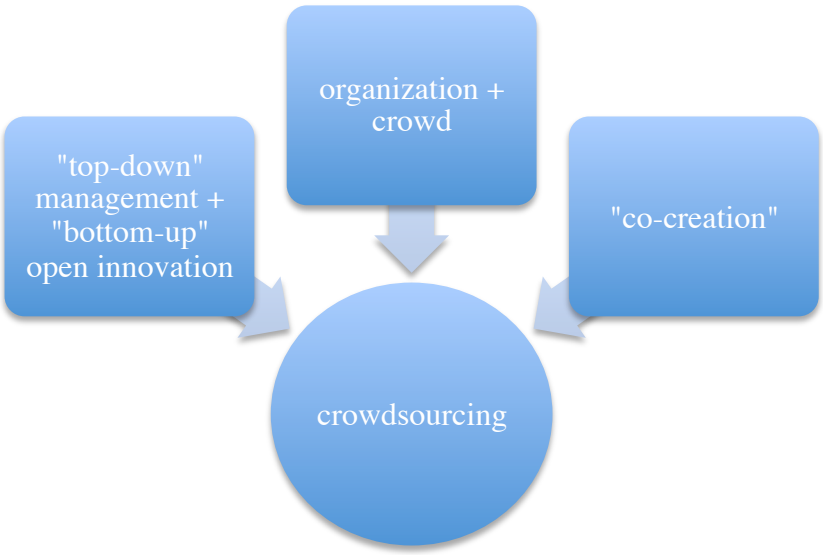


Figure 10. Crowdsourcing from top-down and bottom-up process

Different of Crowdsourcing from close and open innovation

On this differentiation among Close innovation, Open innovation, Crowdsourcing will be clearly defined.

- *Close innovation*; Organization deals with product design and management by own leading without any suggestion and help from outsiders which called “one way” innovation process. Close innovation organization uses “top-down” management to design, process, and produce innovative product.
- *Open innovation*; Organization deals with open process for share new idea from internal and external source. The creative and innovative idea comes from both insiders, the received ideas come from skill-worker and professionals in organization, and outsiders, the received ideas come from partner, customer, supplier, and communities via open source platform. Open innovation is intensely on the design with “bottom-up” of open creation from communities. Instead of on “top-down” management, open innovation has individual management on their own, self-organize, which self-management and own decision on resource, format, governing, and contribution development back to communities. The focus of control and decision still mainly from organization,

which effected to minimize the use of communities and less democratic in the management process.

- *Crowdsourcing*; Organization deals with product design and management by both insider and outsider. The process of "bottom-up" of open creation and "top-down" of management applies from communities which means both relevant and non-relevant, such as organization, partner, customer, supplier, and other etc., have opportunities to make the decision for share, vote, and choose the best idea for developing the design and management of innovative product and process. Thus, democratic was brought to crowdsourcing from sharing equal opportunities for decision making on product and process development.

Benefit of crowdsourcing

Crowdsourcing is not "one step complete action", it helps to ease the approaching innovative strategy and get funding by enhancing organization economical and give intellectually, which is a source of long-term benefit to organization. (Sloane, 2011; Seltzer and Mahmoudi, 2012) Crowdsourcing creates benefit to organization from increase efficiency to solve problem, gives more opportunities to develop skill and knowledge of organization, makes organization move faster and economically from open call which bring project finished easier and quicker than traditional methods by 'crowd' participate who make free task force by work as volunteers to take part in design, develop, improve product to company. The company will receive value not only from timely and costly efficiency, but will also get more acceptability and product's recognition from customers (Seltzer and Mahmoudi, 2012)

Successive crowdsourcing

There are three perspectives to concern for successive crowdsourcing: collecting crowd's ideas, distributing crowd's ideas, and choosing crowd's ideas.

To succeed collecting crowd's ideas, sharing innovative ideas should be based on past development. Challenge of crowdsourcing depends on well defines of problem explanation to provide the correct meaning of the problem, which effect to the independent solver to give the best solution without any tacit knowledge. In addition, make crowdsourcing with entertaining will make more opportunities for crowd to visit platform and share ideas. Also

creating idea contest will allow participation share with complete ideas and concept which easy for use in organization. However to make crowd interesting enough to participate need to use motivation factors that come from intrinsic and extrinsic factor. For intrinsic factor, the crowd enjoys as hobby to participate, share, and be a part to solve tasks that brings entertaining to them. For extrinsic factor, crowd receive reward as motivation to participate and done work such as money, goods, benefit, recognition etc. (Seltzer and Mahmoudi, 2012)

To succeed crowdsourcing sometime has to distribute task into small tasks. The small amount of work on crowdsourcing will be introduced in the form of "Micro task", it requires crowd to do small tasks with less time consuming, which can be done by smartphone, to earn small money such as can translate small sentences, proofreading, scan picture, take a short marketing survey, correction database etc. Micro task effected huge task to be done with a small amount of time, expense, and mistake. (Braham, 2014)

However, in successive choosing crowd's idea it is important to remember that not every crowd ideas can be used, according to "Sturgeon's Law", 1: 10: 89 that mean 90 out of 100 people will launch useless ideas. More extended the meaning, the only single idea will be useful, 10 ideas will be developed and created, and 89 ideas will be inactive. (Seltzer and Mahmoudi, 2012)

Crowdsourcing category

There are four categories of crowdsourcing: crowd wisdom, crowd creation, crowd voting, and crowdfunding. (Sloane, 2011)

- *Crowd wisdom* or *collective intelligence*; the knowledge gathered from random people, including users, without any interaction or connection between crowd. From this, crowd will share various and diversity of idea to develop better product and satisfy customer needs though "user drive innovation" process. (Sloane, 2011; Seltzer and Mahmoudi, 2012)
- *Crowd creation*; happens when company turn to actually create the ideas gathered from crowd. Professional and skilled people will exchange ideas to create product and service though "co-creation" process. (Sloane, 2011)
- *Crowd voting*; crowd's judgment by using popular vote as a key element of organization to process and manage huge quality information by prediction market.

It helps to select the best choice and ranging the choice's order. For example, using vote result to predict sales. (Sloane, 2011)

- *Crowdfunding*: use crowdsourcing for finding support money and source of micro lend. It makes inventor can collect investment from crowds to increase affordability and efficiency to produce innovative product. At the same time, it also helps to reduce risk of founder. (Sloane, 2011)

3.1.3 Crowdfunding

We present Crowdfunding in deep detail: From "crowdsourcing" to "crowdfunding", Crowdfunding concepts, Generate funding though crowdfunding, Two involvement of crowdfunding concept, Type of crowdfunding, Benefit of crowdfunding.

From "Crowdsourcing" to "Crowdfunding"

According to limited economic constraint, making start-up innovative company in developing area is difficult as it is hard to find investment and investors. By this problem, Crowdsourcing process was introduced to find and gather funds and investment money to produce frugal and reverse innovation product though the platform of "Crowdfunding". Crowdsourcing and Crowdfunding provide from the same fundamental of open innovation. (Chesbrough, 2003a) Crowdfunding is derived concept from crowdsourcing, which concern to gather investment from crowd by pitch idea of product and project though Internet web 2.0 to create a product from an entrepreneur's business idea. It helps to increase capability and creates value of enterprise by open call of content. (Schwienbacher and Larralde, 2010; Sloane, 2011)

Crowdfunding concept

Crowdfunding platform occurs by the concepts of "micro-finance" and "crowdsourcing", which bring usage of online community to let creator, or founder, post their ideas to online platform and allow crowd, or individual interesting people, support their money to make project movement. (Steinberg and DeMaria, 2012)

- *Crowdsourcing uses as a platform for founder, funder, and customer to share ideas, give feedback, and provide effective solution to support specific*

of initiating and developing of the project by "open call" for financial resource.

- *Micro-finance is introduced to gathering funding with little money from several donors in communities to develop production, marketing, and management of venture.*

Crowdfunding is introduced when small and medium business or start-up has lack of funding and cannot find sources of funds, it is used as an alternative way to get more opportunities for gathering funding, which exclusion from traditional financial technique. (Steinberg and DeMaria, 2012) According to Belleflamme et al., (2014) Bootstrap financial method is used for gathering investment for crowdfunding, which provide financing activity from external sources (crowdfunders) than internal sources (such as business angle, bank, venture capital, leasing company, government etc.). Most of start-up businesses are formed and seek investment though bootstrapping by the crowd. As the nature of this platform, Funds will be given with small investment money from many individual sources though Internet which mean crowdfunding no need to have financial intermediaries (Mollick, 2014), But crowdfunding undertaking Internet as an intermediate platform for communicating, raising, and gathering funds among business's founder (entrepreneur), business's interested (funders), and potential customers. (Schwienbacher and Larralde, 2010) The most famous platform is introduced by INDIEGOGO and KICKSTARTER platform as in appendix 1. (Brabham, 2013)

Generate funding though crowdfunding

Crowdfunding helps to support innovative ideas or academic research to become true and widely known. Founder will launch idea or project concept, in addition to provide prototype and product's introduction video, on the Internet platform in purpose of seeking for investment from individual or group funders, who interesting to use or develop project ideas by being apart as sponsors or customers, to fundraising and facilitate founder's projects in the form of donation or awards expectation though the power of crowd and the Internet. (Steinberg and DeMaria, 2012; Brabham, 2013) Participants will receive benefit/returns in the form of pre-order product, reputation, vote right, or profit share. (Mollick, 2014; Belleflamme et al., 2014) In addition, Crowdfunding platform allows

information to be shared base on online communities and social networks via the Internet that help to build loyal online communities and predictability of marketing by concern on community based experience. Crowdfunding requires common desire and trust as important driving forces for participate. So, The main focus on commercial and social entrepreneur by stress on social media, online communities, and micropayment technology is needed. (Dresner, 2014)

Crowdfunding is compared as art of funding, which platform uses for the new venture to seek investment for startup new business or funding on the specific purpose project. (Mollick, 2014; Brabham, 2013) Crowdfunding platform helps to seek funding from the crowd to bring entrepreneur idea to market with small loans that suitable for setting up a start-up business. However crowdfunding is not only used for raising funding for small and medium enterprise, but also for high growth startup. (Schwienbacher and Larralde, 2010) Funding gathering in the form of "donation" or "investment" to support on entrepreneurial product or service, disaster relief, artist's vision (Film, music, art). (Schweissguth, 2015) crowdfunding is used for creating opportunities from anywhere via an Internet platform. Which help to acquire an easier way to introduce a product and approaching the market with less time consumer. It is affected to shortened time and brought flexibility from various supporters to founder for easier finding investors and investment money. And also benefits to stimulate the recession of economic to become active. (Brabham, 2013) In addition, the successive crowd effect to create a backup from current customer and spreading good perspective of product through word-of-mouth. (Dresner, 2014) However using crowdfunding also creates the threat to other traditional funding methods. (Brabham, 2013)

Two involvement* of *crowdfunding concept

According to Steinberg and DeMaria (2012), crowdfunding have 2 types of people involve:

Founder: is an innovator or creator who generates business idea but don't have enough money for investing in their own project. To find funding founder have to publish their idea though Internet. They will get initial money for support project and the ability to predict target market.

Crowdfunder: those who have interests in specific product or idea and invest money to make that interesting product or project become authentic. *Crowdfunder* will receive reward in order to exchange supporting activity to founder's product. It can come in the form of equity, donation, or exclusive customer (which will receive limited or special product or priority to access new product, as loyal customer). From this *Crowdfunder* can be investor three ways by (Belleflamme et al., 2014):

- Investor: who is supported by direct funding and expected for equity as a return
- Donor: who is supported by donates funding and expecting for people around the world getting better life or expecting to be exclusive customer or get a reputation as an award.
- Customer: who is supported through investment by pre-purchase product from the product's ideas.

Type of crowdfunding

According to Crowdfunding's Potential for the Developing World (2013) and Candelise (2015) there are two main categories of crowdfunding model: Donation and investment form.

1) Donation crowdfunding model

According to Chest (2015), Candelise (2015), and Gajda and Walton (2013) there are two types of donation Crowdfunding model: Crowddonating and Crowdsponsoring.

1. *Crowddonating*: or called "philanthropic" or "patronage". From this type of funding, Entrepreneur propose non-financial or Non-profit project to crowdfunder which crowdfunder not expected for return. In the same time entrepreneurs have no risk to present the ideas, but hard for finding investor to spend money with non-profit funding. Mostly donation funding proposed to take care of people around the world to get better life which is presented in form of social charity than a business perspective. (Schwienbacher and Larralde, 2010; Dresner, 2014) Most of funder invests money to support founder's ideas since they have the same interest with founder and want to turn founder's ideas to be authentic project. (Savarese, 2015) Most of the project is proposed in the conceptual stage (problem/ solution fit) of business life cycle. (Chest, 2015; Paschen, 2017) The platforms comes in form of

solving social, environment, and political cause project for example GoFundMe, GiveForward, INDIEGOGO, Kickstarter etc. (Dresner, 2014)

2. *Crowdsponsoring*: is the concept of "active investment crowdfunding" and "reward-based crowdfunding". Active investment crowdfunding refers to investment platform that investor involve by giving active and responding on initial process that offering tangible rewards (Schwienbacher and Larralde, 2010). And Reward-based crowdfunding refers to entrepreneur's offers of non-financial return in form of pre-sale product or credit to the investor (Dresner, 2014). Most of project or product is proposed in conceptual to prototype stage (problem/ solution fit) of the business life cycle. (Chest, 2015; Paschen, 2017) All in all, Crowdsponsoring refer to the platform that entrepreneur offering funder to be apart or responding in early stage activity (funding as pre-purchase) and offering pre-sale product or credit as reward motivation for investors to support funding in the early stage of project. The platforms are used for introducing in entrepreneur, business, and artist project. (Dresner, 2014) Reward will come for "thank you" in two forms:
    - Pre-sale or early bird product: where investment exchanges for pre-order product with discount and special benefit. Mostly appear on business and entrepreneur project. (Mollick, 2014)
    - Credit: where donation exchanges record or named investor on product as co-creator for well knows and reputation in social. Mostly appear on the artist (music, art, movie etc.) project. (Brabham, 2013) In addition, Crowdsocial lending is another type of donation crowd with social return expectation. The funder will provide loan with free interest rate for entrepreneurs to support their project. Funders expected for getting reputation and well-know in social than returning of interest rate. From reward, the concept is similar with crowdsponsor except in crowdsponsor, Funder will support money without an investment return, but crowdsocial lending will support money and receive reputation and investment loan back from borrowed. (Gajda and Walton, 2013)

From the reward based crowdfunding, Founder also gets benefit by using in propose of predicting market, which helps to test market and develop product before real launching. (Savarese, 2015) In addition, founder can provide special event for spending time with the core investors that effected and make them feel privileged than normal customer or other investor. By this will help investors and

founder can share ideas and money to develop project and bring loyalty from investor to business. (Schwienbacher and Larralde, 2010).

2) Investment crowdfunding model

According to Chest (2015), Candelise (2015), and Gajda and Walton (2013) there are three types of investment crowdfunding model: Crowdinvesting, Crowdlending, and Crowdroyalty.

1. *Crowdinvesting*: is the concept of "passive investment crowdfunding" and "equity-based crowdfunding". From "passive investment crowdfunding" refer to investment platform that investor involve by giving funding without consuming the product and offering profit share as reward (Schwienbacher and Larralde, 2010; Belleflamme et al., 2014). And "Equity-based crowdfunding" refers to funding in purpose of expected on equity and profit share (Dresner, 2014). Most of the product is proposed in growth stage (Market penetration and Market expansion) of the business life cycle. (Chest, 2015; Paschen, 2017) All in all, Crowdinvesting refers to the platform that entrepreneur offering funder to invest money in purpose of receiving equity as return which affect investor to have the vote and right for project decision and receive a profit share from project. The platforms use for introducing on entrepreneur, social cause, and ICT project. (Dresner, 2014)
2. *Crowdlending*: is the concept of "debt-based crowdfunding" and "peer-to-peer lending" which investor act as lender to propose financial help to entrepreneur by funding with a fixed interest rate of return as loans. (Chest, 2015) However, the interest rate is the motivation for lenders to allow entrepreneur to borrow their money, which brings higher profit than deposit money in bank. In a comparison by entrepreneur perspective, Crowdlending will get less risk than Crowdinvestment because loans only need to return interest rate, which is not related to decision making and profit share like equity-based crowdfunding. Most of project is proposed on start-up stage (product and market validation) of the business life cycle. (Chest, 2015; Paschen, 2017)
3. Crowdroyalty: is a concept based on " royalty-based crowdfunding" which funder will invest in project and receive an award as percentage of right to use license from revenue. The entrepreneur has to pay for royalty interest of intellectually property (IP) which continuous reward for funder until end the right of license

usage. (Crowdfunding's Potential for the Developing World, 2013; Candelise, 2015)

For comparison by funder's perspective among crowd investment method, the lowest to highest of risk and return rate will be arranged for debt (Crowdlending) to royalty (Crowdroyalty) to equity (Crowdinvesting). (Crowdfunding's Potential for the Developing World, 2013)

Benefit of crowdfunding

In crowdfunding platform, it is benefited to both founder, which act as an entrepreneur, and crowdfunders, which act as investors/ donors/ customers. On this part we list benefit in both founder and crowdfunder perspective. (Schwienbacher and Larralde, 2010; Steinberg and DeMaria, 2012)

From the *Founder's perspective*, crowdfunding will get more investment and other extraordinary benefits as follows;

1. Raise funds: For basic benefit of the use crowdfunding platform, The entrepreneur will easily get source of investment money from consumer/individual and raise funds in purpose of continuing their business ideas. Crowdfunding platform allows for fundraising during the development process that helps for further estimate marketing potential. (Schwienbacher and Larralde, 2010) In addition, using crowdfunding entrepreneur has opportunity to get funding more than a target. But in opposite traditional investment method will receive less investment money than the target. (Steinberg and DeMaria, 2012)
2. Further support (Free of charge before real launch product): Crowdfunding platform makes opportunities for founder to build direct and strong connections on the internet platform for allow investors and customers to join and invest their money on project and product while a project idea introducing or before the production process though pre-sale intermediate platform. This platform offers advanced purchase for use money to continue product development and production process with no need to concern on pre-lunching cost which mean companies can get investment money by launching an idea without any initial investment. (Steinberg and DeMaria, 2012)

3. Create Build-in marketing: Crowdfunding platform helps to indicate possibility potential of the customer to buy and invest money on product by testing and estimating trends and customer potentials. From indicate amount and pricing respond before product launch by question on “how many people interesting” and “how many people willing to buy product” will help companies to find marketing potential. (Steinberg and DeMaria, 2012) The ability to predict market will help entrepreneurs to crate appropriate marketing plan, reduce risk of business and give more confidence to investors to increase investment. Crowdfunding does not only create a movement of product and economic but also help entrepreneurs to get public acceptance before the product launch. (Schwienbacher and Larralde, 2010; Steinberg and DeMaria, 2012)
4. Maintain ownership (benefit) to founder: less risky for entrepreneur: In crowdfunding, entrepreneur can do by business without losing ownership or equity. Founder doesn’t need to share controlling power to the other investors. Due to equity and all the decision of the business belong to founder, which mean the power of investors are not affected to decision of entrepreneur. Differently from traditional investment that the founder has to share parts of project to investors, which means they have influence on decision making. In crowdfunding, founder will be receiving a quick return on investment and ability to control cost, time, delivery, marketing, creativity, and customer interaction with their own. (Steinberg and DeMaria, 2012)
5. Collective intelligence: Crowdfunding platform work as collective intelligence which collect all knowledge from a crowd by open call to solve problem base on ideas *“no one knows everything and everyone know something”* which refers more efficiency will get from more people shared knowledge and solution than only from a small group of people. From collective solution, the crowd will give several ideas, which bring more efficiency to solve problem. (Schwienbacher and Larralde, 2010)
6. Easy access and corporate: In addition, companies can get funding from anywhere though Internet platform. Easy accesses with manage and monitor project from anywhere and anytime which information can reach to anybody who has Internet with no need to be famous or gigantic business. (Steinberg and DeMaria, 2012)

7. Corporation place among founder, funder, and customer: Using of crowdfunding can compare as another open channel to connections among founder, funder, and customer. The platform helps to receive useful advice from crowd. While on the marketing aspect loyal customers will turn to be supportive and help to promote the product. (Steinberg and DeMaria, 2012)

From *Funder/ Investor* perspective, Backer will receive awards as return for help investor to continue production or other process. The reward can come in many forms; (Mollick, 2014)

1. Pre order: Crowdfunder will receive reward in term of pre-order product from reward-based type of crowdfunding. Thus, pre-order product is proposed as a future reward for raising funds for founder's project. (Mollick, 2014) Founder invites crowdfunder to pre-purchase and invest money as initial capital for lunching product. Which this platform effected to have 2 types of customers: "crowdfunder" who is presented as pre-order customer and "regular customer" who wait until product launch into the market. The price of a product makes difference between pre-order customer and regular customer. Which pre-order customer gets more benefit and lower price than regular customers. In order to increase investment money, founder will reduce price to attract more crowdfunder to invest money in form of "pre-order" customer for support early development and production than in form of "regular" customer due to investment money depends on "pre-order product". The risings of pre-order investors will affect initial product make perversion in price differentiation between "pre-order" customers and "regular" customers. However, excessive perversion in price differentiates effect to give less initial profit. (Belleflamme et al., 2014)
2. Equity or Profit share: Crowdfunder will receive reward in term of profit share and vote right from the equity based type of crowdfunding. (Mollick, 2014) This crowdfunding works as a micro finance platform which investors invest their money to support a project's founder by no needs to consume product as consumers. (Dresner, 2014) Investors will have right to make marketing decision and only wait for return in form of profit share. More investor will give more benefit in form of more investment money. At the same time, affect less to product's profit. Due to investment money depend on "profit received" not depend on "pre-order product". (Belleflamme et al., 2014)

3. Reputation: Crowdfunder will receive rewards in terms of reputation from Donation based type of crowdfunding (Crowddonating, Crowdsponsoring, Crowdsocial lending) as co-creator who helps to support project to publish or create. From the reputation will help to improve existing of crowdfunder to be better well known. As co-creator, crowdfunder will be mentioned on the product as a supporter and sometime founder make a personal thank you letter or an exclusive party to thank crowdfunders. This makes crowdfunder likely feels important of their participation in the product, and to be treated as an exclusive customer to make them want to continue to support founder as a loyal customer. (Steinberg and DeMaria, 2012) However, people tend to donate money with the crowdsponsoring platform than donation platform because crowdsponsoring help to bring reputation to funders as donors. (Gajda and Walton, 2013)

3.2 3D printing and additive manufacturing

This section will explain about concept of 3D printing and additive manufacturing by grounding with the general concept of 3D printing and additive manufacturing, benefit and trend of 3D printing, and Application of 3D printing. This will help to understand more in case study analysis of 3D printing.

3.2.1 Concept of 3D printing and additive manufacturing

History of 3D printing and additive manufacturing

3D printer has been adopted from the concept of “rapid manufacturing” or “rapid prototyping” and then developed to “additive manufacturing” before concept of “3D printing” itself. (Zee et al., 2015) To understand the term of “3D printing” has to understand the concept of “Additive-manufacturing” which can be represented by various name such as rapid prototyping (RP), rapid manufacturing (RM), layer manufacturing (LM), solid freeform fabrication (SFF), and 3D printing. Even though all name were referring to additive manufacturing, each name also represents their own specific term. (Zeng et al., 2016) From Zee et al. (2015) 3D printing or Additive-manufacturing refer to groups of technology that build physical object from 3D data (Computer Aid Design). Different from conventional manufacturing that use the subtractive process to remove

material from a block of material by turning, cutting, milling, lathing, or machining to build physical object. (Horvath, 2014; Zeng et al., 2016) Instead of using conventional manufacturing, Additive-manufacturing helps to reduce cost, labor force, process step and time in manufacturing, thus also help to reduce the stock of product by changing concept from mass production to mass customization. (Zeng et al., 2016; Xu et al., 2017)

Differentiate of additive manufacturing and 3D printing

From Standard Terminology for Additive Manufacturing Technologies (2013) "Additive manufacturing" was defined differently from the term "3D printing":

> ***Additive manufacturing (AM)*** is a process of joining material to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies.
>
> > *Synonyms: additive fabrication, additive processes, additive technique, additive layer manufacturing, layer manufacturing, and freeform fabrication.*
>
> ***3D printing*** is the fabrications of object through the deposit of material using a print head, nozzle, or another printer technology.

Additive manufacturing refers to a method of manufacturing to produce physical objects by building up part layer-by-layer from the digital model (CAD) and using laser or electron beam for melt and deposit material (powder or filament) into a building plate or previous layers over and over again till finished to form as 3D object. (Zeng et al., 2016; Bhavar et al., 2014) Additive manufacturing can categorize into seven types according to difference type of material and process: Binder jetting (BJ), Directed energy deposition (DED), Material extrusion, Material jetting, Power bed fusion (PBF), Sheet lamination, and Vat photopolymerization. (Eisenhut and Langefeld, 2013)

According to Schniederjans (2017), 3D printing has described as particular of additive manufacturing. The differences between 3D printing and additive manufacturing can be categorized by the type of technology, which 3D printing represent with 3 types of technologies:

- Selective laser sintering (SLS) or laser: is based on Power bed fusion (PBF) technology, which applies heat or binding agents to fused powder bed (metal, plastic, ceramic, glass material) together. To create three-dimension object, each layer of powdered material have been fused by laser or electron beam to a platform and then continuously build up next layer. The powdered material is used as supporting material that offers to print complex part and allow to reuse of unused powdered material. However, the printer still tends to be expensive (if compared to other 2 methods) and hard to deal with the fine powder material. (Moylan et al., 2014; Bhavar et al., 2014; Horvath, 2014)
- Fuse Deposition Material (FDM): is based on Material extrusion technology, which heats up the solid material filament (such as elastomer, ABS, wax etc.) through the nozzle to allow melting material to flow and be deposited into the selective area, which nozzle controlled by Computer-aided manufacturing (CAM). The melting material will immediately form as solid shape layer-by-layer to create 3D objects. This result of this technique will print 3D objects and supportive parts as finished part. Fuse Deposition Material is the most popular technique for 3D printing (Gibson et al., 2009; Dudek, 2013; Horvath, 2014)
- Stereolithography (SLA): is based on vat photopolymerization technology, which selectively applies UV light to solidify the liquid resin vat layer-by-layer to create 3D models. Or Digital light projection (DLP) which harden whole layer in one by digital light projection to create 3D model. However, SLA and DLP are initial gain into the market with more expensive and less controllable with resin (~~if~~ compare to FDM technique). (Gibson et al., 2009; Horvath, 2014)

To use of 3D printer needs to concern and choose proper technique to produce a 3D model according to model complexity, budget, and final resolution (finest detail) etc. (Horvath, 2014)

Process of 3D printing

3D printing allows converting digital design file to physical product. To process 3D printing is not just like 2D inkjet printers that only need to order prints. 3D printing has many steps and associated design to concern before progressing to printing 3D object. The 3D printing process begins with a computer model of an object and then use 3D CAD

modeling to control robotic device by chooses one out of three 3D printing technique to build up part by adding material on a building plate layer-upon-layer until form as a 3D object. (Horvath, 2014)

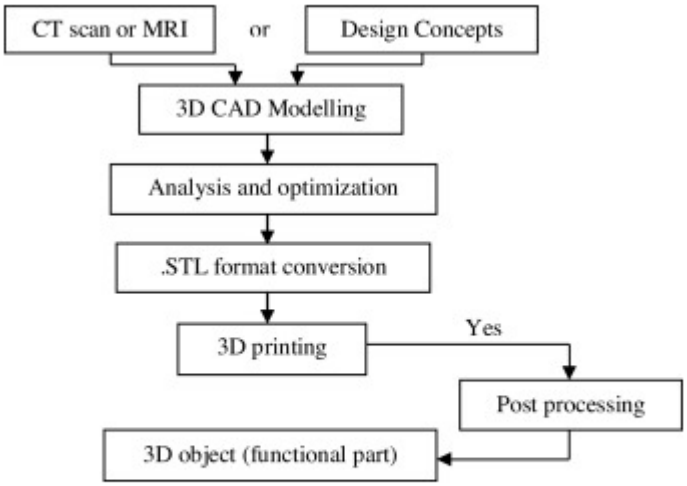


Figure 11. Process of 3D printing (Singh et al., 2017)

To understand the whole system have to deep focusing on each step of 3D printing as shows in figure 11. (Horvath, 2014)

1. *Create 3D CAD modeling*: the process begins with creating a three-dimensional virtual design which offer in two alternative ways
    - *Design concept* – which uses CAD (Computer aided design) to create three-dimensional model.
    - *CT scans and MRI* – which uses 3D scanning to recreate part or the whole object into three-dimension model by using the concept of reverse engineering (RE) instead of drawing model from CAD. RE is the technology that allows 3D CAD model to be able to be constructed quickly and directly from its physical object. (Xu et al., 2017)
2. *Analysis and optimize*: After get three-dimensional model file has to get analyzed and optimized where some holes, gaps, or overlapped areas can be fixed by applying the applications available in 3D printing software (ex. Geomagic Studio software) for preparing file ready to converting into .STL file format. (Iancu et al., 2010)
3. *Transfer into .STL file format*: Convert 3D CAD/CAM (computer aided design/ computer aided manufacturing) model that may appear in different formats to be a

standard format, called stereolithographic (STL) file. The STL model is then sliced with uniform thickness by slicing process. The obtained sliced layers are used to generate commands for building a physical prototype layer by layer. (Iancu et al., 2010)

4. *3D printing*: STL. File will be printed according to choosing one of three types of 3D printing technologies. The finished part can come as 2 parts: 3D part and support parts. Supportive material help to stabilized 3D part for easier printing without failure by overhanging or sticking material. (Zee et al., 2015)
5. *Post processing:* this step refers to process after removed part from 3D printer, which including cleaning, removing supportive part, and finishing (filling, priming, painting). For example: (Grimm, 2016)
    - *Fuse Deposition Material (FDM):* Remove support structures, Light sanding to remove support structure remnants, Gross support removal, Soak to dissolve supports, Rinse and dry.
    - *Stereolithography (SLA):* Gross removal of supports, Soak to remove residual resin, Cure in an ultraviolet (UV) oven, Remove remaining support structures, Light sanding to remove surface imperfections.
6. 3D object: After finish printing and post processing, 3D object is ready for representing as prototype or products.

Example of 3D printing

According to Zee et al. (2015) and Maric et al. (2016) 3D printing product and application used in many leading companies and industries such Industrial/ business machine, Consumer product/electronics, Motor vehicles, Medical/dental, Aerospace, Academic institution, Government military, Architecture etc. (Show in figure 12 - Hype curve of Gartner)

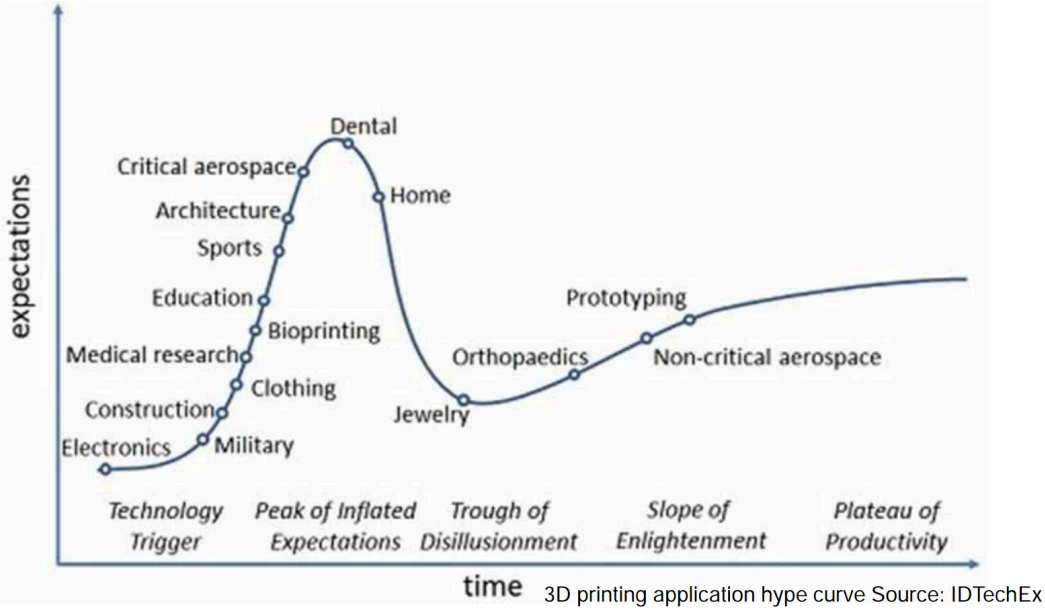


Figure 12. Hype curve of Gartner - 3D printing

3.2.2 Benefit and Trend of 3D printing

Benefit of 3D printing

While 3D printing has to finish process by fulfilling material layer-by-layer, Traditional method had to finish process by removing part & material. It affects to get benefit from applying 3D printing instead of traditional manufacturing. There are 5 main benefits, according to Monahan et al. (2015):

- New capabilities: Business will change from large-scale production into large customization which effect to occur new market of the product. 3D printing offers new product with acceleration, automatic and less waste of production. For example the opportunities to produce complex products with mass quantity can be offered with lower cost than traditional methods.
- Waste reduction: 3D printing software can help to minimize unnecessary part & waste before order to print prototype. And in 3D printing process the unused powder has been reused to reduce material wasted.
- Mass customization: Customers have opportunities to create, custom and build designs without limited of possibility (shape and material). From “on-demand”

technology is supported to the customer/maker easy access product design with less time and less product stock.

- Lead-time and speed: 3D printing using a scanner or online database for custom existing prototype instead of wasting time for building an entirely new prototype with traditional method which helps to reduce the time of design, process, and production cycle that effect to get product into the market faster.
- Supply chain simplification: Production will change to produce to close with demand instead of mass production like a traditional manufacturing for reduced inventory.

Development and trend of 3D printing

According to Basiliere (2016) and Tess (2016), The shipment of 3D printing has been recorded reaching to 219,168 units in 2015 and reach to 455,772 units in 2016. Nowadays, 3D printing and its application uses as prototype, additive manufacturing processes, and final product in many fields such as industrial manufacturing processes, medication, motor vehicle, and so on which will be wider spreading and growing up in the future. 3D printing will continue to develop and expand on a broader range of industries as new technology provider and processes develop. According to Gartner it has been predicted that in 2020 the shipment of 3D printing will be rising dramatically more than 6.7 million. By 2020, it has been predicted the using of 3D printing with 4 main trends:

- 3D printing will be used for *reduce new product introduction timelines* by 25%. 3D printer will be used as additive manufacturing for accelerating prototype processes, for example, use 3D printing as mold which help to reduce time and cost on injection mold process.
- 3D printing will be used for *internal medical devices/ implants at or near healthcare facilities* by 30%, which is predicted to develop 3D printing implants such as on processing printing time, sterilize, and inspect etc.
- 3D printing will be used for *producing tools, jigs, fixtures, and finished product from in-house or 3D printing service point* by 75%. From this the use of 3D printing hardware and software will be expanding and supporting more various types and techniques from existing material and production process to get a better additive manufacturing solution for consumer and company.

- 3D printing will be used with *incorporate robotic for industrial operation in the manufacturing process* by 10%. The proposed of using 3D printing for print prototype had extended and more stress on produce product with complex shapes, short time processing, and customized production technology. Thus, the "automated 3DP systems", which refer to combination of 3D printing with CNC milling or other autonomous machine or called "hybrid machine", are introducing and becoming more important that 3D printing can monitor itself as a printer, inspector, and corrector for fix defect product and process. From the combination of 3DP with automation machine introduced as "smart automation" product concept for help company get better equipped to produce prototype, test, adjust, and present to customers. For example combination of 3DP with automation end-of-arm tooling or automated inspection systems or automation in construction and large scale assembly.

All in all, Developed countries (North America and western Europe) will keep the continuous trend of growing in 3D printing by 2016 and in 2020 developing countries (China and emerging countries in Asia) will expect high growth of adopting 3D printing as combination or substitution of conventional manufacturing.

3.2.3 Application of 3D printing

3D printing is Disruptive

3D printing is a disruptive technology that can be identified from four stages of technology adoption. Firstly, 3D printing adoption as a rapid prototype technique where adoption used for reducing production cost. Secondly, 3D printing adoption as rapid tooling where is increasing use of customized tools and 3D printing mold. Then, Direct Digital Manufacturing (DDM), where fabricated final product with low cost of 3D printing. Finally, Home fabrication where consumers and designers can use a 3D printer as equipment at home. This technology is also included communication platform between designers and consumers. It allows non-skilled to access skilled capabilities which offers to shift consumers to be makers. (Maric et al., 2016) According to Zee et al. (2015) The adoption of 3D printing technology helps to increase ability in 4 areas:

- On-demand manufacturing; 3D printing will offer stockless inventory and rapid prototype will help to reduce product designing time.

- Customization; 3D printing will allow consumers to custom product and offer new business model that emphasis on product design process.
- Economic of scale; 3D printing will allow the manufacturers to minimize production cost per volume as economic of scale.
- Location elasticity; 3D printing will allow companies to bring product manufacturing close to consumers, which effect to reduce the number of product transportation.

3D printing software

3D printing has used open source software and hardware and has been introduced as an innovative solution for addressing the need of BOP and operates organization. It enables BOP easily to connect and access innovative product by being maker and consumer at the same time. (Maric et al., 2016) New value of 3D printing has been created though many features and application of 3D printing software (Monahan et al., 2015)

- *Scanning and digitization app*: The application that is used for scan and digitalize product by rapid prototype. The use of high quality of scanner will provide accuracy and easy to use (convenient, accessible, adaptable etc.). For example, Lala crashes on the design of a red plastic vest but she prefer to buy blue one. However, she is wearing the glasses that can detect vest model, design, and brand. The scanning application helps to analyze data and find blue plastic vast.
- *Online database app*: The application that is used for searching and matching product to design file via crowdsourcing platform. For example, the preference glass can't find on store, but online data base app can detect similar model of vest has been created on online communities platform.
- *Mass customize app*: The application that is used for customize a design as a preference. For example, Lala decides to customize the vast by using interface on her device according to her preference size, color, and material.
- *Printer center*: The center for print and pick up product as order via application. It offers high quality and low cost product to customer and also offers access to any kinds of consumer. For example, Lala goes to the nearest printing center, where she can print product by 3D printer within short processing time.

- *Intellectual property management and payment system*: the user interface that controls payment option and agreement on licensing.
- *3D data and records management*: the user interface that manages a record on management, transaction, and service subscribe information.

Value creation of 3D printing: open source software and hardware

According to Maric et al. (2016) 3D printer is a key technology that presents "new era of industrial production" or called "Renaissance of manufacturing". 3D printer enhances the availability of developing countries to be able to access and reach innovative product by open source concept. Open source software and hardware are working based on "common-based peer product" or "crowd service". It creates value to 3D printing technology by shared knowledge, tool, technology, and know-how to implement and advance skills of manufacturing, digital, and computing though "co-creation" concept and contribute product though "DIY" concept.

> *Co-creation* refers to activity that creates value or unique experience from interaction between individual customers and company. From this activity will bring consumer getting closer to producer that helps consumer increase opportunities for interaction, collaboration, and reaching more technology and innovative product.
>
> *Do-it-yourself (DIY)* refers to unassembled or partly assembled that need consumers to assemble the rest of part by their own. In terms of 3D printing DIY refers to manufacturing or assembly part by consumer. However, Open source software and hardware offering communities to share knowledge and knowhow for individual easily gain and apply knowledge to produce a product.

According to Zee et al. (2015) and Maric et al. (2016), *Co-creation* and *Do-it-yourself (DIY)* concept help to create "*The maker movement*" which refer to individuals collaborating in develop product and process through the online platform for create open source software and hardware communities in purpose of sharing and discovering new knowledge. The maker movement occurs based on people both hobbyists and professional who interesting to meet up for sharing knowledge on open source, peer production, and

crowdfunding. The maker movement led to build communities for makers to meet up, share, and trade ideas and technique among people in communities.

> ***The maker*** *is not only referring to people who know how to use 3D printing or manufacturing tool. The Maker is not necessarily to be engineers or creator. He/she can be someone who has creative ideas to produce innovative product or process. According to Zee et al. (2015) have defined "Maker" related to termination of "the maker movement" with three terms as:*
>
> - *"People who design and prototype products by digital desktop mean (digital do-it-yourself)".*
> - *"Cultural norm committed to the idea that the design and prototype are shared and further development within the community".*
> - *"The usage of common standards for blue prints that aims at closing shortening the gap between maker and commercial service provider".*
>
> ***The makers*** *refer to groups of individuals maker work together in open fabrication environment.*

Thus, the maker movement of 3D printing technology is occurring in open source software and hardware, where it is used in open online platform and co-working space and helps to change the term of DIY (Do-it-yourself) into DIT (Do-it-together). The use of open source communities for 3D printing can also be identified with five-business model concept: *Online platform* where mainly presents and sell product, *Web shop function* which mainly contributes to selling final product, *3D printer retail* where customer can buy 3D printer, *Customize prototype* for industry and private client where can create 3D model though drawing or scanning, *Research and Education activity* where can create 3D objects for education and improvement of 3D technology. For example:

- *Fablab* is workshop with computer-controller tool like a laser, 3D printing, grinding etc. which offers many types of material and machine. It enables to open and collaborative between labs to help maker provide product with low R&D cost. Fablab beginning in MIT and the spread to build in many areas, which help to transfer knowledge and technology from developed countries to developing country. The value creates though many types of people from small players like individual until large companies. (Zee et al., 2015)

- *Hackerspace and Makerspace* is a place to take classes or watch people make things with 3D printer and other conventional machine tool. The Member can attend classes for getting the certificate to use equipment and do own project. It is a place for creates low cost of prototype and meet team member for being entrepreneurial. (Zee et al., 2015)

3.2.4 3D printing related to frugal innovation concept

According to the product itself, it explains from the emergence of frugal low-cost 3D printers which shows 3D printer designed from fab lab was bringing old part or waste component of computer, printers, scanners from local garbage and convert it to new 3D printer. The conversion of wastes from Maric et al. (2016) presents 3D printing as a frugal innovation product by showing the intersection concept between frugal innovation and 3D printing was representing with the concept of "dual nature of 3D printing", which firstly, examine 3D printing as a frugal innovation. And secondly, identify 3D printing from a frugal perspective.

Examine 3D printing as a frugal innovation

To examine 3D printing as a frugal innovation refers to 3D printing has been presented in the form of product development in scarcity environment (lack of money and resource) that observed in the case of "Frugal 3D printer was developed in developing country". From the case study, the conversion of waste to useful thing shows creativity in a scarcity environment (lack of money and resource) brings development to create new products, business and entrepreneur with economically cost, processing, and time. (Maric et al., 2016) According to Ostraszewska and Tylec (2015) The concept of innovation "quick fix" or "DIY" of "Jugaad innovation" was approached to create new innovative products. Jugaad innovation offers "adaptation for less" to get "product innovation" under limited resource to provide a quick solution to solve problem to reach the customer's needs with low cost which refers to offering low cost product innovation with quick fixes that give fast and poor quality solution to solve BOP's non-complex problem.

Identify 3D printing from a frugal perspective

By identifying 3D printing from a frugal perspective referring to "analyst 3D printing as a frugal innovative solution in the form of services development and business model innovation" for offer low-income to reach technology in affordable condition (price, time) by using 3D printing instead of traditional manufacturing method.

According to Maric et al. (2016) 3D printing is used for printing or fabricated transplantable human organ (3D bio print) and prosthetics & orthotics based on open source software, discussion forum, crowd-sourced answers. To create 3D models of prosthetic, the amputated part has to be scanned for creating 3D model in order to find the best solution method and convert 3D model for fabrication prosthetic part by using a 3D printer. The result of using 3D scanner and 3D printers helps to reduce time consuming better than traditional manufacturing method and offers to change from traditional mass manufacturing (mass production) to produce a small number of customizable product (mass customization). However 3D scanner and 3D printers help prosthetic part meet the needs that can't provide by traditional manufacturing than replacing existing manufacturing method. In additional also support innovative business model for BOP by offer low cost of 3D bio print and prosthetic leg from 3D printing than traditional manufacturing method. It helps to bring affordable technology to unreachable people in developing countries as a new business strategy which also helps to decrease the gap of low-income people to reach new technology product.

All in all, The use of 3D printing, technology was transferred from developed country to developing country which allows development of new product and service to latecomers have opportunities to get alternative product or alternative way to access product more easies by reducing the gap between developed and developing world. 3D printing is offering easier access to better product and service in an unreachable area to consumers with lower price, high capability, and quality which helps human life ~~to~~ receive more opportunities to reach innovative product (For example medication - get cure and treatment). 3D printing offers mass customization and lower production costs compared to the traditional manufacturing method to reach frugal mindset by reducing inequality and contributes to participation and empowerment. It affects to reduce the problem of fully costed and lack of variety of product and service choice, increase competition in the market, increase incomes to company and national GDP.

4. RESEARCH METHODOLOGY

4.1 Research strategy

The study uses both qualitative and quantitative research data. According to Saunders et al., (2009) qualitative data refer to the use any data collection technique and data analysis procedure without numerical data such as case studies, interviews, and videos or pictures etc. it allows a deep analysis to develop a real sense of understanding to a situation. While Quantitative data refer to the use of raw data to processing and analysis by measuring data or identify numerical scale to transfer useful data to the researcher such as graphs, charts and statistics etc. It allows numerical data to gather for categories, ranking order, and measure in unit of measurement. The task of this thesis was to explain support factors enabling for the feasibility of introducing frugal innovative product within crowdfunding platform and find techniques to be successive in introduce frugal innovative product within crowdfunding platform.

4.2 Case study

Case study is the secondary data strategy which is used for the purpose of explanation or exploratory on the research. Case study is for generating the answer by study and questioning with “why”, “how”, “what” to get deep understanding on specific interesting. (Saunders et al., 2009) In this thesis, cases studies are for find how to be successful in introducing frugal innovative products within crowdfunding platform by explore the existing theory and provide a source of new research question. Which is separately collecting and analyzing though 2 types of data:

- Data have been collected through 12 cases of 3D printing from 4 different type of crowdfunding platform (Crowdonation, Crowdsponsoring, Crowdinvesting, Crowdlending) to find the best crowdfunding type for introduced frugal innovative product (in case of 3D printing concept). As show on table 1

Type of crowdfunding	Platform name
Donation-based (Crowddonating)	GoFundMe.com
	experiment.com
	betterplace.org
Rewards-based (Crowdsponsoring)	Indiegogo
	Kickstarter
	Startnext
Equity-based (crowdinvesting)	AngelList.co
	crowdcube.com
	seedmatch.de
Lending-based (Crowdlending)	Grow.ly
	kiva.org
	prosper.com (more like loan institute)

Table 1. Methodology: 12 cases of 3D printing: 4 different type of crowdfunding platform

- Data have been collected through 20 successive cases of 3D printing that introduced within crowdfunding platform for analysis by using 10 cases from Indiegogo and 10 cases from Kickstarter platform to find the important content and information that founder need to provide and concern to successive introduce frugal innovative product by crowdfunding platform. Moreover, find the problem of existing platform and develop the pattern of crowdfunding platform for suitable introducing 3D printing concept. As show on table 2.

Crowdfunding platform	Name
Kickstarter	eora 3D	High-Precision 3D Scanning on Your Smartphone
	3Dvarius - High-end 3D printed electric Violin
	FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.
	LIX - The Smallest 3D Printing Pen in the World
	FormBox: A Desktop Vacuum Former That Makes Beautiful Things
	Altergaze: 3D printed VR Goggles for Smartphones
	Tiko - The Unibody 3D Printer
	M-One: An opensource, professional desktop DLP 3D printer
	Bocusini - World's first plug & play 3D Food Printing System
	Deltaprintr - A simple, affordable 3D Printer!
Indiegogo	Felfil Evo. 3D printers filament extruder
	BASE by Wiivv - Custom, 3D Printed Insoles
	Ares: An Affordable All-in-one 3D Printer
	Gizmo 3D Printers SLA DLP - It works, lasts & wows
	FABtotum PRISM
	Rapide Lite 200XL - 400mm Desktop Plus 3D Printer
	reaks3D: the World's First Portable 3D Printer
	NEA 3D: Stylish & Upgradeable 3D Printing for All
	CreoPop - Cool Ink. Infinite Creativity.
	3D Printer For Class

Table 2. Methodology: 20 successive cases of 3D printing (Kickstarter and Indiegogo)

4.3 Collection of research material

This study has (i) analyzed 12 cases studies of 3D printing introduced by different type of crowdfunding platform and (ii) analysis in deep detail of 20 case studies of 3D printing from Indiegogo and Kickstarter platform. These are introduced by donation and reward-based crowdfunding platform to find the strategy and platform pattern to be successive in introducing frugal innovative product within crowdfunding platform. In addition, considering literature review as alternative ways to explain supportive factor enabling for the feasibility of introducing frugal innovative product within crowdfunding platform.

The first part explains a supporting factor enabling for the feasibility of introducing frugal innovative product within crowdfunding platform by reviewing data according to literature review. In this part, an analysis and the comparison on definition, characteristic, and properties between frugal innovation and crowdsourcing are present. “Crowdfunding” platform, which is invented from crowdsourcing’s sub-ideas, act as the main platform for introducing frugal innovative product in developing countries which are lacking of investment. The approval of suitability for introducing frugal innovative product by “crowdfunding” have been proven by classifying “Frugal innovation” as “initial cause or motivation” and “crowdsourcing” as “solution”. After analysis and compare definition, characteristic, and properties between frugal innovation and crowdsourcing though qualitative data. This brings the result to help to support the use of “crowdfunding” platform for introducing frugal innovation product into the market.

Second part, the best techniques for find strategy, content, and platform pattern to approaching frugal innovative product by crowdfunding platform have been introduced from the data set of 12 and 20 case studies of 3D printing’s crowdfunding platform. The data were reviewed and analyzed. The results have been separated into 3 main purposes of the result:

I. In the first part, the 3D printing cases studies support the different type of the crowdfunding platform are present as follows:
    - Review theoretical of Chest (2015) and Paschen (2017) to show the different types of crowdfunding are separated though the business stages.

- Analyst 12 cases studies use for support theoretical review from Chest (2015) and Paschen (2017). These 12 case studies are searching with "3D printing" and "3D printer" as a keyword on different type of crowdfunding platform (Crowdonation, Crowdsponsoring, Crowdinvesting, Crowdlending). The numerical data will be counted on data searching result.

The numerical data will help to support theoretical review to differentiation on using each type of crowdfunding platform.

II. In the second part identifies the main content of this study which are the founder's need and concern in crowdfunding platform for success of introducing frugal innovative product by sorting and analyzing the similarity characteristic from 20 cases studies (10 from Indiegogo and 10 from Kickstarter) of 3D printing's Crowdfunding platform with using both qualitative and quantitative method used.

III. In this third part, 20 successive cases (10 from Indiegogo and 10 from Kickstarter) of 3D printing's crowdfunding platform are analyzed in detail with using qualitative method to find the problems of existing platform and develop the platform pattern for suitable introducing 3D printing concept, which can develop concept to create successive way to introduce frugal innovative product by crowdfunding platform in the future.

Collection of research type	Finding
1) Qualitative/ collective and comparative data	Prove the supportive reason that enabling the feasibility of introduced frugal innovative product within Crowdfunding platform by comparing "Frugal innovation" as "initial cause or motivation" and "crowdsourcing" as "solution".
2.1) Qualitative and Quantitative / collect theoretical data and compare with secondary data (case study) from searching result	The theoretical and 3D printing cases studies supported different type of the crowdfunding platform used to present different stage of product by: • Review different types of crowdfunding are separated though the business stages by theoretical of Chest (2015) and Paschen (2017). • 12 case studies are searching with "3D printing" and "3D printer" as a keyword on different type of crowdfunding platform (Crowdonation, Crowdsponsoring, Crowdinvesting, Crowdlending).
2.2) Qualitative and Quantitative / collect and compare by numerical data on secondary data (case study)	In-deep analysis 20 successive cases (10 from Indiegogo and 10 from Kickstarter) of 3D printing's crowdfunding platform to find the main content that founder needs to provide and concern to successive introduce frugal innovative product by sorting and analyzing the similarity characteristic of platform.
2.3) Qualitative/ secondary data (case study)	In-deep analysis 20 successive cases (10 from Indiegogo and 10 from Kickstarter) of 3D printing's crowdfunding platform to find the problem of existing platform and develop the platform pattern for suitable introducing 3D printing concept, which can develop concept to create successive way to introduce frugal innovative product by crowdfunding platform in the future.

Table 3. Research type and finding

4.4 Data analysis

The objective of analysis was to evaluate the feasibility of frugal innovative product introduced within crowdfunding platform and the identification of key factors to successive. The qualitative research material was grounded for Find supportive reason that enabling the feasibility of introducing frugal innovative products within crowdfunding platform. While the both qualitative and quantitative research analysis of case study use for identify strategy, characteristic, and platform pattern to successful in introducing frugal innovative products within crowdfunding platform. The resulting of collected material is present in next chapter, on research analysis.

5. RESEARCH ANALYSIS

This chapter is to identify and propose the most appropriate ways to approve and introduce frugal innovative product by crowdfunding platform.

5.1 Enabling the feasibility of introducing frugal innovative product within crowdfunding

In this part analysis and compare definition, characteristic, and properties between frugal innovation and crowdsourcing help to support the use of “crowdfunding” platform for introducing frugal innovation products into the market. “Crowdfunding” platform, which comes from crowdsourcing’s sub-ideas, act as the main platform for introducing frugal innovative products in developing countries which lacking of investment money and investors. The approvals of suitability for introducing frugal innovative product by crowdfunding have been proven from classifying “Frugal innovation” as “initial cause or motivation” and “crowdsourcing” as “solution”. Which can explain through three main reasons from according concepts: (as in table 4)

Factor No.	Frugal innovation as cause factor	crowdsourcing as result factor
1	Concern "real environment", not theoritical	Outsourcing process: receive ideas from both outsider and insider according from principles of open innovation, collective intelligent, wisdom of crowd, and marginality by concerning on real environment
		Work base on "voice of customer" and "customer co-creation"
		solving according from '"Crowd wisdom" and "Crowd creation"
2	Concern "do more with less for more" which mean "do more efficiency with less cost for more people"	"Top-down" management + "Bottom-up"open innovation • "Bottom-up"open innovation as "do more efficiency for less cost" • "Top-down" management as "for more people" which mean intensive on mass product
3	Resource constraint (limited resources) : lack of support money and raw material	Solve problem to get more business opportunities from • Scare resources (lack of raw materials and investment) • Find substitution or new solution (resource) • Multi task: reduce time and cost of R&D and process
	Institution constraint (human interaction and behavior) : lack of agreement and intermediary among company, supplier, and consumer in supply chain	"Crowd voting" + "Crowdfunding" • "crowd voting" for doing crowd judgment by vote • "crowdfunding" make predictable of production before produce innovative product. Which helps to avoid breaking agreement
	Social constraint : approachable and affordable of low purchasing power customer to reach needs	Get rid of unaffordable and inaccessible from high expense in investment and product cost for both investor and customer. Which crowdsourcing helps to: • Find investment from cheap platform • Do R&D, production, and supple chain with low price that help to reduce product cost

Table 4. Support reasons of introducing Frugal innovation product by Crowdsourcing method: comparable characteristic and properties

5.1.1 Frugal innovation concerns real environment

Due to frugal innovation concerns on real environment for solving problems to approach the needs of customer in scarcity condition. The solution was introduced by crowdsourcing to solve problem by open call to receive creative ideas from crowd to company for produce innovative product. The reasonable base on:

Crowdsourcing is outsourcing process

Crowdsourcing is outsourcing process that helps to open process to receive ideas from both insider and outsider. It is created from the integration principle of open innovation, collective intelligence, wisdom of crowd, and marginality by concerning on real environment. From deep comparable, point-to-point, of frugal innovative as cause and show result according from crowdsourcing principal:

- Open innovation: This helps to open source and receive new innovative ideas from insider (organization) and outsiders (ex. users, customers, partners etc.) to develop product and service's efficiency. This means that not only receive ideas from insider who only concern on organization target, but also from outsiders who create new innovative ideas by concern on real environment.
- Collective intelligence: This is capable to handle with connection of the large scale of interaction. (Braham al et, 2014) This is a crowdsourcing, which helps in gathering huge amount of shared idea according to real environment from crowd.
- Wisdom of crowd: This refers to crowd that provide solution though online platform with democratic participation for outsourcing and create product and service innovation. (Sloane, 2011; Brabham, 2013) Which mean crowd have equality right to share and choose innovative idea according from their own environment condition.
- Marginality: This refers to organization gained difference experiences and out-border knowledge from outsiders or less involve people to organization, who have difference problem-solving environment from insider, to create different and various problem's solution. (Braham al et, 2014) This means not only solving problems through the organization, but solutions can also come from outsider according from their environment constraint.

"Voice of customer" and "Customer co-creation"

Crowdsourcing work is based on “voice of customer" and "customer co-creation” to open, receive, and share for any kind of ideas and solution according from the crowd’s environment. For "voice of customer" refers to gathering ideas of crowd by open sourcing for share creative solution process via Internet to use with the organization. This means that gathered ideas are based on real environment from both bottom of pyramid (scarcity environment) and top of pyramid (affluent environment). For "customer co-creation" refers to a corporation between organization (insider) and crowd (outsider) helps to select the best solution idea which is based on real environmental constraint for solving complex problems.

Frugal innovation solving according from "Crowd wisdom" and "Crowd creation”

The processes of “crowd wisdom” and “crowd creation” are confirming the work of crowdsourcing come from an influence of crowd’s environmental constraint to help to solve complex problem of organization. As the following:

- The process of “crowd wisdom” explain the various and diversity of ideas come from crowd according from their environment constraint. Each idea has been gathering from random people without any connection between crowds to generate differences ideas from the other crowd through “user drive innovation” process. (Sloane, 2011)
- The process of “crowd creation” explains through “co-creation” process when the gathered ideas sharing, discussing, and choosing the best idea before turn it to be real. From this, all of decisions have been decided through the organization and crowd who is multi-discipline expert.

5.1.2 Frugal innovation as concept of "Do more with less for more"

Frugal innovation activity is based on the concept of "Do more with less for more" for solving complex problems to approach the needs from massive among of customers in scarcity environment. However, to succeed introduce frugal innovation have to understand 2 main challenges: the value architecture of frugal innovation and build local organization

structure for enabling frugal innovation. Which brings “bottom-up” open innovation and “top-down” management process to solve problems.

- The value architecture of frugal innovation with the concept of “do more with less” solve by “bottom-up” open innovation process:

  “Frugal innovations are the result of unique and valuable architecture that is grounded in the drive to meet basic requirements at the lowest possible cost”. This means that understanding of the need of customers to create and develop product and process to reach the basic requirement with high value and low supply chain cost by focus mainly on develop main function, cut unnecessary parts, and use low-cost processes (Zeschky et al., 2011) as "do more efficiency for less cost" concept. Moreover, the purpose of frugal innovation is to create maximize efficiency with costless product. From this, the solutions of open sourcing to receive ideas from low-income and high-income people are introduced to produce product based on customer needs though open innovation from bottom to top of pyramid, called “bottom-up” open innovation.

- Build local organization structure for enabling frugal innovation with the concept of “for more” solve by “top-down” management process:

  The purpose of frugal innovation is to build local organization structure for enabling frugal innovation in both local and international areas to make more opportunities for people to be able to reach and affordable innovative product, which refers to “for more people” concept. According from Zeschky et al., (2011) “Building effective capabilities for frugal innovation depends mainly on the ability of the R&D team to sense local need and translate them into effective, low-cost product” means to successive introduce frugal innovation have to build separately supporting R&D and management section for more understand, translate, and develop the needs from local knowledge and resources (environments). This will create suitable and affordable innovative product and process for reaching more people. However, every local R&D and management section needs to have centralized section to control overall development perspective. Therefore, the solution of open sourcing to receive R&D and management ideas from each local area, as “ bottom-up” innovation, are used for make suitable innovative product according to local environment, but still have to concern “top-down” management to work as a core development team to develop open innovation strategy and

support implementation. From this, “top-down” management used as a management strategy to corporate from top to low ranging for reach more massive customer.

All in all, to successive “do more with less for more” concept have to apply both “bottom-up” open innovation and "top-down" management concept which are a process provided in crowdsourcing for developing the best design and management strategy of innovative product and process to approach customer needs in both developing and developed markets.

5.1.3 Three constraints of frugal innovation

To succeed introducing frugal innovation products into the market have to concern environmental constraint through business, institutional, and social as key factor. The solution was introduced by crowdsourcing to solve problems which platform model creates according from resource constraint, institutional constraint, and social constraint.

Resource constraint

Resource constraint means limited resources that refer to lack of support money and raw material. The problems occur from lack of resources constraint such as lack of raw materials and investment. To solve problems have to bring more business opportunities to organization by bringing accessible to reach and control resource scarcity which related to controlling, procurement, and coordinate of skill, labor, and material. The solution can come from finding substitution or a new solution to introduce to the system. From that crowdsourcing can work as a platform to gather solution ideas, such as an alternative source of raw material and funds, to obtain benefit from local R&D to organization for produce affordable and accessible product to customers. In additional, crowdsourcing platform can be more advantaged by applying multi tasks to help organization to shorter time and cut unnecessary cost of the R&D process to get more efficiency solution from crowd via Internet.

Institutional constraint

Institutional constraint means lacking ability of human interaction and behavior. Which refers the problems occurs from complex institutional and lack of agreement and intermediary among company, supplier, and consumer in supply chain. To solve the

problem mandatory control and responsible sense of making peaceful society was introduced to make agreement by “crowd voting” and “crowdfunding” though crowdsourcing platform.

- Crowd voting: which help to make a democratic agreement from crowd judgment by vote among crowd and organization to select the best choice and ranging the choice’s order without any complexity of institutional.
- Crowdfunding which help to manage and control agreement and offering deal among company, supplier, and consumer in supply chain though pre-financial agreement to avoid breaking an agreement and reduce risk of founder.

All in all, crowdsourcing platform will help the organization to increase affordability and efficiency to produce innovative product from “crowd voting” and “crowdfunding” by bringing less complex institutional and avoid lack of agreement and intermediary among company, supplier, and consumer in the supply chain.

Social constraint

Social constraint means approachable and affordable of low purchasing power customer to reach needs that refer to ability to bring accessible and affordable to reach product with less cost to customers. To solve the problem has to bring more business opportunities to customers by getting rid of unaffordable and inaccessible to innovative product. The solution can come from decreasing R&D, production, and supple chain cost to reduce product cost through crowdsourcing platform. Which crowdfunding platforms help to gather the best solution ideas to organization for produce affordable and accessible product to customers with less cost and time of R&D, production, and supple chain process. In addition, crowdsourcing platform is also presented as a cheap investment platform to use.

To summarize, Frugal innovation concern on producing low cost product by intense on using available resource and avoid waste with same or better main product's function to meet customer needs can be supported by crowdsourcing platform. Which help to deal with product design and management by open sourcing from insider and outsider through crowd wisdom, crowd creation, crowd voting, and crowdfunding.

5.2 Successive techniques to introduce frugal innovation product within crowdfunding platform

Analysis the effective techniques to successive introduces frugal innovative product by crowdfunding. Firstly, collected, review, and analyzed information of 12 cases studies of different 3D printing's crowdfunding platform (Crowddonating, Crowdsponsoring, Crowdinvesting, Crowdlending) to find the suitable platform for introducing frugal innovative product. Secondly, collected, review, and analyzed information of 20 successive case studies of 3D printing from crowddonating and crowdsponsoring platform to find the content or information needed to provide in platform for successive introduce a frugal innovative product by crowdfunding. Finally, analyze deep detail 20 successive case studies of 3D printing's crowdfunding platform to find the problem of exiting platform and develop the pattern of crowdfunding platform for suitable introducing 3D printing concept to create successive ways to introduce a frugal innovative product by crowdfunding platform in the future.

5.2.1 Type of crowdfunding platform for introduce frugal innovative product (3D printing case)

The theoretical and 3D printing cases studies supported different type of the crowdfunding platform used to present different stage of product by:

Theoretical

By theoretical of Chest (2015) and Paschen (2017) the crowdfunding model has separated into 3 types depend on each product stage (Pre-startup, Startup, Growth). The donation crowdfunding model, which is crowddonating and crowdsponsoring, is suitable for the pre-startup stage. The platform helps to achieve problem/solution fit and product validation. Which all refer to support product in development stage. While, The Lending and Equity crowdfunding model is more suitable for start-up and growth stage. The platform helps to achieve market validation, market penetration, and market expansion. Which all refer to support product in marketing stage that helps to achieve marketing purpose than developing product purpose.

From the nature of frugal innovation, products have been produced in a scarcity environment (lack of money, resource, knowledge etc.) which is needing financial support to complete the project, either supporting money on the whole project or some part of the project for development product purpose. Many of frugal innovative products affect to slow down and stuck in the development process which is situated on the pre-startup or start-up stage. From this theoretical refers that the best way to receive funds for develop frugal innovative product is crowdfunding project though donation platform (or Crowddonating), which is more suitable for product development stage than lending and equity platform that more intense in marketing development stage.

Case study

The case study of introducing 3D printing product and service through crowdfunding platform was observed to demonstrate the suitable type of crowdfunding platform for introducing Frugal innovative product (as in Appendix 2.)

Most of 3D-printing case studies are mainly crowdfunding in purpose of developing product or some part of product to completed project. The comparable case analysis of 3D printing, by using “3D printing” and “3D printer” as a keyword, searched though all types of crowdfunding platform (Crowddonating, Crowdsponsoring, Crowdinvesting, Crowdlending) was presented (as in table 5.)

Type of crowdfunding	Platform name	Searching result with "3D printing" and "3D printer" keyword
Donation-based (Crowddonating)	GoFundMe.com	Result found (967)
	experiment.com	No result found
	betterplace.org	No result found
Rewards-based (Crowdsponsoring)	Indiegogo	Result found (more than 1000)
	Kickstarter	Result found (morethan 1000)
	Startnext	No result found
Equity-based (crowdinvesting)	AngelList.co	result found (7)
	crowdcube.com	No result found
	seedmatch.de	No result found
Lending-based (Crowdlending)	Grow.ly	No result found
	kiva.org	No result found
	prosper.com (more like loan institute)	No result found

Table 5. 12 cases of 3D printing: 4 different type of crowdfunding platform

From the result of introducing of 3D printing technology and product by crowdfunding platform, In Crowdinvesting (2 out of 3 - Crowdcube.com, Seedmatch.de) and Crowdlending (3 out of 3 - Grow.ly, kiva.org, Prosper.com) searching results are not appearing. In the opposite, 3D printing technology and product are popular introduced by Crowddonating (1 out of 3 - GoFundMe.com) and Crowdsponsoring (2 out of 3 - Indiegogo and Kickstarter) platform with more than 200 searching result. Comparable to AngelList.co, which is one of Crowdinvesting, shows only 7 searching result that not present with high searching number as other platform. Thus, crowdsponsoring are suggesting as crowdfunding method for introducing 3D printing.

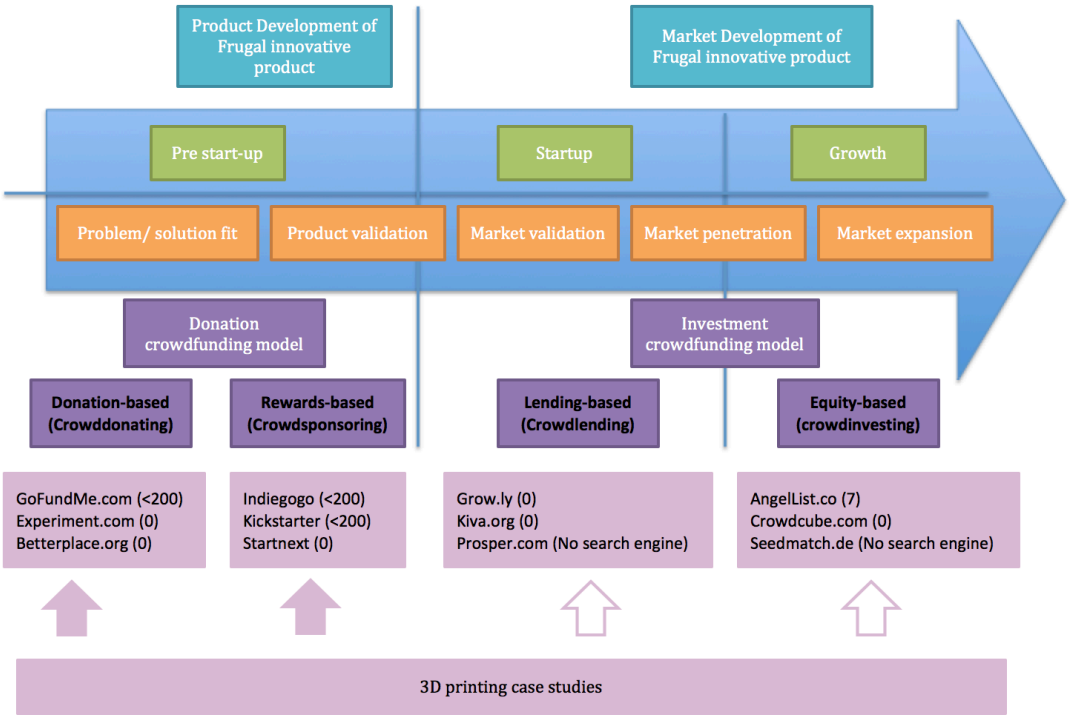


Figure 13. Analysis of Crowdfunding type: theoretical and cases studies

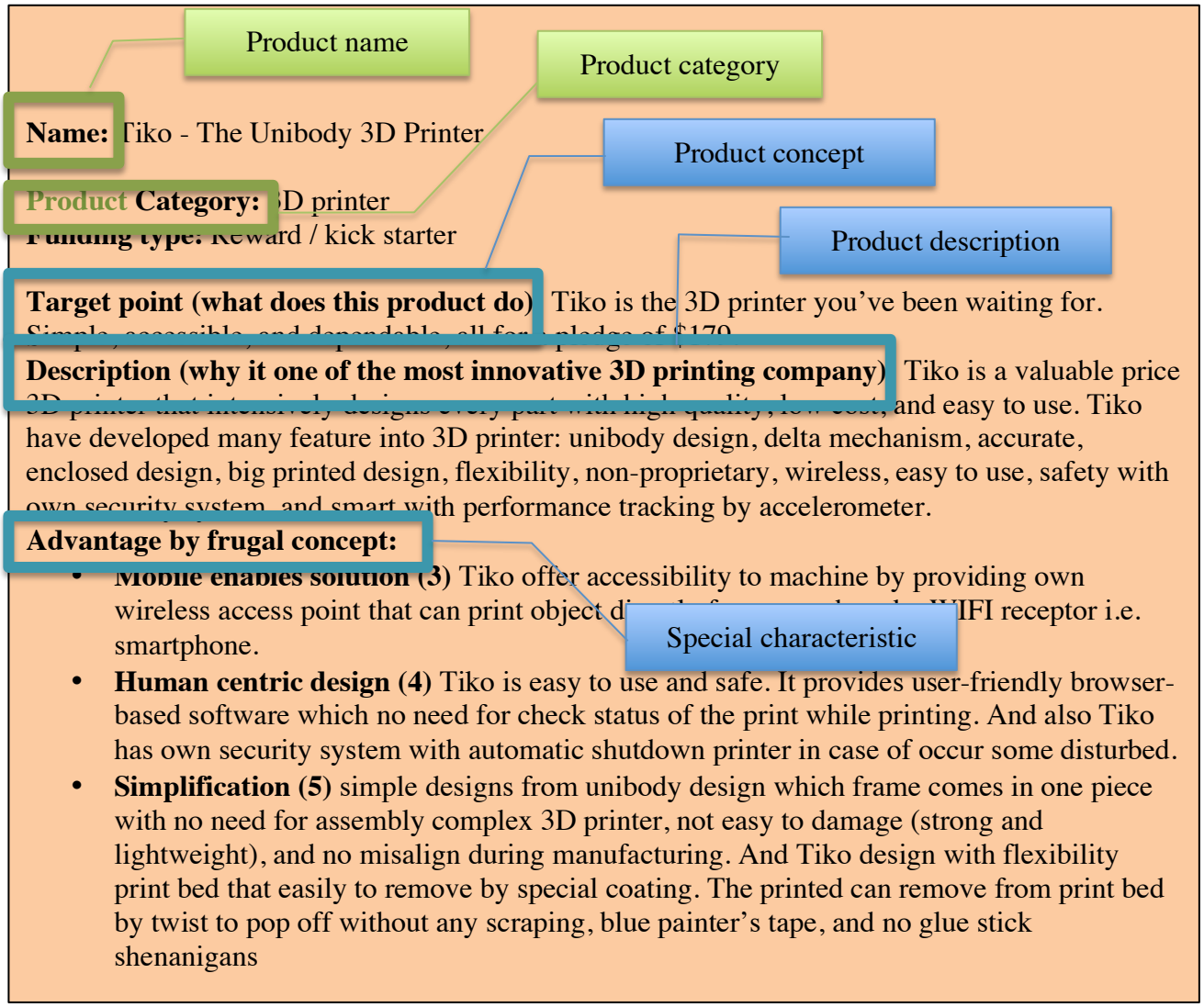
Overall, from both theoretical and 3D printing case studies show the successive way to crowdfunding for frugal innovative product in development process is more suitable for introduced by Donation Crowdfunding model (Crowddonating and Crowdsponsoring) than the Investment Crowdfunding model (Crowdinvesting and Crowdlending). Thus, 3D printing as frugal innovative products are needed funds for invested in developing process more than marketing process.

5.2.2 The important content in crowdfunding platform

According from 5.2.1 crowdfunding platform of 3D printing was introduced in form of Crowddonating and Crowdsponsoring, which supported mainly by Indiegogo and Kickstarter platform. In this part, we collected, review, and analyzed 20 cases (10 from Kick-starter, 10 from Indiegogo) of the 3D printing crowdfunding platform as in Appendix 3. For analysis, the important information that founder needs to provide and concern to successive introducing frugal innovative product by crowdfunding platform.

After analysis as in Appendix 4 found that there are mainly 9 contents need to provide in crowdfunding platform.

1) Product Name and category:



- **New distribution model (6)** Tiko provides the delta mechanism, accurately, enclosed and big print design to offer interesting properties to users:
    - Delta mechanism: Tiko provides with the 3 set of 3D printer arm in unison movement to control the print head and provide ideal configuration for unibody.
    - Accurate: Tiko provides high repeatability mechanism to print consistent layers without high-precision component with 50-200 micron resolution.
    - Enclosed design: Tiko is enclosed design which help to control and reduce the problem of outside environmental factor during printing. Such as no need to scare of error printed result from wind blown.
    - Big printed design: Tiko design with space efficiency for big printed design while compare to other delta printers. Tiko design by circular print volume and give more corner area for long printed.

- **Adaptation (7)** with non-proprietary, Tiko can use with many different material i.e. PLA, ABS, Nylon, Hips etc.
- **Use local resource (8)** Tiko consists with an accelerometer which has auto calibration to measure and track performance. The company can bring data to analyze and improve Tiko performance.

Funding:

- Funding period start: 30-Mar-15
- Funding reached: 13-Apr-15
- Funding period end: 30-Apr-15

Target:

- Funding target: $100,000
- Funding raised: $2,950,874
- Successive rate: 2950.87%

Supportive or published by company: more than 10 such as Readwrite, 3Dprinting industry, Techvibes, Gizxag etc.

Website: https://www.kickstarter.com/projects/tiko3d/tiko-the-unibody-3d-printer?ref=category

Figure 14. Product name and category & Product detail

- "***Product Name***" can adopt from name of a product or name of the company as the other 3D printing case studies provide.
- ***"Product Category"*** which users can easier find 3D printing type according from their interesting. Platform better to identify "which type of 3D printing that co-founder wants supportive funds" (Hardware – 3D printer or Software – 3D services). In case of:
    - 3D Hardware (3D printer) can identify with 9 types of printer by categorized as Powder bed fusion, Directed energy deposition, Sheet

lamination, Binder jetting, Material jetting, Material extrusion, and Vat photopolymerization.

- 3D software can categorized as scanning and digitization app, online database app, Mass customize app.

2) Product detail: Product description is used for telling stories about the product that is consisting by

- ***"Product concept" or "Target point"*** uses to present and describe about *"What is this product do?"* which company will explain with short description to identify about the project/product. Try to use "keyword" for heading the main concept of project/product. In addition, many platforms also provide initial pledge price in the last word of the sentence.
- ***"Product description"*** is used to present and describe clear concept of project/product. Which refer to *"Why it is the most innovative project/product?"* And *"What is it offering better than other project/product?"*.
- ***"Special characteristic***" uses for present outstanding concept related to 10-core characteristic of frugal innovation. From the result (as in table 6.1, 6.2) is showed crowdfunding platform of 3D-printing presented innovative product with prominent feature from 10-core characteristic of Frugal innovation: Ruggedization, Lightweight, Mobile enables solution, Human centric design, simplification, New distribution model, Adaptation, Use local resource, Green technology, and Affordability (Basu et al., 2013) to make outstanding property to product and increase attraction of frugal innovative project/product to investors and customers. Thus, 10-core characteristics of Frugal innovation enhancing a direct successive way for introducing frugal innovative product by "crowdfunding" platform is presented.

Name	Frugality concept
Eora 3D | High-Precision 3D Scanning on Your Smartphone	- Mobile enables solution (3) - Adaptation (7) - Green technology (9)
3Dvarius - High-end 3D printed electric Violin	- Ruggedization (1) - Simplification (5) - New distribution model (6) - Adaptation (7)
FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE. (A difficult choice made easy, 2015)	- Ruggedization (1) - Mobile enables solution (3) - Human centric design (4) - Simplification (5) - New distribution model (6) - Adaptation (7)
LIX - The Smallest 3D Printing Pen in the World	- Light weight (2) - Simplification (5) - Adaptation (7) - Affordability (10)
FormBox: A Desktop Vacuum Former That Makes Beautiful Things	- Mobile enables solution (3) - Human centric design (4) - Simplification (5) - Adaptation (7)
Altergaze: 3D printed VR Goggles for Smartphones	- Mobile enables solution (3) - Human centric design (4) - Simplification (5) - New distribution model (6) - Adaptation (7) - Affordability (10)
Tiko - The Unibody 3D Printer	- Mobile enables solution (3) - Human centric design (4) - Simplification (5) - New distribution model (6) - Adaptation (7) - Use local resource (8)
M-One: An open-source, professional desktop DLP 3D printer	- Simplification (5) - New distribution model (6) - Adaptation (7) - Affordability (10)
Bocusini - World's first plug & play 3D Food Printing System	- Mobile enable solution (3) - Human centric design (4) - Simplification (5) - Adaptation (7) - Use local resource (8) - Green technology (9) - Affordability (10)
Deltaprintr - A simple, affordable 3D Printer!	- Simplification (5) - New distribution model (6) - Adaptation (7) - Affordable (10)

Table 6.1. 10-core characteristic of Frugal innovation (Kickstarter)

Name	Frugality concept
Felfil Evo. 3D printers filament extruder (Cocomeri, 2016)	- Human centric design (4) - Simplification (5) - New distribution model (6) - Adaptation (7) - Use local resource (8) - Green technology (9) - Affordability (10)
BASE by Wiivv - Custom, 3D Printed Insoles (Wiivv, 2016)	- Ruggedization (1) - Mobile enables solution (3) - Human centric design (4) - Simplification (5) - New distribution model (6) - Adaptation (7)
Ares: An Affordable All-in-one 3D Printer (Arts, 2015)	- Ruggedization (1) - Simplification (5) - Adaptation (7) - Affordability (10)
Gizmo 3D Printers SLA DLP - It works, lasts & wows (du Toit, 2016)	- Ruggedization (1) - Mobile enables solution (3) - Human centric design (4) - Simplification (5) - Adaptation (7) - Use local resource (8)
FABtotum PRISM (FABtotum, 2015)	- Mobile enables solution (3) - Human centric design (4) - New distribution model (6) - Adaptation (7)
Rapide Lite 200XL - 400mm Desktop Plus 3D Printer (Team, 2015)	- Ruggedization (1) - Human centric design (4) - Simplification (5) - Adaptation (7)
Freaks3D: the World's First Portable 3D Printer (Tech, 2015)	- Light weight (2) - Mobile enables solution (3) - Simplification (5) - Adaptation (7) - Affordability (10)
NEA 3D: Stylish & Upgradeable 3D Printing for All (D, 2015)	- Ruggedization (1) - Human centric design (4) - New distribution model (6) - Adaptation (7)
CreoPop - Cool Ink. Infinite Creativity. (Pop, 2014)	- Lightweight (2) - Simplification (5) - New distribution model (6) - Adaptation (7)
3D Printer For Class (Forsyth, 2015)	- New distribution model (6) - Use local resource (8) - Affordability (10)

Table 6.2. 10-core characteristic of Frugal innovation (Indiegogo)

3) Prototype Appearance:

The appearance of prototype will help backers feel more reliable with project offering. To provide the appearance of prototype can present with both photo and video. Moreover, It help co-founder easier to share product campaign on social media.

- The photo: product should be located in the middle of the picture with product's material, software package or physical finished prototype.
- Video: should be recorded with high quality camera with approximately 3 minutes long which in content provide with
    - What is a problem of the current situation?
    - What kind of solution can be offered to help the world by product?
    - Present the main characteristic of the product?
    - What is the purpose of crowdfunding? What kind of help from backer product need? Support money for part or whole product production? How much money do they need?
    - What kind of reward offer will give to backer?
    - Where products come from?
    - Who or which company/ organization/ corporate are supported product?
    - Ending with brief slogan and main special characteristic of product and thank you for watching

4) Trustworthiness partner:

From 11 out of 20 case studies are named the supportive and technology companies which help to publish news or press conference to create the trustworthiness to project/product's platform. In 3D printing, the review and comment will be shared through news agency (Forbes, CNN, BCC etc.), 3D printing communities (3dprintingindustry.com, 3Ders.org, 3darena.com etc.) and technology webpage (techcrunch.com, newatlas.com, techcrunch.com, geeky-gadgets.com etc.) that published content and arrange a press conference to support the project/product as shown in table 7.1 and 7.2.

Name	Supportive organization
eora 3D	High-Precision 3D Scanning on Your Smartphone	-
3Dvarius - High-end 3D printed electric Violin	More than 10 such as CNN, CBC news, NBC News, GIZMODO, designboom etc.
FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.	Gizmag, TechCrunch, engadget, übergizmo, 3Ders
LIX - The Smallest 3D Printing Pen in the World	-
FormBox: A Desktop Vacuum Former That Makes Beautiful Things	-
Altergaze: 3D printed VR Goggles for Smartphones	-
Tiko - The Unibody 3D Printer	More than 10 such as readwrite, 3Dprinting industry, TECHVIBES, gizxag etc.
M-One: An opensource, professional desktop DLP 3D printer	-
Bocusini - World's first plug & play 3D Food Printing System	More than 10 such as Facebook, twitter, 3D printing industry, DISQUS, Scoop.it! etc.
Deltaprintr - A simple, affordable 3D Printer!	More than 10 such as GIGAOM, 3ders, TC techCrunch, PC PCMAG.com etc.

Table 7.1. Supportive partner and organization (Kick-starter)

Name	Supportive organization
Felfil Evo. 3D printers filament extruder	3ders.org, gigazine.net, impresion3daily.es, open-electronics.org, geeky-gadgets.com, 3dprinti.com
BASE by Wiivv - Custom, 3D Printed Insoles	many kind of people get benefit from fit insole such as Olympic swimmer (Martha Mccabe), Nurse, Climber, Physiotherapist etc.
Ares: An Affordable All-in-one 3D Printer	3D print, GadgetSin.com, SMZDM.com, 3D Printing Industry, Microfabricator, RapidReady, the crowdfundingcenter.com, DIT3dprinting.com, 3D ARENA.com, fabcross, 3D printing magazine etc.
Gizmo 3D Printers SLA DLP - It works, lasts & wows	-
FABtotum PRISM	-
Rapide Lite 200XL - 400mm Desktop Plus 3D Printer	-
Freaks3D: the World's First Portable 3D Printer	3D printing.com, 3D printing industry, www.3der.org, Geeky Gadgets, 3DP system, origo, gadgetify, Microfabricator etc.
NEA 3D: Stylish & Upgradeable 3D Printing for All	3D printing industry, 3D printing.com, Fargo 3D printing
CreoPop - Cool Ink. Infinite Creativity.	More than 10 such as Mashable, TechCrunch, engagedget, Forbes, Business Insider etc.
3D Printer For Class	-

Table 7.2. Supportive partner and organization (Indiegogo)

For example in case of “Flux All-in-one 3D printer” (Figure 16) have provided references from supportive 3D technology sites like gizmag, TechCrunch, engadget, übergizmo, 3Ders, 3I print.com, GIZMODO, GIGAOM, Connectedly and SLASH GEAR. (As figure 15.)

Figure 15. Example of 3D partner companies

Most of platform will provide logo of publication source on the platform. However, for more effective, according from “Felfill evo” case studies (as figure 16). Founder also released comments that gain from each publication source to represent and make customers can depict the benefit that backers (funders and customers) can gain from the product.

> ***“An excellent and very cool looking design, that will be a great addition to any desktop: the Felfil Evo.” 3ders.org***
>
> ***"3Dプリンターで出力したあとのゴミを集めて溶かしてフィラメントに戻せる「Felfil Evo.」" gigazine.net***
>
> ***“Con este fabricador de filamento plástico, tu podrás hacerte tu propio filamento de una manera fácil y sencilla, además de barata. El Felfil Evo es lo que te faltaba…” impresion3daily.es***
>
> ***"You will be able to choose your filament colour, diameter and material, day by day, according to your creativity and your curiosity." open-electronics.org***
>
> ***"Recycle And Make Your Own 3D Printer Filament Using The Fulfil Evo Extruder" geeky-gadgets.com***
>
> ***"..if you’re at all eco-minded, throwing away your useless creations, recyclable or not, is guilt-inducing. A group of Italian designers understands your pain, and the Earth’s." 3dprint.com***

Figure 16. Example of Comment: Felfill Evo

5) Funding Purpose:

There are two main purposes to crowdfunding, which are funded to develop the whole project or some part of project for hardware or software. Which co-founder should write with clear state for help backer easier understand the situation and reason of company that is the reason why company need to ask for funds by provide the information of:

- Description of limited environment constraint: the lacking situation is needed for identifying as the reason of requiring fund.
- Project development details: Identify how to develop product/project though funds.
- Funding needed: Identify how much funds are needed.
- Time Limited: Identify when the funding period will be ended.

However, in 3D printing case studies can identify the purpose of funding for 3 main reasons:

- For develop 3D printing hardware (3D printer) which co-founder can design for funding for developing whole product/project or some part of them.
- For develop 3D software that categorized as scanning and digitization app, online database app, Mass customize app.
- For develop a product that generated from 3D printing concept.

6) Funding time and Target investment:

To setting target funding for donation and reward base suggested by Steinberg and Demaria (2012) should not over than 100,000 euro. According from the case studies record (as shown on the table 8.1, 8.2), funding target has risen around 0 to 100,000 euros ($ 106,865, £ 87,821.0133) as in theoretical. However, Deltaprintr case is only the case that expecting for funding target around $195,000.00, which is over than 100,000 euro. The results show it is is affected to reach the second from the last successive rate if compare to other case studies.

Name	Funding target	Funding raised	Successive rate
eora 3D	High-Precision 3D Scanning on Your Smartphone	$ 80,000.00	$ 599,925.00	749.91%
3Dvarius - High-end 3D printed electric Violin	€ 50,000.00	€ 53,231.00	106.46%
FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.	$ 100,000.00	$ 1,641,075.00	1641.08%
LIX - The Smallest 3D Printing Pen in the World	£ 30,000.00	£ 731,690.00	2438.97%
FormBox: A Desktop Vacuum Former That Makes Beautiful Things	$ 50,000.00	$ 588,775.00	1177.55%
Altergaze: 3D printed VR Goggles for Smartphones	£ 25,000.00	£ 31,988.00	127.95%
Tiko - The Unibody 3D Printer	$ 100,000.00	$ 2,950,874.00	2950.87%
M-One: An opensource, professional desktop DLP 3D printer	$ 100,000.00	$ 180,481.00	180.48%
Bocusini - World's first plug & play 3D Food Printing System	€ 30,000.00	€ 40,581.00	135.27%
Deltaprintr - A simple, affordable 3D Printer!	$ 195,000.00	$ 236,451.00	121.26%

Table 8.1. Funding cost (Kick-starter)

Name	Funding target	Funding raised	Successive rate
Felfil Evo. 3D printers filament extruder	€ 37,640.27	€ 56,084.00	149.00%
BASE by Wiivv - Custom, 3D Printed Insoles	$ 54,162.55	$ 254,564.00	470.00%
Ares: An Affordable All-in-one 3D Printer	$ 10,332.59	$ 106,529.00	1031.00%
Gizmo 3D Printers SLA DLP - It works, lasts & wows	$ 97,705.04	$ 135,810.00	139.00%
FABtotum PRISM	$ 61,551.17	$ 157,571.00	256.00%
Rapide Lite 200XL - 400mm Desktop Plus 3D Printer	$ 5,785.56	$ 203,073.00	3510.00%
Freaks3D: the World's First Portable 3D Printer	$ 21,183.33	$ 151,249.00	714.00%
NEA 3D: Stylish & Upgradeable 3D Printing for All	$ 107,190.99	$ 356,946.00	333.00%
CreoPop - Cool Ink. Infinite Creativity.	$ 46,088.79	$ 213,852.00	464.00%
3D Printer For Class	$ 500.00	$ 525.00	105.00%

Table 8.2. Funding cost (Indiegogo)

According from case studies (as shown on the table 9.1, 9.2), Normally crowdfunding platform will be estimating time for funding around 1-2 month. There are only 3 cases (Delta printr, Felfill Evo, Ares) that used longer time than 3 months, which 2 out of 3 represent with less successive rate. Funding process will not take a long time because investors can use investment money for other purpose instead of support founder's product/project. Thus, if funding process spends long time and ends up by failing project. It will make investors to loss "opportunities cost" for investing and getting profit from other product/project.

Name	Begin	Reached	End	Duration for funding (days)	Duration for reaching (days)
eora 3D	High-Precision 3D Scanning on Your Smartphone	19-Oct-15	19-Oct-15	18-Nov-15	31	1
3Dvarius - High-end 3D printed electric Violin	18-May-16	14-Jun-16	17-Jun-16	31	28
FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.	11-Nov-14	11-Nov-14 (2:40 hr)	21-Dec-14	41	2:40 hr
LIX - The Smallest 3D Printing Pen in the World	29-Apr-14	before 2-May-14	29-May-14	31	4
FormBox: A Desktop Vacuum Former That Makes Beautiful Things	5-Feb-16	5-Jul-16	6-Mar-16	33	6
Altergaze: 3D printed VR Goggles for Smartphones	3-Mar-14	28-Apr-14	5-Feb-14	31	57
Tiko - The Unibody 3D Printer	30-Mar-15	13-Apr-15	30-Apr-15	32	15
M-One: An opensource, professional desktop DLP 3D printer	24-May-14	25-May-14	24-Jun-14	32	2
Bocusini - World's first plug & play 3D Food Printing System	12-May-15	21-May-15	11-Jun-15	189	172
Deltaprintr - A simple, affordable 3D Printer!	12-May-13	on 7-Dec-13 (reach quarter of our goal in less than 24 hours)	1-Apr-14	31	Around 31

Table 9.1. Funding time (Kick-starter)

Name	Begin	Reached	End	Duration for funding (days)	Duration for reaching (days)
Felfil Evo. 3D printers filament extruder	10-Jan-15	no data	3-Oct-16	99	no data
BASE by Wiivv - Custom, 3D Printed Insoles	Jan-16	no data	2-Jun-16	37	no data
Ares: An Affordable All-in-one 3D Printer	Jan-15	no data	14-Aug-15	106	no data
Gizmo 3D Printers SLA DLP - It works, lasts & wows	no data	no data	1-Apr-16	no data	no data
FABtotum PRISM	no data	no data	9-Oct-15	no data	no data
Rapide Lite 200XL - 400mm Desktop Plus 3D Printer	no data	no data	17-Apr-15	no data	no data
Freaks3D: the World's First Portable 3D Printer	Jul-15	no data	16-Aug-15	47	no data
NEA 3D: Stylish & Upgradeable 3D Printing for All	May-15	no data	5-Jul-15	66	no data
CreoPop - Cool Ink. Infinite Creativity.	no data	no data	17-Aug-14	no data	no data
3D Printer For Class	no data	no data	no data	no data	no data

Table 9.2. Funding time (Indiegogo)

7) Reward level and Delivery time

For rewards, the reward price should set by adding: % of platform fee, material cost, and worker cost to get profit. Moreover, should provide tangible rewards with at lease main 5-reward levels:

- Donation reward - which support project by not expected a reward as a return (give funding for free)
- Small investment reward – which give T-shirt, cap, bag, or small souvenir for backers as a return. However, reward in this stage shouldn't have many various because it will effect difficult to producing with economic of scale and also not good in logistic perspective to deliver different kinds of reward with small amount.
- Early birth reward – product should control limit number of products since product will offer with less or non profit prices in purpose of motivating people to interesting to invest money for develop the project. Normally the number of

product sales at this level will be limited not over than 5-10 units to protect the excessive loss in profit gain.

- Normal reward – can have many sub-level with different package of product such as provide 3D printer with filament material, 3D printer with a software package (scan and costume app), two 3D printers with discount price etc. However, in this level founder will set the price as the normal sale price or give a little discount for investor but mainly in purpose of take profit for further development.
- Exclusive reward – should provide this level in purpose of gain money by offering backers to have special time with founder (ex. Dinner or exclusive small party). Which the profit gained at this level will be significantly higher than other level.

For delivery time: co-founder need to provide exact and clear detail of product timeline to customers and investors to make projects more reliable. And also should give the real delivery time as company promise to provide rewards. From case study it takes around six months to a year for delivery product to backers. To provide delivery time has many small stages of product to concern:

- Collect investment: 30 days or more to gathering money after campaign close
- Manufacturing: depending on each company
- Shipping: have to spare time for trialing shipping before the real one for checking product will not damaged with the package during delivery.

Thus, the company should concern according from the above list before promising to provide rewards and delivery time to investors. It's not only to pass reward to backers on time, but it also shows the responsibility of company's words to investors, which continue effected to build trustable to customers.

Name		Delivery time				Duration between funding end to delivery time (normal level)
	Funding end	1 st level (Donation & Small investment reward)	Early birth level	Normal level	Exclusive level	
eora 3D	High-Precision 3D Scanning on Your Smartphone	Nov-15	Jun-16	Jun-16	Jun-16	Apr-16	6
3Dvarius - High-end 3D printed electric Violin	Jun-16	Sep-16	Dec-16	Dec-16	Dec-16	7
FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.	Dec-14	Jan-15	Jul-15	Jul-15	Jul-15	7
LIX - The Smallest 3D Printing Pen in the World	May-14		Oct-14	Feb-15	May-14	9
FormBox: A Desktop Vacuum Former That Makes Beautiful Things	Mar-16	May-17	Nov-17	May-17	Jul-17	14
Altergaze: 3D printed VR Goggles for Smartphones	Feb-14	Nov-14	Nov-14	Nov-14	Sep-14	9
Tiko - The Unibody 3D Printer	Apr-15	Nov-15	Nov-17	11-Nov-15 - 4-Jan-16 (ever month)	-	7-12
M-One: An opensource, professional desktop DLP 3D printer	Jun-14	Aug-14	Nov-14	Jan-15	Oct-14	7
Bocusini - World's first plug & play 3D Food Printing System	Nov-15	Sep-15	Jan-16	Nov-16	Dec-15	12
Deltaprintr - A simple, affordable 3D Printer!	Apr-14	Jun-14	Jul-14, Aug-14	Jul-14, Aug-14	Jul-14	3-4

Table 10.1. Delivery time (Kick-starter)

Name	Funding end	Delivery time				Duration between funding end to delivery time (normal level)
		1 st level (Donation & Small investment reward)	Early birth level	Normal level	Exclusive level	
Felfil Evo. 3D printers filament extruder	Oct-16	Sep-16	Sep-16	Sep-16	Sep-16	Refunding
BASE by Wiivv - Custom, 3D Printed Insoles	Jun-16	-	Apr-16	Apr-16	Nov-16	Refunding
Ares: An Affordable All-in-one 3D Printer	Aug-15	Oct-15	-	Dec-15	-	4
Gizmo 3D Printers SLA DLP - It works, lasts & wows	Apr-16	Jul-16	Sep-16 - Nov-16 (super speed level)	Sep-16 - Nov-16 (normal)	Nov-16	6-Apr
FABtotum PRISM	Oct-15	Nov-15	Feb-16	Feb-16	Feb-16	4
Rapide Lite 200XL - 400mm Desktop Plus 3D Printer	Apr-15	-	Jan-16	Jan-16	Jan-16	9
Freaks3D: the World's First Portable 3D Printer	Aug-15	Aug-15	Aug-15	Aug-15	Aug-15	Refunding
NEA 3D: Stylish & Upgradeable 3D Printing for All	Jul-15	Oct-15	-	Dec-15 - Feb 16	-	5
CreoPop - Cool Ink. Infinite Creativity.	Aug-14	No information	No information	No information	No information	No information
3D Printer For Class	No information	Sep-15	Nov-15	Nov-15	Oct-15	No information

Table 10.2. Delivery time (Indiegogo)

Moreover, in the case study (as table 10.1, 10.2), delivery times are easier categorized by main 5-reward level (Donation reward, Small investment reward, Early birth reward, Normal reward, Exclusive reward). Normally, reward from donation and small investment level will be the first items that backer will receive. After that exclusive level will be set as

the first priority reward before early birth and normal level due to backer support money with exclusive activity. Then, early birth reward will be the next item to delivery and finished with product of normal reward in the last. However, the founder should avoid launching a product/project with many choices of reward and followed by setting the rewards with 5 main levels to reduce confusing to backers.

8) Tracking project status

The founder should provide comment and update status of the project at least every month to let investor know project/product status.

- In funding process, keep updating the status when reach 50%, 75% of funds. To let investors know the successive of funding, which also help to create motivation for outsider interesting to turn to be backers for support product/project. In addition, after finishing funding say a big "thank you" to backers for support investment.
- In the product development process, try to make investors feel their investment is not just go to somewhere they don't know. The founder should always keep continue update the successive developing step of product to them. In addition, after finishing funding say another big "thank you" to backers for waiting for the product until it was finished.

9) Sharing products to social media

Crowdfunding offers better opportunities and more channels for companies to get closer with more people both investors and customers to better well know about the project/product. Thus, the company has participated in social media such as Facebook, tweeter, Tumblr, Pinterest etc. for promoting the project/product. Moreover, can also use data statistic from social media to analyst behavior of customers. However, using social media for crowdfunding is not just for getting "share" and "like" on project/product, but the main purpose is to encourage people to support and funding for project/product. To achieve successive using social media company has to:

- Know target market: which specific target will help companies get more stronger respond impact than just from random people who not have or have less interest in project/product. Presenting the project/product to target market before spreading to other people, as speech "make a good grounded before build the building", "project's familiar people" will help company easier to get credibility and

connection which better than company create entirely new connection and translate project propose to people who have less interest in the project/product. In 3D printing case, “Project’s familiar people”, are potential supporters people, who is interesting in 3D concept like university, industrial, 3D communities and journal, 3D news and online news pages, 3D printing professional, existing customer of 3D printing product, technology investors etc.

- Update status of project: Create Facebook page, tweeter, Pinterest, and Tumblr for projects where founder can create communities for share, comment, and update news about project/product status. For more efficiency co-founder should:
    - Think about creating value to the product more than find investment and sale product through social media by providing knowledge related to project/product to provoke interesting of people and make them feel that co-founder want to provide knowledge to them than just focus on sales.
    - Including attached product’s webpage link into every post through social media.
    - Update information when the project reaches half or full way of the goal.
    - Encourage people to share and use unique hashtag as a campaign. Which helps people easier to find and discover about project/product within one place.

5.2.3 Advanced crowdfunding platform for introduce 3D printing.

Regarding 5.2.1 and 5.2.2, the analyst of crowdfunding platform of 3D printing cases to find a suitable type of crowdfunding platform and important information that founder needs to consider the successive introducing frugal innovative product (3D printing) by crowdfunding platform. Resulting to know that to do crowdfunding platform of frugal innovation (3D printing) is needed to concern on product type (3D printer, 3D scanner, product of 3D concept) and product stage (5.2.1) before choose to apply for each crowdfunding platform. However, in this section we find what crowdfunding platform should look like to serve 3D printing concept, which is one category of frugal product, and can develop concept to create successive way to introduce a frugal innovative product by crowdfunding platform in the future by analyst cases studies to find the problem of

existing platforms and develop the platform for suitable for introducing 3D printing concept.

Problem of existing platform

1) ***Software:*** 3D software is used for functioning and operating as scanning and digitization, online database, mass customize product. From case studies (as in table 11.1, 11.2), there are many software providers for difference 3D printers. Some founder provides whole software package while some is not provided or provided only one or two functions, which mostly is functioning for product customize. For example (figure 17):

- ***Freaks3D*** uses Cura (by ultimaker) and Repetier Host, which come from the software provider, as customize software.
- ***FLUX All-in-one 3D printer*** uses Flux Studio and Flux delta, which developed software by the company, as customize software.
- ***Ares*** uses Freelss as scanning software, Thingvierse as online database software, Octopi and Cura as customize software. Which all come from the software provider.
- ***Eora 3D*** uses Eora 3D as scanning software and uses 3D Hubs, Shapeways, Sketchfab as customize software. This comes from provider and developed by company.
- ***Tiko*** uses Tiko's browser-based software as customize software. Which developed software by the company.
- ***Rapide Lite 200XL*** can be used with all open sources. But in this case users need to find an open source software provider by themselves.

Overall, to provide 3D software to users, founders have to create own software or use software from other software provider, which have to make contact and pay user's fee. Thus, all of these processes are complicated.

Name	Type of product	Program corporate								
		Software suitcase								
		name	Hardware suitcase	3Dmodel		Mass customize (STL. File) -> printer setting	Printer center	other coporation (Hub communities)	work with
				Scanning and digitization	online data base (3D model CAD-crowd service)				
eora 3D	High-Precision 3D Scanning on Your Smartphone	scanner	eora 3D, 3D Hubs, Shapeways, Sketchfab	-	eora 3D app	3D Hubs, Shapeways, Sketchfab	3D Hubs	-	Bluetooth 4.0 (Android, iOs)
3Dvarius -	High-end 3D printed electric Violin	3D product	-	-	-	-	-	-	-
FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.		3D printer + scanner	FLUX Studio, www.structur3d.io	FLUX Studio (3D modeling, hardware control, and system configuration)	-	-	Flux studio	-	www.structur3d.io (100 source of material choice for user loads into a syringe cartridge system)	Wi-Fi module, USB Type-A port
LIX - The Smallest 3D Printing Pen in the World		3D printing pen	-	-	-	-	-	-	-	-
FormBox: A Desktop Vacuum Former That Makes Beautiful Things		reverse engineering concept	Mayku Library	-	-	-	-	-	Mayku Library (online platform)	-
Altergaze: 3D printed VR Goggles for Smartphones		3D product (concept of low cost VR)	-	-	-	-	-	-	-	VR
Tiko - The Unibody 3D Printer		3D printer	Tiko's browser-based software (no cloud service)	-	-	-	Tiko's browser-based software (slice option)	-	-	wireless (smartphone)
M-One: An opensource, professional desktop DLP 3D printer		3D printer (open source)	M-One software	-	-	-	M-One software (slice option)	-	M-One's board was developed on Arduino	window, Apple
Bocusini - World's first plug & play 3D Food Printing System		3D printer (food)	Bocusini® Pro 2.0	-	Bocusini® Pro club	Bocusini® Pro club	-	bocusini.com (find recipes for printable food products)	WIFI (computer or tablet)
Deltaprintr - A simple, affordable 3D Printer!		3D printer	Slic3r	-	-	Slic3r	-	-	-

Table 11.1. Software (Kickstarter)

Name	Type of product	Program corporate							
		Software suitcase							
		name	Hardware suitcase	3D model		Mass customize (STL. File) -> printer setting	Printer center	other coporation (Hub communities)	work with
				Scanning and digitization	online data base (3D model CAD-crowd service)				
Felfil Evo. 3D printers filament extruder	application (filament recycle and maker m/c)	-	-	-	-	-	-	-	-
BASE by Wiivv - Custom, 3D Printed Insoles	3D printing product	wiivv	-	wiivv (by taking photo)	-	wiivv (custome color, style)	wiivv	-	iOs app
Ares: An Affordable All-in-one 3D Printer	3D printer	Raspberry-Pi, Octopi, Cura, Freelss, Thingvierse, any brand no limit	Raspberry-Pi (pen source hardware)	Freelss	Thingvierse	Octopi, Thingvierse, Cura (slicing software)	-	Windows, Mac Os, Linux and Android.	
Gizmo 3D Printers SLA DLP - It works, lasts & wows	3D printer	Gizmetor (own software)	-	-	-	Gizmetor	-	pro3dcure, Monocure and Vitang (resin communities)	-
FABtotum PRISM	3D printer (all the functions of the machine: 3D Printing, 3D scanning, Milling, Costumizations and Maintenance)	FABU	-	FABU	FABU	FABU	FABU	FABU	cabled LAN, Wireless LAN and even remotely from the Internet (windows Pc, Mac, Linux, Android, IOS.)
Rapide Lite 200XL - 400mm Desktop Plus 3D Printer	3D printer	all open source 3D Printer software	-	-	-	-	-	FABU	SD Card Stand Alone or USB connected (Mac, PC and Linux)
Freaks3D: the World's First Portable 3D Printer	3D printer	Cura (by ultimaker), Repetier Host	-	-	-	Cura, Repetier Host	-	-	SD Card or USB connected (print direct though USB to machine- Repetier Host)
NEA 3D: Stylish & Upgradeable 3D Printing for All	3D printer	NEA compatible with most 3rd party and open source software applications	-	-	-	-	-	-	-
CreoPop - Cool Ink. Infinite Creativity.	3D printer pen	-	-	-	-	-	-	-	-
3D Printer For Class	3D printer class	-	-	-	-	-	-	-	-

Table 11.2. Software (Indiegogo)

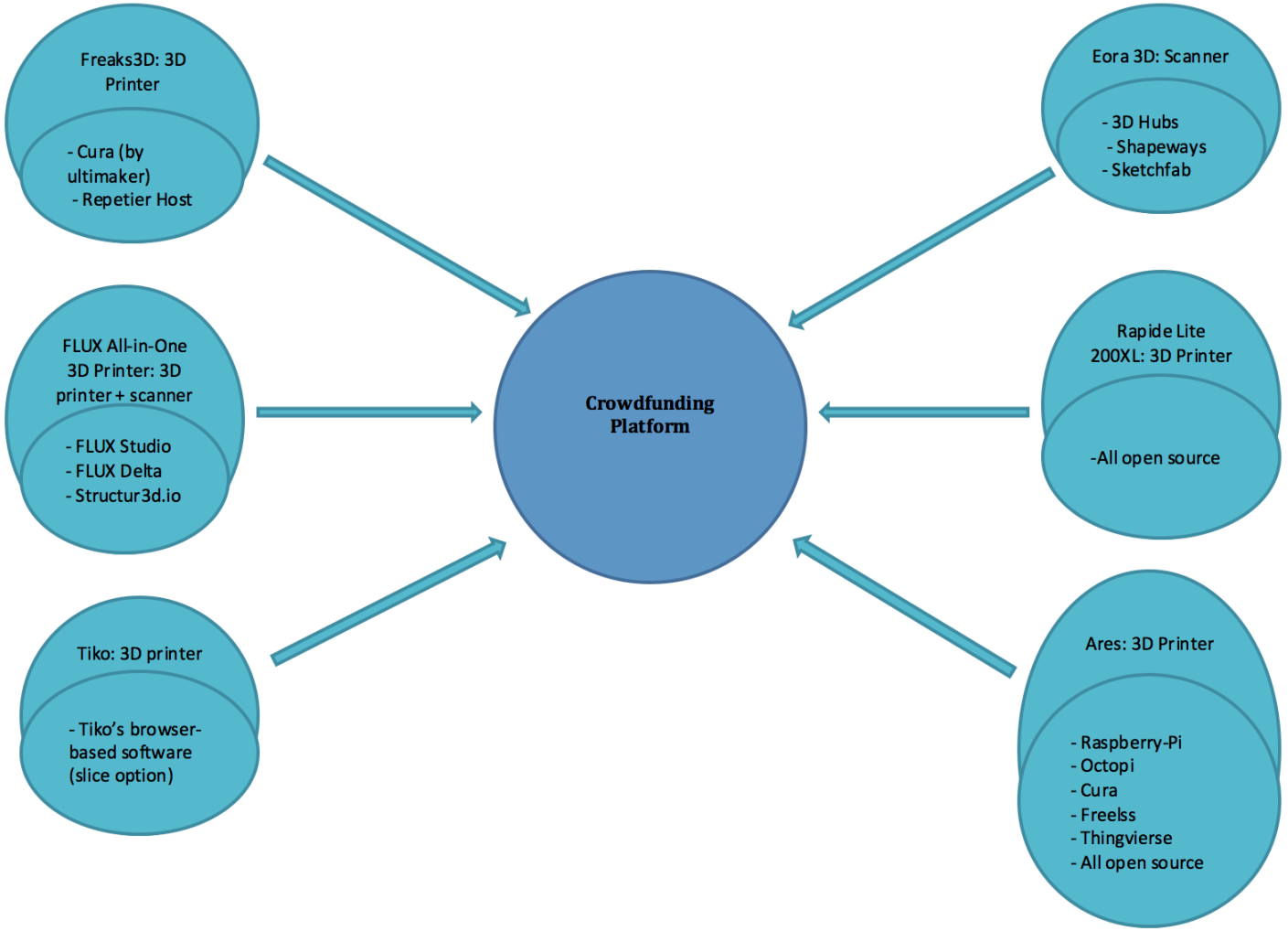


Figure 17. Originate crowdfunding platform (case: software focus)

2) Moving platform: By cases studies most of 3D printing is crowdfunding in purpose of developing production process of project/product (as in 5.2.1). However, after finishing production crowdfunding, project/product still has to continue funding for marketing purpose (such as market expansion, market validation). Which affected founder to crowdfunding though another type of crowdfunding platform (crowdinvesting and crowdlending). This effects to occur the movement of crowdfunding platform (from donation/ reward-based to investment/ ending-based) as in figure 18. From differentiate of each type of crowdfunding platform, it makes founder have to wasting time to study the new strategies for be the best of presenting a product/project on another crowdfunding platform. Not only wasting time to study the new strategic but also have to repeating does some activity again (such as filling whole information to a new platform, contact with new shipping company). The most important is founders have to find new investors again in other platform. By using new platform make old investors who want to support product/project in further develop have to reconsider with reliable and feature of the new platform. Which affected founder to slower collect investment.

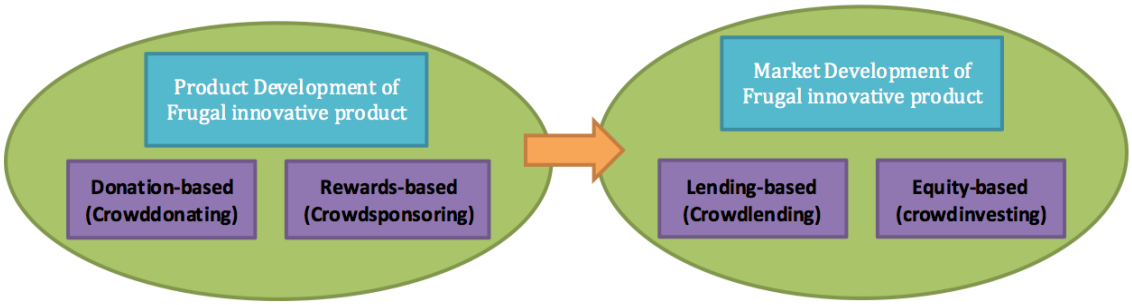


Figure 18. The movement of crowdfunding platform

3) Delivery: By many case studies, backers (or funder) always have problems with tracking and shipping process. Sometime backers have to ask product status from founder or sometime backers have some delivery problem such as receiving product with broken part which hard to claim. This brings the investors worry on delivery from logistic partners. Moreover, after delivery most of backers have been charged more fees for vat and tax of the product. In contrary, founder have to find a reliable delivery company which helps to ship a large amount of product on time and protect product before reach to backer hands with perfect features and functions.

4) Lack of motivation for investing in next stage: after investing on donation or reward crowdfunding steps, some backers may have more motivation to invest for helping develop on other product or same product into a better stage of market development. Somehow, to be backers for support on crowdinvesting and crowdlending will give more risk to them to receive a return. Thus, backer decide to stop their investment only on product development stage, which is more clearly see the reward as physical product. However, the platform should find some strategy, which helps backers have motivation to support the project and help founder to get advantage from the solution also.

Solution of developed platform

1) ***Provide software for crowdfunding platform users***: To get rid of complexity to provide and use software from many sources, Making the central 3D printing software (C-3DP software) for crowdfunding platform without any association to the software provider, which means not necessary for each co-founder to find 3D software for support 3D printing. Anyone that invested funds - at least for early birth product stage - will be allowed to use software from crowdfunding platform. The C-3DP software provides suitcase software for every user can share, comment and update knowledge and news of 3D printing in communities. The software will be consisted of scanning and digitization software, online database software (share 3D model), and mass customize software. Founder can choose to apply own software with C-3DP software or use C-3DP software from crowdfunding platform. The C-3DP software for crowdfunding platform will turn to be enormous crowd sources and communities for exchange information about 3D printing. Which benefit to founder no longer to spend time for developing own software or find software provider. Moreover, users will have standard and large size of crowd database to access instead of using an individual small data source of difference 3D software. The variety choices of 3D printer will be offered without concern on providing 3D software cause crowdfunding platform already provide C-3DP software as open source software for every backers on user page. Thus, to be users of 3D printing software can come from 2 ways:

- Project/ product backers: From being backer of crowd donation and crowd reward at least for early bird level

- 3D printing software backers: is a direct support to develop 3D printing software which offers people to use 3D printing software to share, comment and update knowledge and news of 3D printing in communities. The software suitcase offering as scanning and digitization software, online database software (share 3D model), and mass customize software.

2) Provide all types of crowdfunding platform: From the problem of making a movement from product development to market development, Bring old crowdfunding platform (donation-based and reward-based) have to be changed to use other type of crowdfunding platform (Investing-based or lending-based) for support new purpose of crowdfunding. Which affected users to losing time for study on the new platform. Thus, introduce 3D printing crowdfunding platform that offering all types of crowdfunding (donation-based, reward-based, Investing-based, and lending-based) in the same platform will be benefited (from figure 19). The all type crowdfunding platform will be advantageous to both founder and backers:

- For *founder* due to project/product can be continuous use the previous data source with minor change for marketing purpose (ex. crowdfunding method, supportive purpose statement). Which is no need to spend a lot of time for finding new investors, calculating some prices, and designing information to provide on new crowdfunding platform.
- For *backers* can also read reviews and comment, analyst statistic data and predict product/project growth from previous information (analysis result from donation-based and reward-based crowdfunding) in the same place as new crowdfunding located. In addition, the platform also provides reliable 3D software and communities to support using of 3D printing. Which make investors become confident by the stability of platform that they will be received profit return in form of equity or loans as same as received successive in donation and reward-based.

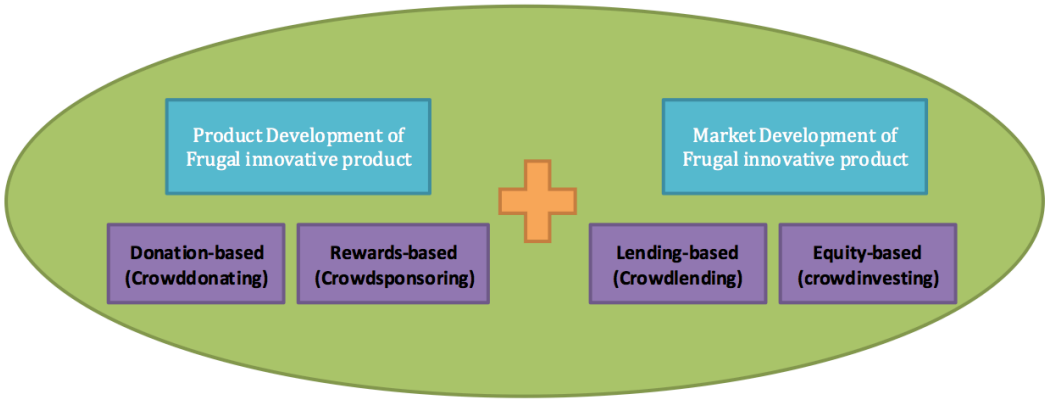


Figure 19. Integrate all type of crowdfunding platform

3) Provide logistic partner for crowdfunding platform users: our platform provides as all-in-one process with shipping program. Which users no need to worry about not receive the product or can't tracking product. Due to the platform have relationship connected to logistics agents. So, delivery status can be informed and tracked via users page of platform. Moreover, delivery fee will be calculated and informed to backers before the shipping process without any additional cost, which mean price was including vat and tax already. In addition, shipping company can give a convenient to founder by help to packing, providing test shipping and shipping large amount of products from founder's manufacturing to backers within few days. The shipping company also provides special discount rate and insurance to product/project.

4) Co-working space for 3D printing: regarding the problem of support on crowdinvesting and crowdlending will give backers more risky on receiving the return. This problem brings our crowdfunding platform offer the co-working space for 3D printer as solution. The idea of co-working space comes from crowd working areas that provides knowledge, machine and equipment related to the product/project concept for users. In the case of 3D printing, previous 3D backers can trial-use other 3D printing to make sure that other project/product are as good as founder claim and provide enough performance to get profitable after invest and develop on this product/project. In opposite, founder also gets more opportunities and channel to introduce their product to other backers by testing machine from co-working area. To be users of co-working area can come from 2 ways:

- Project/ product backer: From being backer of crowd donation and crowd reward at least for early birth level

- 3D co-working area backer: From direct supportive to develop 3D co-working area which offer people to use co-working area for print 3D product and try new 3D printing machine. Which may benefit to by turning them to project/product backer.

All in all, the newest model of 3D printing crowdfunding platform will be functioning as service and community platform for gathering investment from the beginning stage of product development till the last stage of market development. The new crowdfunding platform allows people to access software suitcase, delivery program, and co-working area. (As in figure 20) In addition, people can become backers for support development of 3D software or 3D co-working space in crowdfunding platform. Which they will be allowed outsider, who is not a backers of the project /product on 3D printer's crowdfunding, to access 3D software or 3D co-working space with little access fee.

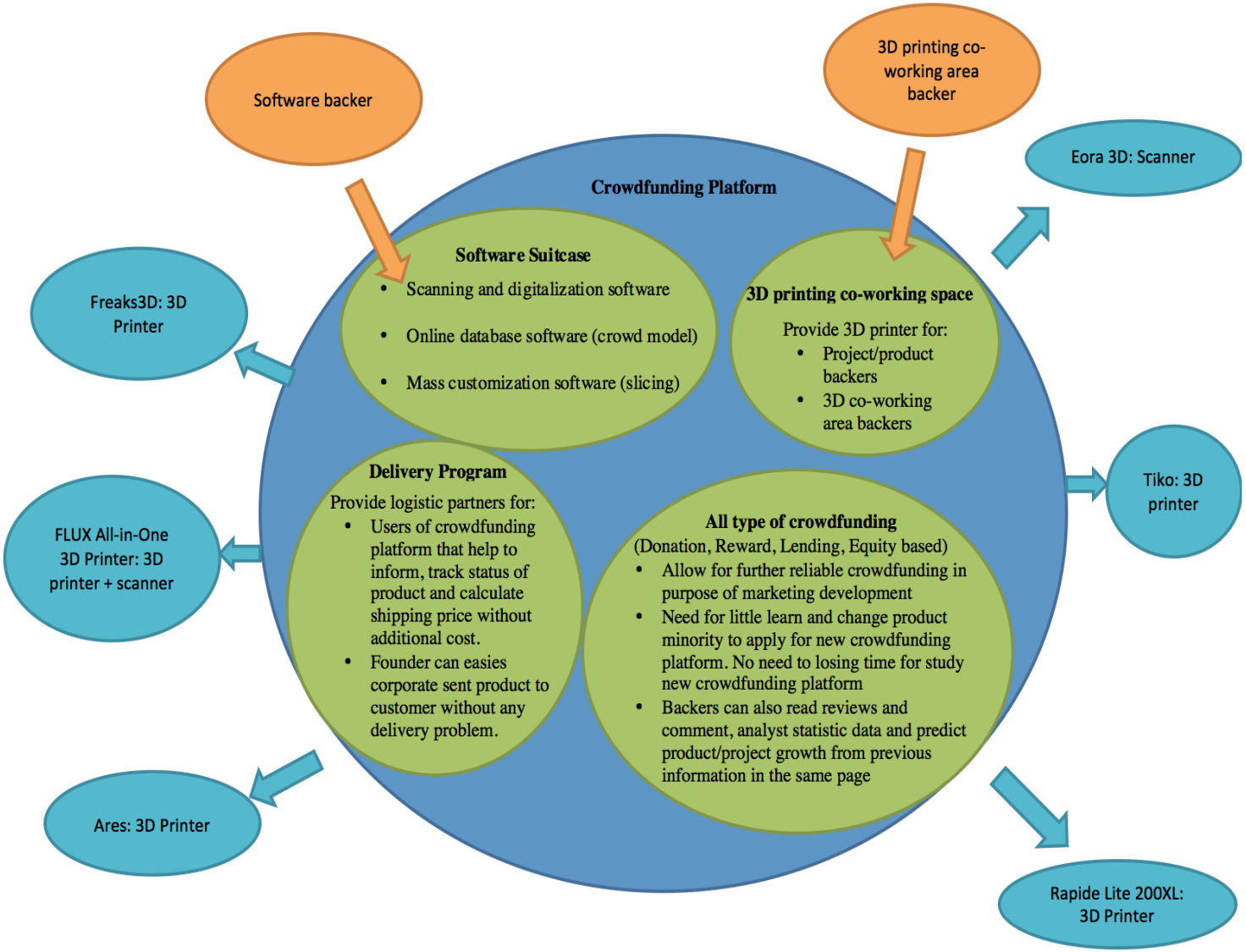


Figure 20. New crowdfunding platform

6. DISCUSSION AND CONCLUSION

6.1 Discussion

The nature of the Frugal innovative product has begun and developed in the low purchasing power market. The business will be processed under constraint environment and factors for developing market such as inadequate investment, resource scarcity, and limited material etc. This refers to cut off opportunities for low or middle-income people to create and use the innovative product. However, under local knowledge, experience, and environment conditions help for improving product to be suitable for introduced in developing markets by improving efficiency by reducing loss of assets in both investments and resources. It will affect to create new innovative products in developing or lacking of the resource constraints areas. They sometimes have been adapted to developed countries to bring the benefit of new innovative product to both customers and providers. However to introducing frugal products into worldwide still have problem of lacking of materials, money, and technology supports to accomplish the project. crowdsourcing concept has been leading to the use of “crowdfunding” as business strategy to seal the gap of introducing frugal innovative product into the both developing and developed markets. Crowdfunding is an alternative funding method of generating funds though crowdsourcing. The main searching of this study is to evaluate the feasibility of frugal innovative product introduced within crowdfunding platform and to identify the key factor to success by question:

1. Which factors support the feasibility of introducing frugal innovative products within crowdfunding platform?
2. How to succeed the introducing frugal innovative products within crowdfunding platform? (Techniques: in case of 3D printing)
    - 2.1. Which type of crowdfunding platform should be provided for introducing frugal innovative product? (Strategy)
    - 2.2. What is important content that founder need to provide in crowdfunding platform? (Characteristic)
    - 2.3. What kind of development should be provided for introducing platform pattern of 3D printing’s crowdfunding? (Platform pattern)

As the result from 1 (5.1 in research analysis) there are three factors support the feasibility by assuming frugal innovative product as initial cause and crowdfunding as solution which refer to:

- Frugal innovative product concern on Real environment not theoretical and Crowdfunding refer as solution to produce product according from need of customers.
- Frugal innovative product concern on "Do more with less for more" which refers to do improve efficiency with investing less money for helping more people easier to reaching product. Crowdfunding refer as solution to offering top-down management and bottom-up open innovation concept.
- Frugal innovative product concern on Resource constraint which refers to lack of supporting money, raw materials, approachable, affordable, agreement and intermediary among company, supplier and consumer in supply chain. Thus, all of the concerning it can be solved by adapting crowdfunding platform for introducing frugal innovative product. For example help for searching of scarce resource, find substitution resource, find investment etc. by using multi task concept, apply crowdvoting for doing crowdjudgment, apply cheap business strategy to receive the lowest price of R&D, production, and supply chain.

Crowdfunding is an open call of financing techniques and sources for entrepreneur to gathering funds from crowd by pitching an idea from entrepreneur's business idea though Internet Web 2.0 to create of product and project. Crowdfunding platform is occured by using of online community to let creator or founder posts their idea to online platform and allows crowd or individual interest's people support their money to make the project movement. Crowdfunding model can be separated into two types of model, which is donation crowdfunding (crowddonating and crowdsponsoring) and investment crowdfunding (crowdinvesting, crowdlending, and crowdroyalty). However, an introducing product through crowdfunding platform can be successively or fail depending on how founder introducing crowdfunding platform to supporters (investors and customers) in order to successive bring interesting to product/project. To guide technique to successive introduces frugal innovative product by crowdfunding (from 2 as 5.2 in research analysis) it has to analyst through 3D printing case studies, which is one of the

frugal innovative products to find strategy, characteristic, and platform pattern that suitable for each type of innovative product. The analysis is finding with 3 scopes:

Firstly (from 2.1 as in research analysis 5.2.1), for finding the suitable type of crowdfunding platform, it has to be analysted from theoretical and case study of 3D printing though 4 main types of crowdfunding platform. On theoretical, Chest (2015) and Paschen (2017) were reviewed different type of crowdfunding are suitable to serve for different stages of product/project purpose. In case study, searching "3D printing" and "3D printer" keyword with 4 types of crowdfunding platform through gofundme.com, experiment.com, betterplace.org, Indiegogo, Kickstarter, Startnext, Anglelist.co, crowdcube.com, seedmatch.de, grow.ly, kiva.org and prosper.com platform show with numerical of searching result. The resulting introduction of 3D printing technology and product by crowdinvesting and crowdlending, which are suitable for supporting on marketing development purpose, are less and not appearing in searching result. In the opposite, 3D printing technology and product are popular introduced by Crowddonating and Crowdsponsoring platform, which are suitable for supporting on product development purpose. The resulting from both theoretical and actual case studies are supported to indicate and conclude that Crowddonating and Crowdsponsoring are suitable for introducing Crowdfunding platform for 3D printing product which are intensely focused on product development process. The analysis from theoretical and case study of 3D printing crowdfunding platform help to guide other frugal innovative product as guidelines for using crowdfunding platform with 2 stages of development purpose; product development (use crowddonating and crowdsponsoring) and marketing development (use crowdinvesting and crowdlending)

Secondly (from 2.2 as in research analysis 5.2.2), for finding the important content that founder need to provide in crowdfunding platform by analyst 20 successive case studies from Indiegogo and Kickstarter platform. The analysis result shows there are mainly 9 contents needed to be provided in crowdfunding platform:

- *Product name and category:* which helps to identify product and categorize product type.
- *Product detail:* which use to describe product stories such as product concept, product description and special characteristic, which described based on 10 core characteristics of frugal innovation.

- *Prototype Appearance:* which provide appearance of prototype for investor and customers though video and picture.
- *Trustworthiness partner:* which provide partners and supportive company to increase the trust's ability from investors and customers to believe in beneficial of product/project.
- *Funding Purpose:* which identify the purpose of founder to find funding such as support whole project, support some part development, support to expand the market.
- *Funding time and Target investment:* which guideline and identify the proper time and target of funding in order to limit time and investment target for backers to invest money for product/project, which help to reduce loss opportunities cost in term of project fail. And help to identify the limited amount of money that a company's target.
- *Reward level and Delivery time:* which help to identify the level of tangible reward as a return from support investment, which rewards should provide at least with 5 levels. And also guide the delivery time to pass the tangible reward to backers should not over than 6-12 months by concerning from time of the product/project process including time for collective investment and shipping.
- *Tracking project status:* which help to update product/project status to let backer know progress and successive in the development process.
- *Sharing products to social media*: which offer better opportunities and more channel for help founder easier to get closer with more people both insider and outsider though using advantage from social media. In additional, help founder to easies update project/product movement, understand more need and target market.

Thirdly (from 2.3 as in research analysis 5.2.3), for finding the problem of existing platforms and develop the pattern of crowdfunding platform for a suitable way introducing 3D printing product by analysing 20 successive case studies from Indiegogo and Kickstarter platform. The analysis result shows 3D printing's crowdfunding platform improvement through 4 dimensions:

- *"Develop software suitcase"* where platform provides software for scanning, online database, and mass customization to users. the central 3D printing software

helps founder and backers no need to be complexity in finding different 3D software from various providers to use.

- *"Provide delivery program"* for advantaging both founder and backer. Which help founder no need to find a logistic partner for delivery reward to backers. And also help backers for more predictable and trustable on delivery process before tangible reward reaching to their hands.
- *"Develop platform for all-type of crowdfunding"* which platform allow to use in purpose of both product and market development. All-type of crowdfunding platform helps founder no need for wasting time to change to use the new platform from other provider. Due to nowadays each stage of product introduce through the different crowdfunding platform by different providers. Which effect founder waste time for study on new platform for well introduce product. It helps backers to provide backup and historical product record that outsiders can study on information to help for make investment decisions.
- *"Provide co-working area"* which help to provide physical place and communities for test and try 3D printing product among project/product backers and backers of 3D co-working area.

All in all, to be successive on represent frugal innovative product by crowdfunding platform we have to concern type of crowdfunding base on product/project purpose, adopt nine main characteristic contents into platform topic and apply the suitable platform pattern for approach more founder and backers to interesting to use crowdfunding platform for introducing frugal innovative product. In additional with concentrate on study of 3D printing cases, the new suitable platform pattern will be advantaged by providing the central 3D printing software, delivery program, all-type crowdfunding platform, and co-working area.

6.2 Conclusion

To apply crowdfunding as a business strategy is given more opportunity to find supportive funding for developing frugal innovative product. However, To provide a proper crowdfunding platform for any type of frugal innovative product founder have to concern 3 main topics: type of crowdfunding which apply by concerning on the purpose of development (on production or on marketing), introduce crowdfunding platform with 9 characteristic content, and integrate similarity share interesting/ equipment/ program to offering more convenient and effective platform for users. For example, in case of 3D printing develop software suitcase, provide delivery program, provide co-working area, and develop all type crowdfunding platform. Thus, by concerning three main topics will allow to develop crowdfunding platform for apply on any type of frugal innovation product. In addition, before the company decided to entrance into the market by crowdfunding need to have well prepared with rigor product/project plan (such as timeline of product life cycle plan, purpose of funding, product properties etc.) for proposing trust's ability to both investors and customers. Which effected to transfer the worthy feedback of product to a company and make the product more interesting to invest and consume. Therefore, presenting the product without guideline or give unclear information through crowdfunding platform, will not only effect to present error project to investors but also effected to publish project error to customers too. Which is unlike traditional business strategy that failure of information can rectify among a small group of people (investor) before launch product/ project to the market.

One of the limitations on this study is only providing the crowdfunding platform pattern in case of 3D printing which one of the frugal innovative product. However, on further study, platform provider can apply knowledge concept in this thesis to create crowdfunding platform for other type of frugal innovative product from concern 3 successive techniques to introduce a frugal innovative product by crowdfunding platform. Moreover, another possibility is to continue study by calculate “break event point”, platform fee, and create a business plan of 3D printing’s crowdfunding platform.

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APPENDICES

Appendix 1: Example of Crowdfunding platform

Indiegogo;

According to Indiegogo (2017) is Donation - based and Reward – based crowdfunding platform. It was found by Danae Ringelmann, Eric Schell, and Slava Rubin on Jan 2008. *Indiegogo* allow many kinds of project from allow the world to be funded such as Art, donation, movie, documentary etc., which is categorized into 32 types; Audio, Camera gear, Energy & Green tech, Fashion & Wearables, Food & Beverages, Health & Fitness, Home, Phone & Accessories, Productivity, Transportation, Travel & outdoors, Other innovative product, Art, Comics, Dance & Theater, Film, Music, Photography, Podcasts & Blogs & Vlogs, Tabletop games, Web series & TV shows, Writing & Publishing, Other creations, Animal right, Culture, Education, Environment, Human rights, Local businesses, Spirituality, Wellness, Other community projects. The platform is funded, or called "raised", by backer to support creator's project with less "buzz" around that effected for less credibility than Kickstarter (compared 1/6 th size). It was supported with famous social media channel (Facebook, Tweet, Link, Follow) and analytic tools to track activity and benefit. *Indiegogo* offer flexibility with 2-project types for creators to get funding:

- Fixed: which is allowed to keep money raised from only project that reaches the goal with the concept of "All or Nothing" (AON).
- Flexible: which is offered opportunities to keep money raised from project that does not reach goal with the concept of "Keep it All" (KIA), this can keep money from what creator can earn.

The fee is combined from Funded fee and Payment processing fees.

- Funded fee: two type of funding plan (Fixed and Flexible)
    - Flexible: 5% of total funds raised if meet goal. But if not can decide to keep the rest of money or not, if keep will cost 5% of the money. (Which is more like a donation platform without knowing project will dead or continue)
    - Fixed: 5% of total funds rose if meet a goal, no fees if don't meet the goal.
- Payment processing fees:
    - 3% + $0.30 per pledge
    - 3-5% for PayPal transactions
    - $25 international wire fee

- 25€ bank transfer fee

Provide important information:

- Funding information: (Gained amount of funds now, $) USD raised by (No. Backers) + (Achieve percent, %) of (target amount, $) (type of investment).
- Story: Story telling of project
- Update: update status of product
- Comment: for ask question and give review of product (need to log-in)
- Backer: history of project investment (backer name, amount of investment without country source detail)

Kickstarter;

According to Kickstarter (2017) is Reward – based crowdfunding platform. It founded by Perry Chen, Yancey Strickler, and Charles Adler on 28-Apr-09. *Kickstarter* allows only "Creative project" to be funded, not like fund my college tuition, kick start my business etc., which is categorized into 15 types; Art, Comics, Crafts, Dance, Design, Fashion, Film& video, Food, Games, Journalism, Music, Photography, Publishing, Technology, Theater. The platform is funded, or called "pledge", by backer to support the creator's project. It's biggest crowdfunding with credibility. It was supported with many social media channels (Facebook, Tweet, Pinterest, Tumblr, Link) and analytic dashboards to track project activity, pledges sources, and post-campaign survey. *Kickstarter* offer only the fixed type of project for creator to get funding which is allowed to keep money raised from only project that reached the goal with the concept of "All or Nothing" (AON).

The fee is combination of Funded fee and Payment processing fees.

- Funded fee: Fixed: 5% of total funds rose if meet a goal, no fees if don't meet the goal.
- Payment processing fees: 3% + $0.20 per pledge

Provide important information:

- Funding information: (Gained amount of funds now, $) pledged of (target amount, $) goal + No. Backers + No. Days to go
- Campaign: Story telling of project
- FAQ: Frequency question
- Update: update status of product with deep detail timeline

- Comment: Comment: for asking question (not in FAQ) (no need log-in)
- Communities: history of project investment (No. Backer, source country of investment money).

Appendix 2: 12 cases studies from 4 different type of crowdfunding

Type of crowdfunding	Platform name	Supporter/ partner	Describe	Costs for submitter	Platform cost	Searching result with "3D printing" and "3D printer" keyword
Donation-based (Crowddonating)	GoFundMe.com	Forbes, USATODAY, FAST COMPANY, The new york times, CNN, Bloomberg Businessweek, npr, Mashable, TIME	GoFundMe personal online fundraising websites are perfect for individuals, groups & organizations	fees are deducted from each donation	5% GoFundMe Platform + 2.9% + $0.30 Payment Processing = 7.9% + $0.30 per donation	Result found (967)
	experiment.com	Popular science, The economist, BBC, Nature, The new york times, Tedx	Help fund the next wave of scientific research	fees are deducted from each donation	5% platform fees + 3.5% payment processing fees	No result found
Rewards-based (Crowdsponsoring)	betterplace.org	vodafone, SAP, Wall	betterplace.org is the largest online donation platform in Germany and build practical tools for online fundraising. This foundation is a non-for-profit corporation. Stakeholders have invested in betterplace.org because they believe in our idea. Instead of profits, the return is something better: the priceless feeling that comes from doing something good. In our research department we analyse digital social trends. With this knowledge we make ourselves and the social sector more professional. With our help, businesses increase their social engagement together with their customers and employees.	betterplace.org show our business partners how they can best engage for social causes in society. They value our expertise, our platform, and the solutions that we develop for them. Numerous sponsors support us, because they are convinced of our ideas on how people can do good on the internet. They share their networks and experience with us. Many donors help us by giving us an extra "tip" when they donate to a project, which we use, for example, to pay bank fees necessary to transfer donor's money to the social organisations and projects.	no fees, no catches	No result found
	Indiegogo	Youtube, Philip, DC Entertainment, Startup america partnership, kiva, University of california san francisco, Google, Honda,Nokia	Indiegogo helps empower your creative, entrepreneurial, and passion projects. "Dream it. Fund it. Make it. Ship it" We help at every step from concept to market.	• Fixed: which is allowed to keep money raised from only project that reached the goal with concept of "All or Nothing" (AON). • Flexible: which is offer opportunities to keep money raised from project that do not reach goal with concept of "Keep it All" (KIA), this can keep money from what creator can earn.	5% platform fees + 3%+ 0.30 payment processing fees	Result found (more than 1000)
	Kickstarter	partner support separate on each project	Kickstarter will create tools and resources that help people bring their creative projects to life, and that connect people around creative projects and the creative process.	• Fixed: which is allowed to keep money raised from only project that reached the goal with concept of "All or Nothing" (AON).	5% platform fees + 3%+ 0.20 payment processing fees	Result found (morethan 1000)
	Startnext	media partner: Crowdsourcing.blog.de, the huffington post, zeit online, arte creative, technology review etc. Cooperation partner: co-funding, seecupny, finlane, Tyclipso, seedmatch crowdfunding für startups, viaprinto, DAS PACK HAUS, Corporation	Startnext is the largest Crowdfunding platform for creative and sustainable ideas, projects and start-ups in Germany, Austria and Switzerland. Artists, creators, inventors and social entrepreneurs present their ideas and finance them with the support of many people.	fees will be incurred. If it is not successfully financed, you have no costs .	avg. 5% platform fees + 4% transaction fee	0 result found

Type of crowdfunding	Platform name	Supporter/ partner	Describe	Costs for submitter	Platform cost	Searching result with "3D printing" and "3D printer" keyword
Equity-based (crowdinvesting)	AngelList.co	Hinge, Stripe, VSCO, GV, Gusto, Sequoia capital, DuckDuckGo, SeatGeek, coinbase	AngelList.co builds a diverse portfolio of early-stage startup investments. Private and oversubscribed deals · 46% unrealized IRR	IRR		result found (7)
	crowdcube.com		Crowdcube is a leading investment crowdfunding platform where you can handpick the businesses you want to back and invest anytime, anywhere.	equity	7% of successfully fund + 0.5%-2.9% for payment card fee	0 result found
	seedmatch.de	green alley, consor, startnext, Für-gründer.de, deutschland startet, secupay	Seedmatch is a crowdfunding platform for startup companies and investors. Seedmatch basically selects only startups, whose teams persuade personally, who pursue a promising business model and who communicate openly and directly with the crowd. Seedmatch does not provide investment advice or other advice. Seedmatch does not give an investment recommendation, but offers only a platform for the representation of investment offers as so-called Internet service platform.	investment	<10 %	No search engine
Lending-based (Crowdlending)	Grow.ly	Forbes, La vanguardia, Larazon	Grow.ly is Participatory Financing Platform registered at CNMV. The place where people like you, lend to businesses like yours	Free, optional donation from starters and backers	Loan	No result found
	kiva.org	Hp foundation, Master card, Google.org, MetLife Foundation, Capital one, pepsico foundation, Maybank kim eng, cisco etc.(mostly is financial institution)	Kiva mission is to connect people through lending to alleviate poverty. Kiva can help a borrower start or grow a business, go to school, access clean energy or realize their potential.	Free, 100% of every dollar you lend on Kiva goes to funding loans. Kiva covers costs primarily through optional donations, as well as through support from grants and sponsors.	Loan	No result found
	prosper.com (more like loan institute)	The washington post, npr, nerdwallet, cardrates.com	Prosper is Loans institute with low interest rate, fixed 3-5 term, single monthly payment, and no hidden fee or prepayment penalties. Investors can earn solid returns by investing in personal loans listed on Prosper	Free	Loan	No search engine

Appendix 3: 20 case detail analyst from Indiegogo and Kickstarter

Name: Eora 3D | High-Precision 3D Scanning on Your Smartphone

Category: 3D scanner

Funding type: Reward / kick starter

Target point (what does this product do): A high-end multi-material 3D liquid jet printer. Print circuit boards, flexible materials, and full color.

Description (why it is one of the most innovative 3D printing company): The NexD1 by Next Dynamics is the first 3D printer to ever give high end prototyping capabilities to everyone by making Multi-Material, 3D Electronics printing, extreme precision, high reliability and fast printing times available in one exciting machine. We took the most advanced, industrial 3D printing technology called PolyJet™ , optimized and reconfigured it and shrunk the cost radically. Which called "DigiJet" technology is able to print a wide range of materials, including special resins with nano-particles or pigments.

Advantage by frugal concept:

- **Mobile enables solution (3)** NexD1 is easy access and can connect with any smartphone (WI-FI) and touch screen that can print prototype from anywhere.
- **Adaptation (7)** 3D printer present with Digijet technology which is highly precise and cost efficient print-head. NexD1 offer 6 multi-materials print-heads at the same time with precision of 10 microns at a very high speed. Each print-head provides 200 liquid-jetting-nozzles with a diameter of 5 microns and pre-heating system. In addition, print-head can be able to print 3D electronics, which can implement electronics design and custom circuit to prototyping by galvanizing a nano-particle infused resin. The print-head is innovated from the company itself, not like other 3D printer use print-head technology from big company (Ricoh and Xerox). The Digijet technology helps to reduce production cost and increase printer efficiency.
- **Green technology (9)** support material made from non-toxic and highly water-soluble, which mean print can finalize by water and no need for toxic chemical. In addition, NexD1is provide a silence environment (operating) from noise pollution.

Funding:

- Funding period start: 19-Oct-15
- Funding reached: 19-Oct-15
- Funding period end: 18-Nov-15

Target:

- Funding target: $80,000
- Funding raised: $599,925
- Successive rate: 750%

Reward:

- Number of backers: 2139
- Type and level of reward: 9 reward level
- Reward range: $1-419
- Detail of reward: $199 for early birth product (reward 3th)
- First delivery and backer: -

Tracking with customers:

- Comment: 516
- Update: 14

Supportive or published by company: -

Website: https://www.kickstarter.com/projects/1947576577/the-nexd1-the-first-multimaterial-and-electronics/description

Name: 3Dvarius - High-end 3D printed electric Violin

Category: 3D product

Funding type: Reward / kick starter

Target point: 3Dvarius - High-end 3D printed electric Violin.

Description: The 3Dvarius is an electric violin created by 3D printing technology and based on the model of a real Stradivarius violin. It introduces with a revolutionary design, at the service of the more demanding violinists. Its body is printed as a single piece differently from the traditional musical instrument, which giving it a very unique property: allows for smooth, optimal sound-wave flow throughout the instrument, offering the violinist greater sound control.

The 3Dvarius is combining the precision and power of 3D printing with ancient violin-making skills, its innovative design, in the service of the violinist.

Advantage by frugal concept:

- **Ruggedization (1)** 3Dvarius built with one single piece for increase resistance mechanisms which sound signals travel freely in its body for reduce resonance loss in the joints.
- **Simplification (5)** 3Dvarius design with very light, ergonomic, simplify, ease and accuracy.
- **New distribution model (6**) 3Dvarius present the design with flexibility and comfort for violinist by optimized weight distribution and design without a head to flow musician movement, add tuning pegs for limit its weight and facilitate it turning, design jack near the bridge and don't use preamp for good sound quality. All application help 3Dvarius easy to approach directly to professional or musician customer group.
- **Adaptation (7)** 3Dvarius design for able to use with any violin shoulder rests that can adapt itself to any morphology.

Funding:

- Funding period start: 18-May-16
- Funding reached: 14-Jun-16
- Funding period end: 17-Jun-16

Target:

- Funding target: € 50,000
- Funding raised: € 53,231
- Successive rate: 106.46%

Reward:

- Number of backers: 144
- Type and level of reward: 11 reward level
- Reward range: € 5-6999
- Detail of reward: $6299 for early birth product (reward 9th)
- First delivery and backer:

Tracking with customers:

- Comment: 14
- Update: 15

Supportive or published by company: more than 10 such as CNN, CBCnews, NBC News, GIZMODO, designboom etc.

Website: https://www.kickstarter.com/projects/3dvarius/3dvarius/description

Name: FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.

Category: 3D printer

Funding type: Reward / kick starter

Target point: FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.

Description: FLUX is a combination of printing, scanning, laser engraving, and more modular functions. It is 3D printer suit in both in workplace and at home. FLUX is the right choice for everyone because it is simple to set up, elegantly designed, and has an unlimited capacity for expansion. In addition to the basic FFF (fused filament fabrication) 3D printing, FLUX is equipped with a built-in 3D scanner and supports an ever-increasing array of interchangeable modules.

Advantage by frugal concept:

- **Ruggedization (1)** FLUX's 3D printer uses high-resolution stepper motors to print objects of impressive quality. The 3D printer comes with three efficient cooling fans that enable printing with precision at top speed while minimizing the risk of malfunction due to overheating. Which mean 3D-printing can be protected from overheat.
- **Mobile enables solution (3)** FLUX design for Wi-Fi operation connecting.
- **Human centric design (4)** FLUX design easy for beginners to use and offer advanced setting for professional users.
- **Simplification (5)** Flux is easy-to-assemble modular components and install with simple setup. Including provide user-friendly interface for the process of 3D modeling, hardware control, and system configuration.
- **New distribution model (6)** Flux has a build-in 3D scanner as alternative tool instead of learn complicated software for clone 3D objects. Also provide laser engraving and many other modules (i.e. a dual extruder, a ceramic extruder, and a pastry extruder) for support advance manufacturing.
- **Adaptation (7)** Flux can customize with magnet modules, no tools needed, for effortless interchangeability. And provide an open module SDK, which uses for engineering and customer for share idea to create and develop more module and tool-head of 3D printer.

Funding:

- Funding period start: 11-Nov-14
- Funding reached: 11-Nov-14 (2:40 hr.)
- Funding period end: 21-Dec-14

Target:

- Funding target: $100,000
- Funding raised: $1,641,075
- Successive rate: 1641.08%

Reward:

- Number of backers: 2707
- Type and level of reward: 13 reward level
- Reward range: $1-10000
- Detail of reward: $499 or more for early birth product (reward 5th)
- First delivery and backer: -

Tracking with customers:

- Comment: 2446
- Update: 47

Supportive or published by company: gizmag, TechCrunch, engadget, übergizmo, 3Ders
Website: https://www.kickstarter.com/projects/2117384013/flux-all-in-one-3d-printer-unlimited-elegant-simpl/description

Name: LIX - The Smallest 3D Printing Pen in the World
Category: 3D printer pen
Funding type: Reward / kick starter
Target point: 3D printer pen allows creating with unlimited size and detail of 3D-object in the air without using paper from melting ABS/PLA filament.
Description: Lix 3D pen is a 3D printing pen that allows customers to skate and create objects in the air without using paper. It can create anything with unlimited size and detail of the prototype. It offers comfort and creativity with change 2D view into 3D view prototype. Lix 3D pen can write, accessories, decoration any form of prototype i.e. jewelry, craft, drawing. Lix 3D pen work the same function as 3D printer that melt and cool

colored plastic for creating prototype. It provides with hot-end nozzle to melt ABS/PLA filament from upper part of Lix pen, which filament passed though mechanism and moving to reach hot-end nozzle to melt and cooling down.

Advantage by frugal concept:

- **Light weight (2)** Lix 3D pen design with 40 grams very lightweight and portability design.
- **Simplification (5**) Lix 3D pen design for easy to use, which can draw any imaginable shape and form any type of structures by wait for 1 min heat up nozzle before beginning draw prototype.
- **Adaptation (7)** Lix 3D pen can be applied to use with both ABS and PLA filament. ABS filament offers high strength, flexibility, malleability and high temperature resistance with melting point at 356 F and work at 446 F. While PLA filament offers various choice of colors and level of translucency with less strength, flexibility, and sensitive to moisture comparing to ABS filament. In addition, Lix 3D Pen can use for creating new structures or able to customize existing structure such as decorative necklace, ring, and other items.
- **Affordability (10)** Lix 3D Pen offer alternative way to make prototype instead of using complicated, skilling, and costly CAD programs.

Funding:

- Funding period start: 29-Apr-14
- Funding reached: no mention but before 2 may
- Funding period end: 29-May-14

Target:

- Funding target: £30,000
- Funding raised: £731,690
- Successive rate: 2438.97%

Reward:

- Number of backers: 8030
- Type and level of reward: 10 reward level
- Reward range: £3-2,425
- Detail of reward: £43 or more Very early bird product (reward 2nd)
- First delivery and backer: -

Tracking with customers:

- Comment: 3028
- Update: 46

Supportive or published by company: -

Website: https://www.kickstarter.com/projects/lix3d/lix-the-smallest-3d-printing-pen-in-the-world?ref=category

Name: FormBox: A Desktop Vacuum Former That Makes Beautiful Things

Category: reverse engineering concept

Funding type: Reward / kick starter

Target point: Quicker Than a 3D Printer, Easier Than Baking a Cake, Powered by Your Vacuum Cleaner.

Description: FormBox is a compact vacuum former that helps customers to make molds for casting by heating material sheet and suction with any vacuum cleaner to make the 3D prototype. It offers simple way and a small area to use on the tabletop.

Advantage by frugal concept:

- **Mobile enables solution (3)** FormBox offering easy ways to cast project from home or simply casting for sell in small business.
- **Human centric design (4)** FormBox design for everyone to use for creating simple forms of prototype for casting.
- **Simplification (5)** FormBox have Mayku library as online platform for share creative idea for building a prototype with project's instruction to other makers.
- **Adaptation (7)** FormBox can cast with various materials: resin, ice, foam, concrete, jelly, chocolate, plaster, silicon etc. Which customer can make a small batch of product with a variety of different colors.

Funding:

- Funding period start: 2-May-16
- Funding reached: 7-May-16
- Funding period end: 3-Jun-16

Target:

- Funding target: $50,000
- Funding raised: $588,775

- Successive rate: 1177.60%

Reward:

- Number of backers: 1745
- Type and level of reward: 15 reward level
- Reward range: $5-5999
- Detail of reward: Pledge $349 or more first batch. (Reward 3th)
- First delivery and backer: Mar-17 (Anywhere in the world)

Tracking with customers:

- Comment: 118
- Update: 15

Supportive or published by company: -

Website: https://www.kickstarter.com/projects/1094489804/formbox-a-desktop-vacuum-former-that-makes-beautif?ref=category

Name: Altergaze: 3D printed VR Goggles for Smartphones

Category: 3D product (concept of low cost VR)

Funding type: Reward / kick starter

Target point: Customisable, 3D printed, smartphone based Virtual Reality Goggles distributed through crowd manufacturing.

Description: Altergaze is a 3D printed VR goggles that bring high quality mobile VR experience to users though smartphone. It is offering both ways to use by handheld or headset. The model of Altergaze is made from 3D printer, which can design for fit to smartphone or customizable. It is the combination concept of 3D printing and crowd-manufacturing. Altergaze give a stereoscopic 3D experience to users on mobile screen without obstraction from the edges of smartphone with a full bright, colorful, and sharp image.

Advantage by frugal concept:

- **Mobile enables solution (3)** Altergaze allow people around the world to reach VR goggles by using 3D printing.
- **Human centric design (4)** Altergaze is developed by open source design that allows designers and users has opportunities to improve the design or add some additional accessories.

- **Simplification (5)** Altergaze is simple to use as accessory by simply slide smart phone into the goggles. Also allow for easy access phone call during use.
- **New distribution model (6)** Altergaze make organizer can use goggles for public event to get a more authentic experience such as concerts, museums, travel tours etc. Which customer will receive goggle at the entrance, then the download appropriate app. for use with the goggle, and enjoy show before return the goggle back at the exist.
- **Adaptation (7)** customer can customize logo or name of producer with unlimited level
- **Affordability (10)** Very affordable price which can use VR for public events such as concerts, museums, theatres, historical sites, travel tours etc.

Funding:

- Funding period start: 3-Mar-14
- Funding reached: 28-Apr-14
- Funding period end: 2-May-14

Target:

- Funding target: £25,000
- Funding raised: £31,988
- Successive rate: 127.95%

Reward:

- Number of backers: 456
- Type and level of reward: 15 reward level
- Reward range: £1-360
- Detail of reward: Pledge £30 or more first batch. (Reward 3th)
- First delivery and backer: Nov-14 (Anywhere in the world) / 100

Tracking with customers:

- Comment: 330
- Update: 47

Supportive or published by company: -

Website: https://www.kickstarter.com/projects/278203173/altergaze-mobile-virtual-reality-for-your-smartpho?ref=category

Name: Tiko - The Unibody 3D Printer

Category: 3D printer

Funding type: Reward / kick starter

Target point: Tiko is the 3D printer you've been waiting for. Simple, accessible, and dependable, all for a pledge of $179.

Description: Tiko is a valuable price 3D printer that intensively designs every part with high quality, low cost, and easy to use. Tiko have developed many feature into 3D printer: unibody design, delta mechanism, accurate, enclosed design, big printed design, flexibility, non-proprietary, wireless, easy to use, safety with own security system, and smart with performance tracking by accelerometer.

Advantage by frugal concept:

- **Mobile enables solution (3)** Tiko offer accessibility to machine by providing own wireless access point that can print object directly from anywhere by WIFI receptor i.e. smartphone.
- **Human centric design (4)** Tiko is easy to use and safe. It provides user-friendly browser-based software which no need for check status of the print while printing. And also Tiko has own security system with automatic shutdown printer in case of occur some disturbed.
- **Simplification (5)** simple designs from unibody design which frame comes in one piece with no need for assembly complex 3D printer, not easy to damage (strong and lightweight), and no misalign during manufacturing. And Tiko design with flexibility print bed that easily to remove by special coating. The printed can remove from print bed by twist to pop off without any scraping, blue painter's tape, and no glue stick shenanigans.
- **New distribution model (6)** Tiko provides the delta mechanism, accurately, enclosed and big print design to offer interesting properties to users:
    - Delta mechanism: Tiko provides with the 3 set of 3D printer arm in unison movement to control the print head and provide ideal configuration for unibody.
    - Accurate: Tiko provides high repeatability mechanism to print consistent layers without high-precision component with 50-200 micron resolution.

  - Enclosed design: Tiko is enclosed design which help to control and reduce the problem of outside environmental factor during printing. Such as no need to scare of error printed result from wind blown.
  - Big printed design: Tiko design with space efficiency for big printed design while compare to other delta printers. Tiko design by circular print volume and give more corner area for long printed.
- **Adaptation (7)** with non-proprietary, Tiko can use with many different material i.e. PLA, ABS, Nylon, Hips etc.
- **Use local resource (8)** Tiko consists with an accelerometer which has auto calibration to measure and track performance. The company can bring data to analyze and improve Tiko performance.

Funding:

- Funding period start: 30-Mar-15
- Funding reached: 13-Apr-15
- Funding period end: 30-Apr-15

Target:

- Funding target: $100,000
- Funding raised: $2,950,874
- Successive rate: 2950.87%

Reward:

- Number of backers: 16538
- Type and level of reward: 9 reward level
- Reward range: $18-179
- Detail of reward: Pledge $99 earliest bird (reward 2nd)
- First delivery and backer: Nov-15 (Anywhere in the world)/ 100

Tracking with customers:

- Comment: 18616
- Update: 26

Supportive or published by company: more than 10 such as Readwrite, 3Dprinting industry, Techvibes, Gizxag etc.

Website: https://www.kickstarter.com/projects/tiko3d/tiko-the-unibody-3d-printer?ref=category

Name: M-One: An opensource, professional desktop DLP 3D printer
Category: 3D printer (open source)
Funding type: Reward / kick starter
Target point: The truly personal desktop factory, with high quality details, the simplest design, and open source for your development.
Description: M-One is affordable, high quality with the desktop-sized printer, reliable, and easy to use for personal and companies. it also provides open source project as 3D printing communities. M-One is elegant design and compact size (380x320x490mm) with round rectangle body and vertical sliding mask. It provides 145x110x170mm building volume with fine resolution for complex model which more than 20 micron thickness layer and 140 micron min. feature size. M-One gives fast printing speed with 2.5 cm. per hour. M-One develops own powerful software system with simple and user-friendly operation to manage:

- Hollow: M-One software can help for specified shell thickness, which minimizing the resin quantity and provide longer lifecycle of vat.
- Support generator: M-One software can help to automatically build and manual edit supporting part.
- Image Modifier & Printing Trace Log: Printing images can be modified and fine-tune for changing position and duplicating the object without any re-processing of model. In addition, tracing log help to maximize utilization of silicon on the vat by identifying over used area.

M-One have a high successful rate by reducing vacuum pressure from tilt motion and flex vat. M-One provides an open-source system and all necessary accessory to finished print part with cost effectiveness.
Advantage by frugal concept:

- **Simplification (5)** and user friendly with own developed M-One software system which help to increase utility and reduce material by minimizing thickness of hollow, provide automatic and controllable software for editing support, and provide an image modifier for changing position and duplicating the object without

any re-processing of model, and provide printing trace log to maximize utilization of silicon on the vat.

- **New distribution model (6)** M-One gives a high successful rate with tilt motion for reduce vacuum force in demolding process and flex vat from silicone which offer elasticity and tension to release the vacuum pressure.
- **Adaptation (7)** M-One board develop though Arduino with open source control system which can modify and extend more printer functions.
- **Affordability (10)** M-One provides cost effective for support material and vat by calculation with the usage and maintenance cost of material selection, software modification, and vat lifecycle optimization.

Funding:

- Funding period start: 24-Jun-14
- Funding reached: 25-Jun-14
- Funding period end: 24-Jul-14

Target:

- Funding target: $100,000
- Funding raised: $180,481
- Successive rate: 180.48%

Reward:

- Number of backers: 134
- Type and level of reward: 12 reward level
- Reward range: $5-8000
- Detail of reward: Pledge $1,699 or more first batch. (Reward 4th)
- First delivery and backer: Jan-15 (Anywhere in the world) /10

Tracking with customers:

Comment: 288

Update: 26

Supportive or published by company: -

Website: https://www.kickstarter.com/projects/makextec/m-one-an-opensource-professional-desktop-dlp-3d-pr?ref=category

Name: Bocusini - World's first plug & play 3D Food Printing System

Category: 3D printer (food)

Funding type: Reward / kick starter

Target point: 3D Food Printer or food printing head, cartridges with printable food, intuitive WIFI user interface and supporting internet platform

Description: Bocusini is the world‘s first 3D food printing system, which easies to use via open source food printing system. It offer users can change cartridges, heat up, and print foods with creative design as 3D printer prints prototype. The mechanism controls pastry bag and allow food run layer-by-layer though small nozzle with precision. Bocusini can use by everyone from beginner to expert skill in gastronomy, patisserie, and home cuisine.

Advantage by frugal concept:

- **Mobile enables solution (3)** Bocusini used software, interface and WIFI control through open source templates from Doodle3D. Which allow user can design and ordering to print food via WIFI and smart device.
- **Human centric design (4)** Bocusini help to guild users with food design, recipes, preparation and serving instruction by download template (3D file and printing condition) though 3D food printing web platform (www.bocusini.com).
- **Simplification (5)** Bocusini is a plug and play printer which allow users to use without any skills and knowledge of software installation and food printing. Users only need to go to the Bocusini web platform to drag & drop creative design, insert food cartridge, and order to print creativity design of food.
- **Adaptation (7)** Bocusini allow to use with many kinds of food cartridge (more than 30 food types) i.e. chewing gum, cream cheese, jelly, mashed potatoes etc.
- **Use local resource (8)** Bocusini also create additional head kit that users can attach to existing 3D printers that they have.
- **Green technology (9)** Bocusini design food cartridge for ready to use and also able to refill food to the cartridge for more sustain.
- **Affordability (10)** Bocusini is 3D food printing system with initial price € 249.

Funding:

- Funding period start: 24-Jun-14
- Funding reached: 25-Jun-14
- Funding period end: 24-Jul-14

Target:

- Funding target: €30,000
- Funding raised: €40,581
- Successive rate: 135.27%

Reward:

- Number of backers: 149
- Type and level of reward: 14 reward level
- Reward range: €1-7000
- Detail of reward: Pledge €249 or more earlier bird (reward 5th)
- First delivery and backer: Jan-16 (Anywhere in the world)/19

Tracking with customers:

- Comment: 73
- Update: 22

Supportive or published by company: more than 10 suchas facebook, twitter, 3D printing industry, DISQUS, Scoop.it! etc

Website: https://www.kickstarter.com/projects/2028227986/bocusini-worlds-first-plug-and-play-3d-food-printi?ref=category

Name: Deltaprintr - A simple, affordable 3D Printer!

Category: 3D printer

Funding type: Reward / kick starter

Target point: The Deltaprintr is the most affordable 3D Printer starting at $499.

Description: Deltaprintr is simple, efficient, affordable, high quality, and user-friendly 3D printing. It is all in one LCD display, SD card, and 60-watt compact power supply in the box. It printed fast speed by three-stepper motors with100 microns resolution, use PLA filament as material. And manufacturing of high precision CNC machine. Deltaprintr allow putting the carriage in-out without any adjustment which provide easy to use and assembly by automatic calibration. Highlighting with easy to control carriage and expand the print volume by used 65lb spectra fishing line instead of expensive belt.

Advantage by frugal concept:

- **Simplification (5)** Deltaprintr is simple with easy to use and assembly, provide automatic calibration with minimal set-up step and no need screws for calibration,

which give short-term maintenance. For more easily it provides picture set-up manual.

- **New distribution model (6)** Deltaprintr uses the polar coordinate system, which allow fast speed with 100-micron resolution. Moreover, Deltaprintr made by laser cutting and high precision CNC instead of printed parts for giving precious resolution printed.
- **Adaptation (7)** Deltaprintr can be expanded print volume and easy to adapt to use with universally acceptable parts.
- **Affordable (10)** Deltaprintr design with less component comparing to other 3D printers and provide substitution cheap material instead of expensive material that is affected to cost less.

Funding:

- Funding period start: 24-Jun-14
- Funding reached: 25-Jun-14
- Funding period end: 24-Jul-14

Target:

- Funding target: $195,000
- Funding raised: $236,451
- Successive rate: 121.26%

Reward:

- Number of backers: 619
- Type and level of reward: 14 reward level
- Reward range: €1-1200
- Detail of reward: Pledge $425 or more earlier BIRD (reward 6th)
- First delivery and backer: Aug-14 (Anywhere in the world) / 5

Tracking with customers:

- Comment: 424
- Update: 30

Supportive or published by company: more than 10 such as GIGAOM, 3ders, TC techCrunch, PC PCMAG.com etc.

Website: https://www.kickstarter.com/projects/shai/deltaprintr-a-simple-affordable-3d-printer?ref=category

Name: Felfil Evo. 3D printers filament extruder

Category: 3D printer application (filament recycle and maker m/c)

Funding type: Reward / Indiegogo

Target point: A filament extruder for 3D printers. Ready for experimentation, it will help you save money.

Description: Felfil Evo. 3D introduces an easy to use filament extruder, which will allow anyone to produce their 3D printer filament on their own, starting from industrial pellet, wrong 3d prints or recycled wastes. Felfil Evo is a small machine that takes functioning from the industrial extruders. It can extrude any thermoplastic polymer whose melting temperature does not exceed 300°C, but is tested for PLA and ABS. Customer will be able to choose filament color, diameter and material, day by day, according to creativity and curiosity. This is an open project, designed and developed by everyone and a Fablab, for both makers and less experienced.

Advantage by frugal concept:

- **Human centric design (4)** offer as an open project by publishing first prototype to everyone for design and develop models of filament extruder machine to increase reliability and performance to suit for usage.
- **Simplification (5)** The filament extruder design for easy and allow everyone to use and build their own 3D printer filament from industrial pellet, wrong 3D prints, recycled wastes with new material and colors by DIY concept.
- **New distribution model (6)** Felfil Evo. Introduced as an open project, which show first prototype to generate better development of product by open sourcing to everyone and developed by Fablab.
- **Adaptation (7)** able to customize and design color, diameter, and material of filament according from customers preferable.
- **Use local resource (8)** allows using material from waste and other local material (any thermoplastic polymer whose melting temperature does not exceed 300°C, but is tested for PLA and ABS).
- **Green technology (9)** can customize filament from recycle printing waste. It helps to get less pollution, time, and money.
- **Affordability (10)** saves money by extrude filament from recycling failure 3D model with new colors, compositions, and material.

Funding:

- Funding period start: 1-Oct-15
- Funding reached: No mention
- Funding period end: 10-Mar-16

Target:

- Funding target: €37640.27
- Funding raised: €56,084
- Successive rate: 149%

Reward:

- Number of backers: 28
- Type and level of reward: 4 reward level
- Reward range: € 230-520
- Detail of reward: Pledge € 230 + Shipping for basic kit (reward 1th)
- First delivery and backer: Aug-16 (Anywhere in the world) / 3

Tracking with customers:

- Comment: 4
- Update: 11

Supportive or published by company: 3ders.org, gigazine.net, impresion3daily.es, open-electronics.org, geeky-gadgets.com, 3dprinti.com

Website: https://www.indiegogo.com/projects/felfil-evo-3d-printers-filament-extruder#/

Name: BASE by Wiivv - Custom, 3D Printed Insoles

Category: 3Dprinting product

Funding type: Reward / Indiegogo

Target point: BASE is a 3D printed insole with custom design and foot digitization captured via a smart phone.

Description: BASE by Wiivv is a body-perfect insole that is engineered to maximize comfort, promote alignment and lessen fatigue by creating BASE insoles that closely follow your unique foot curves to give you the support and stability. To customize a pair of insoles and get measured, all customers need 5 minutes and a smartphone to create a convenience sole base.

Advantage by frugal concept:

- **Ruggedization (1)** design to maximize comfort, promote alignment and lessen fatigue for reduced injuries and increased performance in athletic activities.
- **Mobile enables solution (3)** customer can reach the product of their own without any tailor to measure the size of insole by smartphone which is available in both IOS and android platform.
- **Human centric design (4)** design base on personal insole shape.
- **Simplification (5)** customer can customize a pair of insole and measured within 5 minutes by smartphone.
- **New distribution model (6)** which offer customer to purchase and measuring insole via smartphone for easier to access and customizable product by their own.
- **Adaptation (7)** base insole will be produced based on the unique shape of customer's foot curves to give proper support and stability to reduce joint loading in knee and hip.

Funding:

- Funding period start: 1-Oct-15
- Funding reached: No mention
- Funding period end: 10-Mar-16

Target:

- Funding target: $54162.55
- Funding raised: $254,564
- Successive rate: 470%

Reward:

- Number of backers: 222
- Type and level of reward: 3 reward level --> give product as pre-sale
- Reward range: $75 – $549
- Detail of reward: Pledge $75 + Shipping with one pair of insloes
- First delivery and backer: Apr-16 (Anywhere in the world) / 150

Tracking with customers:

- Comment: 5
- Update: -

Supportive or published by company: many kind of people get benefit from fit insole such as Olympic swimmer (Martha Mccabe), Nurse, Climber, Physiotherapist etc

Website: https://www.indiegogo.com/projects/base-by-wiivv-custom-3d-printed-insoles-fitness-running#/

Name: Ares: An Affordable All-in-one 3D Printer
Category: 3D printer
Funding type: Reward / Indiegogo
Target point: 3D printing, 3D scanning, CNC/laser engraving, and even more extensions.
Description: All-in-one 3D printer which printer integrated with multi-functional modules, as well as stable structure, friendly interface, easy operation and affordable price. It is a luxury version at an affordable price. The printer can meet most of daily requirements in terms of creation and innovation. Ares is especially suitable for fans, enterprise, homes, educational institutions or any other interested in 3D printer. Area designs with full-metal body (non-deformation), modular design (unlimited extension of imagination), commercial open-source (technical support and warranty). All in all, Ares is a 3D printing including with laser engraving, CNC engraving, 3D scanning, Wi-Fi Access and other unlimited additional function.
Advantage by frugal concept:

- **Ruggedization (1)** company introduced low cost 3D printer integrated with multi-functional which is extended performance and ability of 3D printing.
- **Simplification (5)** Ares present as tool that helps users to produce product by 3D scanning, printing within one machine. And also have additional features with a laser and CNC engraving.
- **Adaptation (7)** 3D printing can be integrated with multi-functional modules such as laser engraving, CNC engraving, 3D scanning, WiFi Access and other unlimited additional function.
- **Affordability (10)** 3D printer with cost-effective (low cost) and can be extendable with additional functionality.

Funding:

- Funding period start: Jun-15
- Funding reached: No mention
- Funding period end: 14-Aug-15

Target:

- Funding target: $10516.19
- Funding raised: $106,529
- Successive rate: 1013%

Reward:

- Number of backers: 331
- Type and level of reward: 8 reward level
- Reward range: $1 - $650
- Detail of reward: Pledge $650 Ares 3D printer
- First delivery and backer: Dec-15/ 30

Tracking with customers:

- Comment: 691
- Update: 33

Supportive or published by company: 3D print, GadgetSin.com, SMZDM.com, 3D Printing Industry, Microfabricator, RapidReady, the crowdfundingcenter.com, DIT3dprinting.com, 3D ARENA.com, fabcross, 3D printing magazine etc.

Website: https://www.indiegogo.com/projects/ares-an-affordable-all-in-one-3d-printer#/

Name: Gizmo 3D Printers SLA DLP - It works, lasts & wows

Category: 3D printer

Funding type: Reward / Indiegogo

Target point: alternated 3D printer between speeds to suit high resolution or super fast output needs.

Description: Gizmo 3D Printer is the world's first super speed, top down system SLA and DLP 3D Printer. It benefits to reduce downtime and less money spent while creating 3Dprints. Gizmo 3D Printers provide more reliability, ground-breaking super speed add-on, high-resolution capability, use resin filament, give consistent results and remote repeatability, use innovative software features, expandable model, made for users by users.

Advantage by frugal concept:

- Ruggedization (1) Gizmo introduces with high resolution and quick speed to get the reliability and performance advantage.
- Mobile enables solution (3) Gizmo give consistent results and remote repeatability which can print exactly the same product on the other side by repeating the same

job, with the same results, time and time again with other Gizmo 3D printer anywhere in the world.

- Human centric design (4) gizmo use “made for users by users” concept to provide more flexibility, capability and functionality to use a 3D printer with some mid-level 3D printing know-how.
- Simplification (5) gizmo gives machine easily to switch between ultra-detailed high-resolution prints and super speed prints. And gizmo provide with “Top Down System” to reducing downtime and costs, which users can start printing as soon as the previous print is complete without remove the building plate, the printed object uses less support by sitting on top of the build plate, rather than hanging off the bottom, which help to reduce resin wastage and cleaning time, no replacement parts are required during the printing process due to printed directly on to the resin.
- Adaptation (7) 3D Printer Software presented with full layer manipulation, that customer can customize 3D printed i.e. hollow, solid, detailed or faster by Innovative software features. And also Gizmo can be expandable and simply add-on for upgrade which other 3D printers would require the purchase of a whole new machine.
- Use local resource (8) by use resin as material, which can affordable and widely available in many countries.

Funding:

- Funding period start: no mention
- Funding reached: No mention
- Funding period end: 1-Apr-16

Target:

- Funding target: $ 97705
- Funding raised: $135,810
- Successive rate: 139%

Reward:

- Number of backers: 47
- Type and level of reward: 24 reward level
- Reward range: $5 - $11475
- Detail of reward: Pledge $2950 USD GiziMate 130 Basic

- First delivery and backer: Sep-16/ 30

Tracking with customers:

- Comment: 14
- Update: 27

Supportive or published by company: -

Website: https://www.indiegogo.com/projects/gizmo-3d-printers-sla-dlp-it-works-lasts-wows--2#/

Name: FABtotum PRISM

Category: 3D printer

Funding type: Reward / Indiegogo

Target point: World's first All-in-One Low cost stereolithography 3D printer platform. 3D print, Mill, Scan

Description: The FABtotum Personal Fabricator was designed to be a flexible and expandable platform from day one. Not Just a 3D printer, not just a milling machine, not just a scanner. A new way of prototyping and creating objects with expandable heads, swappable platform and up to 5 axis of motion the FABtotum are the most customizable platform for personal fabrication ever conceived on the market today.

Advantage by frugal concept:

- **Mobile enables solution (3)** The FABtotum is capable of printing autonomously (without being connected to a computer), from cabled LAN, Wireless LAN and even remotely from the Internet. The FABtotum feature a customized web management app, SSH and VNC server on the local network, so with one authorization code you can access all the functions of the machine: 3D Printing, 3D scanning, Milling, Customizations and Maintenance. All these functions are accessible not only from anywhere in your local network, but also on any device with web browsing capabilities. Printing remotely from smartphone, tablet, your windows Pc, Mac, Linux, Android, IOS.
- **Human centric design (4)** The FABtotum has been developed through user on capability of printing autonomously and design for used in many fields by different people, sometimes without any specific knowledge of machining or 3D printing.

- **New distribution model (6)** the FABtotum, which is capable of producing single movements of 0.25 micrometers in XY and 0.47 micrometers in Z natively, with high torque. This kind of fine control helps when printing with very thin layers and for remove resonances in the Z direction, which always problem of not-so-cheap 3D printers. And also The FABtotum manufactured in Europe (80% of the weight of one unit is made up of parts produced in the EU or US), which offer high quality and standard for the machine. From this show the new model offering customer to spend money for both advantaged to approach customer who has a problem with reliability and quality of printing.
- **Adaptation (7)** The FABtotum is a flexible platform that has been built with the concept of multi-functionality and adaptability, which bring more than one manufacturing technology to build complete objects and functional projects with different design choice and fabrication approaches. It is designed for intensely on personal fabrication than 3D printing alone.

Funding:

- Funding period start: no mention
- Funding reached: No mention
- Funding period end: 9-Oct-15

Target:

- Funding target: $ 61551.17
- Funding raised: $157,571
- Successive rate: 256%

Reward:

- Number of backers: 176
- Type and level of reward: 7 reward level
- Reward range: $35 - $1399
- Detail of reward: Pledge $1399 FABtotum PRISM bundle
- First delivery and backer: Feb-16/ 176

Tracking with customers:

- Comment: 308
- Update: 11

Supportive or published by company: -

Website: https://www.indiegogo.com/projects/fabtotum-prism#/

Name: Rapide Lite 200XL - 400mm Desktop Plus 3D Printer
Category: 3D printer
Funding type: Reward / Indiegogo
Target point: The world first Desktop Plus 3D Printer that gives you a massive 16,000cm3 (can print object 400 mm. High) of usable build space.
Description: Rapide Lite 200XL is desktop Plus 3D Printer which user who requires build height product (400 mm. High) that other printers cannot offer on the desktop. The function is included with ARM 32 bit control board and a 214 x 214mm Aluminum Heated Bed with providing precision print through a USB connection or "stand-alone printing" mode that controlled print through SD Card (4GB SD Card included) and a 2.8" LCD touch screen interface. Rapide Lite 200XL provide 50-micron resolution with speed of 150mm. per second
The design of small printers (367mm x 367mm), light weight, fully featured, and offers a large build height (400 mm.) is perfectly suited for office, home or school desktop.
Advantage by frugal concept:

- **Ruggedization (1)** Rapide Lite 200XL represent with speeds of up to 150mm per second, which build speed is comparable to other high resolution printers. A typical printing rate is around 30 mm. of height per hour. Rapide Lite 200XL design for have an ARM 32 bit control board which helps to less moving parts than many high resolution printers and able to use for intensive work (everyday for the whole month). And printer allows to print object 400mm. high of usable builds space.
- **Human centric design (4)** Rapide Lite 200XL made according from the user base evaluating and rethinking how to expand and make the Rapide Lite range of printers more robust, higher resolution and more user friendly than the old 3D printer model, Rapide Lite 200.
- **Simplification (5)** Rapide Lite 200XL is 3D print designs from any .stl file. Which is designed to work with all open source 3D Printer software and is compatible with Mac, PC and Linux. Rapide Lite 200XL is easy to use through the LCD Touch Screen / SD Card Interface.

- **Adaptation (7)** printer can use material from any third party not only from Polymakr. Also Rapide Lite 200XL is compatible with Mac, PC, Linux and uses free to own open source software.

Funding:

- Funding period start: no mention
- Funding reached: No mention
- Funding period end: April 17, 2015

Target:

- Funding target: $ 5785.56
- Funding raised: $203,073
- Successive rate: 3510%

Reward:

- Number of backers: 358
- Type and level of reward: 11 reward level
- Reward range: $29 - $9999
- Detail of reward: Pledge $1199 Early Bird (6th reward)
- First delivery and backer: mid – end April 2015 / no mention

Tracking with customers:

- Comment: 761
- Update: 74

Supportive or published by company: -

Website: https://www.indiegogo.com/projects/rapide-lite-200xl-400mm-desktop-plus-3d-printer#/

Name: Freaks3D: the World's First Portable 3D Printer

Category: 3D printer

Funding type: Reward / Indiegogo

Target point: Freaks3D is quality 3D printer at breaking low price with the concept of simplified structure and portability.

Description: Freaks3D is a 3D printer that can take everywhere that you want. It's introduce with concept of less is more which simplified extruded-aluminum beam to ensure stabilize, give precious position and high quality of printing with high resolution

and fast speed. 3D-Printer is made from all-metal nozzle head with no need for preheat before use and simple insert PLA/TPU filament to entrance path. The purpose of Freaks3D is to get rid of complexity, provide portability and affordability 3D printer. It's reliable with high solution and 10 hours aging before shipping.

Advantage by frugal concept:

- **Light weight (2)** and **Mobile enables solution (3)** Freaks3D is portable with small size and light weight (same scale and weight as your laptop)
- **Simplification (5)** Freaks3D introduces simple with V-slot slider structure, easy to set up, provide one button control and LCD display.
- **Adaptation (7)** Freaks3D is flexible with USB/SD print, battery compatible, and filaments come from various materials of PLA and TPU (Thermoplastic Polyurethanes) with rainbow color.
- **Affordability (10)** Freaks3D introduces with $260 for printer price.

Funding:

- Funding period start: July, 2015
- Funding reached: No mention
- Funding period end: August 16, 2015

Target:

- Funding target: $ 21183
- Funding raised: $151,249
- Successive rate: 714%

Reward:

- Number of backers: 515
- Type and level of reward: 7 reward level
- Reward range: $15 - $3599
- Detail of reward: Pledge $259 Early Bird Kit (2nd reward)
- First delivery and backer: Aug-15 / 30

Tracking with customers:

- Comment: 346
- Update: 19

Supportive or published by company: 3D printing.com, 3D printing industry, www.3der.org, Geeky Gadgets, 3DP system, origo, gadgetify, Microfabricator etc.

Website: https://www.indiegogo.com/projects/freaks3d-the-world-s-first-portable-3d-printer#/

Name: NEA 3D: Stylish & Upgradeable 3D Printing for All
Category: 3D printer
Funding type: Reward / Indiegogo
Target point: Compact, modular, reliable and easy to use 3D Printers straight out of the box.
Description: The ideas come from 2 main problems of 3D printer for beginner with complexity to set up and low quality of print. It brought NEA 3D to create a 3D Printer that is mid-range printers that are affordable, easy-to-use, excellent print-quality, elegant, modular, and upgradeable within $200.
Advantage by frugal concept:

- **Ruggedization (1)** NEA is strong printer shape help to keep vibrations inside the printer which effect has no weak spots and reduces vibrations by dissipating in an outward direction.
- **Human centric design (4)** NEA 3D consists with Extruder Head, Drop & Lock Shelf, Core Drawer, and Cool Spool which Printer designed for perfect balance between accuracy, speed, reliability and repeatability.
- **New distribution model (6)** NEA 3D introduce 3D printer with "Fused Filament Fabrication" technology, which extrudes melted filament (PLA or ABS) out of hot end. It prints high quality layer by layer of cross section, which cool and harden almost instantly. The small incremental stepper motors help for reliable all axis of movement. The developer of the 3D printing model is represented to a customer for more quality printer.
- **Adaptation (7)** with NEA's Extruder Head, Drop & Lock Shelf and Core Drawer is removable and easy to change without tools in case of breakdown. And also provide with Self-Leveling Bed, Open Source software and nonproprietary filament, which mean printer, can adapt according from user preference.

Funding:

- Funding period start: May-15
- Funding reached: No mention

- Funding period end: July 5, 2015

Target:

- Funding target: $ 107191
- Funding raised: $356,946
- Successive rate: 333%

Reward:

- Number of backers: 445
- Type and level of reward: 5 reward level
- Reward range: $28 - $2795
- Detail of reward: Pledge $1995 (NEA PRO+ 61% OFF MSRP $4,995)
- First delivery and backer: Dec-15/ 15

Tracking with customers:

1. Comment: 841
2. Update: 22

Supportive or published by company: 3D printing industry, 3D printing.com, Fargo 3D printing

Website: https://www.indiegogo.com/projects/nea-3d-stylish-upgradeable-3d-printing-for-all#/

Name: CreoPop - Cool Ink. Infinite Creativity.

Category: 3D printer

Funding type: Reward / Indiegogo

Target point: is the world's first 3D pen with cool ink. The possibilities are endless.

Description: CreoPopTM (www.creopop.com) is the world's first 3D pen with cool ink. In contrast to other 3D pens, there are no hot parts, no melting plastic and no unpleasant smell. Instead, CreoPopTM uses photopolymers that are solidified using LED diodes to let users create amazing 3D designs. Since no heating is required, CreoPopTM is safe in a home environment. The most innovative feature of CreoPopTM is the large selection of cool inks available including with different colors, elastic ink, magnetic ink, glow-in-the-dark ink, temperature sensitive ink and body paint ink.

Advantage by frugal concept:

- **Light weight (2)** 3D printing introduces with light-sensitive photopolymers into the small size of a portable pen.

- **Simplification (5)** CreoPop offer 3D pen with various kinds of ink that can DIY such as conduct electricity ink for science experiments, change color temperature ink that can change text as coffee is poured into a preference level of the mug.
- **New distribution model (6)** offers a better solution of 3D pens with non hot parts, no melting plastic and unpleasant smell. For target home user customer who have no professional equipment for protect toxic or smell from melting filament.
- **Adaptation (7)** Infinite creative with various kinds of filament i.e. glow-in-dark, temperature, elastic, conductive, magnetic, aromatic, body paint, and glittering.

Funding:

- Funding period start: No mention
- Funding reached: No mention
- Funding period end: August 17, 2014

Target:

- Funding target: $ 46089
- Funding raised: $213,852
- Successive rate: 464%

Reward:

- Number of backers: 2341
- Type and level of reward: 4 reward level
- Reward range: $15 - $229
- Detail of reward: Pledge $130 CreoPop Starter
- First delivery and backer: No mention/ 3

Tracking with customers:

- Comment: 1030
- Update: 37

Supportive or published by company: more than 10 such as Mashable, TechCrunch, engagedget, Forbes, Business Insider etc.

Website: https://www.indiegogo.com/projects/creopop-cool-ink-infinite-creativity#/

Name: 3D Printer For Class

Category: classes on 3D design and 3D printing.

Funding type: Reward / Indiegogo

Target point: Help us get a 3D printer to learn, make, and share with.

Description: Makerspace offers 3D printer classes on the use of a CAD software for 3D design and 3D printing in order to support funding for buy 3D printer to Makerspace.

Advantage by frugal concept:

- **New distribution model (6)** Makerspace creates access to the new 3D printer by crowdfunding though launching 3D printer classes.
- **Use local resource (8)** Makerspace use their own resources which are CAD software for 3D design and 3D printing in order to exchange for funding money to buy a new 3D printer.
- **Affordability (10)** Makerspace introduce with affordable price for the 3D printing course.

Funding:

- Funding period start: No mention
- Funding reached: No mention
- Funding period end: no mention

Target:

- Funding target: $ 500
- Funding raised: $525
- Successive rate: 105%

Reward:

- Number of backers: 7
- Type and level of reward: 5 reward level
- Reward range: $1 - $65
- Detail of reward: Pledge $20 + Shipping come In And Print! or study class
- First delivery and backer: Nov-15/ no mention

Tracking with customers:

- Comment: 4
- Update: 5

Supportive or published by company: -

Appendix 4: 20 cases studies from Indiegogo and Kickstarter

10 Kickstarter cases

Name	Funding target	Funding raised	Successive rate	begin	reached	end	Backers	Type and number of level	Detail of reward	Delivery (Early birth level)	comment / update	No.publisht d (share, like)	website
eora 3D	High-Precision 3D Scanning on Your Smartphone	$ 80,000.00	$ 599,925.00	749.91%	19/10/15	19/10/15	18/11/15	2139	9 reward level	$199 for early birth product (reward 3th)	1/6/16	516/ 14	No info.	https://www.kickstarter.com/projects/eora/eora-3d-high-precision-3d-scanning-on-your-smartph/description
3Dvarius - High-end 3D printed electric Violin	€ 50,000.00	€ 53,231.00	106.46%	18/5/16	14/6/16	17/6/16	144	11 reward level	$6299 for early birth product (reward 9th)	1/12/16	14/15	No info.	https://www.kickstarter.com/projects/3dvarius/3dvarius/description
FLUX All-in-One 3D Printer - UNLIMITED. ELEGANT. SIMPLE.	$ 100,000.00	$ 1,641,075.00	1641.08%	11/11/14	11/11/14 (2:40 hr)	21/12/14	2707	13 reward level	$499 or more for early birth product (reward 5th)	1/7/15	2446/47	No info.	https://www.kickstarter.com/projects/2117384013/flux-all-in-one-3d-printer-unlimited-elegant-simpl/description
LIX - The Smallest 3D Printing Pen in the World	£ 30,000.00	£ 731,690.00	2438.97%	29/4/14	before 2/5/14	29/5/14	8030	10 reward level	£43 or more Very early bird product (reward 2nd)	1/10/14	3028/46	No info.	https://www.kickstarter.com/projects/lix3d/lix-the-smallest-3d-printing-pen-in-the-world?ref=category
FormBox: A Desktop Vacuum Former That Makes Beautiful Things	$ 50,000.00	$ 588,775.00	1177.55%	2/5/16	7/5/16	3/6/16	1745	15 reward level	Pledge $349 or more FIRST BATCH. (reward 3th)	1/3/17	118/15	No info.	https://www.kickstarter.com/projects/1094489804/formbox-a-desktop-vacuum-former-that-makes-beautif?ref=category
Altergaze: 3D printed VR Goggles for Smartphones	£ 25,000.00	£ 31,988.00	127.95%	3/3/14	28/4/14	2/5/14	456	16 reward level	Pledge £30 or more First batch (reward 3th)	1/11/14	330/47	No info.	https://www.kickstarter.com/projects/2782031?3/altergaze-mobile-virtual-reality-for-your-smartpho?ref=category
Tiko - The Unibody 3D Printer	$ 100,000.00	$ 2,950,874.00	2950.87%	30/3/15	13/4/15	30/4/15	16538	9 reward level	Pledge $99 EARLIEST BIRD (reward 2nd)	1/11/14	18616/26	No info.	https://www.kickstarter.com/projects/tiko3d/tiko-the-unibody-3d-printer?ref=category
M-One: An opensource, professional desktop DLP 3D printer	$ 100,000.00	$ 180,481.00	180.48%	24/5/14	25/5/14	24/6/14	134	12 reward level	Pledge $1,699 or more FIRST BATCH. (reward 4th)	1/11/14	288/26	No info.	https://www.kickstarter.com/projects/makexteci/m-one-an-opensource-professional-desktop-dlp-3d-pr?ref=category
Bocusini - World's first plug & play 3D Food Printing System	€ 30,000.00	€ 40,581.00	135.27%	5/12/15	21/5/15	11/6/15	149	14 reward level	Pledge €249 or more EARLier BIRD (reward 5th)	1/1/16	73/22	No info.	https://www.kickstarter.com/projects/2028227986/bocusini-worlds-first-plug-and-play-3d-food-printi?ref=category
Deltaprintr - A simple, affordable 3D Printer!	$ 195,000.00	$ 236,451.00	121.26%	5/12/13	on 7/12/13 (reach quarter of our goal in less than 24 hours)	4/1/14	619	14 reward level	Pledge $425 or more EARLier BIRD (reward 6th)	1/7/14, 1/8/14	424/30	No info.	https://www.kickstarter.com/projects/shai/deltaprintr-a-simple-affordable-3d-printer?ref=category

10 Indiegogo cases

Name	Funding target	Funding raised	Successive rate	begin	reached	end	Backer	type and level	detail of reward	Early birth level	comment / update	No.published (share, like)	website
Felfil Evo. 3D printers filament extruder	€ 37,640.27	€ 56,084.00	149.00%	1/10/15	no data	10/3/16	28	4 reward level	€230 EUR + Shipping for basic kit (reward 1th)	1/9/16	4/11	17	https://www.indiegogo.com/projects/felfil-evo-3d-printers-filament-extruder#/
BASE by Wiivv - Custom, 3D Printed Insoles	$ 54,162.55	$ 254,564.00	470.00%	-/1/16	no data	6/2/16	222	3 reward level	$75 USD + Shipping with one pair of insloes	1/4/16	5/-	911	https://www.indiegogo.com/projects/base-by-wiivv-custom-3d-printed-insoles-fitness-running#/
Ares: An Affordable All-in-one 3D Printer	$ 10,332.59	$ 106,529.00	1031.00%	-/5/15	no data	14/8/15	331	8 reward level	$650 USD Ares 3D printer	-	691/33	1227	https://www.indiegogo.com/projects/ares-an-affordable-all-in-one-3d-printer#/
Gizmo 3D Printers SLA DLP - It works, lasts & wows	$ 97,705.04	$ 135,810.00	139.00%	no data	no data	1/4/16	47	24 reward level	$2950 USD GiziMate 130 Basic	1/9/16, 1/11/16 (superspeed level)	14/27	237	https://www.indiegogo.com/projects/gizmo-3d-printers-sla-dlp-it-works-lasts-wows--2#/
FABtotum PRISM	$ 61,551.17	$ 157,571.00	256.00%	no data	no data	9/10/15	176	7 reward level	$1399 FABtotum PRISM bundle	Jan-16	308/11	2315	https://www.indiegogo.com/projects/fabtotum-prism#/
Rapide Lite 200XL - 400mm Desktop Plus 3D Printer	$ 5,785.56	$ 203,073.00	3510.00%	no data	no data	17/4/15	358	11 reward level	$1199 Early Bird (6th reward)	1/1/16	761/74	2005	https://www.indiegogo.com/projects/rapide-lite-200xl-400mm-desktop-plus-3d-printer#/
reaks3D: the World's First Portable 3D Printer	$ 21,183.33	$ 151,249.00	714.00%	-/7/15	no data	16/8/15	515	7 reward level	$259 Early Bird Kit (2 nd reward)	1/8/15	346/19	1776	https://www.indiegogo.com/projects/reaks3d-the-world-s-first-portable-3d-printer#/
NEA 3D: Stylish & Upgradeable 3D Printing for All	$ 107,190.99	$ 356,946.00	333.00%	-/5/15	no data	5/7/15	445	5 reward level	$1995 (NEA PRO+ 61% OFF MSRP $4,995)	-	841/22	1179	https://www.indiegogo.com/projects/nea-3d-stylish-upgradeable-3d-printing-for-all#/
CreoPop - Cool Ink. Infinite Creativity.	$ 46,088.79	$ 213,852.00	464.00%	no data	no data	17/8/14	2341	4 reward level	$130 USD CreoPop Starter	-	1030/37	3319	https://www.indiegogo.com/projects/creopop-cool-ink-infinite-creativity#/
3D Printer For Class	$ 500.00	$ 525.00	105.00%	no data	no data	7	7	5 reward level	$20 USD + Shipping Come In And Print! or study class	1/11/15	4/5	20	https://www.indiegogo.com/projects/3d-printer-for-class#/