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A REVIEW OF TECHNOLOGY INNOVATION: A LONGITUDINAL REFLECTION ON TECHNOLOGY EPIPHANY

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Abstract

Technology epiphany represents a new innovation strategy where radical design innovation meets with radical technology innovation. To create a technology epiphany, the overlap of two different innovation strategy required. One the one hand, technology push innovation strategy which provides radically new technologies. On the other hand, design driven innovation strategy which provides radically new meanings. Indeed, technology epiphany is occurred by these two strategies' distinct characteristics. This new strategy engages many companies in the process of their new product development. This study provides a systematic literature review and description of the state of art of the literature about Technology Epiphany. 60 related articles with technology epiphany are published in top academic journals and this study aims to uncover general trend of publication frequency, general trend of journal frequency, trends in research methodologies adopted, trend of keywords, different units of analysis, findings about innovation strategies and industry identification. Finally, study proposes future directions for the research

Keywords: technology epiphany, technology push, design driven innovation, innovation, role of design in innovation

Table of Contents

List of Figures

List of Tables

Chapter 1 Introduction

An innovation can be defined as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in external relations, business practices or workplace organisations (OECD, 2005).

In fact, innovation term is not only about product innovation. Process innovation is another aspect of innovation. Product innovation is related with an alteration in the way of products that are produced in the market. On the other hand, process innovation is related with an alteration in the technology and process of supply or distribution of a product. (Wonglimpiyarat, Yuberk, 2006).

For companies in the competitive market, innovation has become one of the key drivers of competitive advantage and their success in their market for years. To attract their customers and not to lose them to their competitors, they require to innovate their products or services at some point. Besides, firms need an effective ability to innovate because for developing and sustaining their competitive advantage, innovation is the single most important factor (Davey, Brennan, Meenan, McAdam, 2011. If they act successfully, they can even gain their market's leadership (Montalvo, 2006). Because of this reason, lots of money are invested by industry leaders. Their goal is to advance their innovativeness of their firms and the industry (Rosenzweig, 2016). However, every industry has different dynamics and according to that they have different strategies in order to implement innovation.

These firms have two choices in front of them. They can radically or incrementally innovate their products. First of all, radical innovation is described as products that are radically changed by involving the development or application of significant new technologies. Also, these radically new products can play a crucial role to provide a competitive advantage and have an influential leap in terms of customer familiarity and use. As an example, airplanes, automobiles, personal computers and televisions can be given (Veryzer, Jr., 1998).

On the other hand, incremental innovation does not focus on radically new products or new technologies to use. This kind of innovation involves minimal changes in the technological

basis of a product in order to match customers who achieve minimal improvements in their benefits (Herrmann, Tomczak, Befurt, 2006)

Over the years, companies considered new technology as an opportunity to substitute the previous technology under the name of innovation. Most of the companies used technology as a major driver for innovation. Those type of companies generally choose to follow an innovation strategy called technology-push. Their innovation originated from their research and development activities and therefore companies can create new products through the identification and development of new technologies (Dell'Era, Marchesi & Verganti, 2010). In the strategy of technology-push, new technology means new opportunities for companies in their market competition.

There can be given many examples about innovation of technology such as introduction of personal computers, cordless telephones relative to wired phones by using a substantially new technology, DVD players by using optics technology as opposed to the magnetic technology used in VCRs (Govindarajan, Kopalle, Danneels, 2011). All these innovations of technologies were implemented to substitute the product with the new one that has a new technology.

After some discussions about theories of innovation, it can be said that a product's functional utility, its meaning or both may be considered by innovation. (Verganti, 2008). Companies should not only look for an innovation in functional utility but also consider for an improvement in the meanings of their product. Functional innovation can imply an incremental or radical improvement of technical performance. On the other hand, innovation of meaning can also be radical or incremental (Verganti, 2008).

Therefore, it appears that technology is not the only major dimension of innovation. Meaning is the other major dimension of innovation. Since companies realized that consumers buy and use their products for deep reasons alongside with functional utility, they are now considering product's meanings as another dimension for innovation (Verganti, 2011). Therefore, innovation of meanings can be another way to reach their customers. When companies pursue a way to radically change their meaning, it means that they are following a design-driven innovation strategy. This strategy based on the idea that each product holds a particular meaning for consumers; style is just a possible language that can be exploited to communicate it (Dell'Era, Marchesi & Verganti, 2010).

An example can be the Swatch a watch company which launched first in 1983. It was a radical innovation of meaning which changed people's perceptions on what a watch previously meant for people. People considered watches as jewels in the 50s and 60s and it was considered as time instruments in 70s. The Swatch overturned the watch's meaning into that of fashion accessory. This change of meaning had never foreseen by anyone before the Swatch but their intensive use of plastic, colourful style and low price were the ways for the Swatch to convey this new meaning (Verganti, 2008).

The concept of Technology Epiphany comes up with the interplay of two different strategies which is defined above. Technology Epiphany can be defined as a particularly effective type of innovation strategy able to merge technological breakthroughs with the radical innovation of meanings (Dell'Era et al., 2017). Until now, especially in the technology management, substitutions in technology were the main area of investigation. However, technology epiphany can be a promising as an area of investigation in innovation and technology management for next decades (Verganti, 2011).

In this research, the state of art of the literature about Technology Epiphany will be reported with the goal to present insights into academic researches on Technology Epiphany. A particular focus will be given to the journals that are related. The following questions are going to be tackled: What is the trend of publication frequency? Which journals are publishing research articles on Technology Epiphany? What keywords is used most in research articles? What methodology is used in research articles? Which innovation strategies are being addressed? Which industries are affected by relevant research articles?

While doing this study, a review of innovation, technology-push and the role of design in innovation will be mentioned in detail -which are closely related- in order to understand the concept of technology epiphany fully and then technology epiphany concept will be explained. Plus, this concept will be supported with the examples of companies who embraced technology epiphany as a strategy in their market competition.

To sum up the headlines of the study:

In Chapter 1, a brief introduction will be presented. This chapter will continue with the explanation of relevance of technology-push and design driven theories which will help to understand the concept of Technology Epiphany. In the end of the chapter, the overlap between technology push and design driven innovation in other words technology epiphany will be mentioned.

In Chapter 2, the state of art science of the literature review of Technology Epiphany will be presented.

In Chapter 3, research process and how the literature database was built will be described with the figures and tables.

It will continue with the main findings gathered from research and the industries relevant to Technology Epiphany in Chapter 4 as empirical results and Chapter 5 is the conclusion part.

1.1 Relevance of Technology Push

Typewriters, slides rules and glass plate cameras have been all experienced the same situation. They have driven to virtual extinction. Radical innovations swept away them with word processors, electronic calculators and celluloid film cameras (Herrmann, Tomzcak & Befurt, 2006).

If companies insist on old technologies, they may have put their market position in danger. In this respect, new technology is essential for companies to compete in the market. There are some studies about the evolution of radical innovations. S-shape curve explains the change in performance of existing and new technology over time. In S-shaped curve, the marginal rate at which the capability of the old technology increases is falling. On the other hand, the marginal rate at which the capability of new technology is increasing. In the long run, new technology performs better than old technology (Herrmann, Tomzcak & Befurt, 2006).

In this respect, companies should look for new technologies and search for strategies to develop it. To achieve this goal, technology push strategy can help those companies. It is a strategy that mainly uses radical innovation in technology for a new product development. Technology push approach looks at the innovation process from a completely different perspective. Rather than being driven by the market, innovation stems from the company's research and development activities that, through the identification and development of new technologies, allow it to create new products (Dell'era, Marchesi, Verganti, 2010). But of course, market dynamics should be well understood for this strategy otherwise they would have taken a huge risk. With this strategy, many companies in the world invest in their R&D departments for a radical change in their technology and as a result they substitute their old product with the new one which has a better technology. These companies only focus on functionality of a product or service and they use new technology to strengthen their place in their market competition.

However, radical innovation is not the only way for a new technology. Disruptive innovation is another type of innovation in terms of technological innovation. When disruptive innovation happens, the new product emerges on the lower end of the existing market and then diffuses upward. On the other hand, when radical innovation happens, it directly emerges for the mainstream market and then diffuses downward. Therefore, the difference between them is related with their type of diffusion to which maps (Schmidt, Druehl, 2008). An example for disruptive innovation can be personal computers. When PC was first released, it was targeted

to electronics do-it-yourself hobbyists who were doing experiments with the newly developed microprocessor in the mid-1970s. By the mid 80s, mainstream market adopted personal computers as an office place fixture and common home appliance. From this, it can be understood that disruptive innovation has been found attractive for mainstream customers whereas over time the new product's attributes started to satisfy mainstream customers and thus PC invaded mainstream market as a disruptive innovation (Govindarajan, Kopalle, Danneels, 2011).

After some summary info about technology push, the relevance of this strategy with technology epiphany can be explained. The relevance of this strategy with technology epiphany is about technological breakthrough. When technological breakthrough merges with the radical innovation of meaning, technology epiphany occurs. Additionally, for companies who want to celebrate technology epiphany should give importance to meaning. Thus, these companies can capture the full potential of technology. Unfortunately, short-sighted companies often focus on the search for new markets for a technology without considering its meanings. In this manner, when companies look for potential applications, they simply focus on technological substitutions (Dell'Era et al., 2017).

The relevance between technology push and technology epiphany can be shown with an example of game console industry. Sony and Microsoft who have very powerful game consoles followed technology push strategy but Nintendo followed a different strategy which was technology epiphany. The result of Nintendo's choice for their innovation strategy can be seen in their sales numbers which were very positive for Nintendo and disappointing for Sony and Microsoft: in April 2007, six months after its release, the Wii's sales in the US market were twice those of the Xbox 360 and four times those of the PlayStation 3. In the summer of 2007, cumulative worldwide sales of the Wii surpassed those of the Xbox, which was released a year and a half earlier – 10.57 million units to 10.51 – with the PlayStation 3 lagging behind by 4.3 million units. (Dell'Era et al., 2017).

1.2 Design driven innovation relevance

Consumers are paying increasing attention towards the socio-cultural aspects of products. For this reason, firms must consider the need for linguistic and semantic innovations as well as technological and functional innovations. (Dell'Era, Verganti, 2009). Innovation in linguistic and semantic innovations create design driven innovation. Design driven innovation has a deep connection between design and innovation. This connection can be explained with the innovation of product and service meanings. In here, meaning implies the profound psychological and cultural reasons why people use these products. Design driven innovation concept put emphasis on radically innovation of meaning. (Verganti, 2011).

The starting point of design driven innovation is the comprehension of subtle and unspoken dynamics in sociocultural models and results. These results are important to propose radically new meanings and languages (Verganti, 2011). The thing is these radically new meanings are not coming from the users. On the contrary, firms propose these new meanings and people love it when they saw it. Steve Jobs who was the CEO of Apple explained this situation with these words: ''We have a lot of customers, and we have a lot of research into our installed base. But in the end, for something this complicated, it's really hard to design products by focus groups. A lot of times, people don't know what they want until you show it to them'' (Verganti, 2011). To sum up, design driven innovation is not a concept that entirely focuses on users' need.

Technology epiphany and design driven innovation has a very close relationship. The relevance comes from radical change of meaning. As it mentioned previous, when technological breakthrough merges with the radical innovation of meaning, technology epiphany occurs. Design driven innovation is the other factor that creates technology epiphany.

As an example, for relevance of design driven innovation with technology epiphany, Nintendo can be given. They wouldn't be successful if they had focused on their users' need. As it mentioned above, they had a serious competition with Sony and Microsoft. If they focused on users' need which was a powerful console with a sophisticated 3D game experience, probably they couldn't compete with Sony and Microsoft. However, they followed their path and in the end, they radically changed the meaning of game consoles. (Verganti, 2011).

1.3 Overlap between Design-Driven innovation and Technology-Push: Technology Epiphany

When radical technologies meet radical design, technology epiphany occurs. It is an area that these two overlaps. This overlap can be seen from the Figure 1.3 which is below. It can be defined as the identification of the more powerful and successful meanings enabled by a new technology. (Verganti, 2011). Technology Epiphany is a new and can be a promising concept for companies who are looking for opportunities to gain leadership in their market. In the recent past, main focus of the companies was based on technology substitutions. To satisfy the
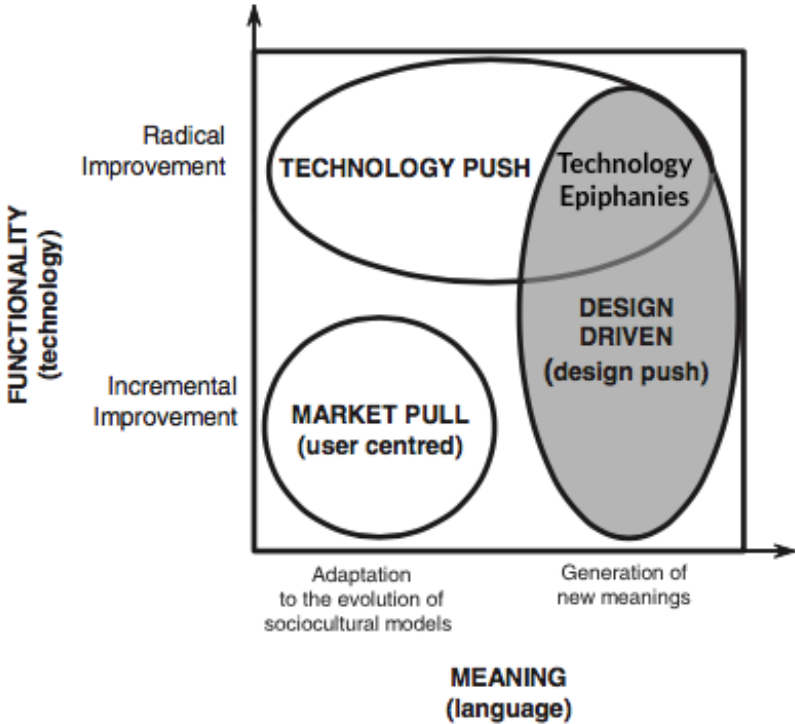
Figure 1.3: Innovation Strategies and the Positioning of Radical Design and Technology Epiphanies (adapted from Verganti, 2009)

market's existing need, companies used new technology as a replacement for old technology. Technology push strategy serves these companies in this manner. Technology push strategy overlaps with design driven innovation strategy in this: The companies who are looking for technology epiphany is investigating how a new technology enables the creation of new products and services that are more meaningful for the people, even these meanings do not fit with existing needs. (Verganti, 2011)

Chapter 2 Literature Review

In this chapter, the author is going to present the theoretical overview of Technology Epiphany by referring sources that are selected. Articles from selected journals are going to be the sources of this literature review. In this way, it will be possible to learn how technology epiphany took part in the literature.

The purpose of this section is to build a theoretical framework for Technology Epiphany topic by defining some key concepts such as Innovation, a role of design in innovation and technology push. By defining them, technology epiphany concept can be described better. Actually, they can be described as parts and together they have a role to compose technology epiphany. For this reason, their descriptions are crucial to fully describe technology epiphany concept.

To sum up, there will four sections in this chapter. First section is about innovation. In this section, the concepts of innovations which may relate with technology epiphany will be described. In the following, there is second section which is technology push. The concepts related with radical innovation of technology will be explained. A role of design in innovation is the third concept. User-centred innovation and design driven innovation will enrich this section to explain which design approach is related with technology epiphany. In the first three section, their definitions and each concept's relation with technology epiphany will be defined. The final section is going to be about technology epiphany that is the main topic of this chapter. While the author is explaining these concepts, related figures and examples from real cases are going to be used in order to explain them better.

2.1 Innovation

2.1.1 Definition of Innovation

In studies of Innovation literature, Schumpeter developed innovation and examined that innovation is a critical source of economic development and effective competition in 1939. In the following years, the scholars agreed that innovation is a crucial and essential element in the process of industrialization. Schumpeter defines innovation as "a process encompassing the development of new ideas into marketable products/processes." (Wonglimpiyarat, Yuberk, 2006).

Innovation term does not only deal about product innovation but also it deals with the process innovation. Product innovation is related with an alteration in the way of products that are produced in the market. On the other hand, process innovation is related with an alteration in the technology and process of supply or distribution of a product. (Wonglimpiyarat, Yuberk, 2006).

2.1.2 Relationship between Innovation and Firm Performance

Innovation is a concept that aims to bring newness and easiness to people's life. Therefore, people benefit from innovation and have a nature to expect always more because they have a basic instinct to enhance their life standards. Nowadays, to reach these standards, consumers are ready to spend money in case of need. Therefore, innovation became a very crucial concept for firms who aim satisfying the needs of their customers. To benefit from this concept, they need an effective ability to innovate because in these days, it is increasingly seen as the single most important factor in developing and sustaining competitive advantage (Davey, Brennan, Meenan, McAdam, 2011). If they act successfully, they can even gain their market's leadership. Further, the competition among firms and innovation can be seen as one of the most important main multipliers in industrialized and emerging economies (Montalvo, 2006). Due to this reason, industry leader firms invest considerable amounts of money. Their aim is to advance their innovativeness of their firms and the industry (Rosenzweig, 2016).

This relationship between firms and innovation examined that firm performance and innovation has a close relationship. A few examples about the relationship between firm performance and

innovation can be given. According to Koellinger, firm sales and employment growth in European e-businesses have a positive relation with product and process innovation. Another example is effect of product and process innovation to manufacturing firms in Netherlands. Thanks to these innovations, these manufacturing firms in Netherlands survived. Therefore, it can be said that there is a positive relationship between firm innovativeness and overall profitability. (Park, Park, Lee, 2012)

2.1.3 Innovation categories: Radical & Incremental Innovation

During the studies of scholars about innovation management, they classified innovation in different categories. One of the category is how innovation is approached such as radical and incremental innovation. These two types have different processes and effects on the market.

Radical innovation is described as products that are radically changed by involving the development or application of significant new technologies. Also, these radically new products can play a crucial role to provide a competitive advantage and have an influential leap in terms of customer familiarity and use. As an example, airplanes, automobiles, personal computers and televisions can be given. All of these were radical innovations when they were first introduced to the public. Plus, sometimes a radical innovation can create a new industry such as PC industry. In the time of PCs were first introduced, it was a new technology that did not exist before. Personal computers were mainly targeting a new market that was completely unfamiliar with the product class so it created a new industry. (Veryzer, Jr., 1998). Radical innovations are going to be the main basis for the concept of technology epiphany which is closely related with radical innovations.

On the other hand, incremental innovation does not focus on radically new products or new technologies to use. This kind of innovation involves minimal changes in the technological basis of a product in order to match customers who achieve minimal improvements in their benefits (Herrmann, Tomczak, Befurt, 2006). Incremental innovation does not focus on creating a new industry so their effect on the market is limited compared to radical innovation. Still, incremental innovation is few riskier than radical innovation so their possibility to success in the market is higher radical innovation.

2.1.4 Innovation strategies

As previously mentioned, the different approaches of innovation have been explained: product vs process innovation, radical vs incremental innovation. The last approach in this section is the innovation strategies that are technology push, market pull and design driven innovation.

In terms of new product development views, technology push and market pull represented the dual polarisation of innovation strategies. However, it is understood that consumers also give importance to socio-cultural aspects of products in these days. Now, consumers pay attention to meaning of product and psychological satisfaction more than ever. This increasing trend made firms to think and they realized that new product languages and meanings have to be considered as well as new functionality and technologies. As a result, firms now have to be more well-informed in two dimensions: technologies and socio-cultural trends (Dell'Era, Verganti, 2009).

Therefore, there emerged a diagram which involves the concepts of technology push, market pull and design driven innovation: (Verganti, 2008)
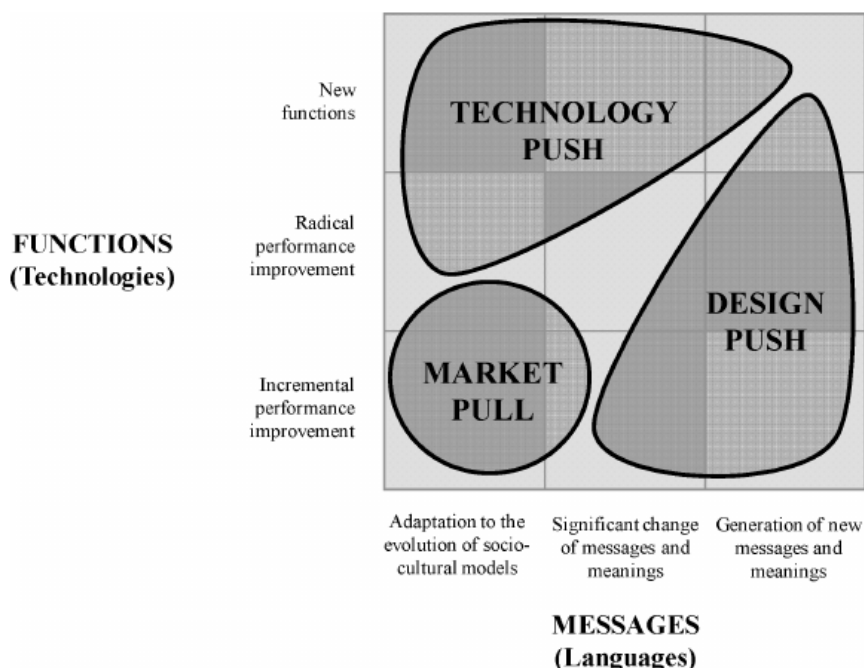
Figure 2.1.4: Different Approaches to Innovation (Verganti, 2003)

Market pull innovation's starting point is the analysis of user needs. The aim of market pull approach is to investigate technologies and meanings that can satisfy the needs of their customers (Verganti, 2008). In other words, this innovation strategy has a user-centered approach other than design-driven innovation and technology push. In this approach, radical changes cannot be seen. On contrary, firms who adopted market-pull strategy look for incremental changes in technology and try to adapt current socio-cultural trends. They use focus groups, questionnaires to understand these socio-cultural trends. Therefore, they can adapt to the market with small changes.

Technology push innovation is the outcome of dynamics of scientific and technological research (Verganti, 2008). Unlike market pull innovation, it doesn't involve in customer research. On the contrary, the main focus of technology push is the tendency to develop innovative technologies in order to implement them to their products. After this process, firms release these products to their market. Technology push concept will be explained in detail in the following section.

Design driven innovation involves socio-cultural aspects. It aims to comprehend the subtle and unspoken dynamics in sociocultural models and results in order to propose radical new meanings and languages. Therefore, a change in sociocultural regimes have been aimed with design driven innovation (Verganti, 2008). In recent years, design driven innovation has been considered increasingly by the firms to emphasize socio-cultural aspects.

2.2 Technology Push

2.2.1 Definition

In competitive global markets, radical innovation which is shaped by rapid technological change is a crucial driver of competitive advantage, superior firm performance and economic growth. Products that are truly innovative have a capacity to open up new markets, create first-mover advantage and generate positive cash flows. As a result, radical innovations in technology can be a path to survival and enhanced performance for both large and small firms (Reid, Roberts, Moore, 2014).
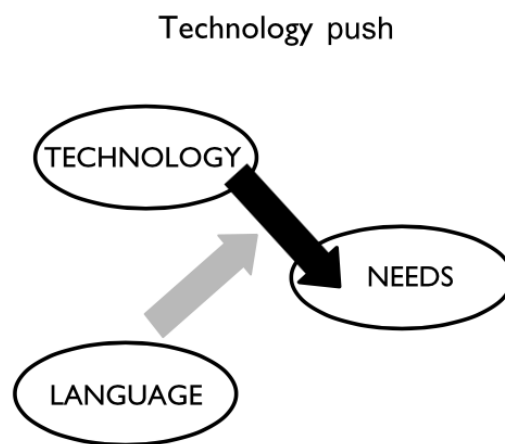
Technology push

Figure 2.2.1: A framework for Technology push (Verganti, 2003)

Technology-push innovation strategy corresponds to the words that are mentioned above. Technology push is an innovation strategy that aims to radically develop new technologies and apply them into their products in order to release them to the market. The main point of technology push is scientific and technological developments. Firms who are adopting technology push strategy make huge investments on their R&D processes. Technology push strategy can help those firms who want to obtain superior firm performance and economic growth in their market.

2.2.2 S-Shaped Curve

According to Schumpeter, the firms who are concentrating on old technology jeopardize their market position to the firms who are looking for radical innovations. Therefore, firms even they are the market leader should concentrate on developing new technologies in order to survive in

the future. (Herrmann, Tomczak, Befurt, 2006)

There are studies about the relationship between life of a technology and its capability. This relationship is reflected on S-shaped curve. Figure 2.2.2 in the below indicates the change in performance of existing and new technology over time.
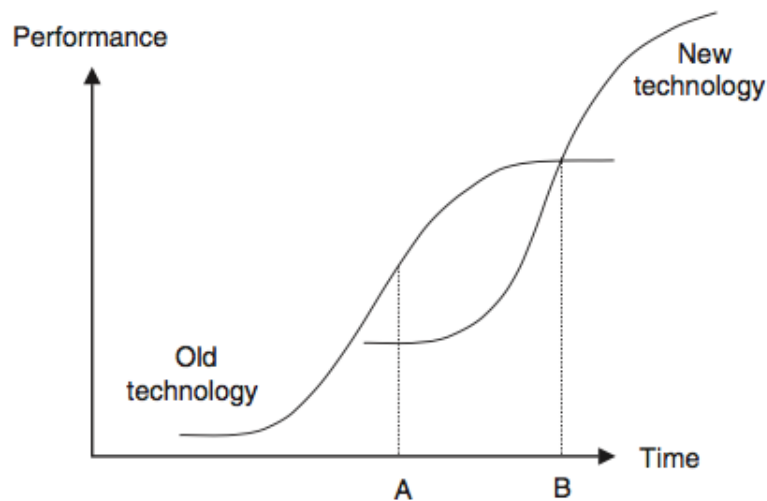
Figure 2.2.2: S-shaped curve (Herrmann, Tomzcak, Befurt, 2006)

In this Figure 2.2.2, new technology makes an entrance in this market at the time of A. Obviously, the performance of this new technology is lower than existing technology. However, as it can be seen in the Figure 2.2.2, the performance of old technology starts to decline over time and on the other hand the performance of new technology increases between the time of A and B. Finally, at the point of B, the performance of new technology is higher than the performance of old technology. In this regard, adopting new technology is the reasonable choice for firms in order to survive and sustain their claim in the market (Herrmann, Tomczak, Befurt, 2006).

From this perspective, adopting new technology is an advantage for firms instead of insisting in the old technology. In order to gain this advantage, firms adopt technology push approach and invest in R&D. Additionally, technology push approach makes sense and becomes meaningful, if firms apply these developments into their products. If not, they can experience tough times in their market.

There are some examples from some firms who had difficulties because they opposed to radical new technologies in the market. IBM and Seagate can be given as examples. IBM ignored the growing demand for personal computers which was a radically new technology in the market. After all, they lost the market leadership. Other example, Seagate was not willing to step towards to 3.5 disks even though they developed it. Instead they insisted in 5.25 floppy disks and tried to improve it. As a result, Seagate has been driven out of floppy disk business. (Herrmann, Tomczak, Befurt, 2006)

2.2.3 Disruptive Innovation

Technology push innovation strategy is usually associated with radical innovations in technology. However, radical innovations are not the only dimension of technology push. Disruptive innovation can be a dimension for technology push. In order to explain disruptive innovation, first of all the difference between radical innovation and disruptive innovation should be described. They are distinct type of innovations and not all radical innovations are disruptive and vice versa. (Govindarajan, Kopalle, Danneels, 2011).

A radical innovation is a new product that is based on new technology relative to what already exits. The target of radical innovation is the mainstream market. The introduction of cordless phones relative to wired phones can be described as radical innovation because it was based on a new technology but targeting the same customer base.

On the other hand, a disruptive innovation is a new product that represents a different set of performance attributes compared to what already exists. Additionally, this set of attributes are initially attractive to an emerging customer segment but unattractive to mainstream customers. (Govindarajan, Kopalle, Danneels, 2011). Therefore, for firms who adopt technology push strategy can also follow disruptive innovation. The only difference from radical innovation is their target customer base at first. An example can be given as cellular phones. When cellular phones have been firstly introduced, it was attractive to niche markets. However, it was not so attractive to the mainstream market due to reasons of lack of reliability, coverage and its high cost.

The reason that disruptive innovations are not attractive to mainstream market is the products of this type of innovation underperform on the attributes that mainstream consumers find crucial. Only emerging customer segments find it attractive at first. (Govindarajan, Kopalle, Danneels, 2011). However, in time, mainstream customers find it attractive and can change

their product selection. If firms do not agree the arrival of disruptive technologies, they may have hard times. There are several examples for companies who suffered from disruptive innovations.

For example, Nokia made a mistake and failed to see the transition from mobile phones to smartphones and they lost market leadership to BlackBerry. This led Nokia to almost bankrupt and eventually Microsoft bought Nokia. Also, BlackBerry made the same mistake as Nokia did and they failed to see the transition from smartphones to touchscreen smartphones. They were holding the market leadership in their hands but after Apple's introduction of IPhone, everything turned upside down for BlackBerry. Smartphones with touchscreen captured the mobile phone market eventually and the sales of Blackberry has dropped. Blackberry couldn't adapt to new conditions and lost their effect on the market. Eventually, they also lost market leadership to Apple. Other than Nokia and BlackBerry, in a different industry, Kodak couldn't make the transition from analog to digital photography and went bankrupt (Fenech, Tellis, 2014).

In Figure 2.2.3, performance development of disruptive technologies can be seen relative to time. Their performance increases in time and can reach to the high end of the market which is the mainstream customers.
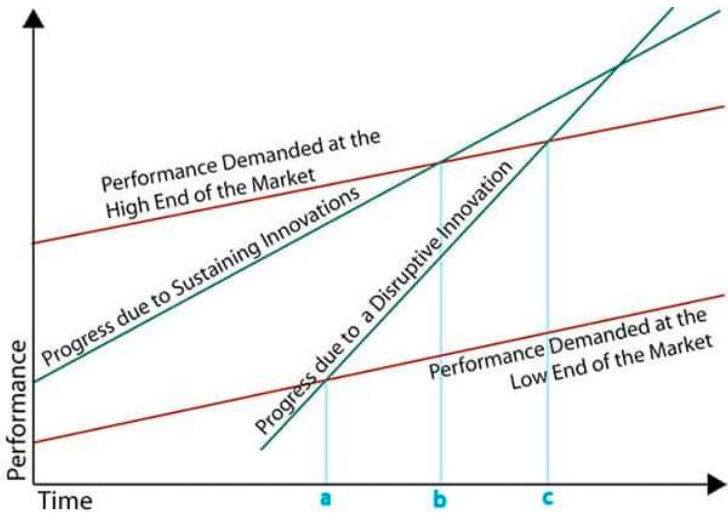

Figure 2.2.3: Progress of Disruptive Technologies as performance (Christensen, Rosenbloom,1995)

In summary, radical product innovations benefit from substantially new technology and mainstream or an emerging market could be targeted by radical innovations. In contrast, disruptive innovations satisfy emerging market initially and its trajectory comes from emerging to mainstream markets. As the technology improves its performance, it becomes sufficient to attract the mainstream market. This trajectory can be seen from the Figure 2.2.3 above.

2.3 Role of design in innovation

2.3.1 A Rise of Design in Business

More creativity and innovation are demanded in business strategies in order to compete in strong market competition in these days. Some research indicates that the design departments of companies need to have a leading role in product development in order to enhance their competence of creativity and innovative thinking (Jang, Yoon, Lee & Kim, 2015). As a supportive material, many articles in academic journals can be shown which explains the contribution of design to business performance and product development (Verganti, 2008).

Even though there are many researches that proves the impact of design in innovation, there are some fluid parts. There are two dominant approaches regarding design which are user-centred and meaning (Goto, Ishida, 2014).

2.3.2 User-Centred Design Innovation

Deep analysis of user needs and visualisation of the industrial design are the points that user-centred design focuses on (Goto, Ishida, 2014). For the overall new product development process, design has an important and great influence (Jang, Yoon, Lee & Kim, 2015). In this approach, product features are emphasized over technology and the user needs are diversifying. Firms are implementing this approach by asking their users about their needs or they can choose to observe their customers when they use existing products. With these investigations and the analysis of user-centred design, it becomes possible to surpass classic and common designs as style. (Verganti, 2008).

As an example, Apple, Philips, Bang & Olufsen and Alessi can be given. These companies aim to gain competitive advantage through design-oriented NPD. In this sense, Apple has a successful policy in design by offering paradigm-breaking new products through innovative designs. iPod is an excellent example to explain their policy. iPod was one of the most

innovative design of its time and this innovatively designed product has negatively affect the highly competitive MP3 player market (Jang, Yoon, Lee & Kim, 2015).

Design-oriented NPD Strategy
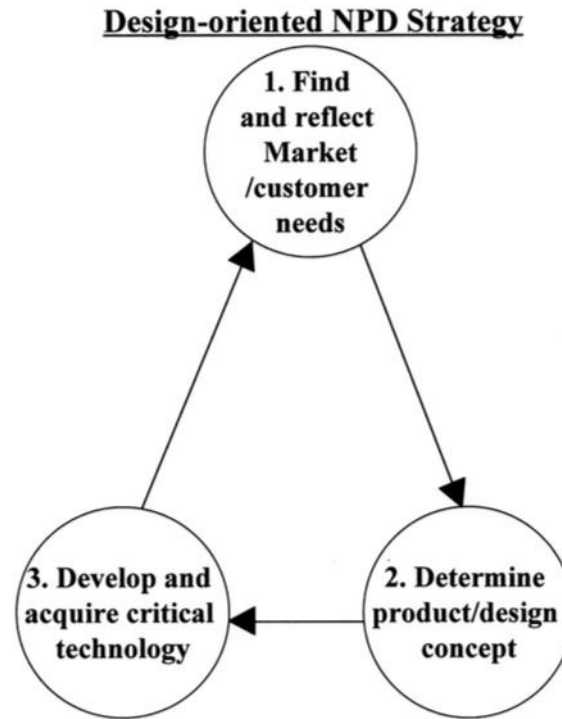
Figure 2.3.2: Design-oriented NPD Strategy Framework
(Jang, Yoon, Lee & Kim, 2015)

2.3.3 Meaning and Design Driven Innovation

Another approach for design is meaning. Meaning can be defined as irrational, intangible values that depend on symbolic and emotional responses of consumers (Goto, Ishida, 2014). With product languages, these symbolic and emotional values can deliver a message and convey specific meanings for customers. These product languages can be materials, colors, shapes and symbols (Dell'Era, Verganti, 2011). Many scholars found out that consumers do really care about product meanings. According to them, consumers are now looking for more of products in the sense of psychological satisfaction and a meaningful meaning of product can give them. Therefore, consumers define a product with not only its functionality but with its meaning that gives it to them. In the light of this new information in studies, new product languages and meanings are introduced as well as new functionalities and technologies by firms. (Dell'Era, Verganti, 2009).

At the moment, firms are investing in innovation in the area of design by considering product meanings as well as technology due to the fact that they realized consumers' attention to meaning. By doing so, firms do not use user-centred approach. Actually, they don't ask the opinions of customers throughout the development phase of products of firms. They focus on possible new product languages and meanings (Dell'Era, Verganti, 2009). An example can be given from Nintendo. While Nintendo Wii has been creating, they did not ask users about their opinions for the product. Instead, they considered feedbacks coming from the developers in the industry. The reason they handled this process by not using consumer's opinions because even consumers don't know what is their want from the product. As a result, innovation in meaning doesn't happen when they get closer to the customers (Verganti, 2011).

To innovate these product meanings, firms have developed superior capability to propose
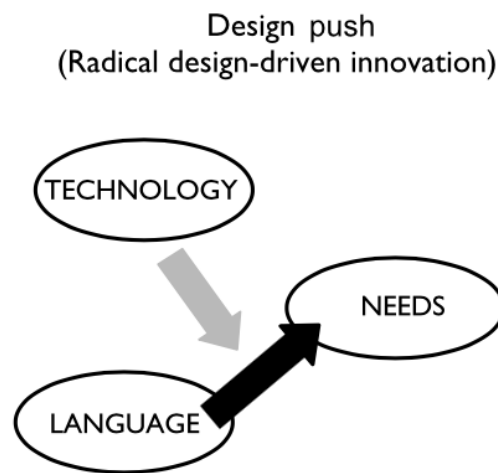
Figure 2.3.3: Design driven innovation (Verganti,2003)

innovations to their customers by radically redefining what a product means for customers. The innovation strategy they developed for radically changing product meaning is design driven innovation. Design driven innovation is not user-centred and actually it is orthogonal to user-centred approach (Verganti, 2008). In design driven innovation, companies conduct their technology development by aiming at generating new meanings through changing of product languages which are the combination of product appearance and signs, symbols and icons (Goto, Ishida, 2014).

Design driven innovation has been applied by successful Italian manufacturers such as Alessi, Artemide and Kartell. Design driven approach gave them an opportunity to become worldwide leaders in their industry. The innovation process of this approach is definitely not user centred.

Instead, design driven innovation emphasizes the radical innovation of a product's meaning (Verganti, 2008). Role of design in this innovation process has played a crucial role by radically changing the product meanings of these successful Italian manufacturers.

A perfect example to explain it further could be Alessi. In 1991, Alessi produced playful, colourful and metaphoric kitchenware with corkscrews which shaped like Chinese mandarins. In the circumstance of 90s world, this thought never occurred to anybody which was "dancing" corkscrews. Before 1991, people didn't ask for Chinese like orange squeezers but they loved this idea when they saw Alessi's products and it resulted in a breakthrough change in what kitchenware meant for people. It was a simple kitchen tool before but now, it transformed into transitional objects. This idea did not come from users but it was inspired by theories of paediatrician and psychoanalyst David Winnicott (Verganti, 2008). Like Nintendo, Alessi chose not to listen their users and they radically changed the meaning of a kitchenware use thanks to their vision.

To conclude, design can take different roles in innovation. Product style can be one of the ways to bring message to the user (Verganti, 2008). Other than styling, emotional and symbolic value which is meaning aims to satisfy the emotional and socio-cultural needs of the customer in addition to the functionality of a product which aims to satisfy operative needs of the customer (Dell'Era, Verganti, 2009). For product styling, the innovation rotates around user needs. On the other hand, the innovation of meaning depends firms' vision about possible breakthrough meanings and product languages that can emerge in the future (Verganti, 2008).

In some situations, a particular type of DDI can be generated by deeply analysing possibilities offered by new or old technologies. A technology epiphany can occur when the innovation comes from the revelation of quiescent meanings hidden in technology (Dell'Era et al., 2017). In the next chapter, a particular type of DDI, in other words, technology epiphany concept will be explained.

2.4 Technology Epiphany

2.4.1 Definition

As it mentioned in the previous pages, radical innovation can be implemented both in design and technology. Technology push strategy aims to radically develop new technologies and design driven innovation aims to radically generate new meanings for their customers. Technology epiphany is the area where these two innovation strategies overlap. In short, it is a concept that where radical design meets radical technology. It can be defined as the identification of the more powerful and successful meanings enabled by a new technology (Verganti, 2011). Technology epiphany can provide some additional understanding into the strategies that companies can obtain value from applications based on new technologies. In this context, Swatch who leveraged on the quartz technology, entirely changed what people meant by a watch to an extent that timekeeping is no longer the focus of Swatch but fashion is (Dell'Era et al., 2017).
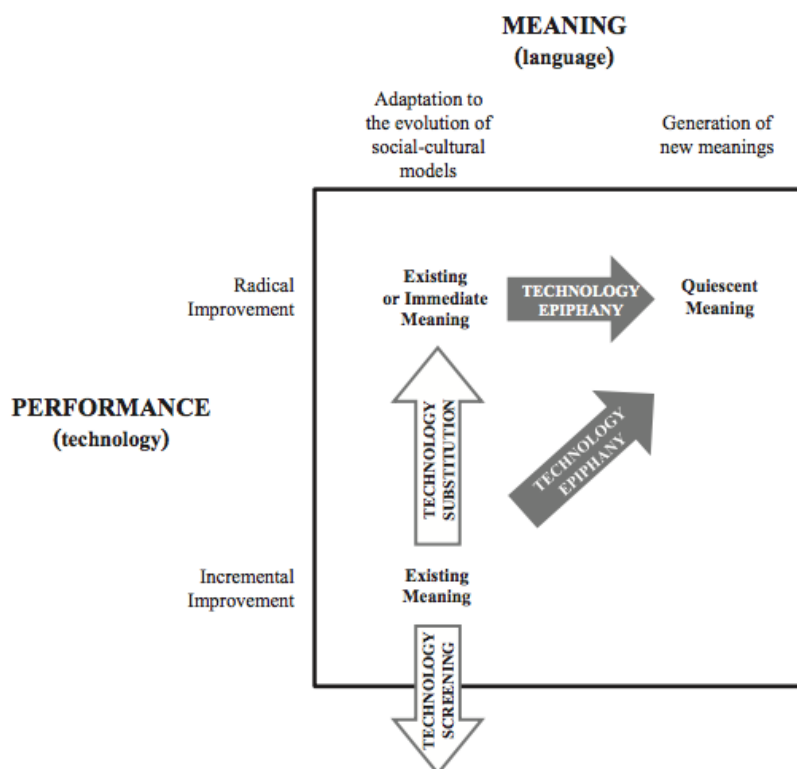
Figure 2.4.1: Conceptual Framework: Technology Screening, Substitution and Epiphany (Verganti, 2009)

2.4.2 Role of Design and Technology in Technology Epiphany

Many established theories of innovation management states that design can act as a differentiator in mature industries. There are some situations that is in the following that design can take a role as a differentiator. Technological discontinuities characterize every industry which emerges at irregular time intervals. These technological discontinuities force companies to innovate regarding their technological paradigms. To explain it more precisely, radically one or more new technologies breaks into an industry which results in a ferment era. In this stage, there can be seen some leapfrog changes of functions and performance. However, during this stage, competitors may have some struggles to find the most effective product architecture and solving technological problems. When technology has come to the end of its course, innovation becomes incremental which results in a decrease in product innovation speed. Therefore, another technological discontinuity is waited. At this very point, design comes to the forefront and starts to play as a differentiator. Design has a significant role on incremental innovations by making products different from those of competitors. Creativity, user interface and style can be leverages that design can use (Buganza et al., 2015).

Verganti states that the concept behind the technology epiphany is that every technology can be considered to embed a set of disruptive new meanings that are expecting to be uncovered. When a company finds out these quiescent meanings, they will have the chance to seize the technology's full value, celebrating a technology epiphany (Dell'Era et al., 2017).

However, companies that follow a short-sighted path focus on searching new markets for a technology without considering the potential new meanings of the technology itself. By following this path, their primary focus will be on technological substitutions when they were looking for potential technological applications. Therefore, these companies include more effective and powerful functionalities or enhance performances without touching existing meaning at all (Buganza et al., 2015). These short-sighted behaviours of the industry cause firms to embrace the new technology for their utilitarian reasons. The missing part of this behaviour is they can't benefit from their new technology's full potential. Instead, only companies which invest in design driven innovation can benefit its full potential. (Dell'Era et al., 2017). The companies which invest in DDI will have eventually a technology epiphany. It will occur if a company understands that a new radical meaning can surface in the market and thus is open to new technologies. In the Figure 2.4.1, it can be seen that a technology epiphany may occur when a company searches for more powerful meanings that a new technology

embeds (Buganza et al., 2015).

2.4.3 Real-Life Examples of Technology Epiphany (Nintendo Wii & Kinesis)

There are a few examples that can explain the process of technology epiphany and the effect of this concept on the market competition. Nintendo and Technogym are the examples that will be discussed in the following. As previously mentioned in the chapters above, Nintendo Wii had benefited from the concept of technology epiphany a lot. Thanks to technology epiphany, they have managed to surpass their competitors Sony and Microsoft according to the sales number (Dell'Era et al., 2017).
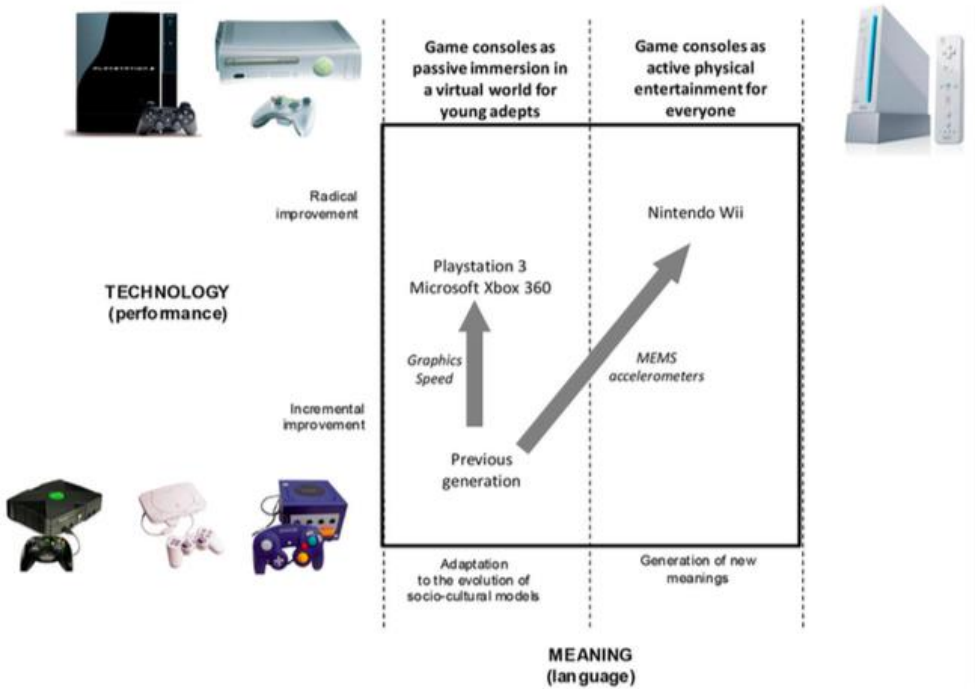
Figure 2.4.3.1: Nintendo Wii's Technology Epiphany (Adapted from Dell'Era et al. 2017)

In the beginning of the millennium, Sony has won the competition by releasing their latest product PlayStation 2. They outsold Xbox of Microsoft and GameCube of Nintendo. The focus of the industry was developing their technological development of the console hardware in terms of faster processing speed, higher definition video quality and increased game complexity. Nintendo couldn't adapt to the market conditions and they suffered their sales compared to PlayStation 2 and Xboxes. In 2006, Sony and Microsoft continued their strategy by increasing the computing power and graphical interfaces in their products and released a new generation of video games consoles which were PlayStation 3 and Xbox 360. On the other hand, Nintendo released Nintendo Wii with a new perspective (Dell'Era et al., 2017). Nintendo used MEMS accelerometers which are the components that make a Wii console sensitive to

movements while Microsoft and Sony were busy for replacing their old CPUs with the new ones. (Verganti, 2011). Therefore, Nintendo Wii became an elegant machine that detect hand movements of their players by using wand-like remote controller. Games like tennis, bowling and boxing were offering players to emulate real life game play experience. Therefore, Nintendo Wii transformed what a console meant for the players: not passive immersion in a virtual world but an active entertainment in the real world. This innovation suddenly combined a radical innovation of meaning with a radical innovation of technology and redefined what a game console playing means for the players (Dell'Era et al., 2017). MEMS accelerometers were the reason for this technology epiphany. By using its potential, they transformed the meaning of a game console.

The number of sales for Nintendo was outstanding. Wii sold 1 million units in the first two months after its release which were twice those of the Xbox 360 and four times those of the PlayStation 3 in the US market. In summer 2007, sales of the Wii outsold both Xbox and with the PlayStation 3 lagging behind by 4.3 million units (Dell'Era et al., 2017). As it can be seen from here, technology epiphany did not just change the meaning of the product but also helped Nintendo to compete with their rivals. In Figure 2.4.3.2, the framework of technology epiphany for Nintendo can be seen.

Another example for technology epiphany is Kinesis of Technogym. Technogym is a company which focuses on home training business. They released a completely new training method called Kinesis in 2005. It was a multipurpose machine that based on cables and spring resistance that allowed the user to perform more than 200 different exercises. Kinesis were able to liberate
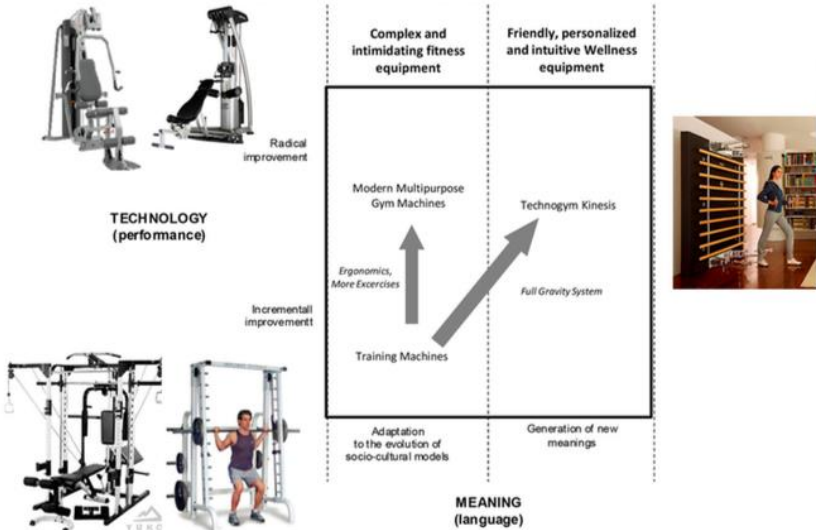
Figure 2.4.3.2: TE-Kinesis (adapted from Dell'Era et al. 2017)

their user from complicated setups and machinery by hiding the main mechanisms.

Kinesis also has a feature that becomes disappeared when it is not in use. By releasing Kinesis into the market, Technogym provided its clients with access to Wellness in addition to selling their machines. Technogym caused a combination between radical innovation of technology and meaning. As a radical meaning, they redefined what a training is about: from Fitness to Wellness, and as a radical technology, they introduced the innovative new system to fulfil the Wellness vision by allowing freedom of movement and mind, with synergic exercises and no setup. Kinesis helped Technogym to demonstrate a significant growth in their competitive performance. Their revenue increased by 19%. (Dell'Era et al., 2017).

In summary, technology epiphany gives companies to gain competitive advantage and it does not require a detailed user analysis. Instead, it requires to understand the full potential of new technologies by utilizing for hidden meanings of products.

Chapter 3 Research Process

In this chapter, the research process that has been followed for this study will be explained in detail. This research process provides a basis for gathering empirical results related with the subject. To explain the research process step clear, research objectives, steps of research process, data collection, data sampling and data organization will be presented in this chapter.

3.1 Research Objectives

In this section, research objectives of this study will be presented. These objectives will be very beneficial while conducting this study and became a reference point for the study. To state these objectives, 3 objectives have been decided for this study:

- Explaining related concepts with Technology Epiphany to understand the concept fully
- Presenting insights into academic research on Technology Epiphany in the journals that are related
- Applying a literature review analysis about Technology Epiphany concept to understand how it is studied in the literature in the selected journals by specifically asking following questions:

    o What is the trend of publication frequency? Which journals are publishing research articles on Technology Epiphany? What keywords is used most in research articles? What methodology is used in research articles? Which innovation strategies are being addressed? Which industries are affected by relevant research articles?

To achieve these three objectives, a systematic literature review about Technology Epiphany has been performed covering articles from 1997 to 2017. The main aim of this the study is to understand how technology epiphany are studied in the literature. By answering these questions above, relevant data will be obtained to conduct a study about this concept. Therefore, the main aim of this study will be achieved.

3.2 Defining Steps of Research Process

In this section, the steps of research process will be explained to conduct a literature review about technology epiphany. First of all, the author made an initial inquiry about technology epiphany to define possible keywords. In the selection of keywords process, the main keywords have been decided. This process called *Data Collection*. In the following, the author selected the relevant journals by using ABS 2015 list. Then, the total number of articles have been found by using selected keywords in selected journals in *Data Sampling* step. In the next step, If the articles are relevant, they have been chosen but if not they have been eliminated. In *Data Organization* step, these relevant data added in an Excel file to map the research. At the sixth step, empirical results have been gathered from the research process. In Table 3.2, the steps of research process can be seen. In the following sections, these steps will be explained in detail.

```
Initial inquiry → Data Collection → Data Sampling → Related with TE? → Data Organization → Empirical Analysis
                                                          ↓
                                                    Elimination
```
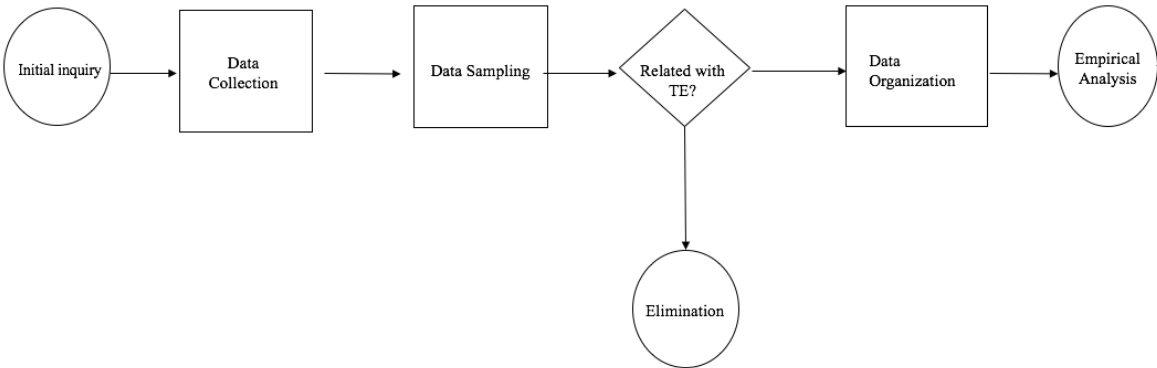
Table 3.2: Steps of Research Process

3.3 Data Collection

In order to make a study about literature review, appropriate databases should be used in order to find and analyse the relevant knowledge. Appropriate keywords selection and the searching these keywords in a database were the first steps in order to apply the research process. Scopus has been selected as the main database to conduct this search and it is the only database that is used to find relevant articles. Scopus is an online library and has one of the largest database of peer-reviewed literature in online and is a reliable source. Scopus is a very useful database which enables users to filter the articles according to the need of users. Therefore, the necessary filters which will be explained in the following were very helpful to access relevant articles.

At a starting point, a set of keywords were defined in order to find most relevant articles about Technology Epiphany for a literature review. These keywords were selected according to their relevance with the concept. In this process, the author reviewed the concept and decided which keywords can be useful to find relevant articles in Scopus. According to this preliminary investigation, the author constructed a table in order to define which keywords will be used to create the most relevant database. 21 different keywords have been found as appropriate to conduct the research. These keywords were searched in Scopus in two keyword forms. First keyword form is using integrated keywords. For example, first of all, *technology epiphany* has been searched. After finding articles about this keyword, the author used second keyword form which are separate words. As an example, *epiphany* and *technology* keywords have been searched separately. This is the second keyword form of the research. Also, the plural version of every keyword has been used to expand the research area. In this case, *technology epiphanies* will be the plural version of the search for constructing the relevant database for the research. Below, there is a table that indicates all of the main keywords that has been used throughout this process.

Keywords in all the configuration possible	
technology epiphany	epiphany
unlock	technology opportunity
unlock technology	hidden
hidden technology	hidden meaning
unveil	technology push
unveil technology	unveil opportunity
latent	latent technology
tacit technology	tacit
tacit opportunity	disclosed technology
disclosed	generic opportunity
generic technology	

Table 3.3: Keywords in all configuration possible to find relevant articles in Scopus

Table 1 indicates all the main keywords of the research process. In research process, all of these keywords were searched only as *Abstract title and Keyword* in the filter of Scopus. Another filter was the time interval of publications which were between 1997 and 2017. The number of articles found by keywords were divided into two different time periods such as the period between 1997-2007 and 2007-2017. The total time period is the publication of last 20 years.

(1997-2017)

3.4 Data Sampling

In the phase of sampling, the research journals have been chosen other than finding appropriate keywords to find the most relevant articles. After finding the relevant research journals, the keywords that are defined above were searched in each journal by using online library of Scopus. The author categorized the total number of articles for each keyword by using these research journals. According to results that are collected from the keyword search, *technology* keyword had to be excluded due to the fact that result of *technology* was too broad and it has a lot of topics other than technology epiphany which can result in irrelevance. Other than *technology* keyword, rest of them were used as defined keywords to search the research journals in order to construct an initial database for the literature review.

The source of the research journal was the Academic Journal Guide which is published by the Association of Business Schools (ABS) in 2015. It is based upon peer review, editorial and expert judgements in consecutive to the interpretation of many publications which are in hundreds. Additionally, it is informed by statistical information relating to citation. It is a guide to the range, subject matter and relative quality of journals in which business and management academics publish their research ("ABS 2015",2015).

The next step was the selection of journals which are relevant in order to implement a literature review about technology epiphany. The search has been divided into two categories. First of all, all of the research journals in the category of *innovation* has been selected which was in page 33 in the ABS 2015 list. Second, the journals apart from page 33 and the words includes *technology* and *innovation* has been searched throughout the ABS 2015 list. After finding all the journals according to the desired conditions, the elimination process has started. Irrelevant journals have been eliminated because these journals cannot meet the requirements that are necessary to conduct a research about technology epiphany. As a result, the author had 10 journals that have the words *technology* and *innovation* and 29 journals from the page 33 which was *Innovation* category. In total, there has been found 39 journals as a database.

In the tables below, there are the list of journals according to their category. Table 3.4.1 has the journals that is *Innovation* category. Table 3.4.2 has the journals which have the words *technology* and *innovation*. In both table, there are ISSN and Journal title sections. Shortly, each journal has a ISSN number which is used as one of the tools in order to find the journals in the

online library of Scopus during the research and each ISSN corresponds to one journal title.

ISSN	Journal Title
0737-6782	Journal of Product Innovation Management
0048-7333	Research Policy
0892-9912	Journal of Technology Transfer
0810-9028	Prometheus
0033-6807	R and D Management
0166-4972	Technovation
0963-1690	Creativity and Innovation Management
1366-2716	Industry and Innovation
1447-9338	Innovation: Management, Policy and Practice
1363-9196	International Journal of Innovation Management
0923-4748	Journal of Engineering and Technology Management
1047-8310	Journal of High Technology Management Research
0895-6308	Research Technology Management: international journal of research management
2243-4690	Science & Technology Studies
0162-2439	Science, Technology & Human Values
0138-9130	Scientometrics
0306-3127	Social Studies of Science
0954-349X	Structural Change and Economic Dynamics
1460-1060	European Journal of Innovation Management
1368-275X	International Journal of Entrepreneurship and Innovation Management (IJEIM)
1740-2824	International Journal of Foresight and Innovation Policy
0219-8770	International Journal of Innovation and Technology Management
1741-8194	International Journal of Technology and Globalization
1740-2840	International Journal of Technology Intelligence and Planning
1474-2748	International Journal of Technology Management and Sustainable Development
1741-5292	International Journal of Technology Policy and Management

ISSN	Journal Title
1741-5284	International Journal of Technology Transfer and Commercialisation
2213-7149	International Technology Management Review
1746-8779	Journal of Technology Management in China

Table 3.4.1: Journals added to the research due to their relevance for the topic studied ("ABS 2015", 2015)

ISSN	Journal Title
1465-7503	International Journal of Entrepreneurship and Innovation
1741-5179	International Journal of Information Technology and Management
1042-1319	Journal of Information Technology Management
1097-198X	Journal of Global Information Technology Management (JGITM)
1741-038X	Journal of Manufacturing Technology Management
0267-5730	International Journal of Technology Management
0953-7325	Technology Analysis and Strategic Management
0143-2095	Strategic Management Journal
0022-2380	Journal of Management Studies
0149-2063	Journal of Management

Table 3.4.2: Journals added to the research due to their relevance for the topic studied ("ABS 2015", 2015)

The keywords that are defined has been searched in the selected journals within online library of Scopus. Time period of this search was the publications of last 20 years (1997-2017). The aim is to create a big database about the keywords. In this process, every combination of defined keywords has been searched in the selected journals. In the following, a table for total number of articles in terms of keywords has been created. Table 3.4.3 represents the analysis of this process. Founded articles are belong to the big database; however, all of them are not relevant with technology epiphany. Therefore, the table below can be considered as a big data for the analysis. By creating this database, the author obtained an idea which keywords have the highest number of articles in selected journals. In addition to this, to make this analysis more extensive, the author divided articles in two different time frames as mentioned above before. The aim was to understand how articles diffused in two different time frames for the empirical analysis.

Single keywords have higher number of articles than integrated keywords due to the fact that a single keyword represent multiple topics other than the keywords integrated with technology, opportunity or meanings. Other realization of this analysis was about singular/plural form of keywords. It has been seen that the articles became same when the author searched the keyword with its plural form. Therefore, plural form of keywords has been eliminated from the table in the research process of finding relevant articles.

Keyword Name	1997-2007	2007-2017	Total Article
Technology Epiphany	0	3	3
Epiphany	0	3	3
Unlock technology	3	2	5
Unlock	5	5	10
Hidden technology	12	18	30
Hidden meaning	0	1	1
Hidden	15	63	78
Technology Push	13	26	39
Latent	13	76	89
Latent Technology	2	26	28
Tacit	84	116	200
Tacit Technology	37	43	80
Tacit Opportunity	6	6	12
Disclosed	3	11	14
Disclosed technology	2	5	7
Unveil	1	8	9
Unveil technology	0	3	3
Unveil opportunity	0	1	1
Technology opportunity	0	14	14
Generic technology	4	11	15
Generic opportunity	4	9	13

Table 3.4.3: Total number of articles in terms of keywords in selected journals

According to this process, a total of 654 articles have been found as a big database for the research. All relevant and irrelevant articles involve 654 articles. For the analysis, relevant articles should be find. Therefore, after creating the big database about the total number of articles in terms of keywords in selected journals, the elimination process of irrelevant articles has started. In order to decide which articles will be chosen or eliminated, the method was the preliminary reading of the titles, abstracts and keywords among the journals that are described above. After reviewing articles according to the parameters explained, the author eliminated irrelevant articles. The decision criteria were if the articles about technology epiphany, they are relevant so these ones have been chosen and the author eliminated the rest of them. In the end, 60 articles found relevant. The others were rejected due to the fact that the author reviewed all the articles by reading their abstract and if they are not relevant with technology epiphany, they are eliminated.

To clarify, *hidden, latent* and *tacit* keywords are the single ones that together combines 367 articles. It is almost the half of total articles. The author realized that, since they are single keywords, they have a broad topic scope in other words they have a lot of topics other than technology epiphany. Even though 60 articles out of 624 seem low, this fact should be considered.

3.5 Data Organization

In order to organize the data, an Excel list which has created after selection of 60 articles. Those selected journals have been added to an Excel document by the author in order to map the research. This excel document has parameters such as Year, Title, Author, ISSN, Journal name, Source, Abstract, Keyword used, Methodology adopted, Implied Industry and Empirical Setting. This categorization helped the author to classify each article and eased reviewing those articles. The most important parameters are methodology, implied industry, and which keyword used to find each article. These three parameters are the distinctive ones to analyse the results of literature review of Technology Epiphany. Just to clarify these parameters, methodology is the first. In methodology section, the author divided the articles into two: qualitative and quantitative. Qualitative ones include case studies conducted in the articles and quantitative ones include surveys, literature review etc. In implied industry section, the author categorized the industries implied in each article. Most explicit industries took place due to the fact that remaining articles focused on country based companies rather than focusing on industries so they didn't involve in the implied industry analysis.

Chapter 4 Empirical Results

In this chapter, the results regarding the literature review about Technology Epiphany will be represented in all relevant articles. The aim is to understand how technology epiphany are studied in the literature. As it mentioned above, there are 60 relevant articles and the empirical results regarding technology epiphany has been done considering these 60 articles. First of all, the paper publication trends between 1997 and 2017 will be indicated. In the following, the number of publications from each journal will be demonstrated. Therefore, it will be a chance to understand which journals are showing better participation on publishing literature about the subject. The next step of the analysis is going to continue with the trends in research methodologies adopted of the articles in terms of percentage. Fourth analysis is going to be about how many articles found relevant with technology epiphany and the number of articles found by searching each keyword. The analysis is going to finish with different unit of analysis as a company level or market level and the distribution of innovation strategies adopted and finally implied industries of the relevant articles will be analysed in detail. All the variables of analysis will be supported with the graphical and analytical data to provide a wide perspective for the analysis.

4.1 Trends in Publication

In empirical results, the first pointer of the analysis is presenting the paper publication trends in the period of last 20 years. Compared to the period 1997-2007, there is an explicit increase of the number of studies about concepts that matters technology epiphany in the period of 2007-2017. Specially the number of publications reached its peak at the year of 2014 with 10 articles. Second highest number of publications is at the year of 2017 with 9 articles. Also, there are 8 articles at the year of 2011. Therefore, it can be said that there is an increasing trend in the number of published articles after 2011 even though there are some low numbers in terms of publications.
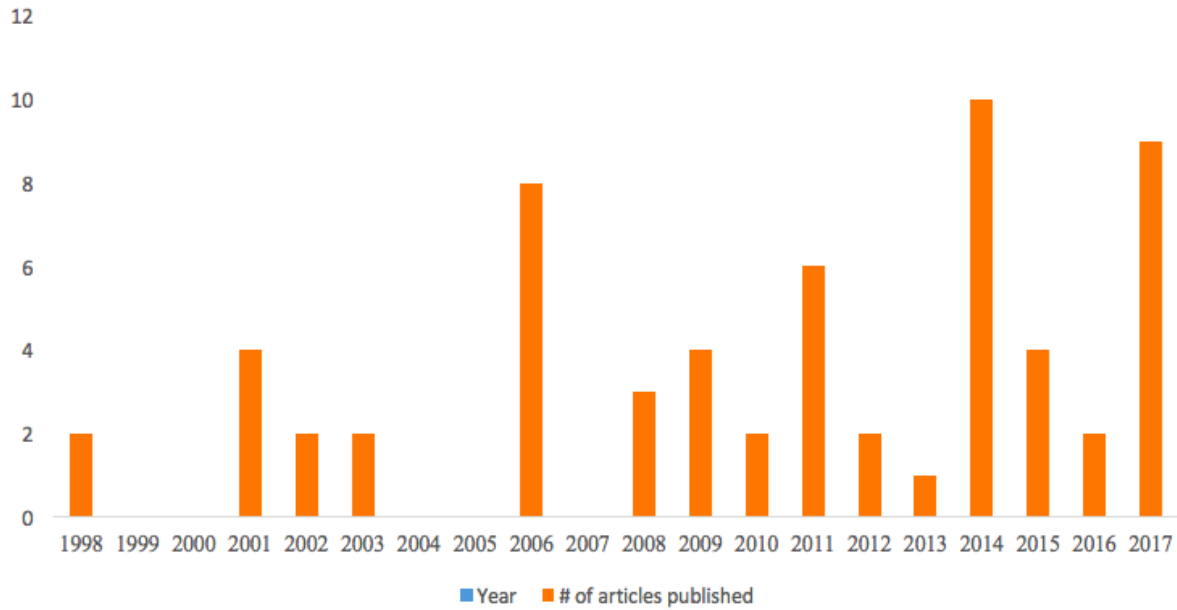
Figure 4.1: Trends in Publication in the period between 1997 and 2017

As a matter of fact, technology epiphany may be seen as a new concept in the literature and the articles directly related with technology epiphany originally appeared after 2011. While the author was researching about technology epiphany, other concepts that are highly related with technology epiphany has been also considered as relevant articles such as the innovation of technology and meaning, technology push, the role of design in innovation. The aim of this is to understand the process of formation of technology epiphany. Due to the fact that these concepts were in the literature before technology epiphany, it can be seen many articles before 2011. Additionally, without these concepts, technology epiphany concept cannot be understood well so that is the reason these articles related with other concepts has also been counted as relevant articles. Therefore, the articles before 2011 are mostly related with concepts that are mentioned other than technology epiphany.

Technology epiphany concept has been defined in 2008 and in the selected journals, first article that is directly about technology epiphany appeared in 2011. Radical design and technology epiphanies: A new focus for research on design management (Verganti, 2011) is the first article that revealed the concept of technology epiphany. After 2011, there seems to be a stagnation period in the years of 2012 and 2013. However, as it mentioned, there is an explicit increase in the number of articles and introduction of this article can be one of the reasons of this increment. Technology epiphany is a growing and promising concept and as it becomes more familiar in

the literature and in the business, there is a high possibility that the number of articles will increase in the future.

4.2 Trends in Journal

Second pointer of the analysis after the publication trends is presenting the trends in selected journals between the period 1997 and 2017. This analysis was implemented within the selected journals of ABS 2015 list. In Figure 4.2, trends in selected journals in the period between 1997-2017 can be seen.

According to the results gathered from the figure, *Journal of Product Innovation Management* has the highest number of relevant articles with the number of 13. It was followed by *Technovation* with 7 articles. *R and D Management* and *Technology Analysis and Strategic Management* journals have the rankings consecutively 3 and 4. *R and D Management* journal has 6 articles and the latter has 5 articles. Additionally, *Innovation* section is the common point of the first 3 journals in the analysis. As a result, *Innovation* section has the most contributed section in the analysis and these three journals constituted almost 40% of the
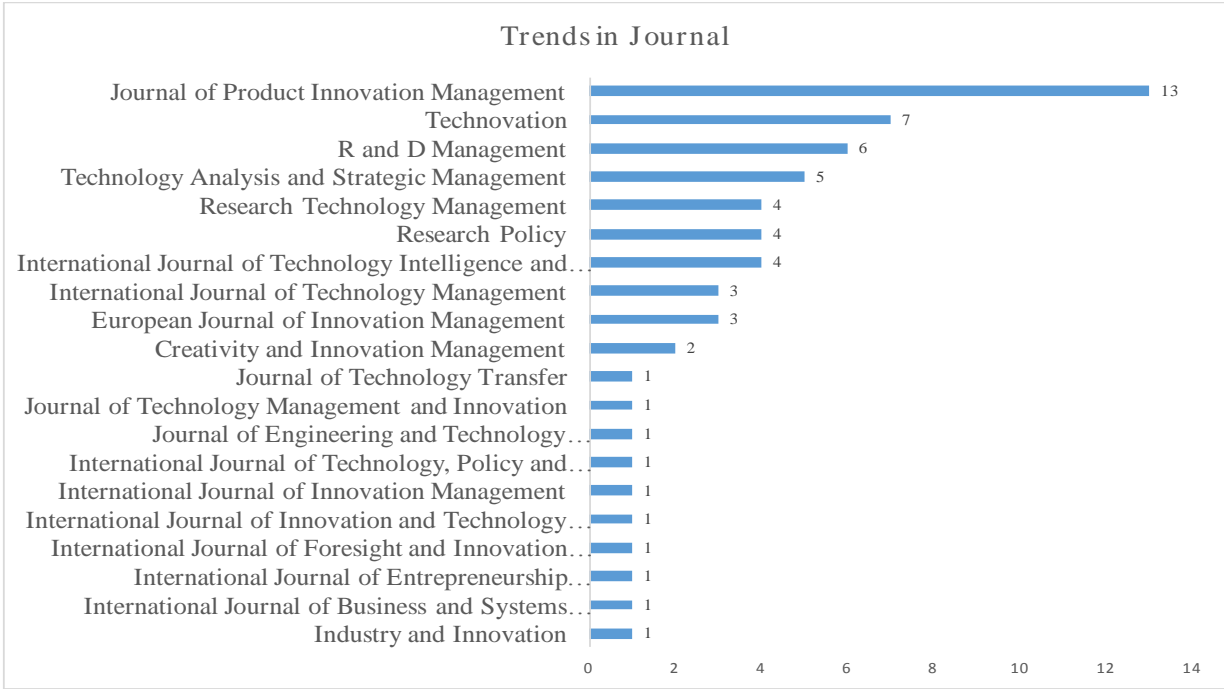

Figure 4.2: Trends in journal in the period between 1997-2017

selected articles. Other than *Innovation* section of ABS list, *Technology Analysis and Strategic Management* has the highest number of article which is 5 articles in terms of journals which includes the keywords *technology, innovation* or both. Therefore, even their contribution to selected articles seem less than the articles from *Innovation* section of ABS 2015 list, it provided a huge contribution for the analysis.

In short, %86.6 of articles are coming from *Innovation* section of journals from ABS 2015 list and %13.3 of articles are coming from journals which include *technology* or *innovation* keyword or both.

4.3 Trends of Keywords

In this phase of the analysis, trends of keywords will be presented. These keywords were searched in Scopus in the research process by using the selected journals. As it mentioned in the *Research Process* part, 21 main keywords were used with the all combination possible. These keywords were searched in single and integrated versions to find relevant articles. Plus, singular and plural versions of the keywords also were used to find relevant articles but it has been concluded that the number of articles with plural versions have the same articles with the singular ones so plural versions of the selected keywords has been excluded from the research.

As a result, out of 654 articles, 60 of them were found relevant about technology epiphany concept. This result may seem low but as it mentioned in Research Process chapter, the number of articles of single keywords such as latent, hidden and tacit combined almost half of the articles and they have a broad topic scope in the literature. Low number of articles have been found relevant with technology epiphany concept so this is why the rate of relevant articles became relatively less than expected.

In Figure 4.3 below, there can be seen the trends of keywords. It indicates the usage frequency of keywords while searching relevant articles. In other words, some keywords have been useful to find relevant articles and when the author searched these keywords, they have been found in more articles compared to others. In Figure 4.3, the author ranked the keywords according to their usage frequency. According to the results, not all the keywords gave the results related to
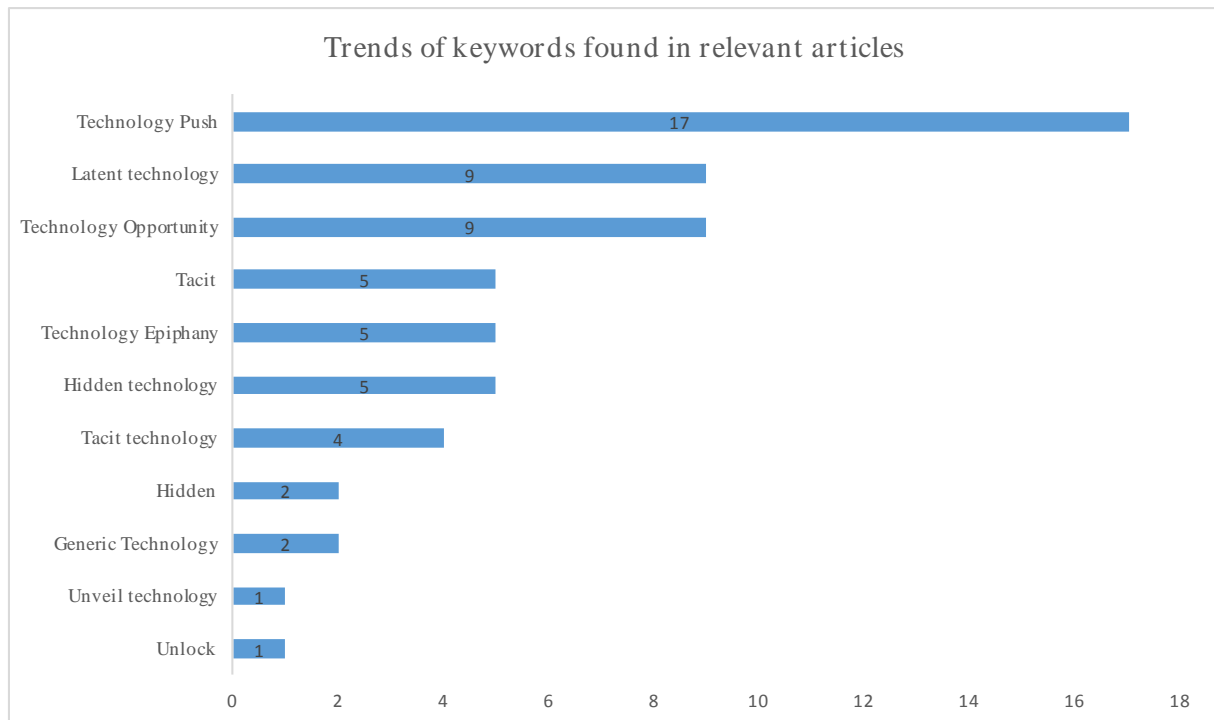
Figure 4.3: Trends of keywords found in relevant articles in the period between 1997-2017

technology epiphany concept but the keywords in below has given the relevant articles for the analysis. Integrated keywords constitute most of the keywords that were useful and there 8 different keywords in this form. On the other hand, 3 single keywords such as *tacit, hidden* and *unlock* has given relevant articles.

According to this analysis, when the author searched *technology push* keyword, 17 articles have been found which is the highest number of articles among other keywords. Technology push can be considered as an innovation strategy that is highly connected with technology epiphany concept so it seems very natural for this keyword to have the highest number of articles among the others.

Articles about technology push is too many in the literature since it is a concept known for years. Due to this reason, these articles are not only related with technology push but other concepts. Specially, technology push has a connection with design driven innovation and market pull strategies so there are lots of articles that compare technology push with these concepts. Since technology epiphany is also connected with technology push, it provided an opportunity for author to find the highest number of relevant articles compared to other keywords. That is the reason why *technology push* keyword has the highest number of articles in the analysis.

Latent technology and *technology opportunity* keywords are following *technology push* keyword. When they have been searched, both have given 9 articles separately. Finding the latent needs of the customers and satisfying them is one of the main goals of the companies for their survival. When companies realize the latent needs of customers, they have the opportunity to gain a competitive advantage over their rivals. Therefore, companies conduct many researches to find it. Since technology epiphany concept is related with the latent needs of the customer, this makes *latent technology* keyword an important one in the analysis and the results gathered from the analysis confirms it by becoming the second highest number of articles in the research.

On the other hand, technological opportunities are also important for gaining competitive advantage for companies over their rivals. When a company finds an opportunity in technology, they should take its advantage in their market. Plus, technology epiphany and technology opportunity has some common points. As it mentioned in the literature review section, Nintendo took the advantage of MEMS accelerometers to adapt their game console sensitive to real life movements Nintendo saw this opportunity and took advantage of it. In return, customers liked this new feature and Nintendo gained the top position of the game console sales (Dell'Era et al., 2017). There can be given so many examples about taking advantage of technology opportunity. In this context, *technology opportunity* keyword's connection with technology epiphany concept contributed to the research with 9 articles.

By searching *technology epiphany* keyword, the author obtained 5 articles that are entirely explaining the concept of technology epiphany. As it mentioned before, this concept is a new concept in the literature and it is growing in every year. That's the reason, low number of articles revealed when the author searched *technology epiphany* keyword. As technology epiphany concept becomes more familiar, the articles related will increase in the literature.

Tacit and *hidden technology keywords* have also same number of articles with *technology epiphany* keyword and they both have 5 articles. Both keywords have connection with technology epiphany. Especially latent and tacit words are similar in terms of meaning so contribution of *tacit* is remarkable to the literature. In addition, it is interesting that single *tacit* keyword has contributed to analysis more than *tacit technology* keyword which is 4.

Other than these keywords, *unlock, unveil technology have given results as* 1 article each and *hidden, generic technology have given results in* 2 articles. Other possible keywords have contributed none.

4.4 Trends in Research Methodologies Adopted

In this part of the analysis, research methodologies adopted by the articles will be evaluated and explained through graphical illustration. In research process, the author added adopted methodology of 60 articles into the Excel document. The aim is to understand which methodology adopted by each article. The author categorized the methodologies in two that are quantitative and qualitative methods.

The analysis of research methodologies has been applied in one illustration which is the trends in research methodologies adopted by percentage to understand which methodology has been used mostly by the relevant articles.

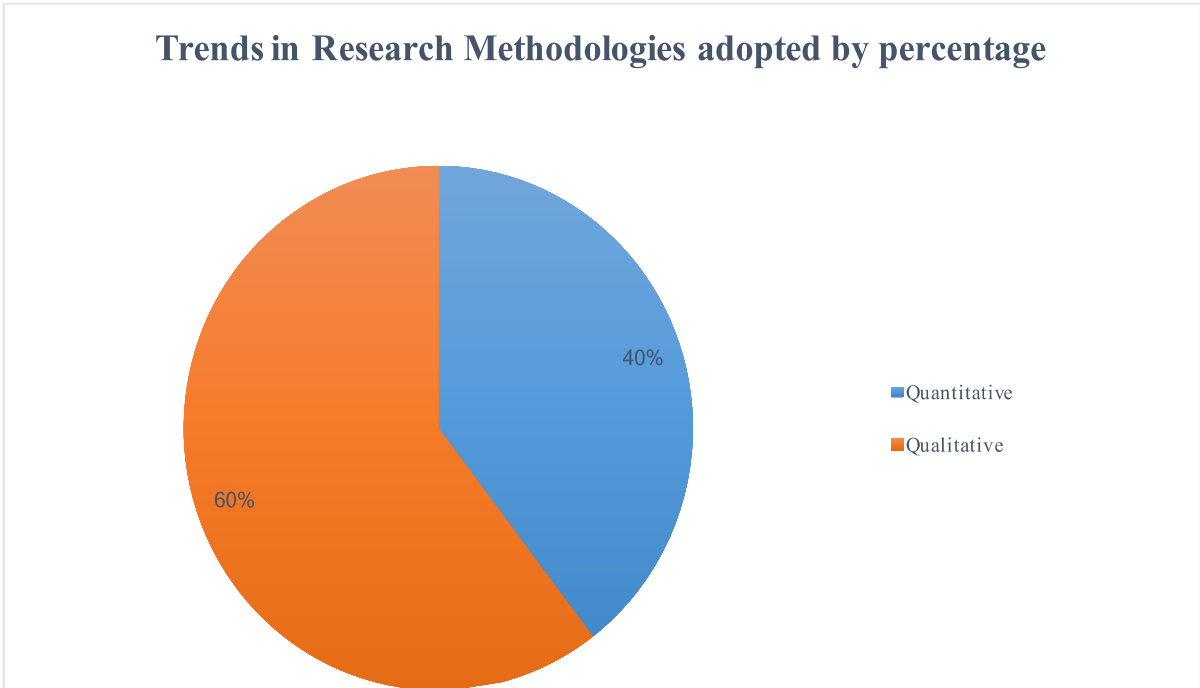*Figure 4.4: Trends in Research Methodologies Adopted in percentage in the period between 1997 and 2017*

Qualitative analysis is an approach that the researcher uses qualitative variables and data for their research. Case studies can be an example of it. On the other hand, quantitative analysis is an approach that the researcher uses quantitative variables and data in the research. Surveys and

literature reviews are the example of quantitative methods. In the analysis, mostly case studies are used for the qualitative analysis; on the other hand, surveys and literature reviews are used for the quantitative analysis.

In Figure 4.4.2, the percentage distribution of both methodologies is depicted to emphasize the total usage of both methodologies. In Figure 4.4.2, qualitative approach was adopted by 60% of the articles and quantitative approach was adopted by 40% of the articles.

In numbers, 35 articles adopted the methodology qualitative approach and 25 articles adopted the methodology quantitative approach. In the previous figure, even though there seems a dominance of qualitative approach in the numbers of articles, in fact there is only difference of ten articles between qualitative and quantitative approaches. This stems from the increasing trend in quantitative analysis after 2006.

It is understood that the researchers were using qualitative methods more than quantitative methods to conduct an analysis about technology epiphany and other concepts that are connected to this concept.

4.5 Different Unit of Analysis

Different unit of analysis section represents two aspects: Company level or market level. There are many articles that investigating some effects on innovation and the level of innovations are one of them. Some articles research innovation in market level and see how innovation affected the market or how it affected the company. That's one of the part of the analysis.

In the Figure 4.5 below, the percentage of different units has been illustrated. 66% of the articles researched the effect of innovation in the market level. On the other hand, only 34% percent of articles researched about the effect of innovation in company level.
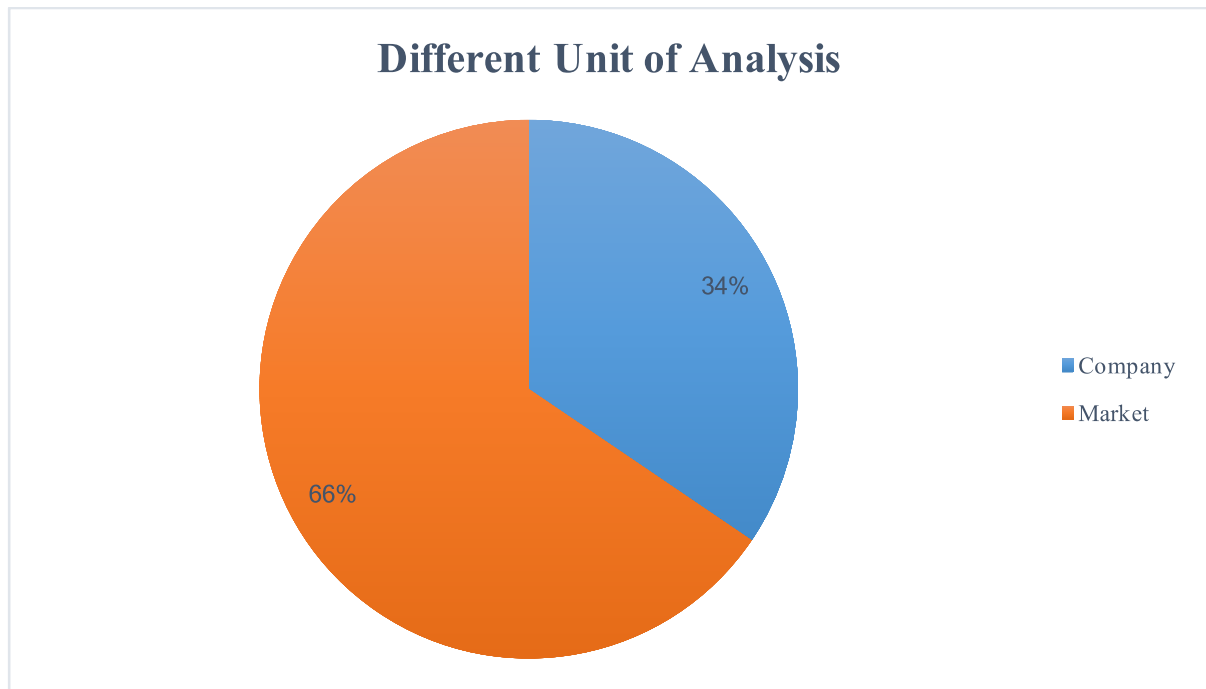
Figure 4.5: Different Unit of Analysis in the period between 1997 and 2017

In terms of market level, when an innovation came into our lives, it can affect the market directly. It can change the dynamics of the market and different requirements may be required by the market. In this sense, researching innovation in market level can be intriguing. As an example, *Unveiling the Potentialities Provided by New Technologies: A Process to Pursue Technology Epiphanies in the Smartphone App Industry* (Buganza et al., 2015) can be given. In this article, the effect of technology epiphanies in the navigation app market has been researched. Even though one company, in this example Waze, becomes a main actor of this effect, their effects on the market should be analysed to understand better Waze's effect.

On the other hand, in terms of company level, an innovation can change the fortune of a company. An example can be given from *Discovering quiescent meanings in technologies: exploring the design management practices that support the development of Technology Epiphanies* (Dell'Era et al., 2017). In this article, there are examples of technology epiphany such as Nintendo and Technogym in terms of company level.

4.6 Findings about Innovation strategies

Technology epiphany is a concept that has highly connected with innovation strategies such as technology push and design driven innovation. All the related information has been given in the literature review section of this report. Due to this fact, these innovation strategies other than technology epiphany has been also added to the analysis. In this part, there is going to be an analysis that how many articles were belong to technology push, design driven innovation or technology epiphany in terms of innovation strategies.
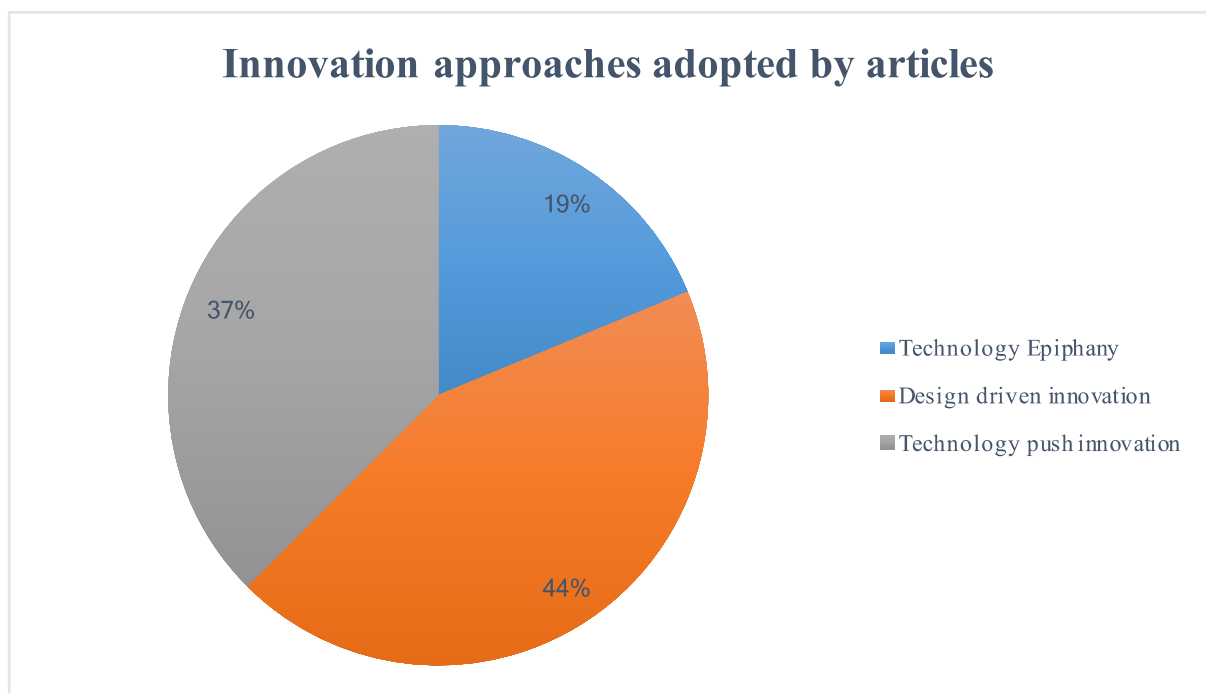
Figure 4.6: Innovation strategies adopted by the relevant articles in the period between 1997 and 2017

In Figure 4.6, there is a percentage distribution of three innovation strategies in the literature. Design driven innovation has 44% and the most mentioned innovation strategy in those articles. Design driven innovation has an enormous contribution on technology epiphany. Plus, selected keywords to find out technology epiphany shares similarity with design driven innovation since they are highly related concepts. Therefore, it is a very natural result that the articles about design driven innovation has the most out of three.

The second innovation strategy that is mentioned most in the literature is technology push. 37% of the articles was about technology push. Radical innovation in technology is another part of technology epiphany so that is the reason why the articles about technology push has been considered important by the author.

Technology epiphany is the last strategy that is adopted by the articles in the literature. Since it is a new and growing concept in the literature, it is very natural that technology epiphany has a limited place in the literature. 19% of total articles are about technology epiphany.

4.7 Industry Identification

The last analysis of this chapter is the industries that are involved in each article are considered. Figure 4.7 indicates the number of articles that implied industries in the period between 1997 and 2017. Implied industries are Information Technology, furniture, medical/pharma, entertainment, automotive, biotechnology, food industry, energy & environment, insurance, real estate and fashion industry.

The most mentioned industry in the articles is Information Technology industry. Since technology is an important asset of innovation, lots of studies made accordingly. 21 articles studied high technology as implied industry. Since technology push is a strategy that is used mostly by the companies for their innovation activities, many studies have been conducted about it.

Second most implied industry is furniture. There are 7 articles about furniture industry. Since design driven innovation became a growing concept in the literature, the number of studies about this concept has increased. In the future, it is very likely that furniture industry will take more place in the literature due to the fact that the importance of innovation of meaning has been understood by many firms.

Both of these industries combine 63.6% of total articles in terms of implied industries. Other industries contributed less compared to first two industries and further research about remaining industries may be conducted to understand how these industries affected by technology epiphany concept.
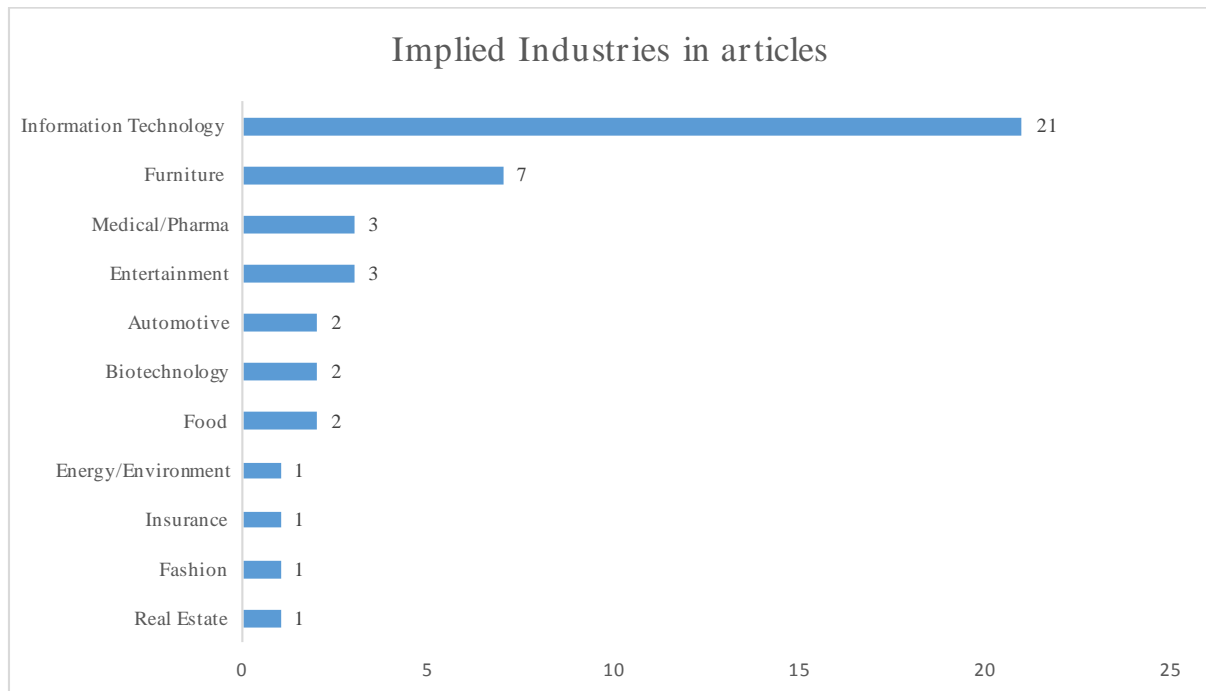
Figure 4.7: Implied Industries in relevant articles in the period between 1997-2017

Especially, entertainment industry may be useful to conduct a research about it since customers give importance to products or services which make them entertained. In these days, companies may rely functionality in this industry but with the emergence of meaning concept, they can combine these two to create a technology epiphany. In this sense, it can be a valuable topic to conduct a study for researchers.

Chapter 5 Conclusion

After expressing the main findings of the report, the overall process of research by emphasizing both the main findings and the objectives will be reminded in the conclusion chapter. In the following, managerial applications and limits and follow-ups will be mentioned to complete the research and in the end further research questions will be presented for the future development of the concept.

5.1 Research Objectives

Before recalling the main findings of this study, research objectives that are mentioned in the Research Process chapter will be summarized. These objectives were very beneficial while conducting this study and became a reference point for the study. To recall these objectives, 3 objectives have been decided for this study:

- Explaining related concepts with Technology Epiphany to understand the concept fully
- Presenting insights into academic research on Technology Epiphany in the journals that are related
- Applying a literature review analysis about Technology Epiphany concept to understand how much it is mentioned in the literature in the selected journals by specifically asking following questions:

  - What is the trend of publication frequency? Which journals are publishing research articles on Technology Epiphany? What keywords is used most in research articles? What methodology is used in research articles? Which innovation strategies are being addressed? Which industries are affected by relevant research articles?

To achieve these three objectives, the state of art science of literature review about Technology Epiphany of relevant articles has been implemented. The main aim of this the study is to understand how technology epiphany are studied in the literature. By answering these questions

above, relevant data has been obtained as it mentioned in the previous chapters. Therefore, the main aim of this study has been achieved.

5.2 Main findings

After recalling the research objectives, main findings of the analysis will be mentioned. First of all, all the process that led to these findings will be summarized by using previous chapters.

As it mentioned in Research Process chapter, this literature review has been conducted by using the database of Scopus. Selected keywords have been used in Scopus to find relevant articles in selected journals listed from ABS 2015 list as it mentioned. A total of 60 articles have been found as relevant articles out of 654 articles in order to conduct a study about technology epiphany.

According these findings in Research Process chapter, empirical results about technology epiphany has been published in Chapter 4 by targeting questions in the Research Objective section. To clarify them in summary:

General trends of publication frequency: According to the result of this analysis, it seemed that the number of studies about concepts that matters technology epiphany has been favoured in the period of 2007-2017 more than to the period of 1997-2007. There is an increasing trend in the number of published articles after 2011. Technology epiphany can be counted as a new concept in the literature and the articles directly related with technology epiphany originally appeared after 2011. At the moment, there seems an increase in the number of articles about technology epiphany. Technology epiphany is a growing and promising concept and as it becomes more familiar in the literature and in the business, there is a high possibility that the number of articles will increase in the future apparently.

Trends of journals that published relevant papers: There were two selection ways of selecting the journals. Initially, all the journals in *Innovation* section in ABS 2015 list has been taken for the analysis. In the following, other than *Innovation* section of the ABS 2015 list, the journals which include *technology* and *innovation* keywords have been selected from the list. According to these results, *Innovation* section has 3 journals in the first 3 in the ranking with *Journal of Product Innovation Management, Technovation* and *R and D Management.* Other than

Innovation section of ABS list, *Technology Analysis and Strategic Management* has the highest number of articles in terms of journals which includes the keywords *technology, innovation* or both. In short, %86.6 of articles are coming from *Innovation* section of journals from ABS 2015 list and %13.3 of articles are coming from journals which include *technology* or *innovation* keyword or both.

Trends in Keywords: 21 main keywords were used with the all combination possible. The author searched *technology push* keyword and 17 articles have been found which is the highest number of articles among other keywords. *Latent technology* and *technology opportunity* keywords are following *technology push* keyword. By using *technology epiphany* keyword, the author obtained 5 articles that are entirely explaining the concept of technology epiphany. So far, *technology epiphany* keyword has not been used widely but it seems that it will be mentioned more and more in the future.

Trends in Research Methodologies adopted by relevant articles: Qualitative approach was adopted by 60% of the articles and quantitative approach was adopted by 40% of the articles. In other words, qualitative approach was used in 35 articles and quantitative approach was used in 25 articles. In summary, there is a domination of qualitative approach in the period between 1997 and 2017.

Different unit of analysis adopted by relevant articles: The percentage of different level of innovations has been illustrated. 66% of the articles researched the effect of innovation in the market level. On the other hand, only 34% percent of articles researched about the effect of innovation in company level.

Innovation strategies adopted by relevant articles: A percentage distribution of three innovation strategies in the literature. Design driven innovation has 44% and the most mentioned innovation strategy in those articles. Design driven innovation has an enormous contribution on technology epiphany. The second innovation strategy that is mentioned most in the literature is technology push. 37% of the articles was about technology push. Technology epiphany is the last strategy that is adopted by the articles in the literature. Since it is a new and growing concept in the literature. 19% of total articles are about technology epiphany.

Industry Identification: Implied industries are Information Technology, furniture, medical/pharma, entertainment, automotive, biotechnology, food industry, energy & environment, insurance, real estate and fashion industry. The most mentioned industry in the articles is information technology. Second most implied industry is furniture.

5.3 Managerial Implications

Managerial implication of the research will be presented in this section. This section can be divide into two groups. The insights that will be mentioned here can be beneficial for both groups. These groups are researchers and companies in the market, start-ups and entrepreneurs. This research may contribute for these groups to a better understanding of technology epiphany.

First group that will gain benefit from this study are researchers who are investigating about innovation strategies. In chapter 2, concept of technology epiphany has been presented by explaining the concepts of innovation, technology push strategy and role of design in innovation. These are explained to emphasize the connection with technology epiphany. Technology epiphany is a growing concept and can be intriguing for researchers. In Chapter 4, they can find the empirical analysis in detail, starting from the general trends in literature, to industries affected. With these results, they can realize that the existence of technology epiphany in the literature is limited so there are so much to find out about this concept.

Second group who will benefit from this study is companies in the market, start-ups and entrepreneurs who want to satisfy their customers with their products. With this research, they will have a different perspective in their innovation strategies to foster their innovation in their products. Some companies count on their new technologies and some of them count on their innovation in meaning and design. However, now there is a new strategy that can change the dynamics of the market which is technology epiphany. In this analysis, they can find out how companies who adopted this strategy became successful and understand this concept in detail. Therefore, they can expand their horizon and adopt a new innovation strategy to develop their new products and finally they can satisfy their customers.

In conclusion, managers should consider technology epiphany as a new perception in their innovation strategy and they can increase their level of innovation and quality of their product.

5.4 Limits and Follow-ups

In the final section of this chapter, limits and follow-ups will be discussed. Limits will be discussed at first. In the following, some suggestions and research questions for further research will be presented.

There are many advantages of developing a study about technology epiphany but at the same time there is one limitation. While doing a study about technology epiphany, lots of journals and lots of articles were researched in the literature. Only limitation of this research is there are limited number of articles about technology epiphany. Since it is a growing concept in literature, there are limited views about this concept and it prevents to have different perceptions about this concept. As the number of articles increases, different perceptions about this concept will reveal and it will cause to conduct further research about this concept.

About follow ups, for further research, the analysis can be conducted by answering some research questions. First question is about the game changer effect of technology epiphany. There are some cases that became successful in some industries but can technology epiphany really become a game changer in most industries?

Second question is about the attitude of the companies. Companies can look for some hidden technologic opportunities to innovate their product. What will be the role of technology epiphany for firms who are looking for hidden technologies in the future?

It is believed that researches about these may contribute to the concept of technology epiphany in the literature.

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