T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

THE IMPACT OF FIRMS STRATEGIC MANAGEMENT ON DEMAND SIZE OF LASER APPLICATIONS

MASTER'S THESIS

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Engineering Management Department

Engineering Management Master in English Program

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LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜ

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DEDICTION

I dedicate my dissertation work to the soul of my beloved father, who was my companion throughout my life and during my academic career. My father words of encouragement and push for tenacity will stay forever in my ears. He passed away from me in this year during this journey. My heart is broken for losing him but he taught me to be strong and continue with hope whatever happens.

I had a great father who did not obtain a higher degree despite his knowledge and perseverance. He was helping others to obtain academic degrees. He was helping others to get appropriate research resources including his 30 printed books. He was considered as one of the most important Iraqi writers and historians, that life forced him to be distracted from himself and obtain what he aspires. He deserves this master certificate.

I also dedicate it to my dear, compassionate mother, and I thank her for her continuous support and encouragement. I just could not imagine my life without her. Without my mother and father, I would be nothing

I dedicate my dissertation work also to my amazing brother. I feel so greatly privileged to have him to traverse the eras of life.

FOREWORD

This thesis is the end of my journey to obtain my M.Sc. It has been a challenging experience riddle of good and bad moments. However, I have felt supported during this time by several people. This thesis also belongs to them. I would like to express my gratitude to all of those people.

First, I am greatly indebted to my supervisor Prof. Dr. GOZDE ULUTAGAY for her support and guidance throughout my research work. It was all fruitful advice during my academic career. I would like to thank Dr. Riyadh Naeem who contributed valuable expertise and excellent advice and data obtaining during this thesis, as well as created a high supportive atmosphere to accomplish the work.

It is with immense pleasure to thank my father who sacrificed his life for me. It is my pleasure to thank my mom, and my brother who stood by me during my study and always offered their love, care and support.

Finally, I would like to thank all participants who took part in the study and enabled this research to be possible.

January 2020 Rabab Razzaq Ibrahim Al-RAMMAHI

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ABBREVIATIONS

SM : Strategic Managements
APP : Appendix
LRM : Linear Regression Model

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ABSTRACT

New innovations and technologies have been playing significant roles in the companies' development and success. Historically, there was strong relationship between technology and companies' development science the early 20th century. In other words, there was strong relationship between technology and companies' Strategic Management. It is well known that having advance technology is considered as one of the most important goals of companies Strategic Management. In addition, it is well known that the high competition between companies have led them to have new innovations and advance technology to keep sustain development and success in the market.

This study focus more on Laser Technology. That is because laser technology applications have used in different industrials. That's is, there is growing demand for laser technology applications around the world in manufacturing, health care, space, and other fields. This study examines the impact of companies' Strategic Management on the demand of laser technology applications. This study reviews first the Strategic Management theory, and reviews second many examples of laser applications that used in different fields.

The study finally empirically tests the impact of companies' Strategic Management on the demand of laser technology applications. This study uses liner regression model to estimate the demand function for laser applications. The estimation results do not show strong evidence that the companies' Strategic Management can positively and significantly impact the demand of laser technology applications. However, the results show that companies' Strategic Managements may positively and significantly impact the demand of laser technology applications.

Keywords: *Strategic Managements, Laser Applications, Demand.*

FİRMALARIN STRATEJİK YÖNETİMİNİN LAZER UYGULAMALARININ TALEP BOYUTUNA ETKİSİ

ÖZET

Yeni yenilikler ve teknolojiler, şirketlerin gelişiminde ve başarısında önemli roller oynamaktadır. Tarihsel olarak, 20. yüzyılın başlarında teknoloji ile şirketlerin kalkınma bilimi arasında güçlü bir ilişki vardı. Diğer bir deyişle, teknoloji ile şirketlerin Stratejik Yönetimi arasında güçlü bir ilişki vardı. İleri teknolojiye sahip olmanın şirketlerin Stratejik Yönetiminin en önemli hedeflerinden biri olduğu iyi bilinmektedir. Ayrıca, şirketler arasındaki yüksek rekabetin, pazardaki gelişmeyi ve başarıyı sürdürmek için onları yeni yeniliklere ve ileri teknolojiye götürdüğü iyi bilinmektedir.

Bu çalışma daha çok Lazer Teknolojisine odaklanmaktadır. Bunun nedeni, lazer teknolojisi uygulamalarının farklı endüstrilerde kullanılmasıdır. Yani, üretim, sağlık hizmetleri, uzay ve diğer alanlarda dünya çapında lazer teknolojisi uygulamalarına yönelik artan talep var. Bu çalışma, şirketlerin Stratejik Yönetiminin lazer teknolojisi uygulamaları talebi üzerindeki etkisini incelemektedir. Bu çalışma ilk olarak Stratejik Yönetim teorisini gözden geçirmekte ve ikinci olarak farklı alanlarda kullanılan lazer uygulamalarının birçok örneğini incelemektedir.

Çalışma nihayet deneysel olarak şirketlerin Stratejik Yönetiminin lazer teknolojisi uygulamaları talebi üzerindeki etkisini test ediyor. Bu çalışma, lazer uygulamaları için talep fonksiyonunu tahmin etmek için astar regresyon modelini kullanır. Tahmin sonuçları, şirketlerin Stratejik Yönetiminin lazer teknolojisi uygulamalarına olan talebi olumlu ve önemli ölçüde etkileyebileceğine dair güçlü kanıtlar göstermemektedir. Ancak sonuçlar, şirketlerin Stratejik Yönetimlerinin lazer teknolojisi uygulamalarının talebini olumlu ve önemli ölçüde etkileyebileceğini göstermektedir.

Anahtar Kelimeler: *Stratejik Yönetimler, Lazer Uygulamaları, Talep*

1. INTRODUCTION

It is well known that the high competition between companies have led them to have new innovations and advance technology Mia & Clarke (1999). Having advance technology is considered as one of the most important goals of companies Strategic Management. That is because new innovations and advance technology can help produce high quality of goods and services. In addition, it can help reduce time and costs of the products. That, by the end can make high customer satisfaction.

Nowadays, laser technology applications have become more attractive for producers in different industrials. More specifically, there is growing demand for laser technology applications around the world in manufacturing, health care, space, and other fields. Therefore, it is attractive to empirically test the impact of Strategic Management (SM) of these companies on the demand for laser technology applications.

Before explaining the impact of SM on the demand of laser technology applications, it is important to review the roles of technology, in general, in companies' development and success. That can provide a historical sight about the importance of laser technology as part of companies Strategic Management.

Historically, new innovations and technologies played significant roles in the companies' development. There was strong relationship between technology and companies' development science in the early 20^{th} century. The results of this relationship improved the experimental and recording devices that used by companies. That provided more wealth and development. The relationship between technology and science was the most productive one during this period. That led most of companies to adopt new technology to keep their ability to compete (Sheehan, 2005).

Magdoff (1975) describe technology as a magic, he said "It is true that there is a kind of magic". The paper discussed the relationship between the technology and the development of agriculture. It is a magic because of automatic machines and

advanced chemical production that farmers used. In addition, there were water conservancy projects, drainage, transportation equipment, and a variety simple machine. All these innovations made big contribution in levels of agriculture output. That motivate more and more companies to use these innovations and technologies to increase their agriculture output and get more profits.

Technology and new innovations can play significant roles in education system which can enhance the education outputs. Technology can improve the educational facilitates and increase the efficiency, effectiveness, and skills for both students and teachers. More specifically, technology can improve the educational achievement by removing the physical barriers to learning and by focusing on the utilities of knowledge (Courville, 2011).

For example, before discovering the internet, school was required that community members to be physically close to each other. And that has been changing after founding high internet and network technology. Another example is that in the graduate schools, teachers no longer have to be geographical close to a university (Courville, 2011).

Technology and new innovations can play significant roles in manufacturing. Technology can be used to maximize products quality and reduce production costs. Technology considered to be one of the most important factors of decision making in the manufacturing process. Technology can directly affect the company's competitive priority (Orr, 1999).

One example that shows the roles of technology in manufacturing is the role of IT (Information Technology) in manufacturing process. The information technology in manufacturing has been improving the whole manufacturing process and making it more beneficial. That is because IT includes "Computer Aided Design (CAD), Computer Aided Engineering (CAE), Process Planning (CAPP) and Manufacturing (CAM) Product Data. Lifecycle Management (PDM, PLM), Simulation, Automation, Process Control, Shop Floor Scheduling, Decision Support and Decision Making, Manufacturing Resource Planning (MRP II), Enterprise Resource Planning (ERP), Logistics, Supply Chain Management and e-Commerce systems." (Chryssolouris, et al ,2004).

Artificial Intelligence (AI) is another important example of technology that has changed the world of manufacturing. AI includes, networks, data-drivenness, shared services, cross-border integration, automatic intelligence, and mass innovation. AI has also the new- generation of information technologies, new energy technologies, and materials technology (Li, et al, 2017).

Chappell, et al (2003) indicate that Auto-ID technologies or Electronic Product Codes can provide good solutions to improve the production operations and get high customer satisfaction. That is because Auto-ID can increase the certainty about the information of the products while they move through the manufacturing process. It also helps improve the control the quality and the efficiency of the manufacturing process itself. The new Auto-ID (Barcode and automation technologies) provide new level of improvement of firms' Resource.

Technology and new innovations have been improving the energy sources. The big change in the energy industries was the transformation to the green energy. One example of this has been happening in China. The Chine's economic reform in 1970s led it to be the second largest economy in the world. There was an expansion of heavy industries which created a high demand for energy, especially for coal. China has increased the coal consumption significantly to 3.45 billion metric tons (Bhattacharya, et al, 2015).

However, the Chinese government has recently adopted new industrialization process using new innovations and technology. More specifically, it started using oil, gas, and nuclear energy. The Chinese government also put plans to achieve various targets in the energy sector that has low carbon. Reducing the carbon and getting clean energy needs the use of advanced technology and structural policy changes (Bhattacharya et al, 2015).

Popp (2001) indicated that technology and new innovations have been impacting the costs of the traditional energy sources. Many of modern environmental policies can enforce the producers to reduce the use of traditional energy sources. Environmental policy such as carbon taxes increases the cost of energy and will lead to the development of more energy-efficient technologies. As a result, new technology can provide more energy-savings and less energy consumption. The results of the paper showed that two-thirds of the change in energy consumption was because of price change, while the other third was because of new technology and innovations.

Technology and new innovations have great impact on health sector. It's obvious how new innovations and technology changed the health care system especially in developed countries. Many technological applications have used in tests and treatments.

One example of that is the use of simulation technology. Simulation technology made a great change in medical practice such as expanding the options for diagnosis and management. Simulation technology has also great contribution in medical education. For example, doctors currently are using laparoscopic techniques, which help surgeons with an opportunity to enhance their skills without risk to patients. The cardiovascular disease simulator is another example that can be used to simulate cardiac conditions. These systems can help develop the skills of trainers and may provide a method for doctors to treat patients efficiently (Issenberg, 1999).

Robotic surgical devices are other examples of technological innovation that used in health care. Robotic surgical devices have changed the entire ways of traditional medical treatment. The play significant role in reducing the risks on patients and reduce the costs of treatments. Robotic surgical devices allow a surgeon at a to operate remote-controlled robotic arms, which can improve the performance of laparoscopic procedures (Barbash & Glied, 2010).

Now, most of the procedures are performed by robot-assisted surgery. The introduction of robots affects both the cost and the volume of surgeries performed. The use of robotic surgical systems has high fixed costs and require costly maintenance. However, the use of robotic systems, some of the new costs will be offset by the reductions of hospital costs and by patients' fast recovery (Barbash & Glied, 2010).

All the above studies show that technology has significant impact on every part of our life. Technology has significant impact on our education, health, agriculture, energy, manufacturing, and more. Technology has made our life easier and more developed. That is why there is high competition between companies to have advance technology. In addition, having advance technology has become one of the important targets of companies' strategic management.

Since my topic is focusing on laser technology, someone can argue about why I focus on laser technology. The answer is that Laser technology has special

characteristics and can do more advanced works with high quality, accuracy, and productivity. It has many types of applications that can be used in different fields which makes it more attractive than other innovations and technologies.

Zlatanov (2016) defines laser as "A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation". The paper shows that Laser has many different applications such as optical disk drives, printers, DNA sequencing instruments, surgery, and skin treatments, cutting and welding materials. In addition, it can be used in military and law enforcement devices and more.

It is expected that there a growing demand for laser technology applications around the world. That motivates me to empirically test whether or not the SM of the companies can impact specifically the production size of laser technology applications.

The purpose of the research is to empirically test the impact of firms SM on the production size of laser applications. To do that, we should first explain the strategic management, the laser technology applications, and the relation between SM and technology. More specifically, the next section will explain the relation between SM and laser applications. The empirical part will show how can statistically test the impact of SM on the production size of laser applications.

This paper is an analytical study, and no field experiments are needed. The study uses data from the Statistics of U.S. Businesses (SUSB) - Census Bureau. The study uses the statistical tools. The study will apply Liner Regression Model to estimate the impact of SM on the production size of laser applications. I use Linear regression model (LRM) because the models that depend linearly on their unknown parameters are easier to fit than models that are non-linearly related to their parameters and because the statistical properties of the resulting estimators are easier to determine.

The rest of the thesis will have three parts. The first part will provide information about strategic Management theory. The second part will provide examples about laser application. Finally, the third part will explain the link between SM and laser technology.

The other sections of the paper will be the empirical work section including the data and variables. It also includes the estimation model and the results. The last section will be the conclusion.

2. STRATEGIC MANAGEMENT THEORY

This section reviews some studies about three related issues. First, it reviews studies about SM theory, which is important to understand why companies have such strategies. The second part, it reviews examples about laser application which is important to explain the role of laser application in different fields. Finally, the third part reviews some studies that explain the link between SM and technology in general and specifically laser technology. The goal it to present the available information that explain the possible impact of companies SM on the production size of laser application.

2.1 Introduction to strategic management theory

Strategic management was defined in many ways, but they all focus on the sustainable success of the company under highly competitive markets. For example, Hill, et al (2014) defines SM as the set of actions that managers take to improve their companies' performance. One of these actions is the investment in new technology. They show that without adopting strategic management, companies will not survive under high competition.

Haberberg & Rieple (2008) presents the SM theory as "a path that is taken by a company on its way to become an effective economic performer". In other words, it is a set of actions that lead an organization to develop its resources and use them to provide competitive products and services. One of these sources that lead to effective economic performance is adopting new technology.

The best way to introduce the SM is to answer some questions. Why some companies' success while the other not? Why some companies be able to outperform their rivals? Why some companies be able to increase their profits while others not? What makes a company growth more and more while others disappear?

The answer to all these questions is that the successful companies have adopted good Strategic Management. In other words, the successful companies have taken many

actions to have competitive advantage of its rivals. One example of these actions or strategies is the reducing the cost structure of the company and charge low prices. As a results the company's profits growth more than its rivals (Wheelen, et al, 2017).

The important part of companies' success is not only adopting individual or many different strategies. However, the key and challenging issue is how to apply all these strategies together and achieve the higher competitive advantage over other rivals. For a company to be unique and different from its rivals, the companies' managers must apply strategies that enable the company to achieve the sustainable and higher profitability and profit growth (Hill, et al, 2014).

The best way to achieve the sustainable and higher profitability and profit growth is to apply a business model. The business model is a way in which the companies' managers do some actions. These actions are:

- Select its customers.
- Define and differentiate it products offering.
- Create value for its customers.
- Keep its customers
- Produce goods and services.
- Reduce costs.
- Deliver goods and services to the market.
- Organize activities within the company.
- Consider its resources
- Grow over time.

By carefully looking at this list of actions, it is clear that most of them can be done using specific innovation and technology. Select customers is not easy and needs many data analyses for different markets. So, using computers and advance softwares can help doing that.

Produce goods and services can be done using new technology to cover the increased demand for these goods and services. Reduce costs can be done using technology that help reducing the time of operations and the number of workers.

Laser technology can be used also to do some of these actions. For example, it can help reducing costs by doing process accurately. It also can help produce goods

faster than other technology. Which indicate that adopting laser technology can be one of companies' strategies to keep sustainable growth.

2.2 The goals of strategic management

One of the most important part of applying SM is to achieve specific companies' goals. The goal is a measurable desire future that a company try to realize. Goals must be designed carefully and must have some characteristics (Bracker, 1980).

A companies well designed goals must be measurable, so managers can evaluate them and judge them. A companies well designed goals must focus on the most important issues and must be limited. A companies well designed goals must be challenging and realistic to motivate both managers and employee to improve the company's operation. Finally, companies well designed goals must have time plan to be done which give the mangers and employee the sense of urgency.

The goals of companies SM could be different from company to other. However, all goals of companies focus on maximizing the shareholder returns. In addition, to get high profitability and sustainable profit growth. Some of that can be done in the short - run, while the other can be done in the long – run (Bracker, 1980).

By looking carefully at the characteristics of these goals, it is obvious that they are related to the use of innovation and technology. In other words, a company that use new and advance technology may construct its goals better than other companies that do not use new technology.

For example, measuring, evaluating, and making judgment need to use specific technology like computers and softwares. Using advance technology can help cover many small issues in the operation and let managers focus on limited and important issues. Using advance technology can also reduce the challenge and make the goals realistic to both managers and employee. Using advance technology can significantly reduce the time plan for any goal.

2.3 The process of strategic management

The process of the SM has many steps. It seems to be complicated, but it should be done by doing some preparation actions. First, managers should do an external analysis. They should analyze the companies' external operation environment. The

importance of external analysis is the identify the strategic opportunities that can affect the companies' missions (Hill, el al, 2014).

External analysis has three parts to be examined. The first part is the industry environment in which the company operate. The second part, the country or national environment. Finally, the macroeconomic environment. Doing the external analysis can help any company to identify its strategies and make the right decisions to get its goals.

The second step of SM is doing the internal analysis. This type of analysis focuses on factors inside the company that can impact the operation process. These factors are resources, capital and financial issues, specialization, and others. This type of analysis can help identifying the strengths and the weaknesses of the company.

The third step is the feedback loop. This step indicates that SM is a continuous process. In other word, there is no end, and managers should update their decisions continuously to keep the operation and achieve the companies' goals. This step also can help managers monitoring and evaluating their strategies.

There are other steps that should be helpful to adopt good strategies. By looking at these steps, we can clearly see that technology and new innovations are essential to do them. Gathering information about external and internal environment and analyzing them needs specific technology. The high advanced technology, the best analysis can be done.

2.4 Formulating the strategies

The most challenging part that companies and managers face is how to formulate strategies to be applicable under certain markets conditions. In general, there are common issues that companies focus on when formulating strategies. The first issue is the customers. The company should carefully decide which customers will it serve.

The second issue is the needs and desires of customers. The company should decide how to satisfy the customers' needs and desires. For example, if a company focus on high income consumers, it should provide high quality goods and services. That can be done by selecting locations of the stores, the style of the products, and the quality of other services. In other words, the company must be totally different from rivals (Sekhar, 2009).

As mentioned before, this paper focus on the link between the Strategic managements and innovations and technology. Therefore, I will provide information about common strategies that are related to the use of technology and can help companies to differentiate from rivals.

2.4.1 Lowering costs strategy

Assume that we have large number of companies which produce same products. Now, if a customer wants to buy, which company's product will he/she choose. The answer is most likely be the product with lower price. However, lowering prices is not easy because most companies has a small share in the market. Lowering the costs will be one of the strategies that most companies focus on to compete in the market (Hill, et al, 2014).

Now, the questions are "What is the advantage of lowering costs?" and "How can a company lower its costs". In any market the price is set by the interaction between the demand and supply of any product. If a company can reduce its products costs, it will be able to get profits at the price point while the rivals are losing money.

Lowering the costs can also enable the company to gain more market share and more profitability. The efficiency frontier theory can explain how a company can be able to lower its costs. Figure (2.1) shows how the efficiency frontier theory works.

The concave curve in figure (2.1) represent the efficiency frontier or production possibility frontier. The efficiency frontier can be defined as all different positions that a company can adopt regarding to low costs. The efficiency frontier curve in concave because of diminishing returns which imply that when a company has significant differentiation in its products.

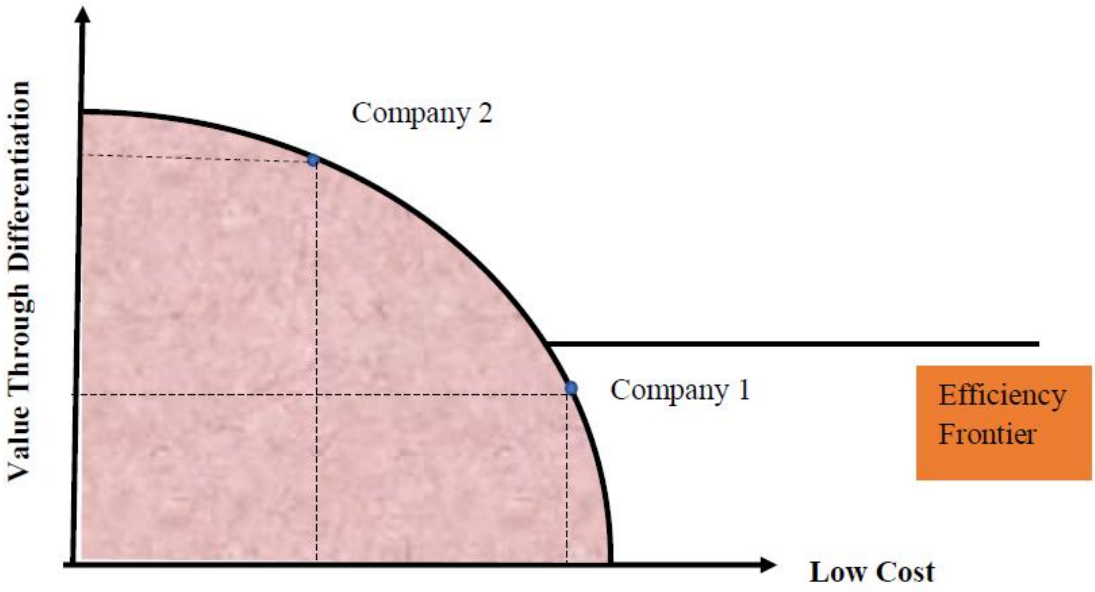

Figure 2.1: The Efficiency Frontier Theory.

Source: (Hill, et al (2014)

Assume we have two companies in the market (company 1 and company 2). Assume that company 1 and company 2 have efficient internal function and organizational arrangements which enable each one to have a position on the efficiency frontier curve. However, if we look at figure (2.1), we can see that company 1 has low costs position while company 2 has relatively high costs position on the efficiency frontier curve. Therefore, company 1 has significant differentiation in its products which enable it to gain more market share and more profitability.

It is important to notice that there could be many possible positions available on the efficiency frontier curve. The role of any company's managers is to identify the applicable position so they can run the operation effectively and efficiently.

The most important issue here is that the efficiency frontier is not static. Efficiency frontier can be pushed outward by adopting new innovations and technology which can improve companies' performance.

For example, in the 1990, Dell company adopt strategy which allow customers to customize their personal computers. Dell also adopt selling computers online using Order Information Submission. However, Dell rivals did keep selling at stores. These innovations and technologies enabled Dell to differentiate itself from rivals and got mor profits. That indicates the strong relationship between new technology and innovations and Strategic Management.

2.4.2 Identifying customers strategy

In this subsection, I go overview the process of identifying the customers that a company will provide them with goods and services that satisfy their needs. In other words, this subsection answers the important question which is asked by any company. The question is "Who are our company's customers". It also discusses the role of new innovations and technology in identifying the target customers (Hill, et al, 2014).

It is well known that customers in the market are not homogenous. Some of them are rich while some other are not. Some are young while some other are old. Some are men while other are women. Individuals have different needs and desires based on their culture, lifestyle, family, community, and many other things.

Based on that, for a company to operate efficiently, it is important to set it target customers and provide them with their desirable products. The methods that can be used to identify the customers is called (Market Segmentation). Market Segmentation is the process of dividing a market into clearly identifiable groups of customers that have similar needs. It is important to know that individuals of any identified groups from Market Segmentation are not perfectly identical, but they relatively homogenous.

There are three ways to do Market Segmentation. The first way is called (Standardized Strategy). Standardized Strategy means that a company does not provide different offers to different segments. However, the company produces and sells standardized products that target the average customers in the market.

For example, one of the companies that used this way is Coca-Cola. Coca-Cola was produces and sells standardized products for all customers. However, 1n 1980s Coca-Cola introduces diet coke and flavor drinks which were provided to different customers' segments.

The second way is called (segmentation strategy). In this way a company produces and sells different products for different customers. For example, Toyota was on of the famous companies that adopt this strategy. Toyota has been providing cars for different income level buyers. That means, Toyota produces cars for young entry level buyers, cars for middle level, and cars for luxury level.

The third way is called (focus strategy). In this way a company produces and sells products for a limited number of segments. For example, Porsche company produces and sells luxury cars that target only high-level income customers. It specifically targeting middle age wealthy customers who are seeking for high speed, high power, and excellent sport cars.

Kia of South Korea is another example of companies that uses focus strategy. Kia is targeting low income customers since it can produce cars with low costs and good quality.

The important issue here is to understand that Market Segmentation process is strongly associated with the companies' ability to adopt and use new innovations and technologies.

In other words, Market Segmentation process is associated with the companies' ability to differentiate themselves from their rivals. That can clearly explain the role of new innovations and technologies in any company's success.

For example, Coca-Cola differentiated itself from its rivals by using lifestyle advertising which made it the icon of American drinks. Coca-Cola also differentiated itself from its rivals by adopting new innovations to produce different flavor of drinks. Another example is Toyota company which differentiated itself from its rivals by adopting new innovations to produce excellent reliability and high-quality cars.

In general, the new and advanced production technology allowed companies to offer different products without big increase in the costs. That can lead to sustainable success and development in providing goods and services.

2.5 Strategic changing

One of the important issues that enable companies to keep sustainable success in the market is the dynamic of their strategies. In fact, everything in this world is changing especially customers' needs and desires. Companies keep changing their strategies to find new products to attract more customers and win the competition in the market (De Wit & Meyer, 2010).

Many actions can be taken by companies to change their strategies. In other words, changing a strategy requires few steps and it does not happen suddenly. The most common actions of changing strategies are:

- Reorganization
- Diversification Move
- Shift in Core Technology
- Business Process Redesign
- Products Portfolio Reshuffle

The first step of strategic changing is to do initial analysis about what should be changed in the operation system. More specifically, companies should identify exactly the areas that need to be changed. The next step after identifying the areas that need to be changed is to determine the size and the speed of the changes. It is important to balance between the size and the speed of the changes to avoid bad or unexpected results.

2.5.1 Areas of strategic changes

Companies have complex systems, and these systems have many different parts or elements which can be changed individually or as groups. Therefore, companies should do deep analysis about these elements to gain more insight about which one should be changed. The most common elements that can be changed are the business system and organization system (Bergh & Fairbank, 2002).

The business system is defined as the way that a company do its business. In other words, it is the way that a company use to make money. This area can be changed by adopting new innovations and technologies regards selling, advertising, finance system, and others.

The other area is the organizational structure of the company. Organizational structure can be defined as companies' tasks and people into small groups. Organizations need kind of labor division to do its functions effectively. The important issue in setting the organization is to identify the criteria that can be used to determine the tasks and the groups of people.

Some companies may use one criterion to determine the tasks and the groups of people while some companies use multiple criteria.

2.5.2 The size and the speed of the strategic changes

2.5.2.1 The size of the strategic changes

It is important to understand the concept strategic changes. Strategic changes are not easy; they are not just small changes that may made by a company on its products. For example, adding flavor to one of Coca- Cola drinks could be important, but it is not a strategic change. Hiring a new CEO is not itself a strategic change (De Wit & Meyer2010).

However, when Coca-Cola started using bottle water that was a strategic change. When the new CEO make a change in the business system or the organization system that will be a strategic change. As a result, some changes consider as small while the other as big. Therefore, we need to measure the size of the strategic change.

In general, the strategic changes could consist of many large changes or many small changes. Figure (2.2) below shows how to distinguish between the size of strategic changes. Y-axes represents the measure of total strategic change. We can see that the change path A shows how can a company make strategic change in two big steps. However, the change path B shows how can a company make strategic change in many small steps.

The size of the strategic change has two parts. The first pare is called (the scope of change) which can be broad or narrow. The broad change is happened when a company makes changes to many aspects and parts at the same time. The narrow change is happened when a company makes changes to specific aspects and parts and its more focus. For example, a narrow change may be developing products or marketing.

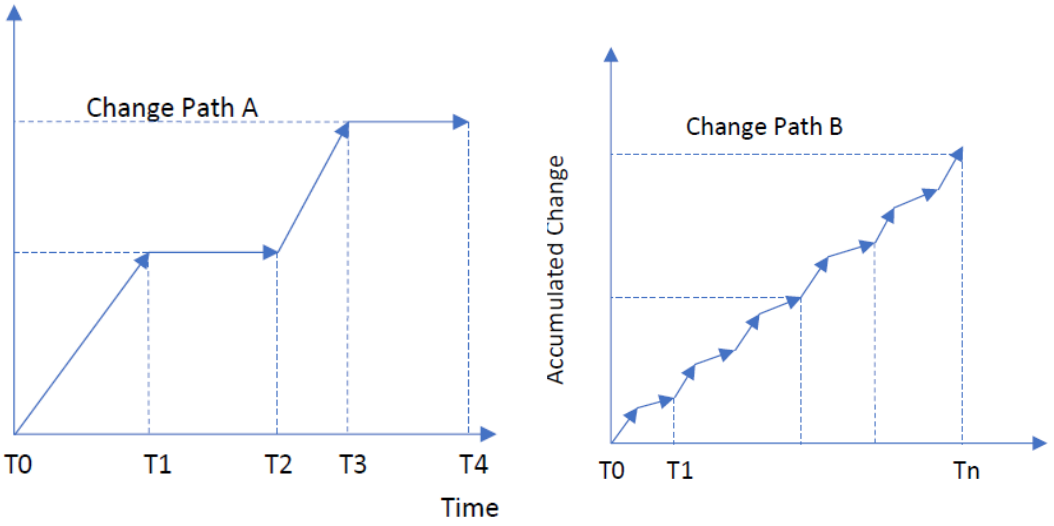

Figure 2.2: How to Distinguish Between the Sizes of Strategic Changes.

Source: (De Wit & Meyer, 2010)

The second part of the size of the strategic change is called (The amplitude of the change). The amplitude of the change could be high or low. It is high when a company changes the business system, organizational system, structure, and process. However, it is low when a company makes small adjustments to the existing systems.

2.5.2.2 The speed of the strategic changes

Strategic changes usually take relatively long time. Some of these changes takes very long time while others take reasonable time. Looking back to figure (2.2) we can see that both changes paths had done at the same time in total, but the changes activities were distributed differently over time. Figure (2.2) shows that the speed of the strategic changes has two parts. The first part is called (Timing of change), and the second part is called (Speed of change) (De Wit & Meyer, 2010).

Timing of change can vary between cyclical timing and constant timing. If the timing was cyclical, it is important that the company pick the right moment of change as shown in figure (2.2) the change path A. However, if the timing was constant, it is not important for the company to pick the right moment of change as shown in figure (2.2) the change path B.

The speed of change can vary from high to low depending on time span in which the strategic changes happen. If the change needs to be done over short time, the speed of that change will be high. However, If the change needs to be done over relatively long time, the speed of that change will be low. The speed of change can be seen in

figure (2.2) by the slop of the arrow of change path A. figure (2.2) shows the speed change from T2 to T3 is higher than the change from T0 to T1.

Timing, speed of change, scope of change, and amplitude of change can together provide many different changes paths. Therefore, it is essential for managers of companies to select the right changes path that lead their companies to gain sustainable success in the market.

Many reasons can motivate or enforce companies to make short time strategic changes. For example, when the company face high competition in the market, it is important to start rapid strategic changes as response to this competition. When a company be under government pressure especially public sector companies, it must do short time changes.

The most important reason is the change in technology. Innovation and technologies can enforce companies to do rapid strategic changes. That is because most companies try to be the first mover and get advantage of producing new products and services. In addition, companies try to catch up with their rival that started using these new innovations, so that it can stay in the market.

2.6 Strategic management under international conditions

Today, the world has become like a small village. High technology in communication, transportation and multinational companies create a global production environment and global competition. Therefore, it is essential now to add the international dimension or factor when design a strategic management. However, adding the international factor requires good understanding to the global system and international business.

2.6.1 International business theory

The start of International business theory was in the early of twentieth century. Initially, the focus was on trade between different countries and the global relations between companies. In the past three decades, fore focus was on export processes, foreign direct investment, transfer of technology, and the management of international corporations (Grosse & Behrman, 1992).

Later, International business was under more advanced researches and efforts to establish a theoretical base and found the international business theory. For example, Vernon (1966). was the first major theory of the production movement overseas. After that, many theories have been put some significant sense to the essential nature of international business theory.

Grosse & Behrman (1992) define the international business theory as a concept that must clearly explain different barriers and incentives to foreign business. These barriers and incentives are imposed by governments of countries that have trading activities. Governments usually imposed these barriers and incentives to impact the gains and the effects of any international transactions.

The international business theory must also focus on the effects of transnational firms on government policies. As a result, the international business theory is basically a policy that combine international business and government policies.

2.6.2 International business and strategic management

As mentioned before, under globalization environment, companies' SM can be effected by government policies. A company strategies and government policies both depend on the bargaining strengths of decision makers. In addition, a company strategies and government policies depend on their assessments of opportunity and costs, and their willingness to deal with the other parties (Toyne & Nigh1, 997).

The question here is "what are the opportunity and costs (or constraints) for the companies and governments?"

The governments usually try to get high economic efficiency, participation in ownership, management, technology, stability in economic, political, and social, acceptable level of interdependence, and others. The companies usually try to access get to global markets, get access to inputs or resources from other countries, lowering risks, good level of freedom in making decisions and operations.

The constraints that governments face are failure to get resources, weakness of power in a country, less ability to achieve economic goals more rapidly, lack of information, and inexperience in negotiations. The constraints that companies face usually the governments which permit them to get access to activities of competitors, resources, and information.

Based on the above information, it looks like that governments are crucial in impacting company strategies. That is because the governments set the rules of the game. As a result, the bargaining relationship between companies and Governments must exist. This relationship can lead to joint maximizing. joint maximizing means that each side looking for getting its goals limited by its resources, its dependence on the other party, and its relationships with other actors.

Therefore, when a company try to make a SM, mangers of this company should take in account the following issues:

- The conflicting rules of the game. That is, the managers should take in account the differences in legal and institutional environments in the countries in which the firm operates.
- The country risks. That is, the managers should take in account country risks that arises from differential treatment of business activities by home and host countries. I addition, they should consider the differential treatment in a host country of domestic and foreign business.
- The managers should take in account the exchange risks.
- The managers should take in account the international competition.
- The managers should take in account the international business cycles.

2.6.3 International business cycles and strategic management

One of the important issues that impact companies' SM is the effect of business cycles. The business cycle is the downward and upward movement of gross domestic product around its long-term growth trend. It can be happened for many factors. These factors could be economic factors which is more common and could be other factors like politics and socialist. The length of a business cycle is the time that has a single boom and contraction in sequence (Kobrin, 2015).

In the developed economies, trading goods and services across national borders have become easier. That kind of trading can transfer the impact of a change in one economy to the other.

For example, if the United States of America has a recession, it will apply many economic policies to recover the economy. As a result, each country that trades with USA will be effected (could be positively or negatively) by these polices (Backus, et

al, 1993). Table (2.1) below shows the effects of the USA economy activities on other countries.

Table 2.1: The Effects of the USA Economy on Other Economies.

Correlation with Same USA Variable						
Countries	Y	C	X	G	N	Z
Australia	0.51	-0.19	0.16	0.23	-0.18	0.52
Austria	0.38	0.23	0.46	0.29	0.47	0.17
Canada	0.76	0.49	-0.01	-0.01	0.53	0.75
France	0.41	0.39	0.22	-0.20	0.26	0.39
Germany	0.69	0.49	0.55	0.28	0.52	0.65
Italy	0.41	0.02	0.31	0.09	-0.01	0.35
Japan	0.60	0.44	0.56	0.11	0.32	0.58
Switzerland	0.42	0.40	0.38	0.01	0.36	0.43
UK	0.55	0.42	0.40	-0.04	0.69	0.35
Europe	0.66	0.51	0.53	0.18	0.33	0.56

Source: (Backus, et al 1993).

Where Y is the real output, X is the exports, C is consumption, G is government purchases, N is the employment, and Z is the productivity. Table (2.1) shows in the first column the correlation between the USA output and other countries output. Table (2.1) indicates that the effect of the fluctuation in the USA output can positively impact the output of other countries listed in the table.

The effect of the fluctuation in the USA output can impact the output of other countries differently. That depends on the size of trading and cooperation between the USA and other countries. For example, table (2.1) shows that the correlation between USA output and Canada output is 0.76 which is the highest. That indicates strong economic relationship between these two countries.

In short, when companies design new strategies or change the old ones, it is important to take care of the international business cycles and the strength of international relationship.

2.6.4 International competition and strategic management

Due to globalization many companies around the world especially the big companies are facing strong competition. Many developing countries like India, China, and others have become strong rivals for US and Europe countries. The emerging economies have been building big companies using their human and natural resources. That created more international competition pressure on the developed countries especially under free trade agreement, (Calori, et al, 2000).

The concept of competition varies between two (local) and (global). In addition, economic activities like production can also be under local or global competition. International competition takes place within geographical areas. These geographical areas are set to allow the flow of products, knowledge, and financial resources.

For example, North America, Europe, and developing countries in Asia (especially Japan) are the three geographical regions that have international competition. The international flow between these countries reached 30%, which is high and represents the existences of international competition. The 30 % represents the ratio of the sum of imports to total consumption and the sum of exports and direct investment.

Given that international competition is existed, companies that face this kind of competition must adopt new strategies or change the old ones to stay in the market. The dynamics of international industries especially with very fast development in technology and innovations enforce companies to adjust their strategic managements.

It is important to note that when the companies face international competition, they should not adopt strategies that prevent or block foreign rivals. That could be fine to keep them in the market, but they will lose a lot of opportunities especially financial resources and new technologies. Managers may combine different local and international strategies to gain more profits and market shares.

2.7 Examples of successful companies

All the information and discussion presented in this chapter were part of the SM theory. Some people can ask whether this theory is abdicable, or have this theory succeeded. In this section, some examples of successful companies will be presented.

This section discusses what these companies have done to be in the top position of very high competition markets.

2.7.1 Apple inc (keeping the “i” in innovations)

Apple is one of the most famous companies in the world. Historically, Apple was established on April 1, 1976 by Stephen Wozniak and Steve Jobs who began a partnership which become later Apple company. Apple founders started the company by creating small computer that called (Apple 1). The founders took many strategic changes based on the increase demand for their products. By the end, they build what is known now as Apple Inc (Hitt, et al, 2012).

The growth of the company started when the two partners added new partner which was the first SM action. The goal of adding new partner is to expand their company and it officially became Apple computers Inc after that step.

The next SM action that was taken is changing the quality of the products. Apple II computer was the first computer that has a sleek plastic casing and color graphics. That was a big change in the computer production industry. This new product led the company to gain more than 10 million dollar annual sales and hire thousands of employees.

The next SM action was when the company became a public company. That was on Dec 12, 1980, the company share price increased from $22 to $29 at that day. At that time, Apple reached around $100 million as annual sales. However, Apple started facing a competition from new rivals (IPM company). IPM started its first computer in 1980.

The manager of Apple Steve Jobs realized that Apple would have to move faster to remain in the top position. That reflects the needs of the company to respond to any change in the market, so that it can stay in the market.

The market competition led Apple to start many new products to satisfy different customers’ needs and desires and over performer its rivals. However, these new products which were Apple III computer and Lisa computer were not sold well.

The failure in reaching the goal of past SM(introduce new products) led Steve Jobs to hire new CEO. Jobs started himself working on new product (Macintosh or MAC computers) which became the best computer in the market.

Apple have been doing very hard work to improve its products and services. Apple products like iPhone, iPod, iPad, Apple TV, iTunes and more become the most popular products. Recently Apple share price reached $500 which is big change. That was a result of excellent SM actions and great managers.

Table (2.2) below shows the growth in net sales, net income, and earning per common share for the years 2006 – 2010. All numbers in table (2.2) are in millions of dollars except the common shares which are in thousands of millions of dollars.

Table 2.2: The Net Sales, Net Income, And Earning Per Common Share for the Years (2006 – 2010)

Years	2006	2007	2008	2009	2010
Net Sales per common share					
Net Sales	19315	24578	37491	42905	65225
Net Income	1989	3495	6119	8235	14013
Earnings per common share					
Basic	2.36	4.04	6.94	9.22	15.41
Diluted	2.27	3.93	6.78	9.08	15.15

Source: (Hitt, et al 2012).

2.7.2 Ford motors company (staying ford tough)

Ford Motors Company started on June 16, 1903. The engineer and entrepreneur Henry Ford started his company with 11 associates and $28000 in capital. The first car made by Ford was Model A built in Detroit, Michigan in the United States. Cars was considered as luxury item at that time, and only rich people can buy them (Hitt, et al, 2012).

Henry Ford had a believe that these vehicles has the potential to transfer the society, he said " *I will built car for the great multitude….large enough for the family, but small enough for the individuals to run and care for. It will be constructed of the best materials by the best men to be hired, and after the simplest designs that modern engineers can devise. It will be so low in price that no man making a good salary will be unable to own one and enjoy with his family the blessing of hours of pleasure in God's great open spaces*"

The above Ford's statement is like a SM plan since it like a guide for the company. It has plan for cars design, for customers' needs and desires, and plan about selling and prices.

Ford faced big challenge when the market crash happened, and it lost too much without any ability to stop going down. However, the company started many strategic managements actions to recover its loses and stay in the market. Ford started restructure every aspect of business. Ford started improving its cars design to reduce costs and enhance quality. Fords started improving marketing by offering different brands targeting different customers' segments.

The other big strategic action is that ford started producing minibus line in China. The Chinese line enabled Ford company to compete General Motors by getting low cost production.

In early 1999 Ford purchased the Swedish car company (Valvo). That action opened the gate to the European cars market which increased the Ford company profits.

Another big strategic action was made in 2006. Ford announced to cut around 30000 hourly jobs and 12 percent of management positions. It decided because it has a plan to invest in new robotic technology and innovations. It also decided to close 14 facilities as part of its massive new restructuring plan which called (The way forward).

Table (2.3) shows the growth in Ford's profits and the changes in the number of employees for the years 2001 to 2010. In short, that growth cannot be happened without good managers and well-designed strategic managements actions.

Table 2.3: Growth in Ford's Profits and the Changes in the Number of Employees for The Years of 2001 to 2010

Year	Net profit margin	Employees
2001	---	354431
2002	0.01%	350321
2003	0.046%	327531
2004	2.03%	324864
2005	1.28%	300000
2006	---	283000
2007	---	246000
2008	---	213000
2009	2.30%	189000
2010	5.09%	164000

Source: (Hitt, et al 2012).

2.7.3 McDonald's company (from big mac to p'tit plaisir)

In 1940 the brother Mac and Dick McDonald opened their first restaurant in California, USA. At the beginning the project faced a lot of problems such as labor-intensive work, high turnover, and silverware theft. The brothers decided to try a new business approach to avoid many of these problems (Hitt, et al, 2012).

The first strategic managements action they took is changing the food menu. They started providing self-serve. Barbeque, and other items were removed. The goal was to simplify the menu and to eliminate the need for silverware. One of the most important action was when McDonald used the practice of standardization to create customers' experiences throughout the world. That kind of strategic managements actions allow McDonald to be the world's largest fast-food restaurant. Table (2.4) shows the international expansion of McDonald stores over time.

Table 2.4: The International Expansion of McDonald Stores over Time.

Years	Market Entered
1967	Canada, Puerto Rico
1970	Virgin Isles, Costa Rico
1971	Guam, Japan, Netherland, Panama, Germany
1972	France, El Salvador
1973	Sweden
1974	Guatemala, England
1975	Hong Kong, Bahamas
1976	New Zealand, Switzerland
1977	Ireland, Austria
1978	Belgium
1979	Brazil, Singapore
1980	Spain, Denmark, Philippines
1981	Malaysia
1982	Norway
1983	Andorra, Wales, Finland

Source: (Hitt, et al 2012).

3. LASER TECHNOLOGY AND APPLICATIONS

This chapter provides information about laser technology and laser applications. First, it explains what the laser technology is and what is its history. Second, this chapter reviews some of laser applications that have been using in different fields of our life. Finally, the chapter discusses the important of laser technology and application in comparison with other technologies. One of the main goals of this chapter is to highlight the important development that made by using laser technology which led it to become more attractive to firms.

3.1 Introduction to laser technology

Historically, the first laser was built in 1960 by Theodore H. Maiman at Hughes Research Laboratories. Laser technology was introduced by the theoretical work of Charles Hard Townes and Arthur Leonard Schawlow (Gillner, et.al, 2005).

A laser differs from other sources of light by focusing very high energic light on a tight spot. That can create special applications such as laser cutting and lithography. In addition, laser beam can stay narrow over great distances which enabling applications such as laser pointers. Lasers can also emit a single color of light. Temporal coherence can be used to produce pulses of light.

A laser can be defined as "A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation" (Zlatanov, 2016).

Zlatanov, (2016) shows that Laser has many different applications such as optical disk drives, printers, DNA sequencing instruments, surgery, and skin treatments, cutting and welding materials. In addition, it can be used in military and law enforcement devices and more.

Zlatanov, N. (2016) also indicates that using laser technology can lead to achieve many goals. For example, it can provide new wavelength bands, maximum average output power, maximum peak pulse energy, and maximum peak pulse power. It can

also provide minimum output pulse duration, maximum power efficiency, any minimum cost. That is why laser applications is important and can improve firms' performance.

Gillner, et.al (2005) shows the importance of laser technology in the production of micro parts. The paper shows that the increase demand for micro parts led the producers to switch from silicon technology to laser technology. That is because laser technology has high lateral resolution by minimized focus ability, low heat input and high flexibility.

Gillner, et.al (2005) indicates some examples for laser applications. These examples are micro welding, soldering, selective bonding of silicon and glass, micro structuring and laser assisted forming. This paper shows how importance is laser application for getting high efficiency and low costs.

A laser also can be defined as a source of optical frequency radiation. Laser is very strong and can be controlled which makes it very useful source to be used in different fields especially in production processes.

Laser device has three principle components as shown in figure (3.1), (Bass, 2012). The three principle laser device components are:

1. The amplifying medium.
2. A means of exciting the medium to its amplifying state.
3. An optical resonator.

The amplifying medium is the part that determine the wavelength and the type of excitation that is required. The light that released by the amplifying medium is not by itself as a laser form (i.e. it is not monochromatic, and it is not unidirectional). These three parts are together cause light emitted parallel to its axis.

The light then reflects back and forth through the amplifier. The amplifier will gain equals the round-trip losses in the resonator. The combination of both amplifier and the resonator is at the threshold for lasing.

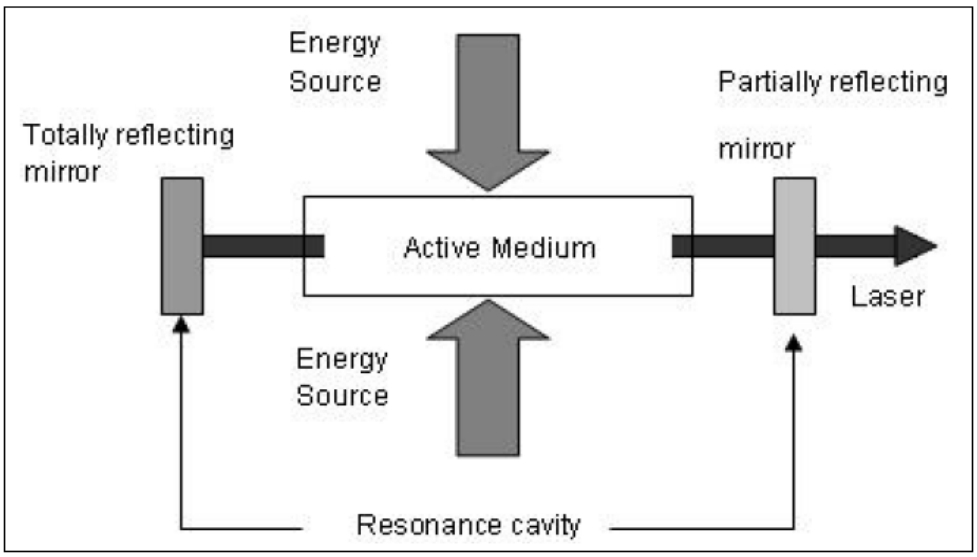

Figure 3.1: Laser Device Components.

Source: (Bass, 2012)

When reaching or exceeding the threshold, the light in the resonator travels parallel to its axis many times. The fraction removed on each pass through the output coupler results laser beam. The multiple use of amplifier makes highly energetic laser output. This highly energetic laser output should have four characteristics to be ready for use. These four characteristics are:

- Nearly monochromatic
- Nearly unidirectional
- Should have a spatial distribution imposed by optical resonator
- Can be very energetic

The laser with these characteristics can be delivered to any position or target using beam handling system. The beam handily system is a combination of reflective and transmissive optics that designed for specific tasks.

The distribution of the laser beam is determined by the desired effect of the light on the target. For example, if laser was used to make a hole, it should be very focused laser beam. That is why many different types of laser beams was designed to be used in different operations.

One of the most important part of using laser is the cooling system. Using laser especially in the manufacturing processes increases the laser system temperature. Therefore, it is important to be cooled to keep it work properly. The most common

cooling system is by delivering cooling water to be flow around the outside surface of laser system parts that heated when working.

Even laser technology has become very useful in many different fields, the significance use was in microtechnology which increased dramatically. The increased demand for micro products led to find many new applications in several areas. Therefore, laser processes have become very attractive to use with microtechnology (Zlatanov, 2016).

When different new beam sources became available, the laser became a universal tool in different operations. The materials processed by lasers can vary from materials of microelectronics, hard materials such as tungsten carbide for tool technology to very weak and soft materials such as polymers for medical products. In addition, laser can be used in processing ceramics, glass, and diamond with high accuracies in comparison with the classical technologies,

3.2 Applications of laser technology

This section presents laser applications that used in different fields. It subdivided based on where the laser was used. For example, if a group of laser applications were used in manufacturing, the will be presented together, and so on.

3.2.1 Applications of laser technology in manufacturing

3.2.1.1 Metal fabrication

The first laser application in manufacturing is the metal forming or metal fabrication laser machines. Layer manufacturing with rapid prototyping techniques used for about 20 years ago. These techniques directly fabricate layer-by-layer using physical models. There are many types of machines in the market that provide different fabrication methods, such as 3-D printing, fused deposition modelling, laminated object manufacturing. After introducing laser technology, selective laser sintering, selective laser melting, and 3-D laser cladding have been used (Santos, et al, 2006).

Historically, the rapid prototyping techniques was first mostly used for the fabrication of prototypes. In this process, polymers were used as communication and inspection tools in the assembly. The fabrication of prototypes made from polymers was well established in the market, but it was slow. Later, the physical models that

come directly from computer solid models helped to shorten the time of production. The next step for these techniques is to produce functional parts directly from metals and ceramics, no more polymers in use. Nowadays, many different systems of the metal fabrication are mostly using laser machines.

Using laser in layer manufacturing for metals introduced in the 1971 by Ciraud, who was the predictor of the 3-D laser cladding processes. In the 1977, Housholder introduced the concept of the selective laser sintering, and selective laser melting systems. These earlier ideas were not ready for use because of the shortage in the advanced computers and the high price of laser systems at the time.

Many improvements and adjustment were made on the laser fabrication machines to make them affordable and easy to use. In 2003, TRUMPF introduced two new machines in the market based on the selective laser sintering and 3-D laser cladding systems. These machines were the first direct metal laser fabrication machines with complete melting of single component metals.

The laser layer manufacturing techniques for the fabrication is shown in figure (3.2). The physical inputs into the systems are the materials, CAD model and laser. By using different this technology, final net shape metallic parts can be fabricated. It is a process in which many tools were eliminated which can reduce the production time and costs.

In addition, the laser layer manufacturing techniques for the fabrication can be suitable for low volume production of materials which are difficult to process. It also suitable for fabrication of complex parts of high value such as the automotive and aerospace industries. It ca also be used for mass-customization such as for the biomedical industry.

In short, laser fabrication system made the production of end-use parts to become one of the most promotional applications. laser manufacturing of metal parts made it easier to deal with small number of pieces and mass customization. Laser fabrication system help direct fabrication of metal products of high density with providing an excellent mechanical property and high accuracy.

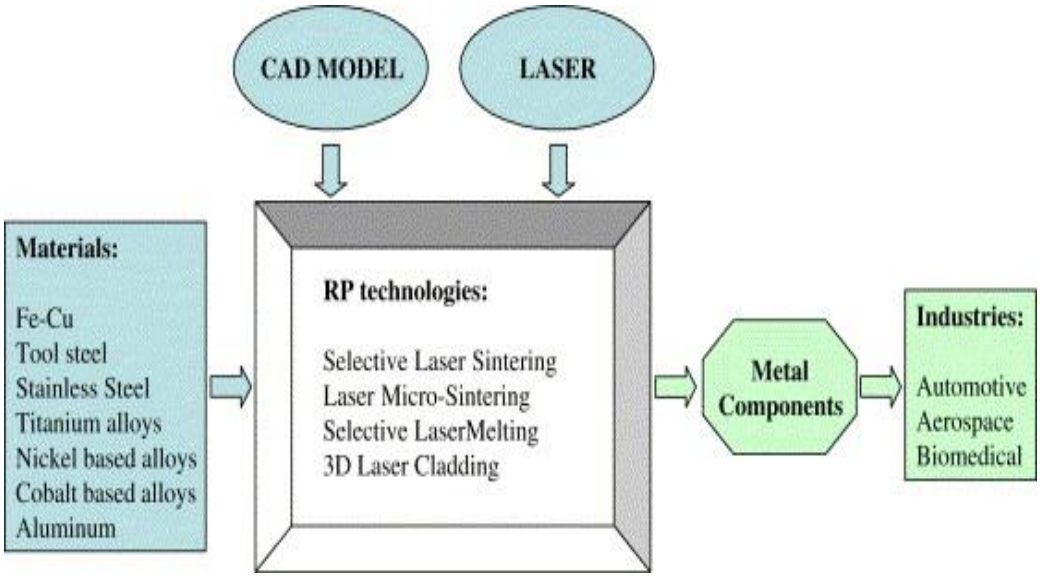

Figure 3.2: The Laser Fabrication System

Source: (Santos, et al 2006)

The most common types of metal that can be fabricate using laser fabrication system are stainless steel which can be used to produce knives, scalpels, implants, and stents. The process is generally used to cut through thicker materials where die cutting is not useful. Aluminum which is a suitable material to be cut with 2D lasers. Mild steel which used for Gears, chain links and others.

The other types of metal that can be fabricate using laser fabrication system are gold, silver and platinum, titanium, copper, nickel, zirconium, zinc, and tin.

Recently, laser cutting has become suited for fabricating glass. Laser cutting has become a more effective method than traditional manual methods of manufacturing glass products. Drinking glasses and smartphone screens are just two of the many applications involved with glass material in this arena of laser cutting.

3.2.1.2 Using laser in apparel industry

The use of laser in apparel industry started in the nineteenth century. The use of laser in apparel industry has been increasing in cutting garment patterns, 3D body scanning, denim fading and engraving leather (Nayak and Khandual, 2010).

The wide use of laser application in apparel industries was mostly because of low cost, flexibility, and anti-counterfeiting. The nature of the garment manufacturing industry requires laser applications because it can combine good performance with low cost by eliminating the handling systems. For example, the artwork of necktie

producers is digitally stored instead of physical patterns. The digital patterns can be converted into physical samples using lasers applications (Lucas et al, 2015).

There are many laser applications that used in apparel industry. The first laser application used in apparel industry is called fabric fault detection.

The idea of this application is that when fabric is received at the garment production unit, the faults in the fabric can be detected with image processing technique based on laser. Laser optical Fourier transform analysis can be used for fault detection in the fabric as the pattern is repeated at regular intervals (Mallik Goswami and Datta, 2000).

A special camera is used to capture the image. Then, the data will be transferred and stored in a computer. The computer programming will compare the acquired images with the stored images by converting the image into binary mode. A fault is reported when the measured parameter is deviating from the standard. The severity of the fault depends upon the amount of deviation from the standard.

The second laser application in apparel industry is Laser cutting. laser cutting in garment manufacturing are widely adopting by the fashion designers. That is because laser cutting can result in well-finished edges as the laser melts and fuses the edge (Petrak and Rogale 2001).

The use of laser cutting is dramatically increased for leather because of the precision of cutting components. In addition, laser cutting can be used to make fashion accessories such as jewelry. In laser cutting a laser is used to cut the fabric into the desired pattern shapes.

The cutting machine has a source of laser, a cutting head with mirrors to reflect the laser beam to the cutting line, a computer to control the system and a suitable mean for removing the cut parts. Laser cutting is cheaper compared with the traditional cutting methods, the laser cutting does not have mechanical action, and it cut components at high cutting speed (Mathew et al, 1999).

The laser cutter is safe, and it has simple maintenance features, which can be operated for longer time. The laser cutters can be integrated with computer technology. They can operate for a wide range of fabric, which is not possible with die cutters.

The other commonly used of laser application in apparel is the denim engraving. The denim engraving has been increasing rapidly because value addition by replacing the traditional methods. the use of laser applications can make very high-quality denim segment that cannot be made by non-laser methods (Kan 2014).

In general, many features that laser cutters have made them better than the traditional ones. These features are: No mechanical wear, good quality, No fixation of material is required, No fabric fraying in synthetic fibers due to formation of fused edges.

In addition, clean and lint-free, simple process due to integrated computer design, high quality raw materials and significant cost saving, extremely high precision in cutting contours, and no chips, less waste (Mathew et al, 1999).

3.2.1.3 Applications of pulsed laser for micromachining

The pulsed lasers for micro-processing material have been used for many manufacturing industries. Manufacturing industry now uses pulsed laser in many areas for which require microfabrication technology (Gower, 2000).

Pulsed lasers can be used for many areas. For example, it can be used for ink jet printer nozzle and biomedical hole drilling, thin film scribing and micro-electromechanical system, and it can be used for etching.

Pulsed lasers can provide photons that absorbed strongly in submicron depths with less time. That makes pulsed lasers to be very effective for micromachining. pulsed laser can provide high process speed, reliability, and low operating costs.

There are several applications of pulsed laser in manufacturing. One of these applications is hole drilling. Drilling very small holes is very important in many industries that produce high-tech products. Using the traditional technology to make these small holes has many technical problems in terms of time and accuracy (Rowan, 1995).

However, laser micromachining was the key solution technology to this problem. It can provide solutions to the problems in producing integrated circuits, hard disks, displays, interconnects, computer, and telecommunication devices. It can satisfy the requirements of material processing which are accuracy, flexibility, micron resolution, high speed, and low costs.

Another application of laser micromachining is the laser scribing of thin films. One of the most common examples of thin film is the electrical power solar cells. Laser micromachining has been using to produce the best large-area thin-film silicon that can be used in solar cells. Laser technological made big improvements in cell design which led to rapid growth for domestic and commercial use on buildings as a local source of electricity (Compaan, et al, 2000).

The cells designed to have electron-hole pairs and a photovoltaic voltage which are generated between diode junction layers. Cells are separated and connected by scribing narrow isolation tracks in each film and collecting the photocurrent at the end of the panel.

Two of the required process of producing cells are cell separation and scribing of top conductor which can be done efficiently by laser scribing. The other requirement is that the cell width is varied to give the required voltage while the length is changed to produce the current. Therefore, the completed panels are cut to smaller sizes. In addition, the isolation tracks should be as narrow as possible to get high electrical resistivity between the collection strips.

Using laser can lead to achieve high spatial resolution with precision depth control without any damage to the cells layers. laser can also be used to scribing cells. Cells glass panels can be processed to the size of 0.5m with the laser operating. By the end using laser in producing solar cells can provide efficiency for generating electricity about 70W per square meter of cell in full sunlight.

Finally, laser is now commonly used for low temperature protecting of the silicon layer in thin-film transistors.

3.2.2 Applications of laser technology in civil engineering

3.2.2.1 Terrestrial laser scanners

Terrestrial laser scanning has become a standard for modeling complex and remote engineering structures. Terrestrial laser scanning can be used to get details about a location geometric information. The traditional methods that used to scan usually suffer from the lack of intensity details and useful data for analyzing. However, using terrestrial laser scanners can make the data very useful for monitoring and analyzing (González, et al, 2012).

It is well known that most of the developed countries have been investing a large capital in their Infrastructure. They invest large capital in transportation networks, bridges and public buildings. Over time, these structures can be effected by many factors.

For example, bridges that built long time age stemming from the effects of heavy traffic and the environmental conditions. That can cause more repairs and can reduced the load capacity (Aveldaño& Ortega, 2011).

Water can cause some types of damage that occur in bridges and other structures that use steel bars in their concrete. That is because the concrete is a porous material, and water can enter the concrete and decrease its durability due to chemical reactions. These reactions cause the corrosion of steel bars in the concrete, which decreases the strength of the steel bars (Yoo, et al, 2011).

Bridges elements and other structures that in touch with water can also effected by biological crusts. This kind of damage can be resulted due to salts and other water materials that come to the surface of concrete (López, et al, 2010).

The key issue in here is how to identify these damages on the structures and fix them to keep them safe. The traditional way to inspect the bridges and other important structures is called bridge management systems. The management systems usually include inspection that supposed to provide information used to evaluate the condition of the structure. However, the evaluation of the is typically performed using data obtained from visual inspections by human inspectors.

The management systems approach has some problems. One of these problems is that the damages are not quantitatively standardized because it depends on the inspector's criteria. Another problem is that the productivity is low because the inspectors usually use paper sheets in the field that sent later and entered to the office computer. The management systems approach can also be dangerous because the inspectors must work at heights and bridges could not be easily accessible.

One of the best solutions to these problems is the terrestrial laser scanning. Terrestrial laser scanning is non- damaging and technique that has been using in the recent years in the field of graphic and metric documentation of objects. Laser scanners can provide a massive number of data points distributed across the observed surface. The data has high accuracy and a high acquisition rate.

By the end, the laser scanners can provide final product as point cloud which has the coordinates of the acquired points and their density. The geometric information that obtained from the laser scanners has been used successfully by civil engineering, geology, and geomorphological analysis (Armesto, et al, 2009).

Recently, some companies introduced a mobile scanning system that combine a 2D laser scanner with a global navigation satellite system for position calculation. These new devices have high productivity and the possibility of using quantitative data (Petrie, 2010).

3.2.2.2 Laser beam guidance device for civil engineering

A laser beam guidance device is used for guiding a civil engineering measurement. The device has laser beams that have laser emitter and two laser receivers. The laser receivers mounted on a displacement unit mobile with two degrees of freedom. The device also has two receiver position sensors that associated with each unit. These position sensors are used to measure the device position with reference and to generate signals representative of this position (Gaffard, 1994).

After generating the position's signals, a computer responsive to these signals and stores the geometrical features of the surface the the laser device used to guide. Then, the computer controls each receiver in two dimensions to get and maintain its centered on the beam from the laser emitter. Finally, the computer generates real time command instructions that will be applied to controlling the device based on the obtained geometrical features.

Before introducing the laser beam guidance device, the civil engineers were using a guidance machines that are guided by using wires stretched along either side of the road or path to be surfaced. These traditional devices have some measurements problems.

One of these problems is that these devices are complicated and consume more time especially when many operations are required to lay the wires.

Another problem is that if the road or path has curved shape, the curve will be approximated by many short straight lines segments along which the guide wires must be stretched. As a result, the number of operations required to install and adjust

will be increased especially when the machine reaches junctions between the segments.

Introducing the laser beam guidance device led to simplify the guidance device without requiring significant modification. It allows to guide the machine along a path or road with a three-dimensional surface. It simplifies the guidance of curved paths which can reduce time and measurements errors.

3.2.2.3 Laser operated automatic grade control system for concrete finishing

After placing the concrete in the location of construction, the upper surface must be finished appropriately to be smooth, homogeneous and has good appearance. Many traditional concert finishing devices were use before introducing the one with laser technology. For example, the screeds devices which have long been that used for treating plastic concrete. The other example is the bull floats device which can comprise a flat wooden board attached to a handle.

Nowadays, most of advanced civil engineering use concrete finishing devices that work with laser technology. Their main feature is to provide smooth and continuous concrete surfaces. More specifically, these devices use laser-controlled technology to do concrete finishing (Allen, et al, 1994).

Lasers devices are now widely used on the modern construction site. They are mostly used in examining and leveling operations. The laser device that used in concrete finishing has a system of anchor vehicles and alignment vehicles. The alignment vehicles are connected to the anchor vehicles by wires. The connections of the wires to the anchor vehicles are controlled by means of a laser sensing device.

Many microparts in this system are used to control the shape of the alignment devices to create complex curves in the surfaces. As a result, the laser device shown in figure (3.3) that used in concrete finishing can provide concrete surfaces with smooth, complex, and very good appearance shapes.

3.2.3 Applications of laser technology in agriculture

A big number of laser applications have used in different agriculture processes. Laser technology has proven to be safe when dealing with agriculture products. This technology has become an acceptable technique to the farmers. Laser technology has also proven to be less costly for farmers to get their specific requirements. In

addition, using laser technology can provide high-quality agriculture production (Mandal and Maity, 2013). This section review some of laser applications in agriculture.

Figure 3.3: The Laser Controlled Concrete Finishing System.

Source: (www.google.com)

3.2.3.1 Farm navigation systems

Some studies that evaluated the cost and benefits that are related to farm navigation systems. They found that the navigation technologies can increase profitability. Because of the environmental concerns, the navigation systems have become essential in agriculture. At this point, the Navistar Global Positioning System for precise positioning information, and the microwave-frequency triangulation scheme for measuring agriculture field locations were proposed (Palmer and Matheson, 1988).

These systems were found to be successful in the agriculture process. However, the laser scanning method for agriculture guidance found to provide position accuracies more than the other systems. That indicate the advantages of using laser applications in agriculture production (Mandal and Maity, 2013).

3.2.3.2 Surface topography

Soil surface topography has been an important issue in agriculture production. At the beginning, an optical displacement transducer for the measurement of soil surface profiles was presented. The device collected light from a bright spot on a target

surface. Then, it focuses this light on a position sensing photo diode. This will give an output related to the position of the target. The problem with this system is that the signal cannot avoid the effect of ambient light (Harral & Cove, 1982).

Using laser technology has led to solve this problem. The laser-based meter was very useful for defining surface roughness. The laser-based meter provides reading at a precision of less than one millimeter in vertical and horizontal directions (Huang and Bradford, 1990). That shows the important improvement of using laser technology. laser-based meter

3.2.3.3 Laser controlled land leveling system

Laser controlled land leveling system is a system that used in highway, airport, bridge, building, and agriculture. This kind of laser technology is very useful in agriculture. Rice farming is one example of the most water-demanding types. Farming rice, in most cases, needs the fields to be permanently flooded while the rice is growing.

To reduce the water wastage, the water depth should be reduced taking in account that no part of the field remains un-flooded. This can be done by preparing the fields to be leveled within a few millimeters. Many agriculture tools have been used to help farmers in this issue. However, the best solution was the rotating laser that materializes a horizontal plane.

The laser device was designed to have a laser receiver, which is mounted on the tractor. The device reads the laser plane height and drives a blade that is used to move the soil from above-level sites to under-level sites. China is the country that have commonly used this technology. China has about 9 hundred million irrigated area, above 95% use surface irrigation. Most of these areas prepared using the leveling systems which reduced the waste of water. As a result, mor developing of agriculture production has been done (Mandal and Maity, 2013).

3.2.3.4 Automatic guidance of agriculture vehicles using laser sensor

Many years of work has been done to introduce an application of automatic guidance of agriculture vehicles. That is because this method would allow the driver to concentrate on other vehicle components such as cutter and hopper especially in the case of a combine harvester. The automatic guidance of agriculture is methods that

use vehicles which have laser sensor. This method is used in agriculture in a structured environment (windrow harvester) or in an iterative structured environment (combine harvester), (Chateau, et al, 2000).

The goal of using this method or vehicle is to drive the vehicle along a divided line which has been created in some way. The machine creates a guideline at each path across the field.

Historically, many companies have tried to solve the problem of automatic guidance of agriculture. For example, the Japanese company (Kubota) has developed a method of guidance by photocells. The method was used to exploit the presence of the crop edge left by the previous passage of the vehicle (Yoshida et al., 1988).

Another example is the one that done by the University of Texas. This method has used a monochrome camera to detect the work limit. However, The Carnegie Mellon University (USA) has used a color camera with a GPS2 receiver to manage the half-turn. Its goal was to automatic guidance of a windrow harvester (Ollis and Stentz, 1997).

The applications of agriculture guidance in a structured environment was done by Marchant from England. It has used a monochrome camera to guide a vehicle along cauliflower lines. (Marchant et al., 1997). In addition, Billingsley from Australia has built a vision system to control a vehicle in a cotton field (Billingsley and Schoenfisch, 1997).

Recently, after the increase use of the GPS, the agriculture guidance vehicle with laser sensor has become the best method. That is because, the laser sensor is different from traditional sensors like CCD cameras. The laser sensor is independent of the sunlight conditions, and it can provide 3D information which help estimate the height and volume (Chateau, et al, 2000).

The sensor is a 1D scanning laser that uses laser beam and it works on the principle of light propagation time measurement. A short bright impulse is emitted, and bright ray is then deviated by a mirror. When the ray faces an obstacle, the light is collected by a detector. The distance from the sensor to the object is then calculated from the time interval between the emission and the reception of the impulse.

Using special coordinate system of the sensor, the data will be measured. The sensor then provides the measure of the distance between the reference origin and the object. In addition, it measures the angle between the axis and the beam direction.

The sensor is placed on the left side of the machine which is assumed to be the side of the crop edge. The x-coordinate of the crop edge will be close to zero at the reference position. The machine moves in a repeatedly structured environment.

The sensor parameters will be estimated using a correlation-based approach. The machine has a filter which is incorporated to limit the perturbations caused by dust. This agriculture guidance system robustness can be increased by computing a reliability criterion from the estimate parameters. Vegetation volume and height can be calculated and can be applied to control the vehicle velocity.

All these advantages of using the laser agriculture guidance system can make it the best method in among other traditional systems.

3.2.4 Applications of laser technology in education

3.2.4.1 Laser scanning technology in construction management education

One of the lase applications that has used in education is the laser scanners. This laser application has used as a tool in teaching Building information modeling (BIM). In the BIM class, students learn on how to use the laser scanners. Then, students use the laser scanners to scan exteriors buildings. Students can see the scanning in action and generated point-clouds from the scanner as part of the final project (Shanbari, et al, 2016).

The point-clouds will give the students a large amount of information that were missing in the existing documents. In addition, the information provided by laser scanning technology can help the students better understand the buildings' envelopes.

Laser scanning technology has become an important tool in documenting existing conditions of buildings. It focuses more on the documentation of historical buildings. The Laser scanning technology can also be used in construction progress documentation of new projects.

Building information modeling (BIM) and virtual design and construction (VDC) technologies become the standard in the construction industry. Therefore, using the

laser scanning has emerged as a tool for BIM professionals. The data that collected through the laser scanning process will be used through the lifecycle of the project because of its accuracy and quantity of data points (Yee et al. 2013).

The use of laser scanning that shown if figure (3.4) has a variety of applications on construction projects. It could be used for new construction and for renovations. In addition, the collected data can be useful to the entire project team, including the architects and engineers.

One advantage of laser scanner is that its data accuracy can eliminate the needs to use in paralleled the manual measurement and traditional field surveying methods. In addition, laser scanner can reduce the human interpretation when capturing, as well as during the conversion of field measurements (Shanbari, et al, 2016).

Laser scanner can significantly reduce the time of collecting data about the buildings in comparison with the traditional methods like professional surveying equipment. Laser scanners can collect about one million points per second, leading to comprehensive data sets of given targets.

The use of laser scanning can provide model accuracy with about ¼" (6mm) of variance, or less. In addition, reducing costs can be achieved also when using laser scanners. All these advantages of this technology have led to increase the use of laser scanning and the utilization of point clouds as part of the BIM process.

Figure 3.4: Completed Model Based on the Laser Scanner Generated Point Cloud

Source: (www.google.com)

3.2.4.2 Laser pointers as interaction tools

Smart classroom become now one of the important parts of education, especially in the developed countries. In the Smart classroom, teachers usually use a computer-vision-based tool that is called Laser Pointer. Laser pointer lets teachers do their task in the classroom more effectively. For example, by clicking on the laser pointer, the teacher can indicate a selected image among others that are on the board. The teacher can fix the laser spot on the point of interest for a second the teacher can also circle that point (Shi, et al, 2003)

The other feature of the laser pointer is it can be used as a remote for the Media-Board. The teacher does not need to approach the Media Board to run a slide presentation. However, the teacher can point the laser pointer at the Media-Board to highlight a point in the lecture. A red spot is visible at the position that the teacher talks about. Figure (3.5) shows the teacher using the laser pointer in the smart classroom.

Figure 3.5: The Teacher is using the Laser Pointer in the Smart Classroom.

Source: (www.google.com)

3.2.4.3 The 3d scanning and printing with selective laser technology

The recent advanced technology in education is focusing on 3D models instead of the 2D means of learning such as pictures. That is because the 3D models are so clear, and student (especially student in medical schools) can learn more effectively using them. For example, the anatomical models can be produced with 3D laser scanning

and printing systems. They allow students to easily introduce diverse or numerous specimens into classrooms (Thomas, et al, 2016).

Selective laser sintering 3D printing is currently used for making education models that made from plastic, metallic and ceramic. Selective laser sintering is a 3D printing technology that uses a powder bed to build up the 3D object. This type of printers uses a laser technology to bind the powder particles together instead of the spray solution (Fina, et al, 2017).

In the printing process, the laser is directed to draw a required pattern on the surface of the powder bed. When the first layer is done, a roller distributes a new layer of powder on top of the previous layer. The object is built layer-by-layer, which is then recovered from underneath the powder bed.

One advantage of using the selective laser sintering 3D printing is it provides solvent-free process and offers faster production. Another advantage of using these printers is it has one-step process, and it does not require prior production of suitable filaments by hot melt extrusion. The other advantage of using the selective laser sintering 3D printing is it can produce objects of higher resolution due to the laser precision (Okwuosa, et al, 2017).

However, one limitation of using this printer is it commonly uses materials that are powdered forms of plastics, ceramics and metal alloys that require high temperatures and high-energy lasers to be sintered.

3.2.5 Applications of laser technology in health care

Laser applications are now widely used in health care sector. This section reviews the most common laser application that used in health treatment.

3.2.5.1 Laser photoablation, used for correction of vision problems

Laser photoablation is one of the advanced laser technologies that is relates to the field of photoablation of optical tissue. This laser application is used to correct vision problems especially the treatment of the natural optical lens (Gwon and Berns, 2001).

Until a few decades ago, eyeglasses were mainly used for most vision deficiencies corrections. For example, hyperopia they can fix the problem of parallel rays of light converge to focus behind the retina. The can fix the problem of myopia (parallel rays

of light converge to a focus in front of the retina). Furthermore, the can fix the problem of astigmatism caused by irregularities in the cornea (Singh, 2013)

Even after the introducing of the contact lens, they could not replace the traditional eyeglasses. That is because the contact lens is costly and not affordable for many people. Another method for treating vision problems was by the replacement of a diseased natural optical lens. For example, a natural lens which had been clouded because of cataract can be replaced with a plastic artificial. This kind of lens is now a commonly performed surgical procedure of many individuals who have become blind (Francis and LRI LP, 1988).

Radial keratotomy vision correction method is another modern way to treat vision problems specially for individuals who have myopia. In radial keratotomy procedure, Several slits are made radially inwardly toward the optical axis from the peripheral edge of the cornea. These slits can decrease the curvature of the cornea (Gwon and Berns, 2001).

Even the vision correction methods discussed above are good and effective, they still have some shortcomings especially these methods that need surgical procedures. In addition, many individuals do not like to wear the traditional eyeglasses and the contact lenses. Therefore, researchers have been directed for many years to innovate a method for reshaping the front surface of the cornea.

The excimer laser has now been used to selectively ablate regions of the cornea. This excimer laser operates in the ultraviolet region of less than about 200 nanometers wavelength. This method can correct many vision problems.

For example, regions of the cornea around its optical axis are photo ablated to a greater depth than peripheral regions of the cornea, thereby decreasing the curvature of the cornea to correct myopia.

Using laser technology can eliminate the expected problems of doing surgical procedures and provide good vision without wearing traditional glasses. Figure (3.6) shows the excimer laser method for vision treatments.

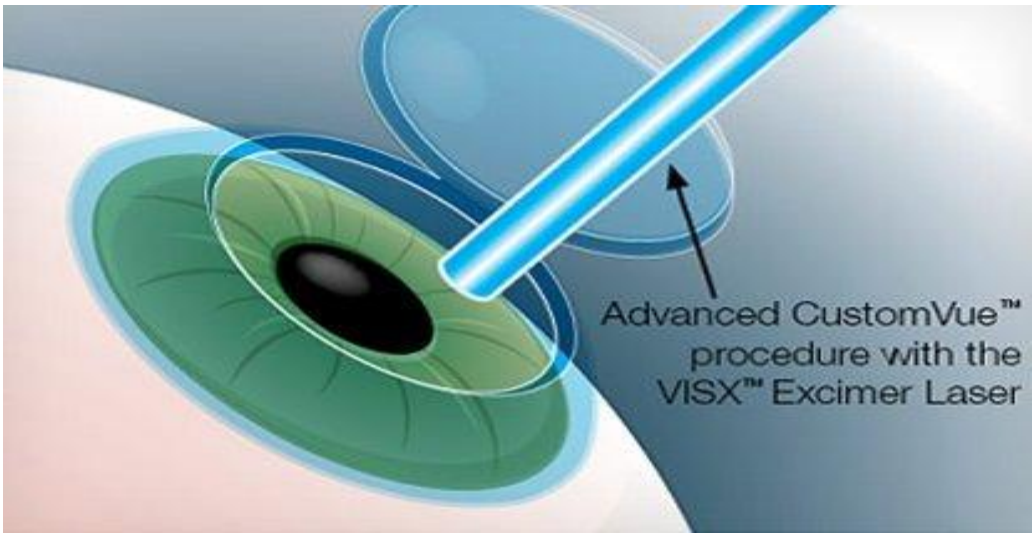

Figure 3.6: The Excimer Laser for Vision Treatments.

Source: (www.google.com)

3.2.5.2 Laser applications in medicine

Lasers applications have been increasingly used in modern medicine for treatment of different health problems. That is because doctors are trying to reduce the invasive of medical treatment, especially the surgical procedures. Laser applications allows surgeons to apply same basic principles to a variety of tissue types using slight modifications of the system (Azadgoli and Baker, 2016).

Laser technology systems have been used in many fields of medicine. For example, Laser technology systems can be used with surgery, lithotripsy, cancer treatment, tumor ablation, dermatology, skin rejuvenation, lipolysis, cardiology, and epilepsy. Using laser energy for to treat these cases is safe and effective.

Using laser for each of these cases can be superior to the use of traditional methods of treatments (Jean, and Bende, 2003). Table (3.1) below shows examples of different types of laser systems that used to treat different medical problems.

Table 3.1: Examples of Laser Systems that Used to Treat Different Medical Problems.

Type of laser	Type of treatment
Ruby	Dermatology, tattoo removal
Nd: YAG	Wide applications
Er: YAG	Surgery
Diode	LLLT, PDT, surgery
Argon	Surgery, PDT, ophthalmology, dermatology
CO2	Surgery
Pumped dye	PDT, dermatology

Source: (Azadgoli and Baker, 2016)

The important question here is how laser light can treat medical problems or how can laser interact with the human body tissues. The effect that a laser has on a tissue is dependent on both properties of the tissue and the laser itself.

The tissue properties include its structure, water content, thermal conductivity, heat capacity, density, and its ability to absorb, scatter, or reflect the emitted energy. The properties of the laser that are its power, density, energy content, and wavelength (Knappe, et al, 2004).

To use laser in medical treatments, it is important to now that the biological targets that are dealt with absorb light very differently. In addition, these targets' optimum absorption depend on the wavelength of the incident photon energy. The most important issue in these treatments is to use the light energy at high peak powers and short pulse widths to destroy the intended target alone. That is, the treatment must not damage the surrounding tissue. The target tissue must contain chromophores that absorb a specific laser wavelength. These chromophores should not be found in the surrounding tissue (Omi, and Numano, 2014).

As mentioned before, laser systems have been using in different medical problems. One example of these treatments is treating cancers. Mucosal ablation techniques using lasers are successfully used for the treatment of superficial gastrointestinal cancers. This includes early gastric cancer, superficial esophageal cancer, colorectal adenoma, and high-grade Barrett's esophagus (Azadgoli and Baker, 2016).

Direct laser ablation has been used for direct destruction of cancer cells through its photochemical, photomechanical, and photothermal effects. The photochemical reactions that occur form toxic radicals can lead to the death of tissues, the photomechanical reactions induce stress on the tissue and lead to its fragmentation and the photothermal reactions induce heating and coagulation, which cause cell death.

3.2.6 Applications of laser technology in aerospace and weapons

Laser applications are now widely used in aerospace and weapons industry. This section reviews most common examples of these applications.

3.2.6.1 Laser ignition for aerospace propulsion

Nowadays, there is an increased interest and needs for more advanced high-speed ramjets and scramjets which associated with more efficient fewer burning engines. That has led to many subsequent developments in the laser application especially laser ignition for aerospace. The main goal of this technology is that the more advanced forms of ignition can meet regulations that seek to reduce the level of pollutants in the atmosphere (O'Briant, et al, 2016).

In addition, many gas turbine manufacturers are trying to increase the combustion efficiency in engines and reducing the pollution. There is also a desire for developing a new generation of aircraft and spacecraft that are utilizing technologies such as scramjet propulsion. Therefore, it has become very essential to use advanced ignition processes to obtain these needs and desires (Manfletti, 2014).

Ignition can be defined as the transformation process of a combustible material, from an unreactive state to a self-propagating state. The ignition source can be removed without extinguishing the combustion process. The electrical sparks have been the common type of ignitions. However, the needs for more advanced form of ignition led to use the laser ignition. Ronney, 1994).

Ronney (2014) indicates that laser ignition can be characterized into four types. These types are thermal initiation, non-resonant breakdown, resonant breakdown, and photochemical ignition. The main difference between laser ignition and spark ignition is that the laser one can work with small amounts of vapor, dust, and

microparticles. It also can reduce the breakdown field strength, while electrical spark discharges are not usually affected by such phenomena.

3.2.6.2 Laser sighting device for weapons

Recently, many types of weapons use laser technology to enhance their probability of hitting the targets. One of laser application that used for this goal is the sighting device. The sighting device for a weapon is an integral part of the handgun that projects a laser beam on the specific point of the target (Toole, 1998).

The device has a laser assembly that is disposed adjacent the front of the trigger guard of the handgun. The power supply may be disposed in the bottom of the handgun's magazine which is in electrical contact with the laser sighting device. Figure (3.7) shows how the laser sighting device can be used when hitting a target.

Figure 3.7: A Gun with Laser Sighting Device

Source: (www.google.com)

3.3 Chapter conclusion

A laser a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. Laser has many different applications such as optical disk drives, printers, DNA sequencing instruments, surgery, and skin treatments, cutting and welding materials. In addition, it can be used in military and law enforcement devices and more.

A laser differs from other sources of light by focusing very high energic light on a tight spot. That can create special applications such as laser cutting and lithography. In addition, laser beam can stay narrow over great distances which enabling applications such as laser pointers. Lasers can also emit a single color of light. Temporal coherence can be used to produce pulses of light.

In short, using laser technology and applications in different fields is associated with high quality, low costs, and high productivity. That has made this technology and these applications in more interest.

4. THE LINK BETWEEN STRATEGIC MANAGEMENTS AND LASER TECHNOLOGY AND APPLICATIONS

4.1 Introduction

In general, this chapter reviews first the relationship between strategic managements and the demand for laser technology. It secondly reviews the demand theory and how can estimate the demand function. Finally, it discusses the estimation results that explain empirically the effect of SM on the demand size of laser application.

In the literature, there are many studies that show the relation between SM and technology. For example, Bianchi, et al, (2019) shows the challenges for Latin American Firms in a Changing World. The paper shows that technological innovations led to significant transformations in SM of Latin firms. This article clearly shows the strong relation between technological innovations and strategic management.

Luo, et.al, (2019) tested the link between technology innovations and the sustainable development of China's strategic emerging industries. The article hypothesis is that improving the efficiency of green technology innovations can be an effective way to achieve the developmental goal. The results of this paper show that the technological progress and promotion of technology efficiency can increase the industrial production. That means, achieving the SM goals.

Rezagholi & Frey (2000) shows the link between the rapid technological change and successful engineering management which focus on market needs. The paper used technology assessment method called "Managing Engineering and Product Technology" (MEPT). The paper shows how it can be applied to technology assessment within an organization.

The main goal of this chapter is to empirically test the impact of companies' strategic managements on the demand size of laser application that are considered as one of the advanced technologies. To do that it is important to investigate the demand

concept, and factors that can effect demand for goods and services. That can help understanding the empirical work and the statistical results.

4.2 The demand theory and demand function

4.2.1 The definition of demand

The demand is a common concept that almost all people know. They may simply know that the demand is an action when a consumer wants to buy something (goods or services). However, many people do not know that there is a theory behind this concept. This theory is called the demand theory. The question here is, what is the demand theory?

Demand theory is an economic theory that explain the relationship between consumer demand for goods and services and their prices in a market. The demand curve is the tool the represents the demand theory basis. The demand curve relates consumer desire to the amount of goods available. With more available goods or services, the demand drops and so does the equilibrium price (Hayes, 2019).

The demand theory focuses on the role that demand plays in price formation, while supply theory focuses on the role of supply in the market. Understanding the demand Theory needs to understand the specific definition of demand. Demand is the quantity of a good or service that a consumer or consumers are willing and able to buy at a given price in a specific time (Hildenbrand, 2014).

Demand exist when individuals within an economy demand goods and services to satisfy their wants, such as food, healthcare, clothing, entertainment, shelter, etc. The demand for a product at a certain price reflects the satisfaction that an individual expects from consuming the product. This level of satisfaction is referred to as utility and it differs from consumer to consumer (Triplett, 1976).

The demand basically depends on two main factors. The first factor is the utility to satisfy a consumer need. The second factor is the consumer's ability to pay for the good or service. Therefore, the effective demand is happened when a good or service is ready to satisfy a consumer want accompanied with an individual's ability and willingness to pay.

The demand theory is one of the important microeconomics theories. It answers the basic questions about how people want things, and how their demand can be impacted by their income levels and satisfaction. Based on the perceived utility of goods and services by consumers, companies adjust the supply available and the prices charged (Rachlin, et al, 1976).

Many factors can affect the demand such as consumer preferences, tastes, choices, etc. estimating and evaluating demand in an economy one of the important decisions making that a business must analyze to survive and grow in a competitive market (Shafer and Sonnenschein, 1982).

The market system is usually restricted by the laws of supply and demand. These laws determine the prices of goods and services in that market. When supply equals demand, prices are in a state of equilibrium. When demand is higher than supply, prices increase to reflect scarcity. However, when demand is lower than supply, prices fall due to the surplus (Shafer and Sonnenschein, 1982).

4.2.2 The law of demand and the demand curve

The law of demand represents the inverse relationship between price and demand for a good or service. It states that when the price of a commodity increases, demand decreases, assuming other factors remain constant. In addition, when the price decreases, demand increases. This relationship can be shown graphically using what is known as the demand curve (Weber, 2012). Figure (4.1) below shows the demand curve.

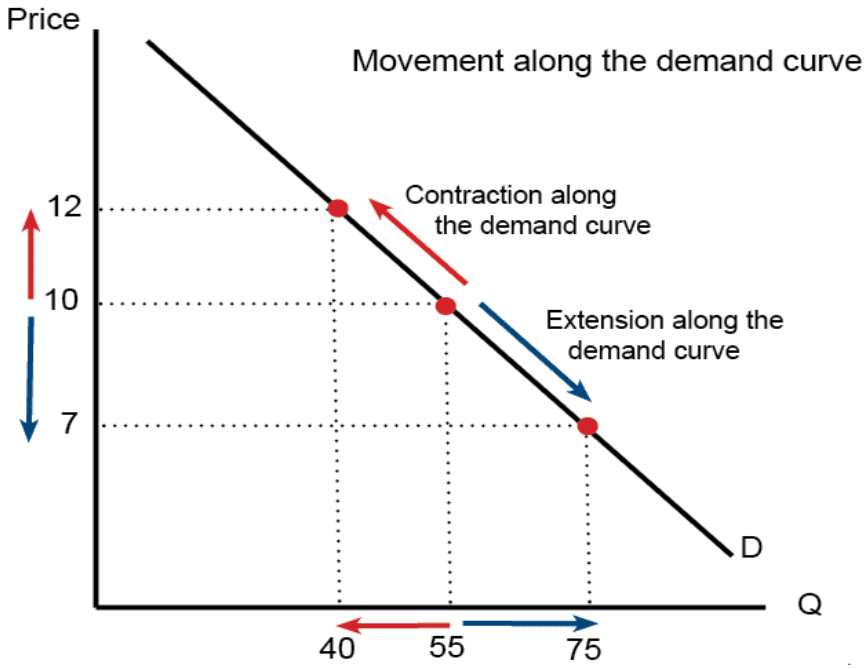

Figure 4.1: The Demand Curve.

Source: (Weber, 2012)

The demand curve has a negative slope downward from left to right to reflect the inverse relationship between the price of and the quantity demanded over specific time. The expansion or contraction of demand happens under the income effect or substitution effect.

When the price of a good or service falls, an individual can get the same level of satisfaction with less spending. That is, the consumer can purchase more of the goods or services using same budget. That is called the income effect. The substitution effect is when consumers switch from costly goods to their substitutes that have lower prices. As more people buy the good with the lower price, demand will increase.

The price is not the only factor that effect demand even it is the main factor. Sometimes, consumers may buy more or less of goods or services due to factors other than price.

This kind of change in demand explains the shift in the demand curve to the right or left based on the change in consumers' preferences. For example, a consumer who receives an income raise at work will have more disposable income to spend on goods in the markets, regardless of whether prices fall, leading to a shift to the right of the demand curve (Kemp, et al, 1992).

For some special cases, the law of demand can be violated. For example, when dealing with Giffen or inferior goods, if the price increases, the demand increases. Giffen goods are inferior goods that people consume more of as prices rise, and vice versa. Because of the Giffen goods do not have available substitutes, the income effect will dominate the substitution effect.

4.2.3 The relation between demand and supply

The relation between demand and supply forms an economic theory that explains how supply and demand are related to each other. In addition, it shows how that relationship affects the price of goods and services. The idea of this theory is that when supply exceeds demand for a good or service, prices fall. However, when demand exceeds supply, prices tend to rise (Buchanan, 1968).

Supply has an inverse relationship with prices of goods and services. That is when an increase in supply for goods and services happened while demand remains the same, prices fall. As a result, lower equilibrium price and a higher equilibrium quantity of goods and services will be achieved.

However, if there is a decrease in supply of goods and services while demand remains the same, prices will rise. As a result, a higher equilibrium price and a lower quantity of goods and services will be achieved. The same idea holds for the demand of goods and services. However, when demand increases and supply remains the same, the higher demand leads to a higher equilibrium price and vice versa.

Both supply and demand move up and down until reaching an equilibrium price. Figure (4.2) shows an example of reaching an equilibrium price. Suppose a good that its price was set to P1. Assuming that the initial demand was high because of marketing advertising. However, not too many consumers are willing to pay that price (P1) for this good.

As a result, the sales of the new item will quickly fall, creating an oversupply and driving down demand for the item from D1 to D2. The company that made the item must reduce the price to P2 as a response to demand reduction. The new price should balance the supply and the demand for the item to ultimately reach an equilibrium price.

What this section tells us is that the technology in general is considered as one of the goods. Technology in general and laser technology in specific can follow the ideas of the demand and supply theory. Therefore, it is possible to estimate the demand for Laser technology and laser applications in a market and test the effect of some factors on the size of demand for Laser applications.

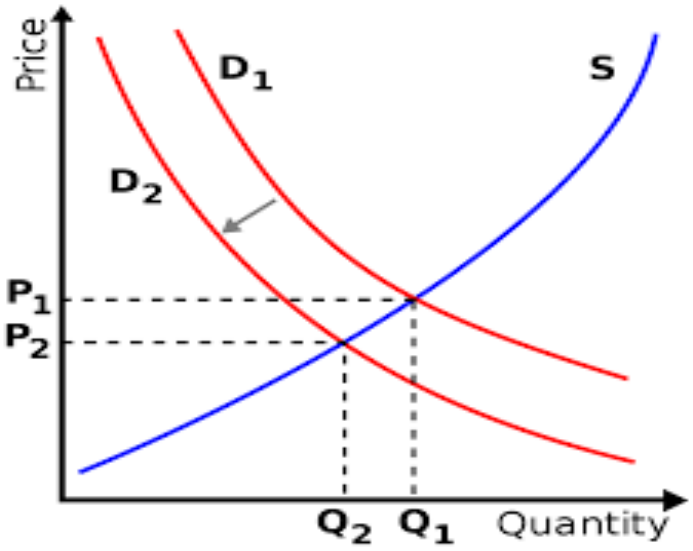

Figure 4.2: Example of Reaching an Equilibrium Price.

Source: (Buchanan, 1968)

4.3 The demand function

The first part of this section introduces the demand equation and explains its variables. The second part introduces the empirical work to estimate the demand for laser applications.

4.3.1 The demand equation

The demand equation is a mathematical relationship between the quantity of a good or service demanded and the factors that affect that demand. These factors can basically effect the willingness and ability of consumers to buy goods and services, (Wikipedia, 2020).

The demand equation takes the form:

$$Qd = f(P1, P2, Y, X) \quad \textbf{(4.1)}$$

Or

$$Qd = constant + P1 + P2 + Y + X + e \quad (\textbf{4.2})$$

Where Qd in equation (4.2) is the quantity of a good demanded, P1 is the price of the good, P2 is the price of a related good, Y is income, and X is a set of other variables the can affect the demand. The function on the right side of the equation is called the demand function. The form of equation (4.2) represents the estimation form of the demand equation. In equation (4.2), the e is the error term.

4.3.2 Estimating the demand equation

A simple example of an estimated demand equation is:

$$Qd = 325 – P2 - 30P2 + 1.4Y + e \quad \textbf{(4.3)}$$

Assuming the demand of a good can be affected by p1, p2 and Y while X is constant, equation (4.3) represents an estimated demand equation. Where 325 is a (constant) which is the repository of all relevant non-specified factors that affect demand for the product. The coefficient of P1 (price of the good) is negative based on the law of demand.

The coefficient of P2 (price of alternative good) is negative which indicate that the related good is a complement; otherwise, it will be a substitute. The income (Y) has a positive coefficient which indicating that the good is a normal good. If the coefficient were negative, the good would be an inferior good.

4.3.3 Method and technique to estimating the demand for laser applications

This section introduces the method to estimate the demand function. Liner Regression Model is applied to estimate the demand of laser applications. LRM is statistical method to modeling the relationship between two or more variables. One of them is the response variables (dependent variable). The other variables are the explanatory variables (independent variables). With one explanatory variable, the

model is called simple linear regression. With more than one explanatory variable, the model is called multiple linear regressions, (Wikipedia, 2020).

In this model, the relationships are modeled using linear predictor functions whose unknown model parameters are estimated from the data. The LRM is used here because the models that depend linearly on their unknown parameters are easier to fit than models that are non-linearly related to their parameters and because the statistical properties of the resulting estimators are easier to determine.

The goal of using LRM is for prediction, forecasting, and error reduction. That is because linear regression can be used to fit a predictive model to an observed data set of values of the response and explanatory variables (Barten, 1968). Figure (4.3) below shows the estimated prediction line resulting from using Liner Regression model.

4.3.4 The estimation of the demand for laser applications

The model that estimate the demand for laser applications is:

$$Qdi=\beta i + \alpha i\, Pi + \gamma i\, Yi + \epsilon i \qquad \textbf{(4.4)}$$

Where, Qd is the variable that represents the quantity demanded of laser applications (dependent variable). Yi in this (in term of data) is the amount of money that a company, which produce laser application, sold in a year. For example, if a company (i) sold $250000 in 2019, Yi will be that amount.

Pi represents the average prices of laser applications that a company (i) produced within a year. Yi is the amount of revenues (money) of a company (i) which did buy laser applications in a year. ϵ is the estimation error. The (βi, αi, and γi) are the coefficients.

It is important to note that the buyer's companies in this case are the customers of the sellers within a year. In addition, the revenues of the buyers reflect how good their strategic managements in a specific year are. That is because strategic managements as discussed before can led to reduce costs especially when using laser technology and increase the revenues.

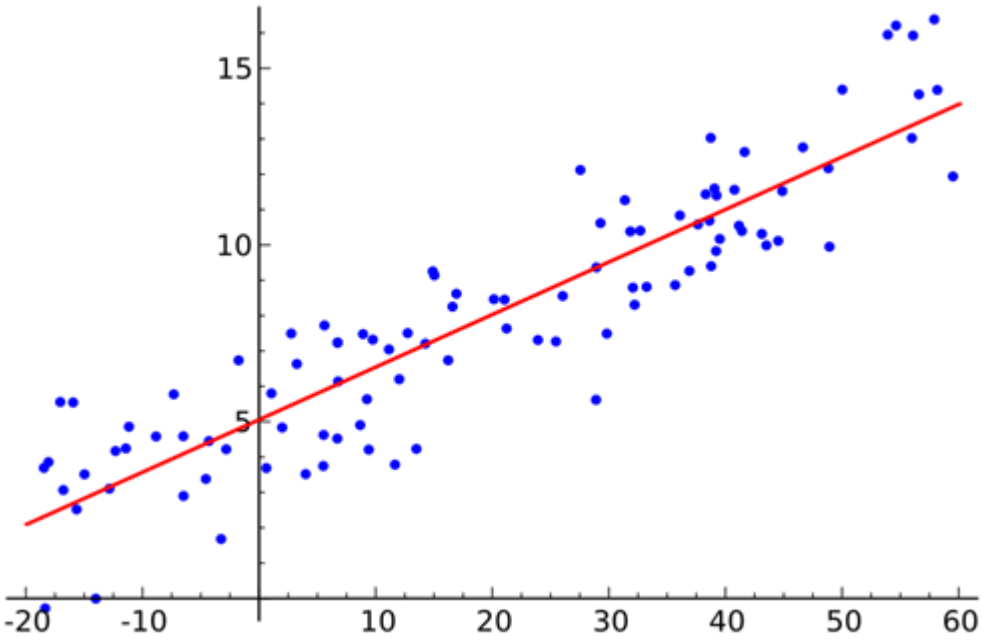

Figure 4.3: The Estimated Prediction Line Resulting from Using Liner Regression Model

Source: (Wikipedia, 2020)

4.3.5 The estimation results and discussion

Using R programming to do the estimation, the estimation results are shown in table (4.1) Table (4.1) shows the estimation results of four years (2015, 2016, 2017, and 2018). First, the estimation was for four years to show the changed in demand over time. Second the years were chosen because the world economy was doing well over these years which can avoid unexpected events. All the date was taken from the Fundamental Analysis website. The data has 680 company that sell laser applications with their customers for each year. That means the estimation size (n) is 680.

Table 4.1: The Estimation Results of Four Years (2015, 2016, 2017, And 2018).

Estimated year	constant	P coefficient (αi)	Y coefficient (ɣi)
2015	47.244671**	-0.001338	0.004645*
2016	49.462215**	-0.001143	0.002356
2017	50.282943**	-0.003098	0.001372
2018	52.089898***	-0.004627*	0.003452*

*** significant at 1%, ** significant at 5%, * Significant at 10%

The results in table (4.1) shows that price (variable P) has a negative relationship with the quantity demand, which is in line with the demand theory. That is, when the

price of laser applications increases, the quantity demanded will decrease. However, the price coefficient of 2018 year is the only significant one at 10% significant level.

The results in table (4.1) shows that revenues (variable Y), which represent companies' strategic managements, has a positive relationship with the quantity demand which is in line with the strategic managements theory. That is, when the Y increases (good strategic management), the quantity demanded will increase. However, the Y coefficient of 2015 and 2018 years are the only significant ones at 10% significant level.

The results in general indicate that good SM may lead to increase in demand of laser applications.

5. CONCLUSION AND RECOMMENDATIONS

The high competition between companies have led them to have new innovations and advance technology. Having advance technology is considered as one of the most important actions of companies Strategic Management. That is because new innovations and advance technology can help produce high quality of goods and services. In addition, it can help reduce time and costs of the products. That, by the end can make high customer satisfaction.

laser technology applications have become more common in different industrial. More specifically, there is growing demand for laser technology applications around the world in manufacturing, health care, space, and other fields. However, it is still needed to empirically test the impact of SM of these companies on the demand for laser technology applications.

Many studies show that technology has significant impact on every part of our life. Technology has significant impact on our education, health, agriculture, energy, manufacturing, and more. Technology has made our life easier and more developed. Laser technology is special one because it has special characteristics and can do more advanced works with high quality, accuracy, and productivity. It has many types of applications that can be used in different fields which makes it more attractive than other innovations and technologies.

Using R programming to do the estimation. The estimation was for four years (2015, 2016, 2017, and 2018). First, the estimation was for four years to show the changed in demand over time. Second, the years were chosen because the world economy was doing well over these years which can avoid unexpected events. All the date was taken from the Fundamental Analysis website.

The data has 680 company that sell laser applications with their customers for each year. That means the estimation size (n) is 680. The results show that good strategic managements may lead to increase in demand of laser applications.

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APPENDICES

Appendix A

Table A.1: R Programing Code for Linear Regression Model.

The R Code	The Action
data <- read.delim ("C:/Users/ /Desktop/Rabab/Data/data.txt")	Reading the data file
> View(data)	Checking the data
> attach (data)	Preparing the data for use
> regression <- lm (q ~ p+r)	Running Linear Regression Model q is the dependent variable p and r are the independent variables
> summary (regression)	View the results of the regression

Appendix B

Table B.1: Example of Data Set.

q (million $)	p (*1000 $)	r (million $)
65	23	830
77	137	674
88	654	51
24	382	1348
9	785	38
74	774	1397
19	770	677
46	242	651
7	261	673
53	122	14
20	133	417
61	49	142
13	423	954
30	966	849
93	754	841
72	634	632
93	220	1336
41	240	469
89	437	929
77	953	695
58	62	1296
97	213	1179
5	225	204
74	292	1176
15	691	158
46	110	1190
32	435	328
44	694	150
84	990	753
91	851	1233
32	248	1080
92	17	1068
8	632	570

RESUME

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