Evolution of the Principles and Practises in Management

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Abstract—By surveying on the history of operations and service management (OSM), it is found that the evolution of the principles in OSM is governed by at least four interrelated factors: (1) increasing complexity of production processes, (2) expanding scope of quality, (3) increasing focus on services and (4) advancing development of technologies. Besides, some phenomena are observed from this survey. Their existence seem not related much to with the history of management. First, there is a persistent increasing demand on the product features & functions and/or service contents. Customers expect products to have more intelligent features. Second, people have not been aware of being discriminated. The discrimination is due to the increasing level of intelligent of the products. Third, executives seldom use design models to communicate strategic decisions already made and the implementation of such strategies. Accordingly, six possible future trends in operations and service management are identified. (1) Production processes would be increasingly complex because of the increasing demand on new features of a product or service. (2) The scope of quality would extend to cover customer quality. (3) Service-oriented thinking would be adopted in both the product/service design and the design of production or service delivery processes. (4) More advanced automated and robotic technologies would be developed to automate the production or service delivery processes. (5) Advancing intelligent systems and machines would appear. (6) The demand of operational, administrative and managerial staffs will decline and hence management schools would be refashioned. These trends reveal that the *future managers* would have to face a lot more challenges than the *past and present managers* ever had. The managers who could stay would likely be those who have dual-level thinking ability. On one hand, they could have an enterprise-wise and even industrial-wise (i.e. macroscopic scope) thinking. On the other hand, they could have fine-detail operational level (i.e. microscopic scope) thinking.

Index Terms—Operations Management, Service Management, Production Complexity, Quality, Technologies.

CONTENTS

I. INTRODUCTION

The beginning of the evolution of the principles of the modern operations[1] and service management is usually referred to the second half eighteenth century in which an English economist Adam Smith published his book *An Inquiry into the Nature and Causes of the Wealth of Nations* in 1776 [1]. The time is around the beginning of industrial revolution. In that moment of time, Europe was one of the powerful continental in the world, with lot of scientists and inventors developing various kinds of tools and machines for industrial automation, such as automated spinning mill and flour mill. Entrepreneurs started up factories in cities gathering labors to produce products for export [2][2]. In subsequent decades, many scholars had published books sharing their experience and viewpoints on manufacturing systems [3], [4], [5], [6]. But one point should be noted. The earliest literatures on operations and service management, especially on the specialization and division of labors, can date back to a few thousand years ago in ancient Greece and ancient China.

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[1]In this paper, operation and process are used interchangeably. For instance, business operations and business processes are referred to the same thing. Besides, labor, staff and employee are used interchangeably for referring to a person who is working in the firm.

[2]The book was written by Richard Cantillon and published in 1755.

A. Operations & Service Management

Generally speaking, operations and service management is about the design and management of production operations and service delivery processes so as to meet the expectation of customers. Before 1960, operations management focused mainly on the management of manufacturing. In the second half of nineteenth century to the earlier twentieth century, US was one of the major outsourcing countries producing products to European countries. During World War II, many countries in the world were devastated and thus many factories were destroyed. Only US and Japan could have factories to produce things to the world. In this regards, many principles in management evolved in that period of time are based on US and Japan experiences. Let us name a few of them – principles of scientific management [7], [8], assembly line production [9] and total quality control [10], [11], [12].

After 1960, this concept has been expanded to cover the management of services. From 1900 to 1960, the US population raised from 76 million to 180 million [13]. Expect in the period of great depression, the internal demand on everything raised and many people became rich. Thus, as noted by Victor R. Fuchs [14] that more than half of the employed population in US in the 1960s was involved in providing services including banking, health care, retailing, and education. The percentage was kept increasing in the subsequent decades which led to the emergent field called service management. Service management was introduced in 1982 by Richard Norman [15]. Norman and Grnroos found that traditional management overemphasized on cost reduction efforts and scale economies. It might become a management trap in service firms resulting low quality of service, deteriorating internal workforce environment, hurting customer relationships, and eventually affecting the interest of a customer on a service [16]. Albrecht [17] asserted that service management is a total organizational approach to deliver high quality of service to the customers is the main driving force for the business.

In summary, operations and service management is about (i) the management of the elements within an organization in order to deliver quality services/products to the end customers, such as the processes, the people and the tools; and (ii) the management of the usage and the development of the services/products.

B. Personal Believes

Before proceeding to the main contents of this paper, I would like to express some of my believes regarding management principles so as to let the readers have better understanding my tones in making comments later in some contents of this paper.

1) Make things work and make them work better: [3] As an engineering graduate, I believe that management principles could only be effectively applied to the people who know how to make things work and how to make them work better. They

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[3]Precisely, we should make the best thing and solve a problem using the optimized solution. Good thing and workable solution are not enough.

see the big picture as well as the details. Their management principles are evolved naturally by their repeating improving their works [4]. Let me give a few examples.

Henri Fayol started his career as a mining engineer. Throughout his life time, he was working entirely in the mining & steel business and eventually being a managing director. Almost at the time of his retire, he summarized his experience on administration in his book *Industrial and General Administration* in French in 1916. Later, this book was translated in English and published in 1930 [18]. Nowadays, his theory is widely called administrative theory.

Frederick Winslow Taylor started his career as an apprentice in steel industry. Later, he was promoted as a machine shop foreman and responsible to design how to improve the productivity. From that experience, he came up with the methods of shop management in his hook *Shop Management* [7] and the principles of scientific management in his book *Principles of Scientific Management* [8]. Moreover, he influenced one of his colleague Henry Laurence Gantt (also an engineer) to come up with the progress chart (i.e. Gantt Chart) in the book *Organizing in Work* [19].

Chester Barnard started his career as a statistician clerk in AT&T and eventually the vice-president of AT&T and the president of NJTT until retire. With his throughout experience as a operation staff, executive and the president, he came up with the book *The Functions of the Executive* [20].

Their principles were evolved solely by their working experience. Now, these principles turn out to be the foundation on the principles of management. Here, we only mention a few contributions from them in the principles of management. As a matter of fact, their contributions are a lot more than your imaginations. Like Henry Laurence Gantt, he had also mentioned about how to improve productivity by carefully designing a waging system [21]. Chester Barnard had written articles talking about executive education.

The aforementioned pioneers are only a few leading icons in the earlier twentieth century who contributed principles in management. Many more you can find in Google and Wikipedia, like Henry Ford, Frank Gilbreth, Jack Welch, Steve Jobs and Morris Chang. All these people have some characteristics in common. They are able to learn new things. They know how to do things and how to do things better. Their principles of management are evolved from their working experience, the problems encountered and the methods for solving such problems.

2) Beware of "thinking outside the box": As stated in Wikipedia[22]: *"Thinking outside the box" was popularized in part because of a nine-dot puzzle, which John Adair claims to have introduced in 1969. Management consultant Mike Vance has claimed that the use of the nine-dot puzzle in consultancy circles stems from the corporate culture of the Walt Disney Company, where the puzzle was used in-house.*

"Thinking outside the box" has always been linked to "creative thinking". If you want to be creative, you need to think outside the box. However, what bothers me the most is

that many people use this as an excuse to ignore what is inside the box. Without throughout understanding what is inside the box, how could you tell people that your idea is creative. It does not overlap with what is inside the box. "Thinking outside the box" turns out to be an excuse for people not to learn what is inside the box (a common management behavior). *Why should I learn to know what is inside? It is your job to learn and tell me what is inside. I have already told you my creative idea coming from outside the box.* Sounds familiar!

To me, "thinking outside the box" and "thinking inside the box" are both important philosophies for solving problems. Which one is more important? I opt to "thinking inside the box", as it is the traditional way of thinking that we were educated in schools. "Thinking outside the box" should better be referred to an alternative of thinking for solving a problem. If you could not think of a solution to solve a problem, take another approach to think. It might give you some hints to have the solution. Which approach should it be? No one knows. But one should be noted that. If you could not think of a solution from the first approach, does it mean that the first approach is not the right approach? It might not be. It could be due to the incapability of a person but not the approach.

Therefore, one should be aware of the myth of "thinking outside the box". Sometimes, you believe that you are thinking outside the box. The truth is that you are still thinking inside the box.

Nevertheless, the ability of problem solving is not depended on whether you can think inside or outside the box. Strictly speaking, it depends on the talent of the person who is assigned to solve the problem.

3) Beware of "management black hole": We would also like to bring the awareness of another issue I called the "management black hole" (will describe it shortly). Should a manager know how to do thing (the job he/she is managing)? My answer is definitely "YES". Many managers (resp. professors) claim that they are good in management because they are good in managing people to do things (resp. researches). They do not have to know how to do the things. They do not have to do the things.

I believe that many people like me do not accept this claim. If the aforementioned claim is accepted, it would happen something like that. *A good manager is someone who could manage someone to manage someone to manage someone ⋯ to manage someone to do things* – "the management black hole". In the end, how many managers are needed in order to make things work. It could be infinite. It is a waste of human resources (as well as cost). Nevertheless, no manager in this infinite loop knows how to define the quality factor for the jobs or the things simply because no manager knows how to do the things. Every person should be aware of it.

Therefore, managers must know how to do the things that they are managing; they must know how to do them better; and not simply managing people to do them.

4) Beware of "the theory" and "the principle": In the literatures, it is not difficult to find a lot of so-called "theory" in management [23], such as administrative theory and agency theory. How to treat those theories? I follow the point of

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[4]See Appendix A and Appendix B for the examples illustrating what do I mean by this.

view from Arthur D. Hall [24] – *the theory is largely a generalization of experience reflecting perhaps the best of what exists now, with gaps filled in by what the author thought the practice ought to be*. These theories might be applicable in some instances. But, for other instances, they could be failed. They are not the silver bullets. Take one example, Michael E. Porter raised the issues regarding competitive advantage and popularized the five forces model for strategic analysis [25], [26]. However, a consultancy firm he founded was bankruptcy and then sold. Why?

So, the application of a management theory or principle should depend on the situation. It is case by case. Therefore, the only theory in management that I buy is the contingency theory. One should have a clear distinction between management theory and the theories developed in other disciplines like economic and science. This is one reason why I do not treat management, business administration and commerce as a scientific discipline.

C. Objectives of the Paper

While operations and service management (OSM) has been studied for many years and the principles in management have been introduced in many textbooks, not much of them has been done on suggesting the factors governing the evolution of such principles and anticipate the future trends in management principles.

This paper has three objectives. The first objective is to survey on the principles in management from four factors and/or perspectives, namely (1) increasing complexity of production processes, (2) expanding scope of quality, (3) increasing focus on services and (4) advancing development of technologies. The principles behind these factors will be introduced and the ideas of the principles advocated will be elucidated. Clearly, these factors are interrelated and they are not the sole factors influencing the evolution of such principles. Political and economic factors are another two that influence the evolution. But they are not the scopes that I am going to cover in this paper.

The second objective of this paper is to conclude from these factors three phenomena, I believe, that have been persistently appeared – (i) persistent demand for both the features of a new product and the content of a new service; (ii) discrimination of people and (iii) communication gap between strategic-level executives and operations-level managers.

The third objective of this paper is to anticipate the future trends in the principles of management along the four factors that we presented in the first objective. Moreover, I add one more anticipation about the obsolete of managers and management schools. It sounds scary but possible (at least I believe). My purpose of adding this anticipation is to let the readers better prepare for their future. As a matter of fact, not just the number of managers and management professors would decline in the future. The number of professors in other disciplines would likely decline as well.

In this paper, evolution on the principles of strategic management, innovation management, technology management, information management and organization theory will not be covered. They are not the objective of this paper. Due to my personal believe, the focus of this paper is on the principles of operations and service management. I believe that the key foundation of management should be operations and service management.

Management could only be accomplished by a good design (and re-design) of an operation and the management activities associated to such operation. In other words, it is about the design of the co-ordination of the people and the tools to work together to produce a product or deliver a service. The design needs to be in detail – what time a person or a tool should do what task. Only based on such foundation, it would be possible to modify the design by adding addition tasks for implementing a strategy. Without the holistic picture of the organization and the detail operations design as the foundation, it is meaningless to talk about strategy, innovation and other management principles.

D. Organization of the Paper

It should acknowledge that the content of this paper is based upon the thesis written by my research student Larbi Yu-Yun Lee entitled *Survey on Operations and Service Management* in 2015 [27], with substantial revision.

The evolution of the principles of management will be introduced in Section II, Section III, Section IV and Section V. We summarize the evolution of the principles in accordance with four major trends. The principles evolved by the increasing complexity on production process will be introduced in Section II. The principles evolved by the expanding scope of quality will be introduced in Section III. The principles evolved by the increasing focus on services will be introduced in Section IV. The principles evolved by the advancing development of technologies will be introduced in Section V. As observed from these four trends, three important observations will be presented in Section VI. Section VII will anticipate a few future changes regarding operations and service management. The conclusion of the paper is presented in Section VIII.

II. INCREASING COMPLEXITY OF PRODUCTION PROCESSES

The first trend is due to the increasing complexity on the production process. It starts from the principles of scientific management, through lean manufacturing and modularization, to global outsourcing.

A. Division and Specialization of Labors (Inception of Modular Design of Production Process)

One earlier concept in production is division and specialization of labor which is advocated by Adam Smith in 1776 [1]. In The Wealth of Nations, he described that division and specialization of labor is able to reduce the costs of production. For example, to produce a needle, four steps are required: (1) chopping a line of steel into small segments, (2) sharpening one end of a steel segment as the needle head, (3) hammering the other end to be a flat end and (4) punching a small hole in the middle of the flat end.

Traditionally, making a needle was solely done by a single craftsman. So, the cost was expensive. However, Adam Smith suggested that the first and the third tasks could be assigned to a low skill labor, as the skill required to accomplish these two tasks are low. The craftsman only works on the second and the fourth tasks which require higher technical skill. In such case, the product cost of a needle would be reduced.

While Adam Smith is the first economist advocating the concept of division and specialization of labors, the concept has long been existed in the government administration, like in ancient China. The officers in the government were divided into different regional governments. Each regional government was responsible for the administration of a local region. Moreover, the central government was also divided into different divisions. One was responsible for census and taxation. One was responsible for the engineering projects in the country. One was responsible for policy making, law enforcement and criminal investigation. Clear division of labors had already been implemented.

B. Interchangeable Parts (Modular Design of Product)

The first concept of interchangeability occurred in the 18th century. Around 1798, the United States was influenced by the French Revolution, Whitney entrusted by the US government to make 10,000 to 15,000 rifles for the US military in 1800. At that time, each gun from beginning to end was built by a craftsman. The components of the guns of the same model were not interchangeable. Eli Whitney thus designed a gun which is assembled by interchangeable components. In other words, the components are interchangeable [28].

Once a component of a gun is broken, it could simply be replaced by the component of the same type. If a product can carefully be designed by interchangeable components, productivity of manufacturing such products could be improved by designing the production process as a series of assemble processes. High technical skill workers make those components and low skill labors do the assembling. The number of high technical skill workers required in production could largely be reduced. Thus, the production cost would be reduced. Repairing of a product could also be made easy, as repairing is simply done by replacing the defective component by a non-defective spare part. The concept of interchangeable part had been kept expanding in the subsequent decades to other industries, such as automobile and computer industries.

C. Scientific Management (Boosting Productivity)

Around 1910s, the scientific management was advocated. Frederick W. Taylor [7], [8], Henry L. Gantt [21], [19] and Frank B. Gilbreth [29] developed scientific methods for operations management [30], with focuses on managing and improving the productivity of workers. The ultimate goal is to design the production process in its best way that the tasks to be done could be simplified, the performance of the workers could be improved and the flow of materials in the workshop could be faster. As a results, the productivity of the workforce could be elevated.

To simplify the tasks to be done, one approach was called the motion study [29]. By filming the motions of the workers in performing tasks and analysing the time spent in completion the tasks, the average performance of a worker in a task could be evaluated. Further by design and re-design of motion sequence, the performance of a worker in completing a task could be raised. To motivate workers to come up with efficient motion sequence (or new procedure or new skill in completion a task), Frederick W. Taylor promoted the worker who had such new idea to be a foreman. The foreman would have to train other workers to learn this new skill. In this regards, the tasks to be done could be simplified and the performance of the workers could be improved.

To assemble a product (like metal train wheel), it involved many machines which were located in different locations in a workshop. Fredrick W.Taylor had been aware that the locations of the machines should be arranged in a way to shorten the distance of the movement of the semi-product. That is to say, production schedule should be taken in account for the arrangement of the machines so as to reduce the time spent in delivery the semi-product from one machine to another. It is what Frederick W. Taylor called shop management [7].

To further motivate the workers to lift-up their production efficiencies, engineers in the era of scientific management developed many different waging systems to their workers, as compared with flat waging [21], [19]. One should not mix it up with the differential waging system described by Adam Smith [1]. In Adam Smith system, the purpose of differential waging is for cost cutting. In scientific management, the purpose of differential waging is for motivating workers to work harder. How to do that? One simple example was to define the earning of a worker as a convex function of the number of products he/she produced. Clearly, the workers would try the best to produce as many as they could.

In this era, another important development was the Gantt chart. Henry L. Gantt originally called it progress charts [19]. Gantt chart depicts which worker should do what task at what period of time. It thus could help managers and workers to schedule and keep track of their tasks to be done in a project.

While there were critics on the motion study in scientific management, the spirit of scientific management still exists nowadays and Gantt charts are widely used today in operations management.

D. Assembly Line (Automated Material Flow)

Assembly line has long been appeared in ancient China [31]. The appearance of modern assembly line could be traced back to 1901, when Ransom Olds utilized electricity-driven assembly line in car manufacturing. Later in 1913, Henry Ford practically applied the concept of assembly line with electricity-driven conveyor belts in car manufacturing.

According to Henry Ford, the design of an assembly line is based on three principles [9].

1) Place the tools and the men in the sequence of the operation so that each component part shall travel the least possible distance while in the process of finishing.
2) Use work slides or some other form of carrier so that when a workman completes his operation, he drops the

part always in the same place–which place must always be the most convenient place to his hand and if possible have gravity carry the part to the next workman for his operation.

3) Use sliding assembling lines by which the parts to be assembled are delivered at convenient distances.

As a result, it led Ford Motor producing Model T in ninety-three minutes. The cost of car production was reduced and the selling price of a car dropped. Eventually, automobile became popular in USA.

Henry Ford's principles in the design of his assembly line match the principles advocated in Scientific Management. His first and third principles are essential in the same spirit of shop management advocated by Fredrick W. Taylor [7]. Carefully design on the flow of component parts could largely reduce the time of production. His second principle is in the same spirit as in the motion study advocated by Frank B. Gilbreth [29]. In other words, Henry Ford successfully realized the Principles of Scientific Management to a much larger-scale level.

Again, Henry Ford's story supports what my believe. Before Henry Ford, many people should have heard of and even leant the principles of scientific management. However, how many of them could actually realize such principles. Henry Ford did. By considering every aspect regarding the production of a car, he came up with a complicated but efficient production design along with the design of the factories, power houses and other facilities for the employees [32]. These works were ever easy but he made it.

E. Modular Production (Modular Design of Production Process)

Owing to increasing demands on the variety of products from customers, traditional production methodology which focused on producing high volume and low variety of products could be ineffective. Therefore, Martin K. Starr introduced a concept of modular production in 1965 [33]. Generally speaking, modular production is divided a product into parts and manufactures each part separately. Subsequently, workers assemble these parts to compose a product. These different parts can be manufactured in one place or different place [33]. Since this new concept for production can reduce cost, improve quality and speed up the innovation, many manufacturers adopt this new concept as their production method.

One of the most famous examples is automobile industry. We take Volkswagen as an example. The new truck factory of Volkswagen in Resende, Brazil, divided the truck into many modules provided by different suppliers. The suppliers had to get their materials and hired their workers to build independent modules. Volkswagen only established the architecture of the production process and modules, set the standards of quality for every supplier, and tested each module and truck in every stage of production in Resende [34]. In conclusion, the concept of modular production has been well established in manufacturing and computer industries, but in recent years, this concept has become an emerging force in service industry, too.

F. Lean Manufacturing (Reducing Waste)

After many years, the production process became more complex than before. The term of lean was derived from the Japanese manufacturing industry. Lean manufacturing is a management philosophy derived from the Toyota Production System (TPS), and it is also called Toyotism. This principle was first coined by John Krafcik for his master's thesis in 1988. Later, James P. Womack and Daniel T. Jones continued his research and co-authored a book titled The Machine that Changed the World in 1990 [35]. The book pointed out that the key success of Toyotas high quality products and high performance production is based on its "Lean. It extends from the concept of mass production manufacturing by adding two new ideas waste elimination and rapid response to customer needs.

Toyota identified seven types of waste which are needed to be eliminated, namely transport, inventory, motion, waiting, overproduction, over-processing, and defects [36]. Transport waste refers to moving products that are not actually required during the production process. Inventory waste refers to all components, works, and finished products not being processed. Excessive storage of the raw materials and semi-products are clearly a waste. Motion waste refers to the movement of people or equipment more than required during the production process. Waiting waste refers to the time spending in waiting for the next production step, interruptions of production during shift change. As the name implies, overproduction waste refers to production ahead of demand. Over processing waste refers to the waste due to poor tool or product design creating activity. Defects waste refers to the effort involved in inspecting for and fixing defects.

As a result, elimination of waste could lead to reduction in production cost and hence the reduction in selling price of car. Rapid response to customer needs could thus improve the customers perceived quality of services associated with car selling and hence enhance the customer relationship. Moreover, rapid response to customer needs could lead to rapid response to the market and introduce new products to the market earlier than other car manufacturers.

It should be noted that the ideas in lean manufacturing overlap a lot with the ideas of total quality control and total quality management, as introduced later in Section III-B and Section III-C. Their ultimate goals are the same – to increase and improve the productivity of a firm. Clearly, quality must be one key performance index in "productivity".

G. Mass Customization (Product Diversification & Customer Involvement)

The motivated reason for introducing mass customization is similar to the reason why Martin Starr introduced modular production [33]. There is an increasing demand on the variety of products. Mass customization refers to the use of highly skilled, flexible work force to make varied and often individually customized products at the low cost of standardized, mass-produced goods [37]. The concept of mass customization was first introduced by Alvin Toffler in 1970. Toffler [38] thought that mass customization would be a trend after 1970. In 1993,

B. Joseph Pine II et al. in Making Mass Customization Work, in Harvard Business Review [37] confirmed Toffler speculation by introducing the success of various manufacturers, including Toyota and Motorola, in mass customization. For example, Motorolas pager factory in Boynton Beach, Florida can produce pagers in lot sizes based on the order from a customer within hours.

With reference to Pine II, mass customization could be categorized in four types[37]. The first type is collaborative customization. A manufacturer co-designs with customer the specification of a product that best meets the customers need. Subsequently, the design specification will be sent for manufacturing the product. The second type is adaptive customization. A manufacturer produces a standardized product with various combinations that can be programmed. Thus, a customer can alter the product features based on his/her own interest. The third type is transparent customization. Each customer can get from a firm a particular product/service that fits for his/her need. The customer never knows that the product is in fact a customized product. One example is the cloud storage services. The service providers normally need to customize the resources to different users. However, users do know how the service providers allocate the resources to them. They simply connect to the Internet and get the services. The last type is cosmetic customization. A manufacturer produces a large variety of standardized products to different customers. It happens usually in cosmetic industry. Normally, different ladies would like different colors and odors of a lipstick. So, a cosmetic manufacturer produces different colors and odors of the same model of lipstick in order to fit for the needs of the customers.

H. Global Outsourcing (Global Factory)

The term "outsourcing" can be traced back to 1980s. In order to maintain the core competitiveness, the enterprise will delegate non-core business process to other enterprises. The reason is that outsourcing can reduce operating costs and labor costs. According to the geographical distribution of suppliers, outsourcing can be classified into two types. One is onshore outsourcing, which refers to the suppliers come from the same country as the outsourcers, and completes the work in their country. Another is offshore outsourcing, which refers to the suppliers come from different countries from the outsourcers, and completes the work in different countries. The offshore outsourcing first emerged in 1990s. Subsequently, due to the thriving of globalization and the development of technology, the enterprises increasingly outsourced to the suppliers in different countries. Finally, here comes the generation of global outsourcing.

III. EXPANDING SCOPE OF QUALITY

The second trend is due to the evolution of the concept of quality. It starts from the narrow definition of quality which focuses only on product quality, to a broader definition of quality which focuses on both product and process (product process, marketing process and service delivery process) qualities. Thus, it leads to the evolution of the principles from quality control, to total quality control and to total quality management. Eventually, international standards like ISO 9000 series and Six Sigma appear.

A. Quality Control (On Product)

According to the definition from Juran, quality control is a universal managerial process for conducting operations so as to provide stabilityto prevent adverse change and to maintain the status quo [39]. The concept of quality control has been used for a long time. It can be traced back to year when The Principles of Scientific Management by Fredrick W. Taylor was published. Taylor, in this book, has explicitly suggested that at least one boss called inspector has to be assigned for quality inspection.

The inspector is responsible for the quality of the work, and both the workmen and speed bosses [who see that the proper cutting tools are used, that the work is properly driven, and that cuts are started in the right part of the pieces] must see that the work is finished to suit him. This man can, of course, do his work best if he is a master of the art of finishing work both well and quickly [8]. Taylors notion of process analysis and quality control by inspection of the final product still apply by many firms today [40]. Later, in the 1920s, W. Shewhart applied the statistical methods into quality control which is called the statistical quality control (SQC) for managing the qualities of the products and the business processes[41].

One of the key tools used in SQC is control chart. It is a tool used to determine if a manufacturing or business process is in a state of statistical control. The control chart is simply a time series chart recording the changes of quality measures of the products/processes of concern in a daily basis with reference to (1) the range (specified as the upper control limit and the lower control limit) of the values in which the quality measures should fall in and (2) the expected value (specified as the control limit) of the quality measure. From the control chart, the manager is able to anticipate if there is a trend the quality is dropping. If it is, appropriate action can be done in advance to correct the production.

While Shewharts laid the techniques fundamental for SQC, Deming advanced the method by introducing 14 principles, also called the Deming 14 Points Program, amended to the ordinal scope of Shewharts SQC [42]. For instance, one principle (Point 9) is that barriers should be removed between departments and the staff areas. Another principle (Point 13) is that the organization should institute a vigorous program of education and encourage self-improvement for everyone. What an organization needs is good people and people who are improving with with education. Advancement to a competitive position will have its root in knowledge. In 1947, Deming was involved in early planning for the 1951 Japanese Census. The Allied powers were occupying Japan, and he was asked by the United States Department of the Army to assist with the census. While in Japan, his expertise in quality control techniques, combined with his involvement in Japanese society, brought him an invitation from the Japanese Union of Scientists and Engineers (JUSE) . JUSE members had studied Shewhart's techniques, and as part of Japan's reconstruction efforts, they

sought an expert to teach statistical control. From JuneAugust 1950, Deming trained hundreds of engineers, managers, and scholars in statistical process control (SPC) and concepts of quality [43]. Since then, SQC began to applied by Japanese industry.

B. Total Quality Control (On Product & Process)

Previously, quality control was mostly based on the statistical analysis, and it was only considered in the manufacturing activities, limited to the manufacturing and inspection department. It only can conduct a remedial work after finding a faulty product. In 1951, Feigenbaum proposed the concept of total quality control (TQC) [10]. It extends the concept of quality which focuses only on product quality to both product and process (product process, marketing process and service delivery process) qualities. TQC is a system which integrates the concept of quality development, quality maintenance, and quality improvement together, and indicates that all people in the organization should focus on the quality, in order to make the production and service delivery process on the most economical ways to fully satisfy customers needs. In 1968, Kaoru Ishikawa applied the concept of TQC in Japanese industries, and he termed this concept company wide quality control (CWQC).

C. Total Quality Management (On Everything in an Organization)

In 1970s, American manufacturing focused on quantity instead of quality, and they ignored the quality of products and services. In 1980, American manufacturing was suffered from the Japanese product and lost the international market. The National Broadcasting Company (NBC) launched a column in 1980, which is *If Japan can... Why can't we?*. It thus raised to the climax of learning and reflection. In 1985, the United States Navy Air Systems Command and Naval Air Depot brought up the term of total quality management (TQM)[44]. It illustrated how to apply Japanese management approach to improve the Navy's operational effectiveness and quality, and reduced aircraft maintenance costs.

TQM indicates that an organization should continuously improve its ability to deliver high quality products and services to customers. How to make it work? The firm has to consider everything related to the improvement of the production (resp. delivery) of a product (resp. service), including but not limited to the quality of the product (resp. service), the quality of the production process (resp. service delivery process), the quality of product (resp. service) design process, the quality of marketing process, the quality of financial control, the quality of staff, the quality of staff training, the quality of executive support and the quality of the management processes that support these processes. Stakeholders, customers, suppliers and partners could also be included in the scope of TQM. Clearly, implementation of TQM is never easy.

D. ISO 9000 Series (Benchmark I)

ISO 9000 is a powerful instrument, which cannot be disregarded. It is one of the most influential initiatives that grew from the quality management of the late 1980s[5]. The ISO 9000 requires users to document their quality assurance system and implement the activities that, when followed, should ensure appropriate management of quality assurance. Enterprise, once the documentation has been complied, can get from the third party the certification of the quality standard ISO 9000. In the earlier inception of ISO 9000, three standards are included.

- ISO 9001:1987 Model for quality assurance in design, development, production, installation, and servicing was for companies and organizations whose activities included the creation of new products.
- ISO 9002:1987 Model for quality assurance in production, installation, and servicing had basically the same material as ISO 9001 but without covering the creation of new products.
- ISO 9003:1987 Model for quality assurance in final inspection and test covered only the final inspection of finished product, with no concern for how the product was produced.

In its 1994 version, ISO 9000:1994 emphasized quality assurance via preventive actions, instead of just checking final product, and continued to require evidence of compliance with documented procedures.

The 2000 version sought to make a radical change in thinking by actually placing the concepts of process management, continual process improvement and tracking customer satisfaction as the focuses. In accordance with ISO 9004:2009, eight quality management principles are defined.

1) Customer focus – Organizations depend on their customers and therefore should understand current and future customer needs, should meet customer requirements and strive to exceed customer expectations.
2) Leadership – Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organizations objectives.
3) Involvement of people – People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organizations benefit.
4) Process approach – A desired result is achieved more efficiently when activities and related resources are managed as a process.
5) System approach to management – Identifying, understanding and managing interrelated processes as a system contributes to the organizations effectiveness and efficiency in achieving its objectives.
6) Continual improvement – Continual improvement of the organizations overall performance should be a permanent objective of the organization.
7) Factual approach to decision making – Effective decisions are based on the analysis of data and information
8) Mutually beneficial supplier relationships – An organization and its suppliers are interdependent and a mutually

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[5]Readers could browse the official website of ISO for further information http://www.iso.org/iso/home/standards/management-standards/iso_9000.htm.

beneficial relationship enhances the ability of both to create value.

Following these eight principles, an enterprise can compile a document submitted to a third party for certification. The main document to be submitted is the ISO 9001:2008 Quality management systems Requirements. It is supplemented by two other documents: ISO 9000:2005 Quality management systemsFundamentals and vocabulary and ISO 9004:2009 Managing for the sustained success of an organizationA quality management approach. Only ISO 9001 is directly audited against for third party assessment purposes. The other two standards are supplementary and contain deeper information on how to sustain and improve quality management systems. They are therefore not used directly during third party assessment.

E. Six Sigma (Benchmark II)

In 1986, Motorola developed the principle of Six Sigma [45]. Unlike ISO 9000 series only provides the management principles for companies to follow, Six Sigma comprehensively demonstrates how to improve process quality by a set of statistical techniques and tools. It seeks to improve process quality and avoid product variation through identification and elimination of defects. Take the lifetime of a light bulb as an example. The key principle of Six Sigma is *to design the production so that the mean lifetime of light bulbs is long and the standard deviation of their lifetime is very small.* The principle is simple but the core problem is how to design. It is related to number of factors, including but not limited to R&D, production process design, the raw materials, the equipments for making the products and the management activities associated.

Jack Welch, a CEO of General Electric, adopted Motorola's Six Sigma quality concept as one of his business strategies in 1995. After Six Sigma has been implemented, the defect rate of GEs products decreased to thirty four per ten million. Apart from improving product quality, Jack Welch also applied the concepts of Six Sigma in designing tools to improve the quality of the business processes in GE. After that, Six Sigma was widely adopted by many companies around the world.

IV. Increasing Focus on Services

The third trend is due to the increasing awareness on the idea of service-orientation – a paradigm shift from goods-dominant logic to service-dominant logic. It starts from the awareness of service economy, to the development of service blueprint for the design of a service delivery process, to the development of gap model for the assessment of a service delivery process, and finally to advocation of an interdisciplinary area called service science, management and engineering (SSME).

A. Self-Service

Before we describe the service, we need to know the story of the first self-service store, the precedent of supermarket. Piggly Wiggly was the first self-service grocery store open in 1916 in Memphis, Tennessee [46]. The prices of the items to be sold in the store were marked or tagged. Customers could thus collect the purchased items and carried them to the checkout counter for payment[6]. Before Piggly Wiggly, to buy items in a grocery store, customers asked the staff for the items. The staff fetched, collected and packed them up to the customers. Customers paid and then got the pack of items.

In this process, customer did not involve in fetching, collecting and packing. Everything was done by the staff. The staff served for the customer. To further improve the efficient of the purchasing process, the foods being sold in Piggly Wiggly were wrapped in standardized size. So, customer could select the right sized foods to purchase and no need to spend time waiting for packing of the items. Because of the success of Piggly Wiggly, many other grocery stores changed their retail operations to self-service in the subsequent years.

Various studies on why customers liked and disliked to purchase in a self-service store and how a self-service store could attract customers were conducted [47], [48]. Self-selling and product-return programs have to be carefully designed so as to improve the efficient and convenient of buying things. The staffs should be trained so as to reduce the communication gap amongst themselves and the customers. The stores should sell more products like personal products the customers need.

For this kind of stores, marketing (or retailing) management is definitely the primary task to be accomplished. The processes to be managed include procurement, self-selling program, product-return program, customer service and advertising.

Nowadays, the idea of self-service is not limited to be applied in supermarkets. Many industries have got their customers to get involved in production processes or service delivery processes. For instance, a customer could select from limited options the configuration of a notebook computer. A customer could select the car frame color that he/she purchased. A traveller could purchase on an airline website a flight ticket, book a hotel and rent a car. Not to mention about other online shopping malls, customers could select the items and settle the payment just by a few clicks.

B. Awareness of Service Economy

Before 1960, operations management focused mainly on manufacturing, but this concept has been extended to other industry since 1960s. Since the 1960s, the global economy underwent a structural change. The service sector has occupied more than 60 percent of GDP [49]. For this change, the American economist Victor R. Fuchs called this new economy as service economy. In 1968, he focused that more than half of the employed population is involved in providing services including banking, health care, retailing, and education [14]. Besides, the proportion is kept increasing. The GDP generated by these service workers is also kept increasing. Thus, service economy indicates a new phenomenon.

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[6]In the 1930s, shopping carts were provided for the customers.

C. Production Line Approach to Service (Industrialization of Service)

In 1960s, McDonald improved their service operation by applying the logic and tactics of manufacturing, which resulted in their sales rose from approximately 54 million to 587 million. This improvement has been termed the production line approach to service by Theodore Levitt in the 1970s [50], [51]. Theodore Levitt described how service operations could be made more efficient by applying the concept manufacturing. The characteristic included (1) simplification of tasks, (2) clear division of labor, (3) substitution of equipment and systems for employees, and (4) employees were afforded to do little decision-making [50]. McDonald's is a good example to illustrate this approach. Here is the purchase process in McDonald's. Employees are taught how to greet customers, and ask for their order. Employees will follow a set procedure for assembling the order (for example, cold drinks first, then hot food), placing various items on the tray, and giving the tray to customers. Next, there is a script and a procedure for collecting money and giving change. Finally, there is a script for saying thank you and asking the customer to come again. This production-line approach lets the organization control over the interaction between customers and employees. It is easily to learn, so employees can be quickly trained and put to work [52], [53].

D. Service Blueprint (Design Model for Service Delivery Process)

Service blueprint was first introduced by Lynn Shostack in 1984 [54], [55]. Before 1980s, service was perceived as an intangible asset. Systematic method for design and control was missing. Service blueprint was thus introduced as diagram (also as a tool) describing the service delivery process in detail. People involving in the service delivery process could thus understand their tasks to be done in the service delivery process. Communication between different levels or departments involving in the service delivery process could become more effective and efficient. Evaluation and review of the service delivery process could make easier.

Service blueprint illustrates service delivery process in five issues. Customer action defines what customer will do during the delivery process. The interaction between customers and employees is divided into two parts, the onstage action and the backstage action. Face to face interaction is described by onstage action. The invisible interaction is described by backstage action, such as the telephone or Internet service. In service blueprint, customers evaluate the quality not only from the interaction but also from the physical entity in the service delivery process. This is what physical evidence defines. For example, during a dining service in a restaurant, the physical evidences include the cleanness of the table, the menu, or the wiring of waiters. Support process is the necessary actions which are taken by the staffs that do not interact with the customers. Without these actions, the service would not be delivered successfully.

E. Service Quality Model (Analyzing the Problems in Service Delivery)

Service Quality Model normally refers to a group of models that are designed for analysis the potential problems in the overall service delivery process. Readers could refer to [56] for a survey on the earlier service quality models. A common characteristic of these analysis models is that the quality is defined as the "perceived quality" of a customer on a service. The perceived quality is determined not just by the interaction between the front-end staffs and the customers, but also the interactions amongst different groups of staffs who are involved in the overall service delivery process and service marketing. Two earliest models were developed in the earlier 1980s. One was developed by Grönroos in 1984 [57] and the other called Gap Model was developed by Parasuraman, Zeithaml and Berry [58]. As their ideas of analysis are similar, only the Gap model is introduced here.

Parasuraman, Zeithaml and Berry [58] found that there was always a big gap between customer expectations and service provider, and they identified five factors of service quality, including reliability, assurance, tangibles, empathy, and responsiveness. Finally, the authors found five gaps that may cause customers to experience poor service quality. The first gap is between consumer expectation and management perception. The second gap is between management perception and service quality specification. The third gap is between service quality specification and service delivery. The fourth gap is between service delivery and external communication, and last gap is between expected service and experienced service.

Gap Model is a model for evaluating the problems in a firm-wide scale. By carefully evaluation on each of these gaps, the potential problems and the causes of the problems could be identified. As marketing scholars, Gap Model largely focuses on the communication gaps amongst different groups of staffs in the firm and the communication gap between the customers and the front-end staffs. Less concern on the design of the service delivery process.

In a similar period of time, marketing scholars developed service quality models Owing to be more specific in the analysis of the gaps, Parasuraman, Zeithaml and Berry developed a questionnaire called SERVQUAL to facilitate the assessment of consumer perceptions of service quality [59].

It should be noted that all these service quality models are used for identifying potential problems in the overall service delivery process only. They do not tell anything regarding how to make the change (such as service delivery process re-design and re-design communication processes amongst different groups of staff) so as to reduce the gaps. Don't expect too much on them!

F. First Generation of Servitization

The servitization was first coined by Vandermerwe and Rada in their 1988 paper entitled *Servitization of Business: Adding Value by Adding Services* [60]. Manufacturer could not earn much simply by selling products with no additional service. Selling a household machine will definitely need to

bundle with repairing service in a warranty period. Selling a car will need similar service. Additional services have to be provided in order to push the sales volume. We call this the first generation of servitization. Its focus is on bundling product and service together. Later in Section IV-K, the second generation of servitization will be introduced. Its focus is on global production process.

In this period, the concept of servitization in the service industry is as same as manufacturing. Here is an example from the paper Servitization of Business: Adding Value by Adding Services. We assume that the customer is the company who wants to buy computers, and the provider is a computer supplier. The provider sells several computers to the customer and also provides maintenance service, teach customer some knowledge about computer, and provide the training course to use computers. The computers also have the software which can let the customers diagnose the computers when there are some problems.

Servitization is an innovation of an organization capability and process to create future value through a shift from selling the product to selling product service. Nowadays, there have been a lot of definitions of servitization brought up by many scholars, such as Adding extra service components to core products by Verstrepen, Deschoolmeester, and van den Berg [61] and A trend in which manufacturing firms adopt more and more service components in their offerings by Desmet [62]. Interested readers could refer to [63] for a literature survey on this topic.

G. Service Productization (Yet another Production Line Approach)

The term service productization was firstly defined by Sipil, J. in 1996. He indicated that service productization is a method that aims at developing and producing a service in a way that maximizes the customer value and ensures the profit targets of the organization are met. The purpose of service productization is to clarify the service offering by adding product-like features to it, leading to the service offering is easy to buy and sell. The more detail description of service productization practice has been defined by Elina Jaakkola in 2011. He emphasized the details and the procedures on the practice of service productization, which includes (1) specifying and standardizing the service offering, (2) tangibilizing and concretizing the service offering and professional expertise, and (3) systemizing and standardizing processes and methods [64].

H. Experience Economy

The concept of experience economy was firstly introduced by B. Joseph Pine II and James H. Gilmore in an article published in 1998, titled "The Experience Economy". They claimed that experience economy will be the next economy following the agrarian economy, the industrial economy, and service economy. Experiences create added value by engaging and connecting with the customer in a personal and memorable way [65]. A famous example is Disneyland. Disneyland lets an adult feeling like going back to his/her childhood and getting into the world of fairy tales. Disneyland not only has many facilities like Roller Coaster and Pirate Ship for customer to get excitements, but also has many theme parks in which a customer could imagine himself/herself as an actor in such fairy tales.

Another exemplar company which values the most of customer experience is a Taiwan-based bookstore called the Eslite. Eslite not only sells books but also provides high quality reading environment for the readers. Each chain store of Eslite must have comfortable lights, sofas, and counter for coffee and tea. Moreover, different chain store could have different style of decoration letting customers have different kinds of experiences. Like Eslite Xinyi in Taipei, the store is decorated with a lot of artworks to let customers feel like reading books in a historical European university library. Owing to fit for the theme of the Sonyan Cultural and Creative Park, Eslite Sonyan is decorated with lot of lifestyle artworks and targeted to sell products particularly in movie, music and other creative artworks. Besides, exhibitions and entertainments related cultural and creative lifestyle stuffs are organized frequently. All these activities aim at providing customers wonderful cultural experiences.

From Disneyland to Eslite, one can observe that shifting focuses of the economy, from manufacturing to service, and then from service to experience, has been underway. Likely, Apple and Tesla would follow to produce products that can let customers to have wonderful experiences, such as being connected and amazing driving, while they have bought such products.

I. Service Outsourcing

Service outsourcing means that companies outsource their non-core service operation to the external professional organization. Therefore, they can focus on their core operation, and result in reducing the cost, improving efficiency, and reinforcing competitive advantage. Service outsourcing includes business process outsourcing, information technology outsourcing, and knowledge process outsourcing. Start from around 2000s, since the raise of the Internet and the emergence of the globalization, service outsourcing is not limited to local organization, more companies outsource their service overseas. For example, Taiwans McDonald outsources the telephone ordering service to Hong Kong.

J. SSME (Emerging Area of Research)

In 2003, IBM started to advocate a new discipline termed service science, management and engineering (SSME). The main purpose is to provide an interdisciplinary approach to the study, design, and implementation of service systems, like health care, telecom service, Internet service, cloud service, logistic services, public transportation, finance, education, travel, hotels and restaurants, and technology consultant services. As has been observed that SSME is closely related to another discipline called service design, which was advocated since 1991 in Europe , the scope of SSME has been extended by included design as one focus and thus the name of the discipline SSME is changed to SSME/D (Service Science, Management, Engineering and Design). However, this change

creates a little confusion in the definition of the area. As learned from software engineering, it is noted that design is one of the task to be done in engineering. Highlighting design in SSME/D could lead to an over-emphasizing of design to engineering.

Besides IBM, Service Research and Innovation Initiative (SRII) is another famous academic institution for service research. SRII is led by senior leaders from major IT companies like Google, Amazon, Apple, Facebook, Intel, Microsoft, IBM, etc., in close partnership with academia, research institutes, as well as government organizations from around the world. Its mission is to Drive Research and Innovation for IT Enabled Services for a Better World. There are two main purposes of SRII. One is driving innovation for the growth of "Service Economy" at the global level. Another is driving innovation for IT as a Service and Solution for major sectors of the economy.

From these new activities, it is clear that the scope of services has been evolved to an ever existed large area and this area is multi-discipline. The works related to services are almost everything, from public services to professional services, from dinning service to manufacturing. Researches in services are emerging.

Readers interested in this topic could refer to one of my manuscript entitled *Service Systems Engineering: Framework & Systems Modeling* [66] for a detail survey.

K. Second Generation of Servitization

In 2000, many traditional manufacturing companies chose to refocus their attention from manufacturing to developing integrated product solutions with a large service component. This trend has been termed the second generation of servitization, which was perceived by many traditional manufacturers as a strategy for survival. The main driven of this trend is the thriving of globalization and the increasing of price competition. As the companies outsourced their manufacturing processes to low-cost location, the domestic resources were freed up. Thus, the companies could turn the resourced into the utilization of high-value activities, where the service component is likely to occur. Through the trend of servitization, most traditional manufacturing companies will undergo four stages, from the pure manufacturingoriented companies to the companies with services to support the product. Subsequently, they will transfer to the companies with services to extend the product, and finally the service-oriented companies, which service outweighed the product [67].

V. ADVANCING DEVELOPMENT OF TECHNOLOGIES

The last trend is due to the advancement of technologies. We divide this chapter into two parts. One is the automation, which changes the way of manufacturing. Another is the information technologies, which influence lots on our life and business operations.

A. Automation

Automation refers to automatic control a process to run with minimum operator intervention and it started when Watt invented an advanced steam engine in 1788. The term automation was introduced in 1947 when Ford Motor Company vice president Del Harder set up an automation department [68] aiming at applying technologies hydraulic, electromechanical, and pneumatic to speed up operations and enhance productivity on the assembly line. Later in the 1950s, the emergence of the programmable computer led many radical restructuring of operation design in the industry to fully automate as much of the production process as possible [68].

With the advance of electric motors, electric circuits and computer, computerized automatic control systems could be made and help in almost every step in production. Furthermore, the advance in robotic technologies has also made many production works simpler and faster. For instance, car manufacturers install robotic arms for car frames painting and assembling components. While the major advantage of automation is not to change the management practice, it does change the quality management style from monitoring a labor intensive factory to an almost laborless working factory (i.e. lights out factory).

B. Information Technologies

Technologies have been booming and influenced our lives and business operations for many years. These technologies normally have no direct influence on management. But their indirect effects are tremendous in various aspects of management practise.

1) Computer: The first computer was invented by John W. Mauchly and J. Presper Echert in 1946. They created the first automatic computer which was called ENIAC. After long-term development and improvement, in 1970s, the microprocessor-based computer was invented. A notable model is the Apple II personal computer. Its size is smaller and the price is cheaper. Thus, small and medium enterprises (SME) and families could afford for a computer. Then, computers rapidly spread everywhere, starting the generation of personal computers.

With the emergence of the computer, business operations are simplified. In the past, managing information in a company, like the business and customer information, was accomplished by paper documents. With personal computer, paper documents are replaced by electronic files so that all the information can easily be stored and retrieved. In addition, the physical space for storing information is largely reduced.

Besides, many software like the Words and PowerPoint in MS Office ease the managers and secretaries in preparing reports and presentation slides for meetings. Spelling-check, grammar-check and auto-correction functions of MS Word even reduce the time spent in preparing a report as compared with that in the 1980s. As the time spent in compiling a document is reduced, staffs could spend more time in organizing the contents and formatting the presentation slides in a better way. Communication gaps amongst the managers and their subordinates are definitely reduced. Management is more effective.

2) Network Technology: With network technology in the late 1980s, computers could be connected to form a local area network exchanging data amongst each others. Memorandums are replaced by emails. Informal discussions on

the issues related to works can be accomplished by emails. Documents could be shared within the company. New policies and decisions to be sent from the top manager to the staffs could be arrived instantaneously at anytime from anywhere. Administration can be done more effective than before. Productivity could further be improved by re-designing some of the core processes, as witnessed in the era of business processes reengineering [69].

3) Internet: In the early 1960s, packet switching technology was invented for communication between different computers. In 1969, the project Advanced Research Projects Agency Network (ARPANET) was launched and was the first packet switching networks connecting selective universities and research laboratories in the US. In subsequent decades, different networks were then emerged all around the world. Owing to facilitate the inter-connectivity among different networks, technologies for inter-networking were developed and eventually the Internet formed in late 1980s. In the late 1980s and early 1990s, commercial Internet service providers (ISPs) began to emerge, following by the decommissioned of ARPANET. The Internet became fully commercialized in the U.S. As a result, the size Internet started to expand rapidly in the world as a lot of commercial firms install their own network servers with dedicated IP addresses and connect them to the Internet.

Technologies combined with the Internet have given a new dimension to collect and disperse the information. One example is human resource management. Nowadays, most human resource managers collect the resumes through e-mail or human resource agency websites instead of mails or in person. Another example is marketing management. Through the Internet, overwhelming price and product information can be distributed to the buyers. The manager needs to figure out what content of information can attract customers.

Internet facilitates collaboration among employees from different geographical regions (different time zones) in an organization. Managing a project involving employees from geographical regions is possible. If a manager is on a business trip, he can inspect the progress of a project at any place and at any time. If necessary, the manager can also hold a meeting, via social network systems like Facebook and Line, with his team members and make decision on any critical issue. Workers are able to work in a caf, in a car, in a ferry, in an airport departure hall and even in a toilet. Before a marketing presentation to a client, a salesman could use iPad to access the information from the company database and modified the slides while having a coffee at Starbucks.

Take Verifon, an American electronic payment and transactions corporate, for example. It locates its R&D and manufacturing department in Taiwan, Department of system development in India, and service department in North America and West Europe. Though the departments are scattered around the world, Verifon can still manage each department effectively through the Internet [70].

4) Enterprise Information Systems: With further advancement on the hardware and network technologies, various enterprise-wide information systems like supply chain management (SCM) systems, customer relationship management (CRM) systems, enterprise resource management (ERP) systems have been developed for the companies to manage their global supply chain, customer relationship, finance and daily adminstration [71]. Customers access the website, surf for the products, place an order and pay online. The process is far more convenience and effective than ever before. As an increasing number of customers willing to buy online, online selling has became significant revenue of the firms. Structure of the marketing channels is simplified as compared with the traditional marketing channels. Intermediaries are reduced. Target marketing could be possible. Marketing activities extend from traditional media to Internet & social media, and thus change the way of managing marketing activities.

C. Intelligent Technologies

Similar to that of information technologies, intelligent technologies are something that have tremendous indirect effects on management practise. As mentioned, spelling-check, grammar-check and auto-correction functions in MS Word ease a lot of work of a staff. These functions are basically realized by a number of intelligent algorithms embedded in the software. In a famous enterprise resource planner (ERP) SAP, intelligent algorithms have also been embedded to help solving supply chain management, materials requirement and other difficult mathematical problems.

In the Internet, various different kinds of intelligent technologies have already been applied in various aspects in network routing, network management and security management. Without such technologies, lots of management activities could not be running smoothly. In the end, the performance of a management process will definitely be affected.

If you have been using Google to search for information, you will notice that Google can intelligently give appropriate suggestions to your query. This intelligent function always can reduce the time spent in searching. This intelligent feature can also be found in other platform. Amazon gives recommendations while you are searching for one particular item. While you are searching for some particular things, Google will put some appropriate advertisements for you, so as in YouTube, FaceBook and Bing.

In the development of automation and robotic technologies, various different kinds of intelligent technologies have already been applied in the design of the control systems for such mechanical systems. With the new automation and robotic technologies, lights out factories could be made possible.

These applications of intelligent technologies are just what I call "conventional applications". The intelligent level is not very high. In the last decade, something amazing has already happened. IBM's Deep Blue won Garry Kasparov [72]. IBM's Watson can answer questions by searching and analyzing the information over the Internet [73]. Google's AlphaGo won GO games [74]. These machines are more intelligent than ever. Researches on making machine more intelligent have been undergoing. Something amazing and scary should appear in the future. You can email me if you want to discuss on this issue.

VI. Observations (Unchanged Patterns)

Through the comprehensive survey, we have figured out three important phenomena. These phenomena appeared in the past. They appear right now and possible appear in the future.

A. Demand on New Features & Functions

For the first phenomenon, one could note from the evolution of the telephone. In the early days, the telephone was simply a device for dialing number and making phone calls. Since the launching of iPhone, the telephone can let many people enjoy different services. Apart from making a phone call, it can access the Google map for searching restaurants. Also, people can listen to the music through iTunes. Besides, people can save a lot of photos/videos and messages in the phone and enjoy other services which are made available by other apps. We believe that this increasing demand on the product features and the service contents is the main reason that governs the evolution of OSM and it will continue in the future. As a result, the processes of development, production, and service delivery of a new product/service will become more complex. New management principles would likely be evolved in the future.

One possible driving force for this phenomenon is that people are demanding more convenient and powerful (i.e. intelligent) products (resp. services) to help them solving problems, no matter personal problems or problems related to their works, and enjoying lives. For instance, calculators and computers can help accountants handling accounting data more efficiently. MS Office can help marketing professionals to make presentation materials much easier than before. The calendar app in iPhone could help people better schedule their meetings and personal gatherings. The app will remind the user once the meeting is approaching. Unmanned vehicles can auto-drive the passengers from one place to another. Drivers could thus work on other things during the trips. This driving force is absolutely positive and inevitable. That is the way to leverage our living standards.

B. Discrimination of People

On the pro side, it is good to have such intelligent products and services for people. It could improve working efficient. Professionals could solve more problems than ever before. R&D teams could use such products to speed up their researches. By using Google and Wikipedia, students could complete more reports for assessments. On the con side, these intelligent products become a reference line for discriminating human beings – people who know how to use them to work better and people who reply on them but do not know how to use them to work better.

For the former group of people, they know how to complete a task even if those intelligent products do not exist. With such products, they know in what aspect and what time the products could help them complete the task. Moreover, they know in what aspect the products could not help. They are able to learn by themselves how to use the products in solving their problems. For the latter group of people, they do not know anything about that. They even need someone to teach them how to use such products to solve their own problems. Once a new product comes in the market, they need to get someone to teach them.

As a results, people are discriminated by the ways that they are using the technologies. Technology level of a product turns out to be a reference line. People whose levels are above the line could stay in the workplace. The people whose levels are below will be phased out. Lot of managers are laid off. It is reality.

C. Communication Gaps

For the second phenomenon, all the knowledge presented in textbook, many of them mainly focus on principles. But after the principles in actually in design on the operations, as well as the organization structure, has not been mentioned much. Unlike in soft engineering, many principles in soft engineering also require lots of design diagram in order to let soft engineering really design systems. For example, UML is one set of diagrams which consists 14 diagrams for presented the design of the system from different perspective. However, in OSM, there is lacking of suitable models for operation design. Therefore, it results a challenge in the management. How could those management principles and strategies be actually implemented and realized in the operations? In other words, a gap exists between the strategic levels and the operation levels.

VII. Future Trends

From the evolution and the two phenomena in operations and service management, we deduce at least five possible future trends on (1) increasing complexity on production processes, (2) expanding scope of quality, (3) increasing focus on services, (4) advancing development of technologies (5) advancing intelligence of machines and (6) the decline in the demand of administrative and managerial staffs.

A. Increasing Complexity of Production Processes

While the features of a product become increasingly complex, production process will be no mean more complicated than before. However, we suspect on the other hand that production process is more efficient than before. It is because machines (likely an intelligent system[7]) will replace human workers to resolve various difficult problems in operations management – materials planning, workshop floor plan, production scheduling, logistics and delivery. By collecting historical data on past production records, intelligent machine could predict the performance of each machine in the workshop, the quantity of the raw materials required, design the production processes and finally scheduling the production.

In order to satisfy diverse customer needs, the production processes have to be more flexible (idea similar to flexible manufacturing systems [75]). The machine could re-design the

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[7]Here, intelligent system refers to a single computer or a network of computers that manifests intelligent behavior in problem solving.

production process and the shop floor plan so as to tailor-make the production for particular customers. Customers and partners will work together with the intelligent machines to form a cyber-physical system (as defined in Industry 4.0 [76]) to design new products, the quality factors, the production processes and logistics for which the products are produced and delivered. Therefore future production processes would be more complicated but more efficient, as what we have witnessed the from lights out factory. Then, the context of operations management and the works to be accomplished by an operation manager will have to be re-defined.

B. Expanding Scope of Quality (Customer Quality)

For the future trend of the quality, the scope of quality will likely be expanded from total quality (organizational-wide quality), to supply chain quality (suppliers-oriented quality), and finally to customer quality (customers-oriented quality). Customers have to be chosen so as to ensure the best service quality. Since there are many researches on the quality of supply chain, we focus on the quality of customers, which has been put less attention on. In the future, the quality of customers will also be considered in the estimation of the overall quality of the service. With poor quality of customers, it will probably debase the quality of the whole service.

Take the restaurant as an example. Nowadays, the behavior of customers in having a meal is different from before. In the past, customers spent within average 10 minutes reading the menu and make an order. When a course had been served, customer started to enjoy the food. Once a customer had finished the meal, he/she left within five minutes.

Nowadays, many customers would take photos by using their smartphones once they have been seated and the menus have been served. So, the time spent in making an order is definitely more than 10 minutes. Sometimes, if there is problem in WiFi connection, extra time will be needed for making an order.

When the meals have been served, some customers are excited to take photos of the foods and share them on the FaceBook or the Instagram. Sometimes, some foods will be cooled down after the photos have been taken. The customers will request reheating the foods. Nevertheless, after the meals have been finished, some customers would like to ask the waiters helping them taking group photos. In the end, it is not difficult to see that the time of having a meal nowadays is longer than before. The workload of a waiter is much more than before. As being interrupted from the customers, the waiters could hardly focus on their works. It could reduce the quality of the service.

Some restaurants ban customers taking photos of food, do not provide WiFi connections and even do not allow customers using smartphones in the restaurants. They think that better service quality can be achieved if the customers are of high quality. Though there are only a few restaurants consider customer quality, we believe that more restaurants will follow this trend in the future.

C. Increasing Focus on Services

We anticipate that there will be an increasing demand on product features and service contents as what we have observed from what Apple was doing in the last couple of years. Steve Jobs, while the iPhone was released in 2007, had mentioned that iPhone can let the user to (1) listen to the music by using iPod app, (2) make a phone call by using the telephone app and (3) access the Internet by using the browser app. Only a few technologies, like multi-touch and proximity sensors, were introduced in the press conference. iPhone is just a device for the customers to enjoy these services conveniently. It is not treated as a product. Then, in the subsequent years, Steve Jobs presented the Apple products, like iPad, in similar way. The product is not treated as a product. They are treated as devices for users to enjoy various different kinds of services. Apple makes profit from delivering the services to the customers rather than selling the products alone. To deliver high quality of services, Apple even partnered with Google to develop the Google Map app used by the customers to search for restaurants, theaters and others.

According to this anticipation, we believe that there will be a paradigm shift from product-orientation to service-orientation in the future. Two possible changes will be seen in the future. First, a lot more enterprises while design a product would focus more on the services the customers can enjoy. It makes a big difference to nowadays enterprises. Many of them provide services only for supporting the product, like enquiry service in a retail shop and after sales service. Service was regarded as an added valued service with no tangible benefit to the enterprise. Enterprises make profit by focusing on producing customer-preferred products. So, nowadays, product focus has been changed to service focus (or experience focus). This service focus will be continuous in the future.

Second, the design of production process or service delivery process will be shifting to service-oriented. Factories in a global supply chain will be treated as service units. Production will be considered as a service. Each factory provides services to other factories or end customers. Product quality will be defined as part of service quality. Machines and human workers in a factory will be treated as service sub-units. They will also have their own service qualities to achieve.

D. Advancing Development of Technologies

Internet of Things (IoT) will be the future trend of the technologies development. It means that every device is connected to the Internet integrating computing capabilities and using data analysis to extract meaningful information. As devices are connected to each other, they can become an intelligent system of systems sharing data over the cloud. It will then transform the business, our lives and our world in countless way, such as creating better products faster with lower development costs, or optimizing energy generation and consumption. More intelligent personalized services could be deployed in the future.

Here is an example of a big picture of IoT. There is a smart traffic camera and the camera can monitor the road for congestion, accidents, and weather conditions with data

from other cameras, creating an intelligent citywide traffic system. The intelligent traffic system will also be connected to other transportation systems, which get data from their own intelligent devices. If a traffic accident occurs near the airport or school, they can be notified by these smart systems, so that the airport or school can adjust their schedules. Also, people can be notified to drive optimal routes around the accident and the system will send instructions on the city's digital sign system to guide drivers around the accident.

E. Advancing Intelligence of Machines

Another big change will be the intelligent technologies. As mentioned in Section V-C, IBM Deep Blue, IBM Watson and Google's AlphaGo have already demonstrated their intelligence in many games competing with human contestants. Their successes are due to two major breakthroughs. One is the huge back-end computational resources networked to the front-end terminals. The other is the machine learning (AI) algorithms for analyzing the information to give the best answer. Through the front-end terminal, the engineer could access and control the back-end computational resource to collect huge volume of information over the Internet, analyze the information by some machine learning algorithms and then give the best answer to the engineer. The processing time is almost instantaneous.

On-going researches on artificial intelligence and machine learning have recently conducted intensively in Amazon[8], Facebook (Facebook AI Research[9]), Google (Google Brain[10]), IBM (AI and Cognitive Computing[11]), Microsoft (Machine Learning and Optimization[12]). Even Apple, she has started her AI research in 2016 [77]. One major driver for these researches is NVIDIA's graphical processing units (GPU) [13] and the cloud technologies.

Running a machine learning algorithm is always time consuming if the program is running in any conventional multi-core computer. GPU is basically a CPU specialized design for mathematical computation. Initially, it was designed for processing graphical data. As its computational speed is hundred to thousand time faster than the normal CPU, it has then been applied in running computational intensive machine learning programs for tagging 1.3 millions images [78] and tagging 8 millions video [79]. Another major drive is clearly the cloud, a network of memory and computational resources.

Some of these research results together with their cloud platforms have already been commercialized as intelligent services for anyone who is interested in developing more sophisticated intelligent services for users, like Amazon Machine Learning Services[14], Google Cloud Machine Learning Platform[15] and IBM Watson[16]. Some of these have been commercialized as intelligent business solution for enterprises, like SAP HANA Cloud Platform[17]. Researches in AI for sure will never stop. More intelligent results will show up in the future and more intelligent services will come in the market. More new automation and robotic technologies will be advanced due to the application of AI [80].

F. Demand of Administrative & Managerial Staffs Declines

Earlier in the nineteenth century, political economists had already observed and raised the issue on the reduction of wages or quantities of labors due to the employment of machinery. As asserted in the book entitled *On the Principles of Political Economy, and Taxation* written by David Ricardo in 1821 [81], (P.22) *The principles that the quantity of labour bestowed on the production of commodities regulates their relative value, considerably modified by the employment of machinery and other fixed and durable capital.* Ricardo clearly stated that the value of a labor has to be compared with what a machine could do. If a machine could do a better job than a labor, the value of a labor declines.

In the late nineteenth century to the earlier twentieth century, many firms hired a lot of clerks and secretaries for doing typing. In the middle of twentieth century, photocopier and computer were invented. Their works were thus replaced by these machines (see P.64-65 in [82]). With further advancement in automation and robotic technologies, demand of human workers in agricultural and manufacturing industries declines.

Networking technologies led to the reduction of office assistants. Advancement on the intelligent functions of information systems (including management information systems, decision support systems, executive information systems, supply chain management systems, customer relationship management systems and enterprise resources planning systems) not just eases the jobs of administrative and middle management staffs but also reduces the demand on such staffs. With such powerful information systems, the jobs used to be done by these administrative and middle management staffs could now be easily handled by the senior management staffs.

With further advancement in big data, Internet of Things, automation & robotic, and artificial intelligence, (i) a lot more management information systems could be available in the market, (ii) the intelligent levels of such systems would raise and (iii) factories could be networked together to be a giant autonomous factory producing anything[18]. As a result, many administrative and middle management jobs will decline [19].

In an article in BBC entitled "The end of middle management?" [86], Sydney Finkelstein has pointed out that

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[8]https://aws.amazon.com/amazon-ai/.

[9]https://research.fb.com/category/facebook-ai-research-fair/.

[10]https://research.google.com/teams/brain.

[11]http://research.ibm.com/cognitive-computing/.

[12]https://www.microsoft.com/en-us/research/group/machine-learning-and-optimization/.

[13]https://www.nvidia.com/en-us/deep-learning-ai/.

[14]https://aws.amazon.com/machine-learning/.

[15]https://cloud.google.com/products/machine-learning/.

[16]https://www.ibm.com/watson/.

[17]http://www.sap.com/developer/topics/hcp.html.

[18]Imagine that the factory will look like the research center built by Dr. Will Caster (Johnny Depp) and his wife Evelyn (Rebecca Hall) in the movie *Transcendence*. See https://www.youtube.com/watch?v=VCTen3-B8GU for the official trailer and https://en.wikipedia.org/wiki/Transcendence_(2014_film) for introduction.

[19]Readers could refer to an article in *Harvard Business Review* [83] (specifically P.76) for the viewpoints from a former CEO of a multinational human resources consultancy firm on the decline demand of human labors, an article in Forbes [84] on the issue about how AI replaces human labor, and an article in Forbes [85] that looks at the issue in an opposite side.

technology (like computer) is not the only factor leading the end of middle management. The culture of start-up firms do not like middle managers. The behavior of millennials at work – they believe that they know more than they do. All these factors constitute the down-value of middle management and eventually the end of middle management.

Once the demand of the administrative, production and middle management staffs declines, the roles of human resource management will change and the demand of human resources professionals will definitely be reduced. In the future, the works of senior managers and executives could also be replaced by AI [87]. In the end, many management schools would be obsolete. Some of them would have to change their program structures in a way like the management schools in North America. No undergraduate level program should be offered. Only postgraduate programs are offered.

Moreover, I agree what Jeffrey Joerres mentioned in P.79 in [83]. Management schools should be refashioned to educate graduates with skills that the companies need. But, I like to add a point which is in a spirit originally from Chester Barnard (P.176 in [88]). Management schools should re-focus their roles in helping students to learn how to continue to educate themselves.

VIII. CONCLUSIONS

In the paper, we have given a comprehensive survey on the evolution of the principles in operations and service management. By that, we summarize the evolution of the principles in four major trends. In addition, we find three important phenomena along with these trends. The first phenomenon is an increasing demand on the product features and the service content. It will make the development, the production, and the service delivery process of a new product/service become more complicated. The second phenomenon is that people are discriminated. Based upon their ability in managing and use of the new technologies. People who can do the job better than the new technologies will stay. People who cannot will be phased out. The third phenomenon is that the concept of management mostly focuses on the principles. Less attention has been put on the operation design. It results a big problem in the management. Big communication gap between managerial and the operational staffs. Not many managerial staff know how to design the operations in detail so as to implement a strategy.

Accordingly, six possible future trends in operations and service management are identified. (1) Production processes would be increasingly complex because of the increasing demand on new features of a product or service. (2) The scope of quality would extend to cover customer quality. (3) Service-oriented thinking would be adopted in both the product/service design and the design of production or service delivery processes. (4) More advanced automated and robotic technologies would be developed to automate the production or service delivery processes. (5) Advancing intelligent systems and machines would appear. (6) The demand of operational, administrative and managerial staffs will decline and hence management schools would be re-fashioned.

These trends reveal that the *future managers* would have to face a lot more challenges than the *past and present managers* ever had. The managers who could stay would likely be those who have dual-level thinking ability. On one hand, they could have an enterprise-wise and even industrial-wise (i.e. macroscopic scope) thinking. On the other hand, they could have fine-detail operational level (i.e. microscopic scope) thinking. What would be the future management education? I suspect that management education would be embedded in engineering education as part of its curriculum. It will be possible to train dual-level thinking ability.

Further from these observations, one possible reason of less attention on operation design is lacking of suitable guideline on the use of design models. If there is a proper collection of simple models for operation design, we believe the communication gap between the strategic-level executives and the operation-level managers could be reduced. Another possible reason of less attention on operation design could be the incompetence of management professionals in learning new things. That is what I am worrying the most.

For more than a century, many management principles have been proposed and many design models have been developed. For sure that, these principles and design models must have been applied successfully in many cases. We should have enough principles and design models. But we should have adopted them with appropriate modification and applied them to solve different situations that we are facing.

However, from time to time, many new principles were aroused and new design models were developed for different cases. I would suspect that many management professionals are incapable to learn and apply (with modification of) such principles and design models. Then, the easy way is to argue that the existing principles and design models are not applicable to their situations they are facing. They need to propose something new.

This paper only covers part of the principles in management. The paper written by Walter Kiechel III in *Harvard Business Review* [23] provides an excellent survey summarizing other principles and ideas that I have not covered in this paper.

Finally, I would like to bring the readers' awareness on the scope of management principles and practises. From time to time, many so-called emergent disciplines have been advocated in the field of management and marketing. They include but not limited to (i) service marketing [57], [58], [89], (ii) technology management (resp. management of technology), (iii) total quality management and (iv) service science management and engineering. All these emergent disciplines have one common characteristics. The issues to be embraced in these disciplines are *everything* – every issue related to the selling of a product or the delivery of a service. Their spirits are in line with total quality management, as I have introduced in Section III. The scope of management and marketing is industrial-wise. In the future, the scope would likely to be expanded to multi-industrial-wise.

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APPENDIX A
MAKE THINGS WORK BETTER I

Here is an example showing what do I mean by making things work and making things work better. John is asked to find out the addition of the number from 1 to 100, i.e. $1 + 2 + \cdots + 100 =?$. John comes up with two approaches to answer the question.

Approach 1: As $1 + 2 + \cdots + 10 = 55$,

$$
\begin{aligned}
11 + \cdots + 20 &= 10 \times 10 + 55, \\
21 + \cdots + 30 &= 10 \times 20 + 55, \\
\vdots \quad \vdots \quad \vdots \\
91 + \cdots + 100 &= 10 \times 90 + 55.
\end{aligned}
$$

Therefore,

$$
\begin{aligned}
1 + \cdots + 100 &= 10 \times (10 + 20 + \cdots + 90) + 10 \times 55 \\
&= 10 \times 450 + 550 \\
&= 4500 + 550 \\
&= 5050.
\end{aligned}
$$

Approach 2: By using the formulae that

$$
\sum_{k=1}^{n} k = \frac{(n+1)n}{2}, \tag{1}
$$

we have

$$
\begin{aligned}
1 + \cdots + 100 &= \frac{(1 + 100)(100)}{2} \\
&= 5050.
\end{aligned}
$$

In this example, both approaches can work out the answer. But, it is clear that the second approach is more efficient than the first one. The formulae (1) in the second approach is a tool for solving the problem. Without using the tool (i.e. the first approach), we can solve the problem. With the tool, Eqn (1), we solve it faster.

Which approach is better? The answer depends on many factors. Sometimes, searching and learning for a tool could be time consuming. In term of the time spent on solving the problem, Approach 2 might not be the best. For some difficult problems, we might even have no such tool available. In such case, we would need to make the tool. The time spent on solving the problem will be even longer. In term of the cost on solving the problem, Approach 1 will be better.

So, how to justify which approach is better is also a job for management professionals. The pre-requisite is that any management professional should be capable of giving more than one approach for solving a single problem. That is what my believe that a management professional should not just make things work but also make things work better.

APPENDIX B
MAKE THINGS WORK BETTER II

There are two gates in front of you. One is a gate to heaven and the other is to hell. In each gate, there is a guard. Unfortunately, there is no label telling you which gate is to heaven and which one is to hell. What you can do is to ask the guards. Again, it is not easy to do so as one of the guard always tells truth and the other always lies. No information to you which one is a liar. Now, you job is find out which gate is the gate to heaven? The restriction is that you can only give them logical statement and let them reply "Yes" or "No". For instance, you can ask "I am a man". If you are a man, the liar

guard will say "No". If you are a woman, the liar guard will say "Yes". The honest guard will say "Yes" if you are a man and say "No" if you are a woman.

Approach 1: First, pick up one guard and ask "One day has 24 hours". If the answer is "yes", the guard is honest and then you can simply ask "the gate behind you is going to heaven". Based on the answer, you can identify which gate to go.

Approach 2: Let us label the guards as A and B. The gates behind them are X and Y. Pick up any guard, say A, and ask "If I ask Guard B "Gate Y is going to heaven", Guard B will say yes". Based on the answer of Guard A, one can identify which gate is going to heaven. How? Leave it as your assignment.

Clearly, the questions being asked in the first approach are straight forward. Interpretations of the answers are easier. To compose the questions, shorter time is taken. The question being asked in the second approach is not that straight forward. From the answer to identify which gate is leading to heaven is not easier. To compose the question, longer time is taken.

Now, which approach is better? It depends. In term of the simplicity of the questions and the time spent, the first approach is better. In term of number of questions being asked, the second approach is a better. Imagine that if you can only ask one guard one question. The second approach is definitely the only option. No matter what, as least we have two approaches. We can compare and justify which one is better if additional criteria are given.

ABOUT THE DOCUMENT

The content of this paper is based on the thesis written by my research student Larbi Yu-Yun Lee entitled *Survey on Operations and Service Management* in 2015 [27]. The paper has gone through a substantial revision with new contents added.

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