
2.1 Introduction

Production and operations management (POM) is the management of the production process by which goods and services are made. Research on production management can be found in a large and growing volume of literatures. However, in most POM textbooks (see Gaither and Frazier 1999), it appears to have been repeated on a few topics, the application of methods and frameworks. In recent years, POM research embraces a number of concepts derived from Japanese automobile industry. According to Filippini (1997), Just in time (JIT) and Quality Control (QC)—two building blocks of the Toyota Production System (Ohno 1988)—are becoming two key areas of production and operations management discipline. Moreover, some non-manufacturing industries such as construction are encouraged to emulate the managerial practices proved in manufacturing with the hope of gaining similar benefits (Egan 1998). In this respect, it must further be understood the manufacturing industry and its production management. In this chapter, the first part of the literature review is presented with an effort to cover a number of things. Firstly, this chapter starts with reviewing production management from a systematic perspective, mainly regarding its definition and elements. Secondly, this chapter adopts two approaches to study theoretical aspect of production. One is to search a “theory” of production through economics lens (e.g. Coombs et al. 1987; Perloff 2001), the other way is to review production in production management discipline, in which this study largely draws on Koskela’s (1992, 2000) study. Lastly, as Chase and Aquilano (1992) emphasized the need to put management back into production management, it infers that reviewing production management cannot be isolated with its managerial aspect. Moreover, Toyota Way is a management philosophy used by Toyota (Liker 2004). Hence the most important schools of thought within managerial theory in general are reviewed.

2.2 Overview of Production Management

POM emerged from World War II and entered the 1950s as a manufacturing oriented subject, which had its basis on concepts and techniques from the scientific management era (Andrew and Johnson 1982). The management of manufacturing of products is referred to as production management (Chase and Aquilano 1992; Gaither and Frazier 1999). While, the functions dealing with the operation of services as well as manufacturing and organizations are covered under operations management (Hopp and Spearman 2000), which is broader than the scope of this study that only concerns management of production. Production management deals with the direct production resources of the firms. These resources may be thought of as an amalgam of five aspects of work including People, Plants, Product, Process, and Planning and control (Lockyer 1984; Chase and Aquilano 1992). The people are the direct and indirect work force; the plants include the factories where production is conducted; the processes include the equipment and the steps by which production is accomplished; planning and control are the procedures and information used by management to operate the system.

Furthermore, production management, as defined by most scholars (e.g. Abramowitz 1967, p.8; Neely 1991; Ogawa 1984), consists of two main functions. First, there is production, which is the act of manufacturing goods for which a consumer is willing to pay. The underlying principles of production are outlined by O'Connor (1994, p.136) as given below:

1. The first principle of production is to convert designs into products, at the lowest cost. A production system takes inputs—raw materials, capital, machinery, labour, information, time and other resources—and transforms them into outputs in the form of products and services of higher value than the inputs. It may also be reviewed as a value-adding process.
2. The second principle of production is that all processes are operated or influenced by people, even though the automation has been increasingly adopted to replace human efforts.
3. The third principle of production is that, as far as practicable, nothing should be made that cannot be billed immediately as it leaves the factory.

Second, there are production managers (also called managers), managing the production system. Management was the process of planning, scheduling, commanding, coordinating and controlling business activities (Wren and Bedeian 2009; Ogawa 1984), and their primary concern is with the activities of the conversion process or production (Gaither and Frazier 1999). Drucker (1986) pointed out that production is not the application of tools to materials; it is the application of logic to work. Management needs to understand the logic behind each system of production and applies these principles consistently and thoroughly (Drucker 1986).

Ogawa (1984) pointed out that production management, originally focusing on managing the production line, has evolved into a means that is directly related to corporate strategy such as to cope with systematization, computerization, automation, respect for human, ecological control, safety and welfare. This change is likely to be related to the birth of industrial giants having complex production systems,

such as the Toyota Production System (Ogawa 1984). In other words, production management should encompass not only quality, time and cost as three traditional goals (Hopp and Spearman 1996), but also flexibility, corporate strategy, and the changing business environment (Ogawa 1984).

2.3 Theory of Production: Search in Economics

Economists describe a production process either (1) as an arrangement of productive operations (or tasks) or (2) as a mapping of input quantities into output quantities (Scazzieri 1993). The former approach was favoured by a number of classical economists (Smith and Marx in particular). The latter approach is common to “neoclassical” theory of production, which occupies a rather central place in economics (Coombs et al. 1987). The neoclassical theory of production concerns the first aspect of production management, which focuses on the relationships between quantities of input (factors of production) and outputs in the productive unit. The function that describes the amount of output obtained for specified amounts of the inputs is called the *production function*, and mathematically it takes the form:

$$Q = q(X_1, X_2, X_3, X_4, \dots, X_n) \text{ or } Q = f(K, L)$$

where Q denotes the quantity of output and X_i is the i th input. The inputs encompass all things required for production, including raw material, machines, employees, managers, utilities and so on. However, most of these inputs can be grouped into three broad categories, namely capital (K), labor (L) and material (M) (Coombs et al. 1987; Perloff 2001). Under the neoclassical theory of production, the firm is built upon several important assumptions (Perloff 2001). One of the most important is the presumption that firms maximize profits and reduce cost (Coombs et al. 1987; Perloff 2001). This implies that the firm will attempt to exploit all opportunities to make more money and avoid any project that is not expected to make the firm richer (McCormick 1993). Because at any time there is a given level of technology which determines the techniques available for production, therefore among the available techniques the firm will choose the one which, given existing levels of production factors, minimizes total production costs (Coombs et al. 1987). In Toyota, or any other manufacturing firms, profit can be obtained only by reducing costs. According to Ohno (1988), Toyota Production System was born at the age of slow economic growth worldwide with a focus to develop human ability to their fullest capacity, to utilize facilities and machines well, and to eliminate all waste to achieve the cost minimization goal of the company.

2.4 New Production Philosophy: An Integrated View

2.4.1 Overview

The economic explanation of production only captures one aspect of production theory, which focused on the relationship between input and output. There is a general agreement of the formulation $Q = f(K, L)$ by which the production function involves the transformation (conversion) of inputs into useful products and services. In Koskela's (1992, 2000) view, this conventional view of production was in line with Walrasian production model, which depicts the transformation process of production factors into finished product. Shingo (1988), however, highlighted that this conventional model of production confuses the difference between "operation" and "process", by which they all refer to a worker works on different products. Shingo (1988, p.5) added that there is distinction between process and operation:

1. Process: it refers to the flow of products from one worker to another, that is, the stages through which raw materials gradually move to become finished products.
2. Operation: it refers to the discrete stages at which a worker may work on different products and spatial flow that consistently centres around the worker.

In the meantime, the Japanese owe their leadership in manufacturing quality as a result from the guidance of quality gurus such as W. Edwards Deming and Joseph Juran in the 1950s and 1960s (Drucker 1990). The quality concepts such as Statistical Quality Control (SQC) were developed from statistical theory in 1930s. With SQC's rigorous methodology, Japanese assembly line could deliver built-in process control. Greatly influenced by Shingo's (1988) work which focused on the flow of material as well as quality control concept of production, the term "new production philosophy" has been coined by Koskela (1992). Furthermore, Koskela (1992) outlined that the genesis of new production philosophy was in the Japanese Just in time (JIT) and Total quality control (TQC) efforts in automobile manufacturing and the most prominent application was the Toyota Production System. Additionally, Shingo (1988) outlined that the Toyota Production System represents a pioneering attempt at a new production philosophy over the conventional preoccupation with operations. After that, attempts have been made by Koskela (2000) to develop a model of production that synthesizes all important features of production, especially those that are lacking in the conversion model. Koskela (2000) integrated three different views on the production process, namely the transformation concept, the flow concept and the value generation concept and termed it as a new production model (Koskela 2000).

2.4.2 Production as a Transformation Activity

The transformation concept has deep roots in the present Western thinkings about production (Ogawa 1984; Frisch 1965) and it has been commonly conceptualized in POM textbook as: "*A production system receives inputs in the form of material,*

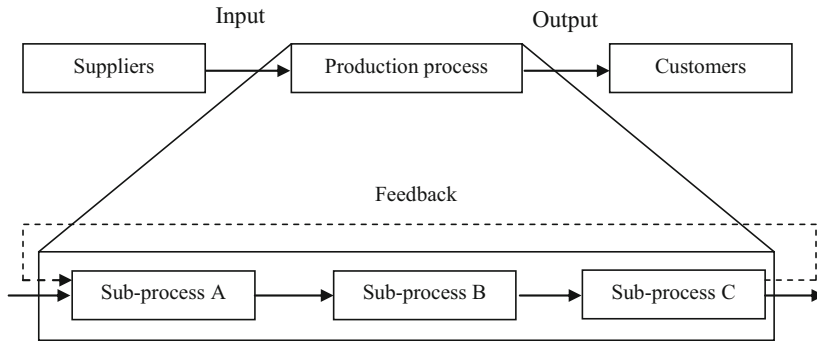


Fig. 2.1 A transformation process of a production process

personnel, capital, utilities, and information. These inputs are changed in a conversion subsystem into the desired products and services, which are called outputs” (Gaither and Frazier 1999, p.154).

According to Koskela (2000), there are three principles in the *transformation model*:

1. Production can be divided into smaller and more manageable sub-processes, finally into tasks, in which all inputs are available and assign these tasks to operatives or workstations [see Fig. 2.1 as adapted from Koskela (2000)].
2. Cost can be minimized by reducing the cost of each sub-process.
3. The output value of a process is associated with the costs (or value) of its input. In practice, the value of the output can be raised by utilizing better materials and more skilled labour.

The transformation concept not only appears in the production management domain, but also can be found in the microeconomics theory of production which employs *production function* to discuss the relationship between input and output. Koskela (1992, 2000) outlined, this transformation concept is predominantly applied in construction industry, where management efforts are centred on task management. This brings to a high chance of causing extra variability that if task management is poorly implemented (Koskela and Vrijhoef 2001).

2.4.3 Production as a Flow Activity

According to Koskela (2000), the transformation model of production had not been challenged until the 1980s when Shingo’s (1988) invention on the theoretical rationale of the JIT movement, that highlighted two core points; one is the introduction of time as an input in production, and the second is in the observation that time is consumed by two types of activities: transformation activities and non-transformation activities. The flow view of production was further developed in Japan, especially in the automobile manufacturing at Toyota (Koskela et al. 2002), which was later embodied in “Lean production”, a term to characterize

the Toyota Production System (Womack et al. 1990). Koskela (2000) explained that the basic thrust of the flow concept of production is to eliminate waste from the flow processes, along with its three types of principles:

1. *Reducing the share of non-value-adding activities (waste)* is the first principle that also serves part of the theoretical and conceptual foundation.
2. There are principles of “*reduce the lead time*” and “*reduce variability*” derived from the flow model.
3. A set of core heuristic principles includes “*simplicity*”, “*increase flexibility*” and “*increase transparency*” are derived based on their usefulness in practice but less direct connections with theory.

2.4.3.1 Reduce the Share of Non-value-Adding Activities (Waste)

Koskela (2000) outlined that the three root causes of non-value-adding activities: (1) the structure of the production system, (2) the way production is controlled and (3) the inherent nature of production attributed the non-value-adding activities in the different time frame of the process (i.e. design, control and improvement of production). With respect to all these root causes, Koskela (2000) proposed the following principles to reduce waste.

2.4.3.2 Reduce the Lead Time

Lead time refers to the time required for a particular piece of material to traverse the flow and can be interpreted in the given formula (Koskela 2000; Monden 1998, p.106).

$$\text{Lead time} = \text{queue time before processing} + \text{processing time} + \text{waiting time} \\ + \text{moving time}$$

Table 2.1 identified a set of strategies to compress the lead time by elimination of queuing, processing, waiting and moving.

2.4.3.3 Reduce Variability

The principle of reducing variability is to deal with two types of variability, namely process-time variability and flow variability (Hopp and Spearman 1996). Process-time variability refers to the time required to process a task at one workstation, which consists of natural variability such as set-ups, operator availability and rework. The flow variability refers to the variability of the arrival of jobs to a single work station (Koskela 2000).

2.4.3.4 Simplicity

According to Koskela (2000), simplification is the result of the reduction of the number of components or steps that link in a material/information flow. Practical approaches can include shortening the flows by consolidating activities, standardizing parts and minimizing the amount of control information needed. Moreover, organizational changes can also bring about simplification, such as multi-skilled and autonomous teams.

Table 2.1 Strategies to compress the lead time

	Explanation	Strategies to gain reduction
Lead time	<ul style="list-style-type: none"> • Time required making products. Simply speaking, it is a sum of the following items 	<ul style="list-style-type: none"> • Reducing the time required for the following four elements
Queue time before processing	<ul style="list-style-type: none"> • The time prior to the commencement of operations 	<ul style="list-style-type: none"> • Establishing one-piece flow through set-up reduction along with the pull method to reduce the lot delay • Standardizing the work in order to reduce the process delay
Processing time	<ul style="list-style-type: none"> • Process time comprises set-up time and run time 	<ul style="list-style-type: none"> • Small sized lot production • Using conveyor system
Waiting time	<ul style="list-style-type: none"> • Waiting time after process is the time that inventory must wait before being conveyed to the next process 	<ul style="list-style-type: none"> • Small sized lot production
Moving time	<ul style="list-style-type: none"> • The duration required to move between employee/machines operations 	<ul style="list-style-type: none"> • A process-based layout so that transport distances are eliminated

Source: Koskela (2000) and Monden (1998)

2.4.3.5 Increase Flexibility

The thrust of JIT production was based on mix flexibility (numbers of different products produced). The practical means to increase flexibility comprise: (1) minimize lots sizes to closely match demand, (2) reduce the difficulty of set-ups and changeovers, (3) training a multi-skilled workforce and (4) training the workforce in operational flexibility and so on.

2.4.3.6 Increase Transparency

Transparency can be used as an instrument to increase the motivation of workers for improvement, reduce the propensity of errors and increase the visibility of errors (Koskela 2000). Koskela (2000) further listed a number of practical approaches for increasing the level of transparency that can include the adoption of 5-S, standardization, using visual controls to enable anyone to capture the difference between the standards and deviation, reduce the interdependence of production units and so on.

2.4.4 Production as a Value Generation Activity

Value creation is the major concern in many modern theories of production management. In the same timeline when the critique originating from the flow concept moved against the transformation concept, the value generation concept was also employed as another approach to evaluate the foundation of production (Koskela 2000). This is a contrast to the transformation concept, which focuses on internal production matters rather than the customers' needs. The value of a product emphasizes more on the customer side, and the goal of production is to satisfy customers' needs. The quality-based movement and marketing-oriented value-based method are two diffusion and practice means of value generation concept

(Koskela 2000). The quality movement originated and disseminated in Japan, under the guidance of Deming, Juran and other quality management techniques (i.e. Quality Control, Total Quality Control, etc.). The value-based approach was fulfilled when a growing number of companies adopted various value generation models including value-based management, customer-driven company, customer orientation and mass customization (Koskela 2000). Overall, the value generation concept of production can be structured into the following five principles according to Koskela (2000, p.79–81):

1. Ensure that all customer requirements, both explicit and latent, have been captured.
2. Ensure that relevant customer requirements are available in all phases of production, and that these are not lost when progressively transformed into design solutions, production plans and products.
3. Ensure that customer requirements have a bearing on all deliverables for all roles of the customer.
4. Ensure the capability of the production system to produce products as required.
5. Ensure by measurements that value is generated for the customer.

2.4.5 TFM Model of Production

Koskela (2000, p.88) highlighted that each concept of production focuses on certain aspects of the production phenomenon and has its own methods and practices, but they are complementary. For integration purpose, Koskela (2000) proposed the “Transformation-flow-value generation” or TFM model of production by conceptualizing the above three complementary ways as shown in Table 2.2.

A closer examination of TFM model of production revealed that each of the three production concepts is closely related to one of the traditional objectives manufacturing firms that strive for, namely cost, time and quality.

1. Cost: cost reduction can be achieved by minimizing the cost of sub-process which transformation concept supports.
2. Time: time can be pressed through eliminating the non-value-adding activities in the flow concept.
3. Quality: the value generation view was started by and later on refined in the total quality movement framework. Ensuring customers’ requirement are met in good manner enables the quality of product should be further underscored.

Koskela’s (2000) TFM production model, however, has received criticisms. For example, Winch (2006) highlighted the following conceptual weakness that all three conceptual pillars share:

1. Focus on the production as material process. Winch (2006) argued that it ignored the factors that some phases in the production process involve non-transformation activities, for example, supplier service to client in the context of construction.
2. Absence of a concept of organization in the analysis.
3. Lack of any analysis of the implications of risk and uncertainty.

Table 2.2 Integrated TFB view on production

	Transformation view	Flow view	Value generation view
Conceptualization of production	As a transformation of inputs into outputs	As a flow of material, composed of transformation, inspect, moving and waiting	As a process where value for the customer is created through fulfilment of his requirements
Main principles	To make production efficiently	Elimination of waste (non-value-adding activities)	Elimination of value loss (achieve value in relation to best possible value)
Methods and practices (examples)	Work breakdown structure, MRP, organizational responsibility chart	Continuous flow, pull production control, continuous improvement	Methods for requirement capture, Quality function deployment (QFD)
Practical contribution	Ensure what has to be done	Ensure what is unnecessary is done as little as possible	Ensure customer requirements are met in the best possible manner
Suggested name for practical application of the view	Task management	Flow management	Value management

Source: Koskela (2000)

4. The unitary concept of value derived from quality management is inadequate for the value generation concept applied through the construction process.

Nevertheless, the development of TFB production model heavily draws on production management literature (Valence 2010) and has addressed how the three aspects of production, namely tasks, flow and value (quality) can be managed. This is important to an understanding of production management.

2.5 Historical Milestones of Management Thoughts: Search in Production Management

In today’s competitive world, it is necessary to understand how production systems should be designed and put into operation in order to support competitive industrial production. Santos et al. (2002b) pointed out that production has been one of the critical laboratories for developing management theories throughout history. The evolution of management thoughts had direct influence on the way how production system was designed and management which reflect its connection with the second aspect of production management. Santos et al. (2002b) revisited the recent history of production management theory and outlined a roadmap for its evolution in Fig. 2.2.

Similar efforts have been made by Mullins (2006), who suggested four main approaches with different focus could identify main trends in the development of organizational behaviour and management theory; the earliest emphasizing production efficiency (classical approach), the second emphasizing human behaviour, the

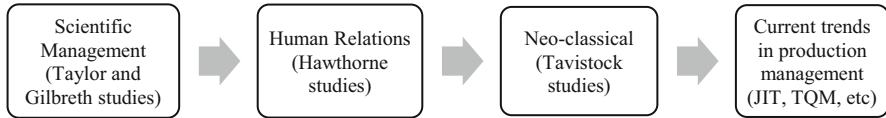


Fig. 2.2 Key contribution of production to the evolution of management

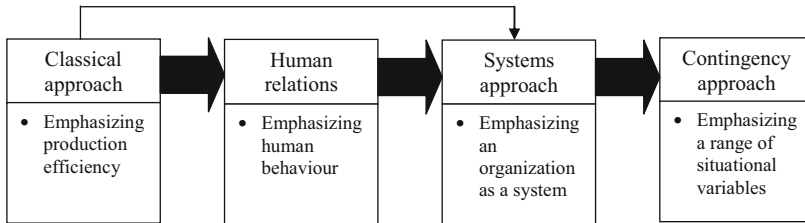


Fig. 2.3 Main approaches to organization, structure and management

third emphasizing organizations as systems and the fourth emphasizing a range of situational variables that determine the success of the organization [see Fig. 2.3 as adapted from Mullins (2006)]. It reflects that the management not only concerns the production process, plants, programmes, but also deals with the people, organization and others. Following Fig. 2.3, the next section reviews these mainstream management thoughts in the domain of production management.

2.5.1 The “Classical” Approach: Scientific Management

The field of production management is generally considered to be an outgrowth of the scientific management movement fostered by Frederick W. Taylor. Notable co-workers of Taylor were Frank Gilbreth (motion study) and Henry Gantt (Scheduling, Gantt chart). Each of these individuals offered great contribution to the scientific management movement and pioneered the evolving methods (Abramowitz 1967). The ideas of scientific management developed by them have had a huge influence on the discipline of production management in the twentieth century (Koskela 2000).

2.5.1.1 The Taylor System of Scientific Management

According to the theory of scientific management, each supervisor and manager is expected to have a total view of the process, define its objectives and steer daily work so that the targets are met. Taylor summarized his method in four principles (Taylor 1934):

1. The proper design of the work tasks such that the absolute maximum amount of work can be extracted from a given labour (using time and motion studies).
2. Scientific selection of the proper workers (finding workers who are highly motivated and controllable).

3. Cooperate with the workers so as to ensure that all of the work is being done in accordance with the principles of the science which has been developed.
4. An almost equal division of the work and the responsibility between the management and the workers.

Time study, used by Taylor to discover “what was possible” in improving job performance, became the foundation of Taylor’s work. With a stopwatch, weight scale, and tape, Taylor literally measured the distances that workers and materials covered. As Wren and Bedeian (2009) outlined, Taylor’s time study had two phases: analysis and synthesis. In the analysis phase, each job was broken into its elementary movements. Non-essential movements were discarded and the remainder carefully examined to determine the quickest and least wasteful means of performing a job. In the synthesis stage, the elementary movements were combined in the correct sequence to determine the time and the exact method for performing a job. This phase also led to improvements in tools, machines, materials, methods, and the ultimate standardization of all elements surrounding and accompanying a job.

2.5.1.2 The Contributions of Frank Gilbreth

Another important pioneer of the scientific management movement was Frank Bunker Gilbreth. His concept of scientific management can best be described as the search for the one best way to do work (Abramowitz 1967). His early work focused on motion study, which aimed to eliminate those variables that affect motion, develop, standardize and determine the best practice. In doing so, they paved the way for modern work simplification by cataloguing 17 different hand motions, such as “grasp” and “hold” (Kreitner 2007). Rather than Taylor’s endeavours on the quality of the operative, Gilbreth offered the view that each worker can be trained in the correct way to sustain those best practices. He sought to improve operator’s performance through reducing unnecessary motions (e.g. unnecessary motions can be eliminated through better design of the workplace) and limiting fatigue by placing far greater emphasis on the total working environment (Sheldrake 1996). The motion study had generated a great influence on the later concepts such as waste elimination (Ohno 1988), which became the cornerstone of the Toyota Production System.

2.5.1.3 The Contributions of Gantt

Gantt is perhaps best known for his development of the graphic methods of describing plans and making possible better managerial control. He emphasized the importance of time, as well as cost, in planning and controlling work. This led eventually to the famous Gantt chart which is still in wide use today. Due to its simplicity, ease of preparation and graphical format, the Gantt chart is widely used as a construction-scheduling tool (Sheldrake 1996).

2.5.1.4 Lessons from the “Classic” Approach

Taylor’s “one best way” method became the standard for managerial work, and has been both celebrated and criticized over the years. Kreitner (2007, p.40) comments:

“within the context of haphazard, turn-of-the-twentieth-century industrial practices, scientific management was indeed revolutionary with its emphasis on promoting production efficiency and waste elimination”. Nevertheless, much of the criticisms being directed towards scientific management were concerned that this management approach and techniques have dehumanized people by making them act like machines (Kreitner 2007). In the 1920s, these aspects were given more attention, which eventually led to *the Human Relations movement*.

2.5.2 Human Relations Approach

In the late 1920s and early 1930s, observers of business management began to develop the human relations school of managerial thought. During that time, workers gradually realized the weaknesses in the scientific management system and started to exploit them. The dehumanization of work on the shop floor, where the imperatives of working with machines had tended to dominate the work of people, had become more evident as mechanization and automation proceeded, threatening jobs which depended on continually expanding markets (Pearson 2009). The human relations school exclusively focused on management’s relationship with people at work. Mayo and his colleagues’ observations at Western Electric’s Hawthorne Works were the first thorough experimental social science study of industrial work, and commonly viewed as having generated great influence on this school. Pearson (2009, p.138) noted that *“Understanding in the field of human relations. . . is of first importance to the executive; for human relations are the essence of managerial, employee, public and political relations”*.

2.5.2.1 Hawthorne Studies

A series of studies, now known as the Hawthorne studies, was conducted from 1924 to 1932 at the Hawthorne Works of the Western Electric Company, as an attempt to investigate how characteristics of the work setting (specifically the level of lighting or illumination) affected worker fatigue and performance. During the experiment, it was found that production output increased when lighting was improved. When lighting was subsequently decreased, however, production again increased. The result suggested that people were strongly affected not only by physical conditions, but also by mental factors. The so-called Hawthorne effect seemed to suggest that workers’ attitudes toward their managers affect the level of workers’ performance (Wren and Bedeian 2009). This experiment also emphasized the importance of social and psychological factors in the work environment and the recognition of informal organization structures at work, in contrast to the assumptions of scientific management that motivation was simply a matter of payment by results.

2.5.2.2 The Influence of Psychology: Neo-human Relations

According to Mullins (2006), the Hawthorne studies did not address the link between “satisfaction” and work productivity. This is because the link between the two was not always correlated clearly and positively. A group of notable writers

such as Abraham Maslow (1954), Frederick Herzberg (1959) and McGregor (1960) made their attempts to understand the forces which motivated people at work and the way in which individual adjustment, group relations and leadership styles impacted on worker motivation (Mullins 2006).

2.5.2.3 Lessons from the Human Behaviour Approach

The human behaviour approach strove for a better understanding of people's psychological and social needs at work as well as improving the process of management (Mullins 2006). According to Kreitner (2007), the human behaviour approach makes it clear to present and future managers that people are the key to productivity and technology, and that work rules, and standards do not necessarily guarantee good job performance. In contrast, success depends on motivated and skilled individuals who are committed to organizational objectives.

2.5.3 System Approach

Whereas classical approaches focused the technical requirements of the organization without the people, and the human relations approaches emphasized the psychological and social aspects of work, excluding the organization, the system approach attempts to reconcile these two earlier approaches by addressing the interrelationships of structure and behaviour, and the range of variables within the organization (Mullins 2006). Ludwig Von Bertalanffy (1973) was the first to use the term "system theory", and who was often cited as the founder of this school. From his perspective as a biologist, an organization is seen as a combination of interdependent parts or subsystems which collectively make up the whole (Mullins 2006). The value of system theory to the study of organizations is its ability to simplify complex situations by considering its subcomponents (subsystems) as well as with the relationship and interdependencies between these subsystems (Mullins 2006). In the system theory the socio-technical system will be discussed as it pertains to production management.

2.5.3.1 The Socio-technical System

The concept of the organization as a "socio-technical" system is concerned with the interactions between the psychological and social factors and the needs and demands of the human part of the organization, and its structural and technological requirements (Mullins 2006). Broadly speaking, the social system is viewed as anything having to do with the selection, development, and characteristics of an organization's people and the culture that emerges through the interaction of those people. The technical system includes not only machines but also the policies and standard operating procedures of an organization. Recognition of the socio-technical approach is of particular important today because people must be considered as at least an equal priority along with investments in technology (Mullins 2006). Morgan and Liker (2006) employed this model to describe Toyota's product development system with three primary subsystems: (1) process, (2) people, and

(3) tool and technology. These three subsystems are interrelated and interdependent and affect an organization's ability to achieve its external purpose.

2.5.4 Contingency Approach

The contingency approach can be seen as an extension of the system approach that highlights possible means of differentiating among alternative forms of organization structures and systems of management (Mullins 2006). According to Kreitner (2007), the contingency approach is an effort to determine which managerial practices and techniques are appropriate in specific situations. This approach to management also acknowledges that there is no one single best way to manage people or work in every situation (Dubrin 2008). It is true that in real-life management, the success of any given technique is dictated by the situation. Given the nature of this management approach, caution should therefore be exercised in this current research study that the so-called best practice of lean or Toyota Way is contingent upon the circumstances and projected outcomes of each unique organization. Simply because it has generally worked well in Japanese manufacturing plants, or because it has now become internationally accepted, it does not necessarily mean that such management practices would work as well in the Chinese construction industry. It is more important to select and/or tweak the principles or combinations of principles to achieve the targeted performance, or to adjust where necessary to better suit the Chinese context.

2.5.5 Discussion

The above literature review has clearly shown that the evolution of management theory from different schools of management thoughts mirrored the changes in the surrounding economic and social environment in the production management discipline. It confirms production as one of the critical laboratories for developing management theories. Moreover, the evolution of the management thoughts had a direct influence on the way how the production system was designed. For example, time and motion study inspired Toyota to eliminate wastes in seven different forms. In addition, the human relations approach laid significant emphasis on people and acknowledged that people are the key to productivity and technology success, while the system approach equally treats the technical aspects and human resource aspects of the organization. The Toyota Way was also developed on the socio-technical system thinking in that the Toyota Way model is incorporated with the people and process parts.

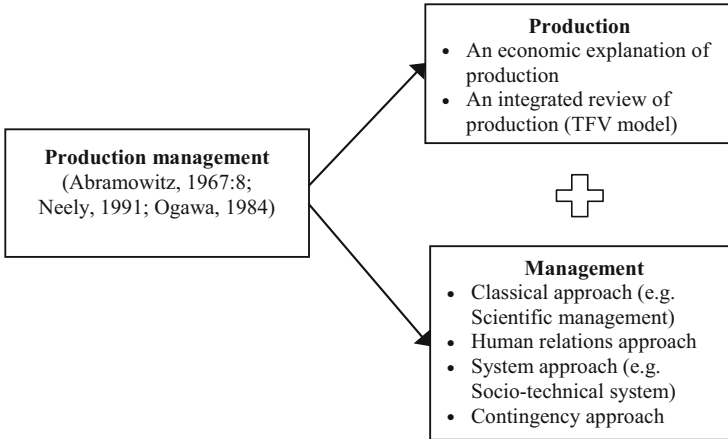


Fig. 2.4 Conceptualization of production management

2.6 Summary

Figure 2.4 outlines contemporary developments in the production management domain with two different emphases, namely on production and management. It parallels Adam's (1983) production management typology that contains two dimensions: the technical transformation axis included the design and operations activities for products and services. The managerial axis separated the classical, behavioural, system, and contingency approaches often used when responding to production and operations problems.

In the course of reviewing production, a brief economic explanation of production has been presented. The development of the neoclassical theory of production was reviewed in particular, which was based on a cost minimizing, profit maximizing firm, with a given level of technology. The economic explanation of production acknowledges all conceivable transformations that can be achieved with given inputs. In order to widen this unitary perspective of production, Koskela (1992, 2000) collectively reviewed three different views of production and integrated them into a new production model, which also laid the foundation for the development of lean construction (see Sect. 3.4). Furthermore, following a chronological order of theory development, this chapter reviewed the evolution of management thoughts from the classical approach to the human relations approach to the system and contingency approaches. Changes in the economy and society worldwide have resulted in a workforce that no longer accept it as being treated like another piece of machinery. In the human relations school, management theorists placed emphasis on motivation, leadership, etc. In the system approach to management, people are treated as equal to technology. The review of conceptualizations of production as well as the various approaches to management theories provides this research with a general theoretical background to review the Toyota Way model, which not only focuses on the manufacturing process, but is also a management philosophy per se.

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