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REVIEW ON THE EVOLVING RELATIONSHIP BETWEEN QUALITY AND PRODUCTIVITY

Abstract: *Quality and productivity concepts were confusing and sometimes used interchangeably by experts both in industry and academics. Though researches, to some extent, tried to show the developments of quality and productivity, as yet, no research was devoted to study their evolution in a way to know how they reached into their existing form and their relationship, whether it existed. This study intends to disclose the reason behind the confusion and concept-intermix by studying the main advancements in the evolution of the two concepts. Their evolution is chronologically determined by grouping basic advancements in to distinct timeframes and their corresponding relationship is identified using natural selection and biased mutation approaches of evolution. The paper revealed that in the first period there was Seemingly Productivity; in the second Primarily Productivity; in the third Primarily Quality; in the fourth Primarily Quality-based Productivity (i.e. one after the other norm); and in the fifth period both quality and productivity will be equally primarily focus of firms (Primarily Quality and Productivity). Through logical justifications, observations made in the existing literature, and based on the nature of future competitiveness orientation, future relationship between the two concepts needs intelligence in that they will be equally, seemingly with trade-off, and concurrently important for organizational growth, agility, and excellence; one will never exist without the other, and after the other.*

Keywords: *Evolving relationship, Quality,Productivity, Improvement, Evolution*

1. Introduction

In the way towards striving for survival and getting market shares, two piercing words came to exist in every industrial setup – Quality and Productivity. Even though these words are very old, they are becoming critical ingredients in today's global market. They become household-terms since everyone talks about them. The exact time when quality and productivity got attention is not clearly known yet. But, ideas for any type of change, in this case 'improvement', goes back to at least 1732 when James Arkwright created spinning frames for the British Cotton Textile Industry to increase the number of outputs. Since then,

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manufacturers became aware of increasing volume of production and sales which by default belongs to enhancing productivity. Then, the quality concept came to exist when firms tried to produce good quality products. Soon however, quality was observed to reduce productivity and industries tried to compensate the expenditure made for quality using mass production so that it can be distributed to large amount of products; because, profitability of firms was the core and the only mission. From such instances, though contradictions existed, the co-existence and relationship between quality and productivity came to be perceived since the mid of the 20th century (Nebl and Schroeder, 2011).

The linking of quality and productivity requires many more researches before the true effects and the true benefits are clearly recognized (Mohanty and Yadav, 1994). As a result, enormous management philosophies had emanated by many gurus and dreamers, especially about the end of the 19th till the mid of 20th century. Even, many case studies for quality and productivity improvements are using similar methodologies or tools and techniques (Bovas, 2010). For years, quality and productivity have been viewed as two important indexes of company performance though they are always emphasized separately (Tangen, 2005a; Lee *et al.*, 2007; Nebl and Schroeder, 2011; Kalinga *et al.*, 2013). Thus, some among the problems observed in the existing literature related to quality and productivity include:

- Their ambiguous relationship is deviating the focus of researchers and practitioners;
- The redundancy of researches and applications is pointlessly congesting the literature
- Their ambiguous relationship is still creating more and more confusions;

In 1979, Sumanth marked his tenderfoot that "the first decade of the 21st century will see a balanced approach to managing three strategic variables: quality, technology, and productivity". Two of these strategic variables, quality and productivity, are the main concern of this paper since confusions and concept intermix is mainly aggravating between these two. Especially now, the confusion and/or intermix reaches in its climax and even some researchers concluded as these two concepts are synonymous. Individuals begin to use them as they want, interchangeably. This scenario may deprive the focus of researchers and practitioners. It might dissolve the supremacy of the accumulated literature. Researcher may not be able to communicate through the body of knowledge. Lastly, this may lead to wrong interpretations. Even though confusions and intermixes existed on the relational orientation between quality and productivity, they could under no circumstances be identical even if things that strengthen their linkage increase; i.e., they have boundary howsoever it is slim. Their co-existence also seems impossible to disintegrate similar to what other researchers stated as 'quality and productivity are inseparable'.

For this reason, studying their clear-cut relationship is by-no-means an issue to be hesitated at this time. Recognizing these intermixes and confusions, few researches have been conducted to study the possible relationship between quality and productivity. Most of the researches mainly focused on creating mediator-based analytical relationship. The mediators used until recently include: profitability (Everett *et al.*, 1981); profit (Sumanth and Arora, 1992); unit profit (Lee *et al.*, 2007); efficiency and utilization and maintenance (Khan and Darrab, 2010). Though the attempts made are appreciable, the existing literature on the relationship between the two concepts basically has the following limitations:

- All of them are case sensitive and difficult to generalize on the relationship;
- They all ignored so many parameters such as customer dynamism, product

type, product variety, and so on that can affect the relationship; and

- They did not consider how the confusion and intermix came through.

To get their true relationship, the source of the existing confusion and intermix should be made clear; trying to blindly create the relationship without the consideration of their evolutionary relationship would be nonsense and might even be resulting in a misleading conclusion on their relationship. The best way is to study them, to know their similarities and differences, and lastly to work for the orientation they demand, be it negative or positive. This means, knowing what the main focus of industries seemed in different epochs helps to known the inconsistence of definitions and applications. This then can indirectly help in recognizing possible directions and core themes on their current and near-future relationships. This paper intends to study the evolution of the two concepts and their relationship and clearly identify the sources of concept intermix among these two ideologies in a way that it helps to clearly see their evolving relationship. Finding of the paper will help firms to reduce redundancy of improvement efforts and to foresee the forthcoming relational setup among quality and productivity.

2. Literature review

In the past two solid centuries, quality and productivity concepts have showed significant development: from an era of substituting labors by machines through a century journey of search for maximizing labor productivity and product quality up to the existing ideology of exceeding customer's expectation. In that long journey, considerable definitions for these two concepts are whirling their position in the literatureand are intermixing to one another and one can get enormous definitions with very few clicks on the internet. The literature is thought to constitute fruitlessly high redundancy of knowledge production. Especially, tools initially designed for quality improvement are also being used for productivity (Kalinga *et al.*, 2013). Moreover, owing to the dynamically changing customer behaviour, markets become vulnerable to these changes; scholars and practitioners came to excessively be aware of all the behavioural dimensions. In doing so, lack of valid descriptions for quality and productivity and their relationship came to exist.

As a result, researches which tried to show and correlate quality and productivity came up around the end of the 1990s. Mohanty (1998), tried to see some peculiarity between the two concepts in terms of some variables. He showed that the two ideologies perfectly correspond in terms of cultureand responsibility; he however observed slightdistinction among them when he viewed in terms of definitions, organizational objectives,and decisions. Whereas definition for quality was customer-driven, definition for productivity was organization-driven; whereas quality's organizational objective was minimizing waste, productivity's organizational objective was maximizing resource utilization. Moreover, Vaziri (1987), depicted the traditional and emerging ideological views of these two concepts; the emerging view primarily targets on delighting customers whereas the traditional view mostly emphasized on end result, which was profit.However, they had little deviation when evaluated in terms of their driving forces and measurement approaches; the driving force for quality was inspection and for productivity it was increasing efficiency. Quality was a concern to meet customer specifications and productivity was used as an approach towards achieving the targets set by organizations – labor productivity.

Garry (1985), noted that the "quality road to productivity is the shortest and most effective route to higher productivity". Pantera (1985), also affirmed as "quality, not quantity is key to productivity". Other

similarstudies also vowed that quality incorporates productivity since only through quality improvement can productivity be enhanced and the route to increased productivity is by increasing quality (Hart and Hart, 1989; Sumanth and Arora, 1992;). Butts (1984), also described poor quality as "a vampire-like creature which takes bite after bite out of productivity". Overall, quality and productivity came closer in most of the criteria used to express their relation. On the contrary, Gitlow (1990), believed that emphasizing only on productivity will sacrifice quality and may even lower output. Hsu and Spohrer (2009), indicated that quality is a measure of value from the customer perspective, and productivity is a measure of value from the provider perspective. There are also other researches which showed possible negative relationships that might exist between the two concepts (Sumanth and Arora, 1992).

Up till now, their relationship remains controversial. Lee *et al*. (2007), identified five sets of researches that attempted to relate quality and productivity: mutually conflicting; synonymous; hard to relate them due to the existence of a large variety of definitions; the relationship exists and should be positive; and productivity can be enhanced through the improvement of quality. Then, what are the sources of such confusions in understanding the linkage between the two concepts, both in academics and practice? Even if based on logical reasoning, most researchers believed as the two concepts have positive relationship (Mohanty and Yadav, 1994). Thus, improving quality and boosting productivity are in conflict only when productivity is narrowly defined and viewed exclusively from the producer's standpoint (Parasuraman, 2002, Parasuraman, 2010; Armando, 2011).

You might observe some seemingly echoes in the previous discussions. But, they were used to show how much these two concepts were intermixing irrespective of the fact that they have so many commonalities and distinctions among each other. The definitions, tools, techniques, and other seemingly related values with these two concepts have been used interchangeably. In this regard, Amare (2012), noticed as many methods of improving productivity have been developed over the years. Scholars have been widening the scope of productivity by incorporating themes and definitions from quality. The large variation in definition and understanding among the recent and ancient views of the two concepts significantly contributes for the confusion and intermix. Lastly, the two concepts come close together contextually.

In general, the confusions on the relationship between them came to exist due to two core reasons: misunderstanding of target group or business orientation and availability of plenty of intermixing literatures. For the definition and interpretation given to these concepts has been enormous, they in the meantime started to be considered as synonymous. Consequently, the broad-spectrum objective of this study is contemplated to identify, analyse, and evaluate the respective evolutions of quality and productivity and their relationship in such a way that the clear-cut boundary, relational path, and their evolving relationship can easily be traced which can help the academics and industries to notice the intermix and to avoid duplication of efforts.

3. Framing and Conceptualizing Quality-Productivity Relational Development

Though there were limited related literatures, the historical developments of quality and productivity noted by (Woodbury 1960; Krar and Gill, 2003; Holweg, 2007; Nevell, 2008; Sun, 2011) are mainly used to trace back the evolutions of quality and productivity concepts. In ancient periods, the main concern of industries was either increasing the number of outputs from labourers or substituting them by mechanisms. Such

efforts goback to 1732 when James Arkwright created spinning frames and when Eli Whitney introduced the concept of interchangeable parts in 1799 (Woodbury 1960; Krar and Gill, 2003; Holweg, 2007; Nevell, 2008; Sun, 2011). For the next 100 years however, manufacturers were mainly concerned with the advancement of engineering drawings, machine tools perfection, and large scale processing. This changed in the late 1890s with the work of F. Taylor. He began to look at individual workers and their methods of doing work. This resulted in Standardized Work and Time Study. Taylor had a peculiar attitude towards workers (Krar and Gill, 2003; Holweg, 2007).

At the beginning of the 20th century, a couple of Industrial Engineers (Gilbreth and L. Gilbreth) came to contribute to the fields such as motion study and human factors. F. Gilbreth, who was thought to be an efficiency expert and a pioneer of scientific management, added Motion Study and Process Charting to the management process. L. Gilbreth then brought psychology into the mix by studying the motivations of workers and how attitudes affected the outcome of processes. Also about 1910, H. Ford fashioned the first comprehensive manufacturing strategy; people, machine tools, processes, and products were assembled into an efficient manufacturing system to produce a Model T automobile. Ford was so incredibly successful. Many companies in the world tried to copy Ford's approach so as to improve their manufacturing processes. But, most of them failed to do so since they did not understand the fundamentals. It is even doubtful that F. Henry himself fully understood what he had done.

Around the mid of 1950s, Japanese industrialists studied American production methods with particular attention to Ford practices. The Statistical Quality Control practice of Ishikawa, E. Deming, and J. Juran made major contributions to quality improvement of manufacturing processes (Krar and Gill, 2003; Holweg, 2006). Deming's work concentrated on how management must learn how to reduce waste and improve quality, productivity, and competitive position of companies. Juranfocused on quality management issues in a way to resolvemanufacturing problems make companies competitive. Deming's and Juran's works were adapted by Ohno and Shingo and began to incorporate Ford production and other techniques into the fundamentals of Toyota Production System (TPS). They alsodiscovered that workers had far more to contribute than just muscle power; worked on the setup time and changeover problems so as to create continuous flow production system similar to that of Ford's concept; and they introduced a flexibility that Henry Ford did not need. This discovery probably originated the Quality Circle movement. All of this took place between about 1940s and 1970s.

When productivity and quality gainsof Japanese companies became evident to the outside world, American executives started to travelto Japan. They brought back, mostly, the superficial aspects like Kanban cards and quality circles. Most early attempts to emulate TPS failed because few understood the underlying principles. By the end of 1980s, some US manufacturers such as Omark Industries and General Electricwere successful in implementing TPS methods; new terms such as World Class Manufacturing, Stockless and Continuous Flow Production and many others came to be common. Then, manufacturers became aware of the need for waste reduction and continuous performance improvement (Tangen, 2005). In 1990, James Womack wrote a book called "The Machine That Changed the World". In the late 1900s up until the early 2000s, what were new phrases were Lean Manufacturing, Kaizen, and Six Sigma; they all involve the reduction of all types of wastes in any business operation, even down to a level of zero.

At all, eliminating wastes and variations will increase productivity, reduce costs and make

a company more competitive on the world markets (Tangen, 2005; Setijono and Dahlgaard, 2008; Jaspreet, 2009; Wu and Zhang, 2011; Mohammed and Al-Dujaili, 2013). It will increase the desirability of the company's products; and lastly customers' base will grow. In the 21st century, what is coming beyond waste elimination and variation reduction is environmental protection. It is excessively bothering industries and countries in the world. Though efforts are being made to protect the climate from pollution and degradation by substituting energy sources by the renewable ones, this environmental issue will highly be intensified in the next half a century so that industries will face a new perspective of challenge.

4. Tracing the Evolving Relationship between Quality and Productivity

Although there was no clear-cut approach that was practiced with critical focus on either or both of the concepts, the activities and thoughts can be framed chronologically in a way that suits grouping of critical developments and perspectives. It, yet, should be kept in mind thatmost of the developments, especially in the early ages, were not targeted towards special needs. Rather, they seemed as problem solving approaches whatsoever the methodology could be. For example, in the very old ages, productivity was principally supposed to be enhanced only from increased volume of production; employees were expected to produce as much higher number of products as possible. Though they might not practice to measure productivity, the intention in their minds had been productivity improvement. In the early ages, machines were created not to help human labor but as their substitutions since labours were unable to produce to the expectations of owners. Quality then again was simply considered as a measure of fulfilment of external features and durability. Thus, the basic developments in productivity and qualityare categorized into distinct timeframeswith the help of rationales from related literatures discussed in before. Evidences indicated by some researchers (Woodbury 1960; Krar and Gill, 2003; Holweg, 2007; Nevell, 2008; Sun, 2011) are used as bases to the classification scheme for respective evolutions of quality and productivity.

Before the 1900s, though enormous progressions might occur, the documented ones were too few. Eli Whitney's perfection of interchangeable parts; Ark Wright's creation of the spinning frames; James Watt's radical improvement of power, efficiency, and cost-effectiveness of steam engines; and Taylor's effort towards standardizing works; all have commonalities that they intended to take advantage of the available markets by substituting machines for labourers and enhance outputs. These personalities can be considered as eye openers since they made subsequent generations to be aware of quality of products and productivity of firms.

F. Gilbreth's effort towards enhancing the number of outputs from labours through the introduction of motion study; L. Gilbreth care for the psychology of employees; and Ford's structured assembly line were the most stated efforts that bring attention of manufacturers in subsequent erasfor capacity utilizationand performance improvement. Also, around the 1920s and 1930s, mathematicians bring the concept of statistics into the manufacturing environment for control requirements. Pareto's 80-20 rule and Shewhart's control chart and Shewhart cycle were the key contributions of that era stated by most quality and productivity literatures. Flanders work should not be ignored for his noticeable effort in the area of Group Technology. All these developments occurred in the first two decades of the 20th century.

Fierce competition among American's and Japanese industries and personalities came to exist after World War II. Industries of these

two countries were copying and competing one another about the 1940s up until to 1970s. During that time many elements of Ford production system were studied by Japanese industrialists through the helps of Deming and Juran (Krar and Gill, 2003). At Toyota Motor Company, Ohno and Shingo brought a new mind set of work which involved workers beyond their muscular work through the TPS (Holweg, 2006). They then discovered so many things as Quality Circle, flexibility, cellular manufacturing, setup and changeover time reduction, and so on. Ishikawa's cause and effect analysis was also a significant contribution around these times as stated by many literatures.

Deming's and Juran's deliverables were underestimated; these two experts were then invited by Japanese companies. Around the end of 1970s, American's observed that the Japanese companies became successful and quality and productivity improvements became evident to the outside world. Then, American executives travelled to Japan to study how the Japanese became successful. For many times, they bring about only what they said "the superficial aspects" like Kanban cards. Lastly, in the mid of 1980s some US manufacturers came to be successful in implementing the Japanese TPS. From then onwards, quality, productivity, waste, variation, etc began to be known all over the world. Successful industries became aware of the need for waste reduction and continuous improvement. In the early 2000s, after Womack's book, what were new phrases were Lean Manufacturing, Six Sigma, and Lean Six Sigma. These philosophies and their derivatives are the recent working principles of industries. And, industries in the next half a century may face new challenges related to environmental safety requirements beyond the existing dynamism of customers' requirement (Elshennawy, 2004). The environment will come to exist as a complement customer to the coming century's human customers.

According to the chronological appearance of quality and productivity related applications and theories, distinct eras or timeframes for the evolution of these two concepts can be generated. Krar and Gill (2003), has proposed seven timeframes of Lean Manufacturing; these were: Early Lean Developments; The Next Hundred Years; Work Standards (late 1800s); Process Charting (early 1900s); The Henry Ford Years (early 1900s); Deming, Juran, and Ishikawa (mid 1950s); TPS; World Class Manufacturing (the 1980s); and Lean Manufacturing (late 1900s –early 2000s). Similarly, Matthias (2006) categorized the whole journey of Lean Manufacturing into three distinct eras: (1850 – 1900); (1900 – 1950); and (1950 – 2000). These two developmental timeframes in the quality-productivity panorama showed the key personalities within each category. However, their contributions were not clearly stated whether they were productivity or qualityfocused. Recently, Lean Manufacturing is thought to be an all-inclusive improvement philosophy which encompasses both quality and productivity improvement requirements.

Based on these foundations, this paper intends to generate a timeframe for quality and productivity evolutions whereby the critical focus of developments could easily be identified so that the evolving relationship between these two core concepts can be easily traced. Thus, all the developments observed before the 1900, due to the difficulty to get consistent documented literature, are aggregated as separated timeframe. Critical and significant developments were observed in the 1910s, 1920s, and 1930s. So, these developments can be aggregated into a second timeframe for quality and productivity improvement.

After the Second World War and up until the end of 1970s, industrial development was boosting and distinct developments that created a base for the existing state-of-the-art management styles have evolved. And so, the time range from 1940s to 1980s can better be considered and evaluated as a

separate development. Krar and Gill (2003), also critically seen the progresses of this timeframe when developing the timeframe for Lean Manufacturing (1940s – 1970s). Around the mid of 1980s, when American's observed the success of Japanese, they felt regretted for instinctively sending the two key experts (E. Deming and J. Juran) to Japan. They then travelled to Japan to study how the Japanese became successful. In addition, Womack's book also notably contributed for the existing latest philosophies and management approaches such as Lean Manufacturing, Six Sigma, and Lean Six Sigma. Hoping that these philosophies and their derivatives will stay being the competitive advantage of recent industries until up to the end of the Millennium Development Goal (MDG) period, 2020, another timeframe is generated in the time range 1980 – 2020. From then onwards, the environmental-related issues may deviate the direction of competition and a prospective timeframe can be represented from 2020s onwards.

Thus, five distinct timeframes, 5Ps, are proposed so as to evaluate respective era's critical focus for quality and/or productivity; these are: Primal-past (before 1900); Past (1900 – 1940); Primal-past (1940 – 1980); Present (1980 – 2020); and Prospect (after 2020). For nomenclature purpose, these five timeframes are known as 5P quality and productivity relational evolution time frames.

5. Discussion

Although almost all the developments and their respective constituents, in one or the other way, are discussed for so many times in previous sessions, only the critical focus of each timeframe with respect to either or both of quality and productivity is shown in this session. In essence, this paper intends to grasp the wide-ranging chronological developments on quality and productivity in a way that the sources for the confusion and intermix can be easily identified and the evolving relationship among these two concepts be envisioned by academics, practitioners, and even customers. Such chronological appearance and relationship can be well-traced using the theory of evolution. Evolution is the change in the inheritedcharacteristics of populations over successive generations and gives rise to diversity. Mutation, being a major source of variation, also functions as a mechanism of evolution. In biological evolution, evolutionary biologists and psychologists assume that all common traits and behaviors must have evolved from an optimizing process of natural selection and/or biased mutation.

In this paper, the traits and behaviors of quality and productivity observed in the literature are critically examined. Here, their related philosophies and concept intermix are assumed to have ancestors. The evolution of the related theories in quality and productivity is also examined either evolution by natural selection and/or biased mutation.Whereas the natural selection part focused on the selection and development of theories relevant towards solving problems that companies were facing in their life time, the biased mutation was a result of biased or targeted selection for improvement methodologies and philosophies.

5.1. Primal-past (before 1900)

Progression made in this era is taken as an initially recognized ancestor for all quality and productivity related theories existed ever. The developments observed in this timeframe could be considered as natural selection for a reason that majority of the personalities such as James Arkwright, Eli Whitney, and W. Taylor had a critical goal to achieve – enhancing labor productivity. There was no any bias or critical focus observed towards quality or productivity. Even though the work of F. Taylor focused only on work methods and increasing labor productivity, he ignored morale of employees; this peculiar attitude of Taylor

negatively affected quality of products (biasing situation). Hence, this time zone of the industry, in terms of its progress with respect to quality and productivity is assigned to be '*seemingly productivity*' era as shown in Appendix. At that time, employees were treated badly, though utilization of resources, substituting machines for labor, and introduction of operating methods were the main focus.

5.2. Past (1900 – 1940)

In this stage of development, a number of personalities came to exist. Ford was successful in creating thefirst wide-ranging manufacturing strategy at the end of 1900s; but, he focused on enhancing the profitability of his company regardless of employees' morale and involvement as a result of which his company incurred losses in later periods of Ford Automobile Company. Likewise, the motion study by F. Gilbreth and Flanders' Group Technology efforts intentionally targeted towards enhancing the volume of production as a result of which the concept of mass production also came to exist (biased mutation). The psychological input proposed by L. Gilbreth also leaned towards enhancing organizational productivity from satisfied employees by increasing the number of units produced per worker (biasing situation). But, motivated employees not only produce more but also care for product quality. This was the hidden good result that the practitioners were surprised. It shows that productivity was the centre of attention, except the work of L. Gilbreth. In this period, the quality aspect of products slightly got higher consideration. The efforts of Pareto and Shewhart, when evaluated in the eyes of today's function of the tools they proposed, seemed as their basic target was quality improvement. Unfortunately, their main focus was still enhancing the volume of production in respective areas of application though they were also improving quality of products and processes.

Despite the fact that these two dogmas came to be the centre of attention, the mass production approach of enhancing productivity made that era's thinking unique. Waste was evaluated with respect to the interests of the manufacturer; anything and any activity that could not bring profit to the manufacturer was considered as rubbish. At that time, the awareness on customer satisfaction was insignificant. The quality dogma was even sometimes thought to be against productivity. At this juncture, you must remind that the stages of evolution are evaluated for their main focus either for customer or company. If the primary focus was customer, that dogma in the evolution is assigned as quality and if the primary focus was organization, the dogma in the evolution is assigned as productivity. Thus, the timeframe 1900s-1940s is considered as *primarily productivity* era. Taking this under consideration, employees' morale or motivation came to improve; modernization was appreciated; resource utilization improved; and more efficient and effective machines and methods fabricated.

5.3. Prior-past (1940 – 1980)

Here, it is decided to name this era as Prior-past since its progress in quality and productivity has close similarity to the existing understanding of the dogmas by academics and practitioners. At the end of the previous period, when practitioners observed that only focusing on volume of production is nonsense (natural selection) and business competition became stiff (Sekkat, 2009) (biasing situation), 'quality' came to exist as a factor which might negatively affect the concern of volume of production and productivity. In this era, significant knowledge-based decisions were made towards continuously improving organizational performances (Mohammad and Al-Dujaili, 2010). Contribution of Kaoru Ishikawa's Cause & effect analysis, E. Deming's PDCA cycle or Shewhart cycle, J. Juran's Total Quality Control, and basically the efforts of Ohno and Shingo's TPS

primarily targeted towards eliminating process variations and wastes. They proved wrong for the previous era's assumptions which thought quality to negatively affect productivity.

These developments paved the way to understand the severity of variations and wastes to customers and the significance of eliminating them to company's productivity. Thus, the timeframe from the 1940s to 1980s focused in improving quality, hence known as *primarily quality* era as a result of which employees' motivation and involvement got good attention; the operational efficiency of machineries was tried to be improved by devising improved work methods; wasteful use of input resource came to be recognized as wicked; and the need for enhanced performance through effective interaction among firm entities such as men, machine, method, etc. help for the fortification of new technologies and innovations for modernization.

5.4. Present (1980 – 2020)

Since the beginning of the 1980s, as Sekkat (2009), noted, the competition among companies became tougher and tougher and drastically expanded its scope all over the world (biasing situation). What came changing through time is the notion of handling the ever-changing customer demand and satisfaction. The notion exceeding customer's requirements followed. This becomes a competitive advantage of firms in the hope, and of course in philosophical ways, that if quality of products and services is continuously improved, there is little or no reason for customers to escape from the surrounding of an organization whatsoever changes occur in the status of customers or other competitors (biased mutation). What the customer intends is tried to be re-considered in the next supply. In this manner, the customer is kept satisfied for long. This notion leads to a conclusion that for every effort exerted to improve quality, the company will equally improve its productivity.

However, according to (Zivaljevic *et al*., 2013; Armando, 2011; Armando *et al*., 2013), the notion that "quality negatively affects productivity" was also observed in the service industry at the beginning and mid of this era (naturally inhibited thinking). From this perspective, this era is made be known as the '*Primarily Quality-based Productivity*'. In this stage, efficient utilization of resources, availability of state-of-the-art machines and methods are approaching to their highest level ever (a combination of natural selection and biased mutation). The technological advancements and innovations observed yet implied that there will be more to come. But, the need of employees for secured and safe working environment is surprisingly increasing. They will require more guarantee for their health and social status (biasing situation). It implies that industries may be expected some more unforeseen requirements from their internal and external customers. This scenario will leave a critical homework for future industrial setups (biased mutation).

5.5. Prospect (After 2020)

Obviously, this is the most difficult era to imagine in accordance to the rate of changes that firms in the globe are facing today. New challenges, new prerequisites, and new technologies are rapidly introduced (Elshennawy, 2004). Governments are becoming too worried on environmental issues. The survival of the Earth is being questioned due to pollution and degradation (biasing situation). Green production will be extraordinarily required and promoted; business excellence may be according to how firms saved natural resources than how they offered highly precious products since it will be a question of survival of the globe. Efforts being made towards reducing variations and wastes through sigma measures are expected to reach to a level of agility, where and when everything seemed relatively perfect. Every company may be

expected to have an ability to realize rapid changeovers for a wide variety of production models in a rapidly changing business environment. In this regard, companies will be in a very tighter situation whereby the trade-off between quality and productivity requirements might revive (biased mutation). Companies may critically question themselves as what, how, and for whom to produce or to offer than ever.

Hence, this stage should focus towards balancing the requirements for both concepts – *Primarily Quality and Productivity*. In this stage of evolution, employees will require a more secured working environment in every aspect; resource utilization will be a more critical issue; a more efficient and effective working methods and machines will be expected. Hence, modernism might even be expected to help and even create all the other firm entities (except men) in a way that employees are secured and resources are protected and more efficient and effective machines and methods than ever are expected to evolve. At this era distinct groups of suppliers may require to be customers of their customers. The existing supplier-customer relationship will be changed into liable and distinct customer-to-customer relationship for a reason that each and every relationship may involve high risk in trying to keep the Earth clean and safe to live for bio-diversity. Hence, the revival for the trade-off between the two core organizational concepts – quality and productivity is then the evolving relationship that organizations may exhibit in their prospective era (Appendix).

6. Conclusion

The main purpose of the paper was to study and disclose the wide-ranging evolution of quality and productivity concepts in a way that it helps to eliminate the confusion created in the literature and to anticipate their evolving relationship. Even though plenty of literatures are available related to these concepts, none of them has traced their long history in terms of their evolutionary appearance and relationship. The paper uses evolution from natural selection and biased mutation to analyze theoretical and practical perspective appearances of the two concepts and their influence on the five basic entities of firms in five chronology of their history. The study revealed that in the Primeval-past period, there was no any notion related to quality; and their focus was enhancing organizational productivity. The Past period, though also focused on enhancing organizational productivity, the notion of quality built within it came to exist. In the Prior-past, notion of quality came to dominate in most industrial setups and efforts for enhancing productivity declined. In the Present period, however, both concepts are being considered in every organization in that productivity can be improved by focusing on quality, but with significant confusion and intermix. In the Prospect period, relationship between the two concepts needs intelligence in that they will be equally important for organizational growth and excellence. One will never exist without the other and after the other. The paper opens up a detailed ease of use of quality-productivity relationship. It also addresses the limitations of most researches whereby they forgot the evolutionary appearance of the two concepts and their relationship. This paper critically noticed the availability of duplicated knowledge in the literature and diluted effort in application during separate implementation of quality and productivity improvements. This paper is first of its kind to reveal the evolutional appearance of quality and productivity and their relationship.

Appendix: Summary of quality and productivity evolutions, key personalities, basic themes, and potential relationship

Evolutionary phase	Time zone	Key Personalities & Contributions	Basic Themes	Remark
Primeval-past	Before 1900s	J. Arkwright (spinning frames of textile industry), E. Whitney (interchangeable parts), F.W. Taylor (Scientific Management),	Increasing volume by substituting labor by mechanism/machine	***Seemingly Productivity***
Past	1900s – 1940s	F. Gilbreth (motion study), L. Gilbreth, H. Ford (JIT as manufacturing strategy), Pareto (80-20 rule), W.A. Shewhart (control chart&Shewhart cycle), Flanders (Group Technology)	Increasing labor productivity by inspiring labor & decreasing process variation	***Primarily Productivity***
Prior-past	1940s – 1980s	K. Ishikawa (Cause & effect diagram), SPC), W.A. Shewhart &E. Deming (PDCA cycle), and J. Juran (QC & TQM), Ohno and Shingo (TPS & JIT), J. Burbidge (Cellular Manufacturing)	Diagnosing problems in processes & continuously improving quality through team work	***Primarily Quality***
Present	1980s – 2020s	E. Deming (PDCA cycle), and J. Juran (QC & TQM), Ohno and Shingo (TPS & JIT), J. Womack (Lean Manufacturing), Kaizen (Japanese), J. Welch (Six Sigma), M. George (Lean Six Sigma)	Continuously diagnosing quality problems by focusing on customers' needs in a way to enhance total productivity with the involvement of all	***Primarily Quality based Productivity***
Prospect	After 2020s	Business excellence, Beyond global competitiveness, Green production, Agile Manufacturing (A. Gunasekaran)	Surviving a very tough competition by exceeding customers&keeping the earth clean & safe; supplier-customer r/ship will be changed into liable & distinct customer-to-customer r/ship	***Primarily Quality and Productivity***

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