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An Integrated Framework of Productivity Management /PIPs Through Conceptual QFD Modeling for High-Performance-Manufacturing Systems: 360^o BSC Perspective

Muhammad Hammad A. K. Khan[1]* Shiming Deng[1] Asif Rashid[2] Junaid Ali Khan[1] Fariha Zulfiqar[3]
1.School of Management, Huazhong University of Science and Technology, Luoyu Road 1037, Wuhan 430074, China
2. Aviation Industry Consultant, Istanbul, Turkey and DEM, College of E&ME, University of Science &Technology (NUST), Rawalpindi, Pakistan
3. Institute of Computer Science and Information Technology, The Women University, Kutchery Campus, L.M.Q. Road, Multan, Pakistan

Abstract
Business competitiveness is no longer a choice but a matter of survival in global market place. This competitiveness demands PIPS to be realigned and recalculated in the light of new culture of customer satisfaction and perceived quality. The employment of TQM, QFD and *Balanced Scorecard* coupled with high performance manufacturing concepts for exceeding customer expectations and business processes are the CSFs for design and architecture of current enhanced PIPs framework. The conceptual mapping of high performance manufacturing indices over a balanced score card scale has been conducted to redefine the direction of research work with a sole aim of earning competitiveness. The methodology radiated is the first step to manifest guidelines for planning performance based on TQM methodology for continuous improvement.The TQM and balanced-scorecard (BSC) technique is employed to predict performance expectations, voice of customers (VOC) and other set of balanced strategies into deliverable objectives. The proposed framework is expected to enhance the chance that a balanced management approach with the collaboration of all stakeholders will earn hyper efficiency and ultimately move towards the ultimate competitive advantage. The embedded smart *Balanced Scorecard* intelligence into design-schema is the key for futuristic development of performance improvement programs and a leap towards smart factory concept.
Keywords: PIPs, TQM, QFD, *Balanced Scorecard (BSC),* TQM, VOC, CSFs, Customer Satisfaction, Customer Expectations, High Performance Manufacturing, smart factory

1. Introduction

The philosopher and technologists Herbert A. Simon quoted that “In the physical sciences, when errors of measurement and other noise are found to be of the same order of magnitude as the phenomena under study, the response is not to try to squeeze more information out of the data by statistical means; it is instead to find techniques for observing the phenomena at a higher level of resolution”. The corresponding strategy for (social science) is obvious. Contextual to the issue, this research proposes a hybrid-scale for productivity performance indices so as to achieve a higher level of resolution.

The pillars of competitiveness in a wired e-world community (global-village) iterate exclusive development of productivity performance indices to earn hyper-efficiency across borderless-industrial enterprises. While performance improvement programs have emerged as a necessity and while more and more researchers are attracted to improve the existing methodology for productivity performance indices yet the game-plan and the results are far less than the craving for ideal performance indices. These general improvements normally involve better utilization of resources and a call for higher quality levels. Essentially, the focus is on enhancing productivity to meet or beat the competition on relevant cost, quality, time, and flexibility concerns. Considering demands of new culture of customer satisfaction and perceived quality, it is easy to speculate about the severity of the problem of existing productivity improvement programs which have frequently produced disappointing results and the enterprises even have a risk to lose their existing competitive advantage.

Business competitiveness is no longer a choice but a matter of survival in global market place. This competitiveness demands that the performance improvement programs research direction be realigned and recalculated in light of systems-theory while ensuring TQM-framework to earn customer-satisfaction in a systematic and logical manner.

In past researchers have evolved comprehensive literature reviews of PIPs-research yet so far no little effort has been made for developing Typologies and Taxonomies by mapping over balanced-scorecard-scale coupled with metrics of high-performance-manufacturing (Schroeder and Flynn 2002) for a complex-structured industry. So TQM and balanced-scorecard (BSC) technique is employed to predict performance expectations, voice of customers (VOC) and other set of balanced strategies into deliverable objectives.

The proposed framework is expected to enhance the chance that a balanced management approach with the collaboration of all stakeholders will earn hyper efficiency and ultimately move towards the ultimate competitive advantage. The embedded smart Balanced Scorecard intelligence into design-schema is the key for futuristic development of performance improvement programs

2. Methodology

The existing literature in industry regarding performance improvement programs was the "raison d'être" which became core source for conducting this research. The balanced scorecard is a strategic planning and management system that is used extensively to align business activities to the vision and strategy of the organization, improve internal and external communications, and monitor organization performance against strategic goals while Quality function deployment (QFD) is a method to transform qualitative user demands into quantitative parameters. So a Framework of Productivity management / PIPs through Conceptual QFD modeling with 360o BSC Perspective have been designed for high-performance-manufacturing Systems. The derived variables were scrutinized based on high performance manufacturing indices and Balanced Scorecard indices to realign the direction and propose a hybrid and yet integrative indices.

3. Theoretical background

Today's companies are in the midst of a revolutionary transformation. Industrial age competition is shifting to information age competition. During the industrial age, roughly from 1850 to about 1975, companies succeeded by how well they could capture the benefits from economies of scale and scope (Chandler 1991). Technology mattered, but, ultimately, success accrued to companies that could embed the new technology into physical assets that offered efficient, mass production of standard products. During the industrial age, the financial control systems were developed in major companies to facilitate and monitor efficient allocations of financial and physical capital(Chandler 1991). A summary financial measure such as return-on-capital-employed (ROCE) could both direct a company's internal capital to its most productive use and monitor the efficiency by which operating divisions used financial and physical capital to create value for shareholders.

The emergence of the information era, however, in the last decades of the 20th century, has made obsolete many of the fundamental assumptions of industrial age competition. The information age environment for both manufacturing and service organizations requires new capabilities for competitive success. The ability of a company to mobilize and exploit its intangible assets has become far more decisive than investing and managing tangible, physical assets(Itami and Roehl 1991).

Industrial age companies created a sharp distinction between two groups of employees. The intellectual elite – managers and engineers – used their analytical skills to design products and processes, select and manage customers, and supervise day-to-day operations. The second group was composed of the people who actually produced the products and delivered the services. This direct labor work force was a principal factor of production, which performed its tasks under supervision of the first group. Today automation and productivity have increased the number of people performing analytic functions: engineering, marketing, management and administration. Therefore, the people are more viewed as problem solvers, not as variable costs. In other words, information age has brought about the concept of knowledge management.

The shift to successful knowledge management has introduced a variety of improvement initiatives: such as Just-in-time, Total quality management, Lean enterprise, Business process re-engineering, Time-based competition, Customer-focused organization, Activity-based cost management, Employee empowerment, Living company, and so on. Some of those programs have meant in practice real breakthrough and improvement, others have proven to be in the best case just a short-time disturbance, but in the worst cases total failures resulting in disarray or even bankruptcy of a particular company. The main reason for that lies in five main implementation problems(Kaplan and Norton 1996):

current performance measurement systems are based on the traditional financial accounting model, which does not enable to objectively analyze information-age companies; if some non-financial performance measurement even is made, it is solely based on employees' tactical performance, not on strategic performance; majority of management and employee salary-based motivation schemes are only short-run profit oriented, that does not enable to align towards long-run goals; overall company strategy is not closely linked to organizational and personal improvement programs; and strategy is not generally linked to resource allocation, which results in under-financing some of the crucial parts of organization's development.

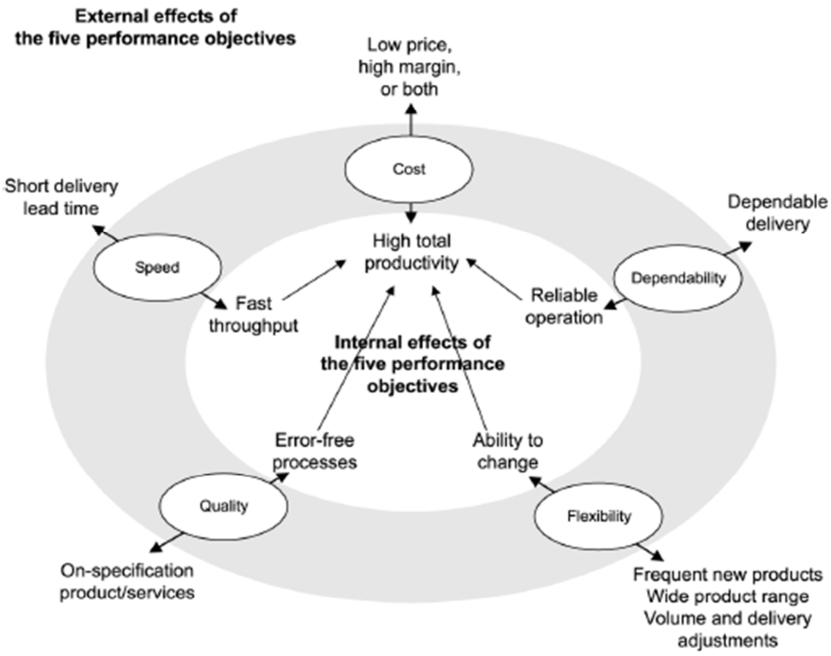
As for today, superior financial performance and efficiency in production are just not enough to gain sufficient competitive advantage, but more and more attention needs to be paid to intangible sides of business.

For at least 15 years, the leading management journals have published articles about how to build up a mechanism that would enable to control all the aspects of a company's performance. One of the most versatile tools for that purpose is Balanced Scorecard.

Introduced in the beginning of 1990-ies by Robert S. Kaplan and David P. Norton, the Balanced Scorecard uses a balanced measurement system that comprises of "the old" financial side and three "new" perspectives of Business processes (operational efficiency);Growth and learning (knowledge management);Customers (satisfaction and image of company to outside partners).

3.1. Productivity
Competitiveness in a global village reiterates employment of productivity and total quality management (TQM) philosophy to reduce wastages and to earn continuous improvement in curriculum & teaching methodologies. United Nations (ILO) charter for national productivity and European quality award model are the part of the few multiple global-initiatives launched in this regard to get conducive environment. The prime objectives are to economize use of resources (in-puts) during "learning-transformation process" so as to earn enhanced outputs with improved quality of services (Propenko and North 1996).

As per UN (ILO) the productivity is defined as ratio of wealth-generated as an output verses economic soundness of resources in production process. As per EPA it is the attitude of mind to do better than yesterday and continuously and forever. In personal perspective productivity means enhancing will to work and potential to work for QoS & QoP. The productivity improvement programs(PIP) are initiated in enterprise so as to enhance the degree to which objectives could be achieved by employing optimal ratio of input to output at constant or high quality services or products (Propenko and North 1996) .



Source: Slack *et al.* (2001)

Figure 3.1: The Productivity model as adopted from (Slack, Chambers et al. 2010)

3.2. Third generation BSC
The third-generation balanced scorecard model is based on a refinement of second generation design, with new features intended to give better functionality and more strategic relevance. The origin of the developments stem from the issues relating to the validation of strategic objective selection and target setting (Lawrie and Cobbold 2004). Third-generation balanced scorecard as a strategic control tool address the implementation issues associated with TQM and other quality tools and is capable to provide:

- A better and more holistic strategic context against which to identify the most important processes where quality initiatives are likely to reap the biggest benefits (long- as well as short-term);
- A process for translating the strategic direction and corporate strategic goals into lower-level goals, medium-term priorities and cross-functional activities;.
- An evaluation of the impact of TQM initiatives against defined strategic priorities;
- A monitoring and two-way feedback mechanism that supports downward communication of changes in priorities or strategic direction, as well as upward communication of operational insights and learning resulting from the quality management initiatives as well as from other aspects of operational learning.

These elements are all integral components of a performance management framework known as third-generation balanced scorecard (Lawrie and Cobbold 2004).In order to support the usage of the BSC as a strategic management system (Kaplan and Norton 2004) introduced a new framework namely, the "Strategy Map" which is a comprehensive architecture for describing the strategy through a series of cross functional cause-and -effect relationships. This provides a visual representation of the strategy and a single page view of how objectives in the four perspectives integrate and combine to describe the strategy, and this clearly highlights that the strategy map serves as a mediator tool that translates the strategy into measurable terms. Further, due to the simplicity in strategy map it can be considered as an autonomous tool of communication as well. Thus, this one page picture can tell us the short story explaining how the organization defines its success and signals to everyone what must be done in order to execute the strategy (Fernandes, Raja et al. 2006, Young and McConkey 2009, Niven 2011). In summary, it can be stated that form the first generation to second and then third, the balance scorecard could be viewed as a methodology which offers four complementary systems or roles: strategic management system, a communication tool, a performance measurement system and a system for organizational change.

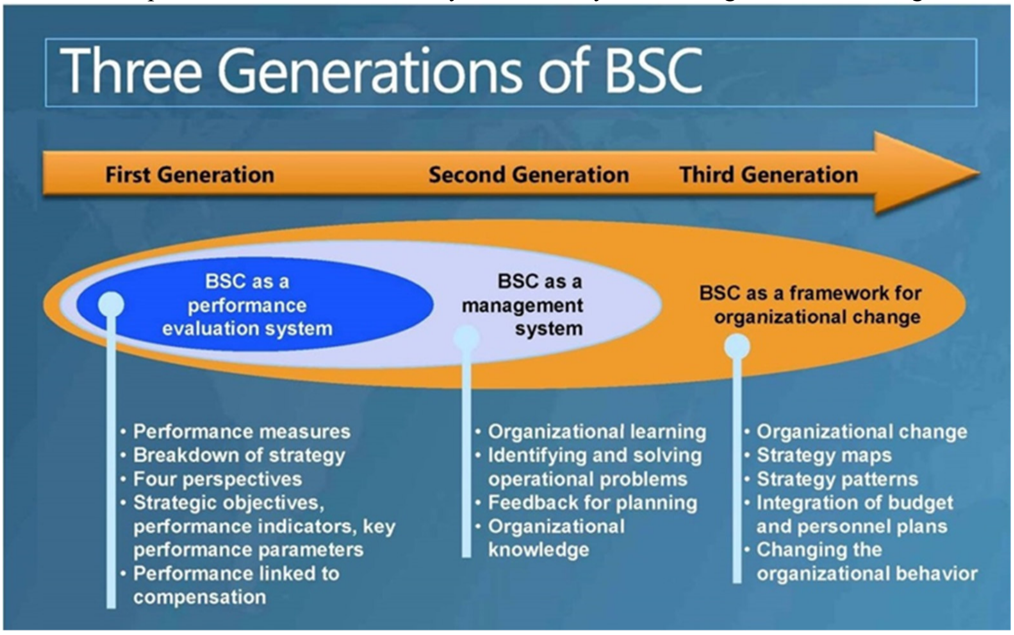


Figure 3.2: A generic overview of three generations of BSC adapted from (Alleman 2003)

3.2.1. BSC based Performance indices

As per the researcher (Porter 1990, Kaplan and Norton 1996, Lipe and Salterio 2000) the performance indices are derived from organizational vision and mission statement. The goals thus derived are then translated into operational-objectives through concurrent teams (Niven 2002). The strategic guidelines in this regard were provided by Moss (Moss 1982). As per the researcher (Moss 1982) the organizational competitive requirements and specific goals are translated for operations in light of present and potential strengths and weaknesses. The competitiveness model has been presented as a researcher (Associates 2002) recommended various competitive advantage indices in terms of critical factors for creating and sustaining superior-performance which has been revalidated by the researcher Porter (Porter and Millar 1985). The BSC based Mission Vision statement Pyramid (http://www.finbrain-itc.be/balance-scorecard/) elucidates the same concept, whereby the top-portion of pyramid houses the organization mission and vision statement, the middle portion houses the strategy and performance measurement modules in terms of Balanced Scorecard. The lower portion of pyramid exhibits the action plan to implement the KPIs (key performance indicators).

3.2.2. BSC based Performance Management System

As per the researcher (Kutucuoglu, Hamali et al. 2001) the summary of the literature on performance measurement suggests that an effective performance measurement system (PMS) should include the following features which are then embedded into balanced set of BSC based performance indices: Few steps toward this goal are as following: Recognize different performance hierarchies; Present a balanced view of the system being measured; Recognize multiple dimensions of performance measures; Relate the measures to the relevant goals; Link performance measures to strategy; Involve employees to ensure that it gets their support; Include subjective measures as well as objective ones; Address cross-functional issues.

Coetzee (Coetzee 1997) provides a comprehensive list of performance indicators and ratios. In doing so, a classification of 21 indices under four BSC categories:

High performance manufacturing models & indices

The researcher (Kutucuoglu, Hamali et al. 2001) conducted a literature review on performance measurement in which the key factors for an effective PMS were identified. As per researcher (Schroeder and Flynn 2002), high performance manufacturing model has artifacts in terms of TQM, JIT, HR , Technology

Management and Information systems. In order to measure these aspects the list of scales could be categorized as Technology Management, Information systems , Manufacturing strategy, TQM, JIT, HR, Plant performance and Plant environment

A number of research papers have been dedicated to the cause of improving the pitfalls of performance improvement programs, but the results are far less than expectations. Hence an effort is directed in this research-work to address this weak area through literature review survey. It is proposed by (Atkinson and Epstein 2000) that , Measure for measure, could be calculated based on competitive strategy commensurate to organizational structure, where by The Idea of Design , an out of box thinking has been reiterated by researchers of Massachusetts institute of technology MIT (Margolin 1995). Nourished on this theme and coupled with the Survey of Performance Measurement from Balanced Scorecard standpoint for Better Performance Measures, cost Management was proposed by (Frigo and Krumwiede 2000).

Past researchers have proposed that technology, HRM and materials can trigger productivity in following proportion, which gives a fair realization of the impact of technology to induce a chain reaction for productivity gain sharing:

Table 3.1: Technology Based PIPs & contribution to performance & productivity (BSC perspective)

S #	Financial aspects	HR Aspects	Internal business coupled with innovation & learning (specific to Technology aspects)
Kendrick, J.W	18	10	72
Denison, Daniel R	20	18	62
Laurits R Christensen	43	14	43
Average	27	14	59

3.3. Quality Function Deployment

QFD is a strategic tool to improve the design of conceptual correlation and product characteristics translation to designers. The benefits of QFD are: it prioritized list of customers and competitors; it prioritized list of customer requirements; it prioritized list of how to satisfy the requirements; it shows a list of design tradeoffs and an indication of how to compromise and weigh them; it helps to make realistic set of target values to ensure satisfaction.

3.3.1. The link between Balanced Scorecard and QFD

In an industry vision, mission and objectives are established by top management. Then the objectives will be evaluated by measuring the performance and the results; The policy-management is then enforced so that business plan is transformed through management focus from results to the means of achieving the results. The means to achieve becomes the primary focus and results measure only how well policy management was carried out (Sullivan 1988) . Organizations can apply QFD as a strategic planning tool (Maddux, Amos et al. 1991). The QFD has a matrix which contains what's and how's of objectives. The BSC serves as a powerful tool to define the ``What's" within QFD. However, it does not indicate the ``How's'". Therefore, this researcher and earlier research has stressed linking up the BSC with QFD, which can then make a more holistic strategic performance management system (Lee and Sai On Ko 2000).

The benefits of deploying QFD were investigated by researcher (Cristiano, Liker et al. 2001) and it was learnt that QFD actually reduces design changes to somewhat 30%. In Japan even 0.3 seconds improvement is considered an achievement, based on same philosophy a QFD approach is deployed for conceptual build up a high performance manufacturing framework to trigger positive chain reaction for productivity, cost recovery, performance and quality.

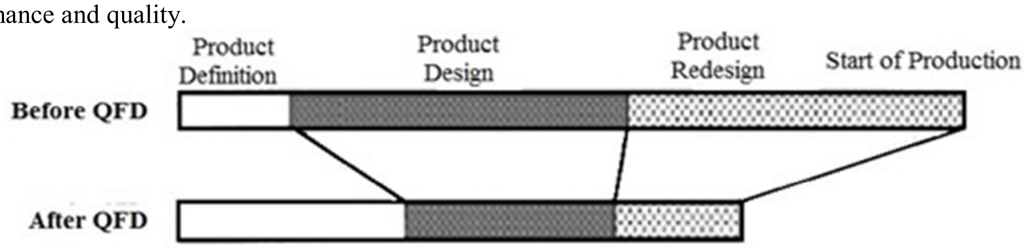


Figure 3.3: Advantages in the Successful Application of Quality Function Deployment (Cristiano, Liker et al. 2001)

3.4. Theory of Constraints (TOC)

Theory of Constraints (TOC) was first presented in 1984 by Eliyahu M. Goldratt (Goldratt 1990) through his revolutionary book, The Goal (Goldratt and Cox 1984). According to Dettmer (Dettmer 1995), TOC is a set of concepts, principles, and tools designed to help manage systems better. TOC is also defined as an example of a management philosophy built upon a limited number of assumptions and designed to provide a process of continuous ongoing improvement (Sivasubramanian, Selladurai et al. 2003). Generally, TOC is a combination of philosophy, concepts, principles, and tools conceived to maximize the performance of any system by identifying, managing and breaking the most restrictive limiting factor that constraints system performance.

TOC provides the methodology to define what to change, what should be changed to, and how to effect the change to continuously improve the performance of an entire system. TOC, like TQM, treats improvement as an ongoing process. But instead of focusing on localized improvements in all areas, it attacks the one constraint or bottleneck that limits the system's performance. TOC can be used as a vital mechanism to assist the implementation of TQM. It must not replace TQM, but rather be used in helping the company to find out problems in its implementation and focus the TQM efforts toward the organization's goal. TOC is an excellent approach in continuous improvement, but has not much been widely studied

Many researchers (Wacker 1989, Daniels 1991, Verma 1997, Tracey, Vonderembse et al. 1999, Rasheed and Manarvi 2008) have proposed that disruptive technologies have changed the market dynamics and have evolved a new style of customer-demand perfection where technology can only be the tool to craft and engrave the hallmark for high performance manufacturing.

4. Conceptual modeling of Productivity management framework for high-performance-manufacturing Systems: 360o BSC Perspective

A hierarchical approach is proposed in this research paper so as to conceptually and clearly diffuse the translation of strategic productivity Triple-P-model model (Tangen 2002) in terms of fuzzy inputs to more compressive socio-technical design of PIPs.

Stage 1: An initial set of house of quality (HOQ) is proposed instead of a conventional single house of quality (HOQ) so that the VOC is first transferred to academia (industrial engineers) which then would be converted into technical specification for the Performance measurement system (PMS) experts. The details are not covered in depth since naturally it does not fall into domain of one single paper; the purpose is to in fact support the idea of using QFD as a conceptual tool rather than a conventional translator.

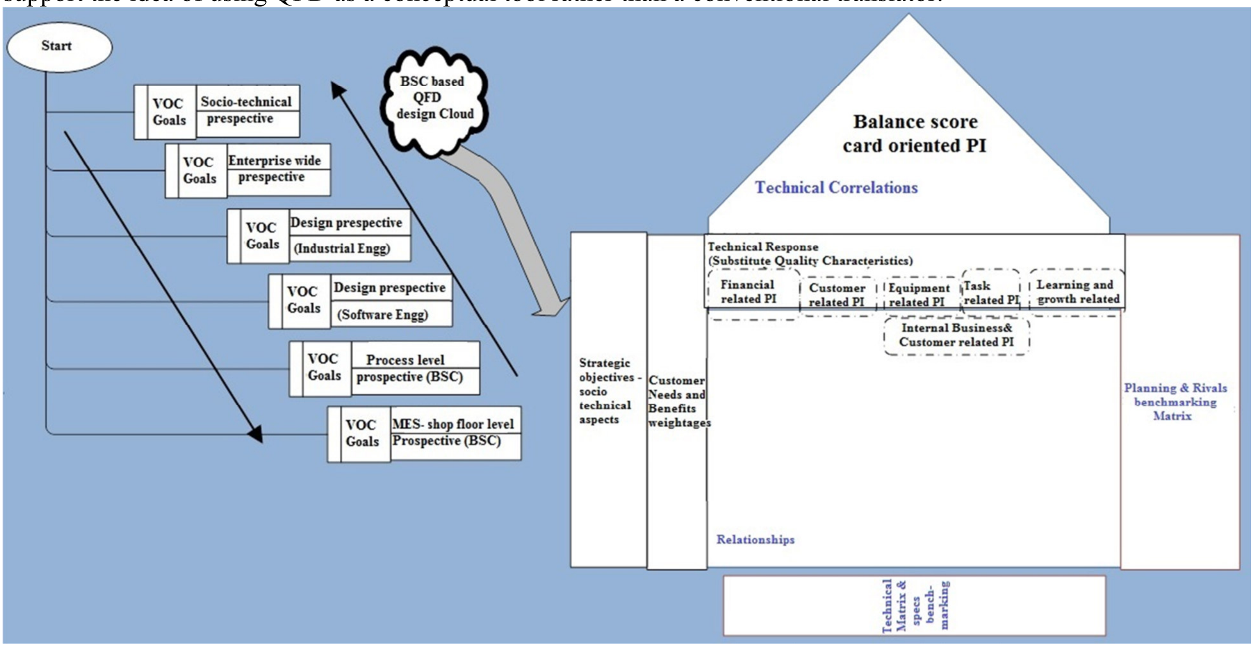


Figure 4.1: The QFD designing for socio-technical harmony

Stage 2: An integrating framework of TQM, JIT and TPM helps to untangle the overlapping manufacturing practices. This is done by specifying a common set of human and strategic practices that are shared by all three programs. This leaves a set of basic techniques that are unique to each of the three programs. Schroeder empirically demonstrate the importance of joint implementation of TQM, JIT and TPM manufacturing programs (Cua, McKone et al. 2001). Each component of TQM, JIT and TPM integrating framework represents a different aspect of improvement initiatives aimed towards product, process, and equipment development. There exist different configurations of practices that are best suited for improving specific performance dimensions, however, each of these configurations consists of practices belonging to all three programs and includes both socially- and technically-oriented practices Demonstrates showed that components of TQM, JIT and TPM integrated framework are mutually supporting in achieving high levels of manufacturing (Cua, McKone et al. 2001).

TQM, JIT, and TPM have the shared objective of making a production system more efficient and effective through continuous improvement and elimination of waste. TQM is focused on the elimination of defects and rework, helping to improve quality and delivery of products. JIT primarily emphasizes reduction of waste in inventory and flow time (Brown and Mitchell 1991). TPM targets waste caused by equipment problems such as failure, unnecessary set-up and adjustment time, idling and minor stoppages, reduced speed, process defects, and reduced yield (Nakajima 1988). The concept of fit explains why different practices may affect specific performance measures. For example, if the plant has a goal of cost reduction, a certain set of TQM, JIT, and TPM practices and techniques might be the best ones. On the other hand, if the plant desires high quality, a different set of practices, most likely including TQM techniques as well as other techniques and practices, might be the best. Nevertheless, fit theory leads us to believe that different sets of practices and techniques are needed to improve different performance measures (Figure 4.2).

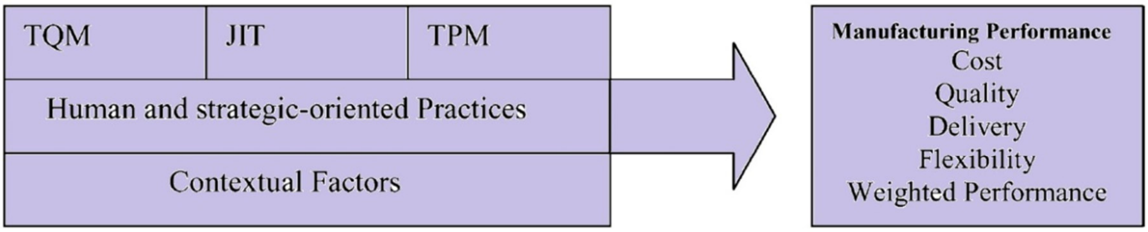


Figure 4.2: An integrating framework of TQM, JIT and TPM adapted from (Cua, McKone et al. 2001)

Stage 3: Integrated Facets of Technology via Theory of Constraint (TOC) gives a fair realization of the impact of technology to induce a chain reaction for productivity gain sharing.

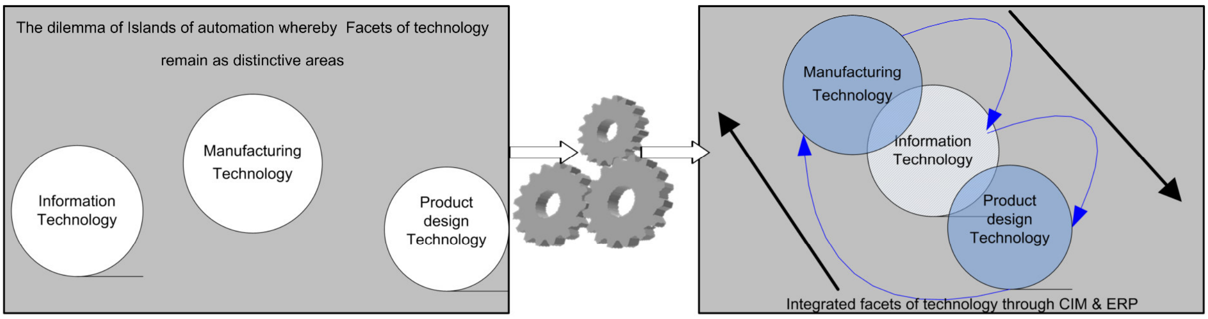


Figure 4.3: From islands of Automation to Integrated Facets of Technology via Theory of Constraint (TOC) adapted from (Rasheed and Manarvi 2008)

Stage 4: HPM -Productivity Chain Reaction Strategy Design shows the flow and steps towards business and operational excellence. Synchronization is very important as seen each stage in Figure 4.4.Technology-management in line with theory of constraint allows passing through the bottleneck in each stage.

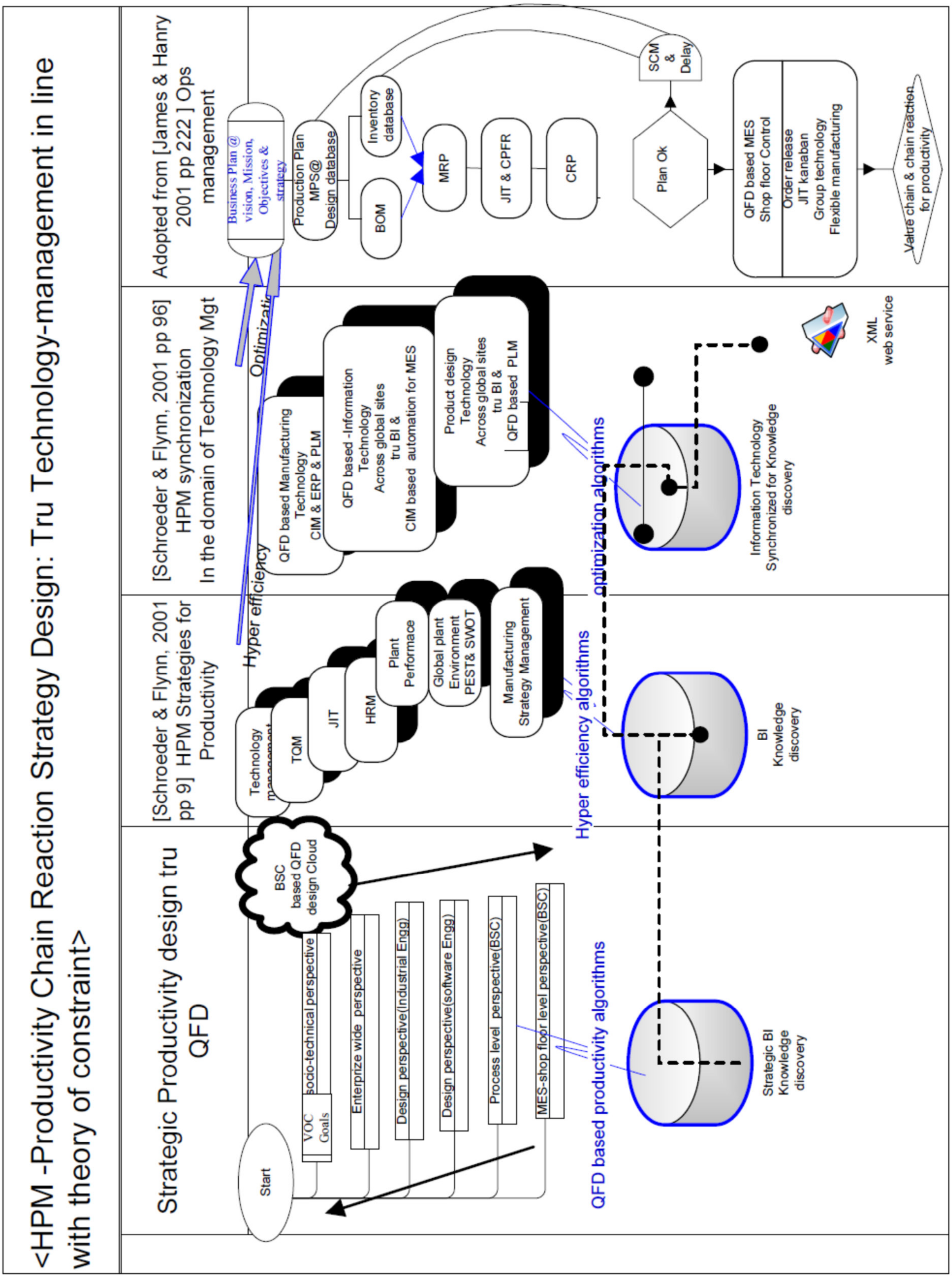


Figure 4.4: HPM -Productivity Chain Reaction Strategy Design: Through Technology-management in line with theory of constraint (Swim Lanes & IDEF diagram)

Stage 5: Active Productivity Chain Reaction Strategy Reinforcing circles are very significant for continuous improvement and to remain competitive. The Figure 4.5 shows the working and synchronization of these circles.

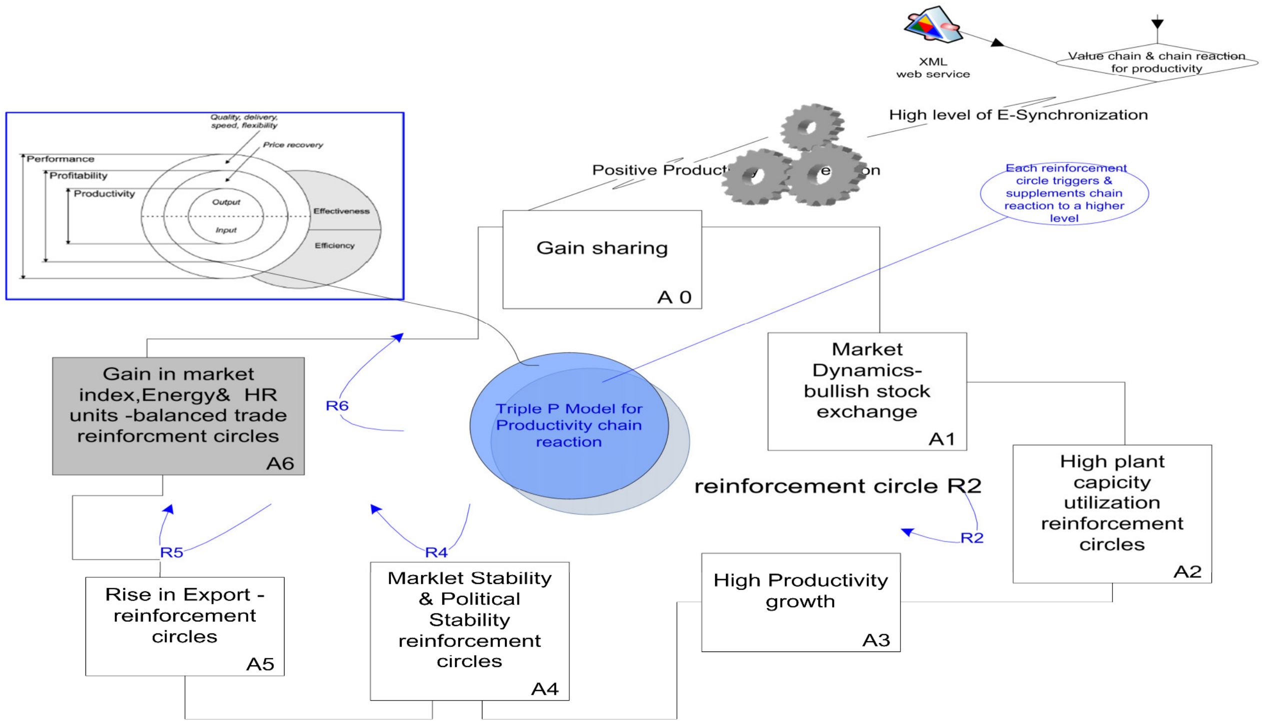


Figure4.5: Productivity Chain Reaction Strategy Reinforcing circles: (IDEF0 diagram)

4.1. Integrated PIPS-HPM -performance measurement system (PMS) -process framework

It shows the processes and their flow mechanism, whereby CSFs as per vision & mission are; BSC/HRM/MRO indices development; selection of measurement as per QFD tool; audit for PIPS for continuous improvement of PMS.

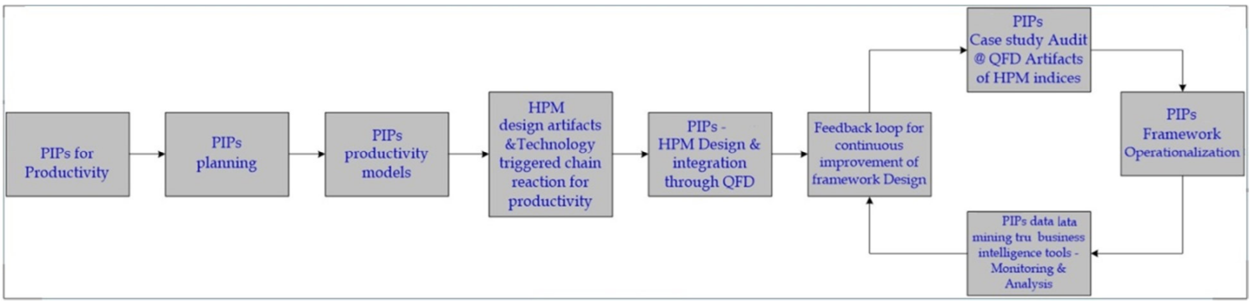


Figure4.6: Integrated PIPS-HPM -performance measurement system (PMS) -process framework

4.2. Monitoring and analysis for proposed PIPs Model

Having evolved the framework for positive productivity chain reaction now the focus is diverted to evolve set of Comprehensive & balanced Indices to monitor and analyze PIPs

Comparison of the BSC based performance indices absolute results for same KPIs as well as the survey measures before and after the implementation of the above HPM Productivity management framework is very important to further authenticate the working model.

4.2.1. The Performance measurement indices as per BSC

Coetzee (Coetzee 1997) provides a comprehensive list of performance indicators and ratios. The potential of the balanced scorecard as an instrument to develop, stimulate and sustain efforts in respect of performance improvement programs need continuous improvement to face the challenges of future. The part of the solution could be improvement of performance indices as a first step towards knowledge-based economy. Since technically speaking it's rational to address the bottlenecks and minimize resources than to go for investment projects.

Table 4.1: The BSC performance indices

	Strategic Productivity indices	HPM Productivity Indices
Financial perspective	ROI	
	EVA	
	Revenue	*Inventory turnover*
	Earnings	
	Capital	*Manufacturing Costs*
	Cash Flown & Misc.	*Knowledge based economy*
Customer - perspective >	Quality & performance	*Customer Service quality, competitive performance*
	Service	
	Pricing	
	Time	*Speed of* Service
	Image	*Product Performance*
	Relations	*Incentives for group performance for internal customers-*
Internal Business Processes >	Production	Production cycle time
	Delivery	*On time* Delivery
	Marketing	
	Operations	*Master schedule adherence, MRP & JIT adoption, Strategic Planning, Communication of Strategic Planning*
	Quality Control	Quality conformance & rewards of quality, cleanliness & organization,
	Service Dept.	*Speed of* Delivery
	R & D	*Speed of new product introduction*
Learning & innovation- >	Employee	*Employee empowerment , suggestion implementation and feedback*
	HR Capital	*Multifunction Employees*
	Knowledge	*Problem solving capabilities*
	Technology	*New technology adoption / diffusion of Knowledge, Advanced performance measurement systems ERP , PLM & CIM solutions Coordination with cooperation , advanced accounting system*
	Best Practices	*Cross training / manufacturing /HR Fit , Management breadth of experience*
	Intangibles / Environment	

5. Case Study

Contextual to above, a case study was conducted at one of the industrial unit associated with the Aerospace-MRO of Lockheed martin Group at Pakistan. The framework for productivity as adopted from (Tangen 2005) and the one proposed in this research were used to operationalize the facets of Technology management framework. The case study was a PIPs measurement to highlight the use of BSC-indices in proposed framework.

- **Finance**

The organization was tracking all financial transaction against the allocated budget and was not following a zero budget scenario. The indices like Return on Investment, Cash Flow, Return on Capital Employed, Financial Results (Quarterly/Yearly) were not being tracked except the cash flows against purchase orders. However there was clear perception to increase capacity so as to earn cost related performance indicators.

- **Internal Business Processes**

The indices like Number of activities per function were being tracked in terms of Concurrent teams functional work packages. The indices like Duplicate activities across functions, Process alignment (is the right process in the right department?), were not under consideration, however, Process bottlenecks and Process automation were being tracked on an irregular schedule. There was a clear understanding and perception to enhance reduces serviceability and reliability of equipment and reduces variations in serviceability and reliability and equipment downtime through preventive maintenance of equipment.

- **Learning & Growth & innovation**

The indices in terms of Training / Learning opportunities and correct level of expertise for the job were tracked in an organized manner as per USAF OJT manual. However, Employee turnover and Job satisfaction were not tracked. The dynamic approach to respond to learning and growth in terms of innovation & global manufacturing were considered vital for competitiveness and survival.

- **Customer**

The indices in terms of Delivery performance to customer, Quality performance for customer, were tracked in terms of micro level indices. However Customer satisfaction rates, Customer percentage of market, Customer retention rate were not tracked.

5.1. Discussion

The QFD tool was deployed to do conceptual evaluation & correlation of HPM indices. The conceptual correlation depicted the much needed smart factory conceptualization as well as some real difficulties for using quality function deployment. In 1991, German researchers described the vision of a future world under the name of Ubiquitous Computing. Since then, many details of the described vision have become reality: Our mobile phones are powerful multimedia systems, our cars computer systems on wheels and our homes are turning into smart living environments. All these advances must be turned into products for very cost-sensitive world markets in shorter cycles than ever before. Today, the resulting requirements for design, setup, and operation of our factories become crucial for success. In the past, we often increased the complexity in structures and control systems, resulting in inflexible monolithic production systems. But the future must become "lean"--not only in organization, but also in planning and technology! We must develop tools and technologies which allow us to speed up planning and setup, to adapt to rapid product changes during operation, and not only to reduce the planning effort but to eradicate the bad practices through proposed QFD socio-technical framework. To meet these challenges we should also make use of the smart technologies of our daily lives so as to trigger chain reaction of productivity.

But for industrial use, there are many open questions to be answered. The existing technologies may be acceptable for consumer use but not yet for industrial applications with high safety and security requirements. Therefore, it is argued that the productivity in Smart Factory could be achieved through smart QFD initiative be supported by industrial and academic partners to create and operate a demonstration and research test bed for future factory methodologies and technologies (Zuehlke 2010).

5.2. Limitations of This Case Study & research

There are two significant limitations to this study. The first limitation is that the methodology to resolve disproportionate set of requirement between the various academic centers has not been covered. The second limitation of this study is that the in depth literature survey was not conducted to formulate the conceptual methods for perfection of aims that is currently being addressed through an expansion of case- study. (Carnevalli and Miguel 2008) has presented a review, analysis, classification and codification of the literature on quality function deployment (QFD) produced between 2002 and 2006 the same suffice for this limitation. The studies focused more on conceptual understanding of QFD rather than the quality matrix problem solving and the main difficulties. However, few studies have been done on solutions for other important aspects. Further research is needed on how to reduce the difficulties of using smart-QFD for perfection of means.

6. Conclusion

While the temptation to evolve a system of indices is irresistible due to its tremendous dynamics, overwhelming return on investment (ROI) and massive capabilities, yet the perplexities of implementation in industry reiterates an out of box thinking for “redesigning schema for performance improvement programs”. The employment of TQM, QFD and Balanced Scorecard and high performance manufacturing concepts for exceeding business process and customer expectations are the CSFs for design of architecture for productivity performance indices. The proposed framework based on BSC-method is expected to enhance the chance that a balanced management approach is practiced for collaborated competitiveness of all stakeholders to earn hyper efficiency. The embedded smart Balanced Scorecard intelligence into design-schema is the key for futuristic development of performance improvement programs. This paper attempted to embed Balanced Scorecard based QFD as part of business-intelligence (BI) algorithms of a productivity enhancement and PMS as a system. It is an attempt to attain the goal of smart factory and a breakthrough in productivity growth.

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