3P Model and Feedback Loops for Productivity Improvement: The Case of ABC Printing Company

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Abstract

3P model is designed and developed to measure the economic health of the organization. Economic efficiency is the deciding factor for any company success. High productivity, growing market share and the rising profitability are the true indicators of the company growth. The growth of developed economies is due to productivity enhancement which is largely attributed to the technological innovation. Productivity improvement in any firm is not a knee-jerk activity. It is result of continuous and structured effort, technology implementation, human motivation and organization culture due to top management commitment and management support. Organizational culture and leadership style constitute the key components of productivity improvement coefficient having techno-ware, info-ware, human-ware and orga-ware. Feedback thoughts are the system structures that establish the role of key elements of productivity improvement. This paper unveils the underlying structure of 3P model considering variables that are interlinked, interconnected and time-dependent with feedback notion. The proposed mental model depicts the true story of the productivity improvement model.

Keywords: Pakistan, Packaging Industry, Productivity and Systems Thinking

Introduction

Economic efficiency is the deciding factor for any company success. High productivity, growing market share and the rising profitability are the success factors for the company growth. To determine the health of the organization, always focus productivity instead of production, profitability instead of profit and penetration in the market share instead of sales. Production, profit and sales are the misleading indicators to determine the health of the organization. Doing the things right at the least possible cost in the least possible time, with highest possible quality and to the maximum level of the satisfaction of the customers and employees (Guo & Tang, 2008) are the key elements of productivity. Improvement in productivity is dream of every firm and a way to have the competitive edge specifically in the printing and packaging industry of the Pakistan. It has been observed even the biggest printing and packaging complex are in search of technology diffusion for enhanced productivity. Every day there is a cut-throat competition that compels the businessmen to be cost effective. In printing industry, short change over time, reduced paper waste, high printing press speed and integration among pre-press, press and post press activities put the companies on the track of improvement. With new technology, productivity can be stepped up to exponential growth. In the economic production context, technology is simply a means for achieving transformation of available inputs into outputs. A process of translating input into output has a lot of potential for optimization. Higher production cost is due to poor management around the machine which

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increases downtime (Render & Heizer, 2018). Productivity declines when the speed of press is much lower than designed capacity and optimization vanished when make-ready times are not time bound. There is a dire need to get better insight into role of technology and analyze factors that are vital for the improved productivity. Roland 706 LTTLV model in the printing industry is fully equipped with technology orientation and contributes for production efficiency. Organizational efficiency and performance are linked with the efficiency of production facilities and better management around the machine.

Background

ABC printing company is one of the finest printing complexes in south Asia. Quality, comparable cost and customer satisfaction are the key objectives of the company under study. Demand for quality packaging materials is rising every day. Packaging division in the any packaging company comprises following departments:

1) Proof press
2) Art and camera
3) Reproduction
4) Production planning and control
5) Customer service
6) Coating
7) Paper store
8) Ink factory
9) Offset printing
10) Cutting and creasing
11) Die making
12) Folding and gluing
13) Dispatch
14) Logistics and transportation

From concept to reality, pre-press (proof press) is indeed an important consideration at ABC printing company. Tailer made solutions have been followed using make to order production strategy. Engineers and artists design the product as per the customer expectations. Vibrant designs are created by a team of artists and colour separations are made on computerized equipment and then handed over the staff of offset printing department for printing job on high-speed printing presses. Quality products and improved productivity give the competitive edge. Roland 706 is the first printing machine that is equipped with modern and latest technology to capture the growing demand of the market.

Productivity

Productivity is a relative term and have multiple definitions. A productivity is a comparative tool for managers, industrial engineers, economists and politicians. It compares production at different levels of economic systems with the resources consumed. Productivity is considered as ratio of output to input (Heizer & Render, 2004). Accountants and financial analysts have emphasized that productivity is representative of economic or financial performance and it reflects returns on investment, profitability growth, rate of turnover and cash flow. Productivity, in a broader sense, is a measure of how efficiently and effectively resources are used as input to produce output of products and services of the quality needed by the society in the long term (Huang et al., 2003). Productivity can be ratio (dimensionless) when output and input both are measured having the same unit of measure; it can have dimensions such as units per input unit expended in a given particular time.

3P Model

The choice of new technology may depend upon on combination of factors e.g. future prospects, return on investment, market trend and passion to excel in consumer industry. 3P model consists of three elements high profitability, high penetration in the market share and high productivity shown in figure 1.

Figure 1: Key Elements of 3P Model

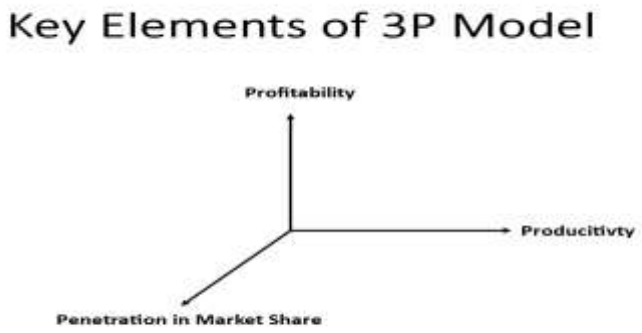
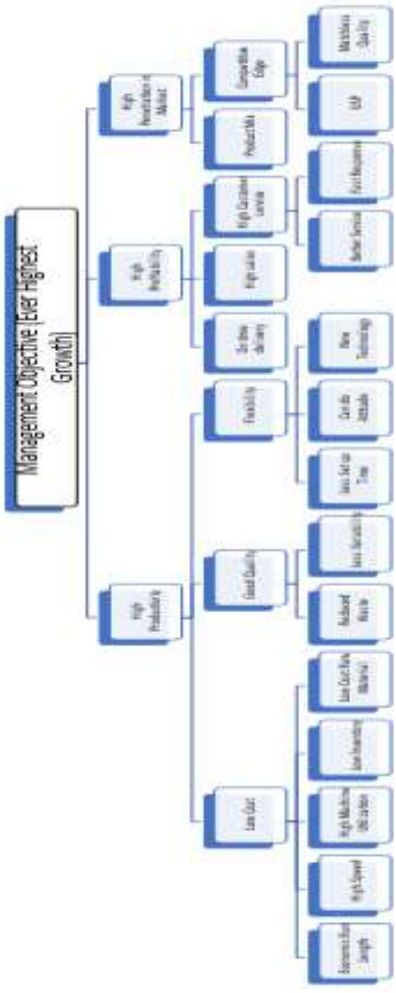


Figure 2: 3P Model for Company Growth



Company growth is the management objective. Top management objective can only be achieved if we work on productivity and quality initiatives. Lean manufacturing, lean six sigma, down time analysis, advanced production planning, concurrent engineering, quality function deployment, supply chain management and enterprise resource planning are the few tools which help to enhance productivity and generating more profitability.

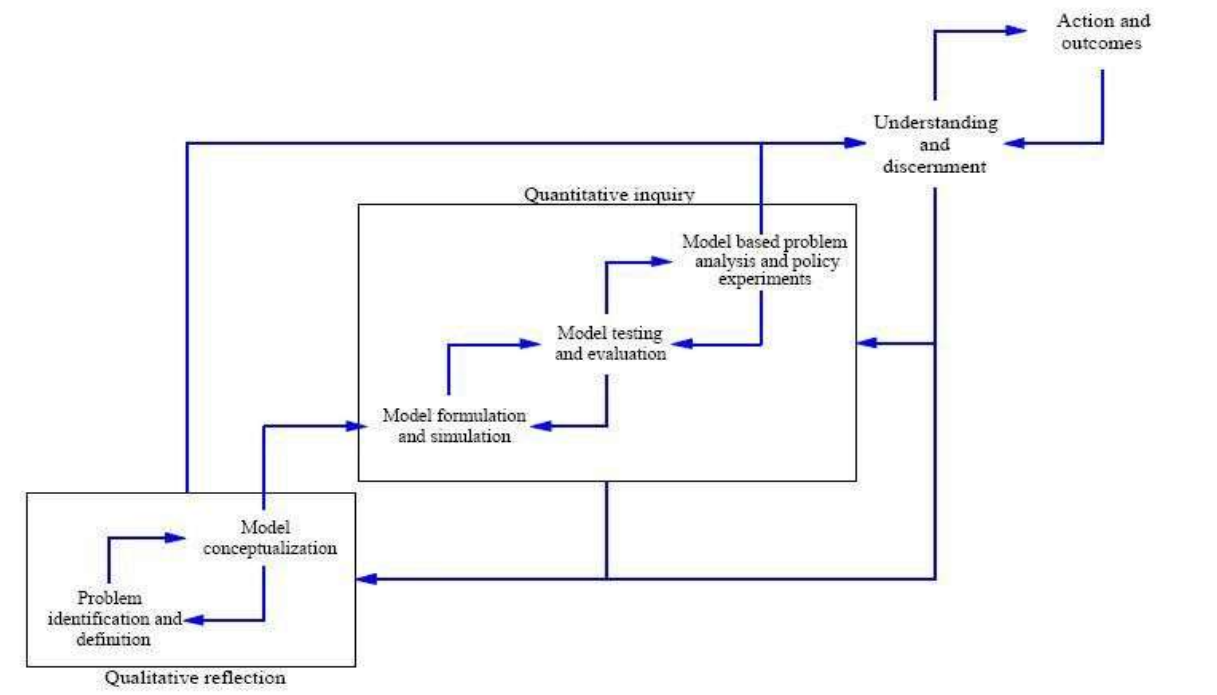
On quality front, the emphasis has been shifted from product to process, from inspection to production. This evolution of process-oriented quality was accelerated during 1960's to 1970's by remarkable success of Japanese initiative is companywide total quality control (CWTQC) whereas Americans coin the same term as total quality management (TQM).

Methodology

Systems Thinking is widely considered essential in the effective management of complex dynamic systems at the core of the problems (Sweeney & Sterman, 2007). Systems thinking gives a holistic view of the problem understudy. There is interconnection, interdependence, and linkages among the variables (Yusuf, 2023) of production system. System thinking, in practice, is a continuum of activities which range from the conceptual to the technical (Richmond, 1993). This comprehensive definition of Barry Richmond describes the steps of modeling process. Conceptual phase comprises system conceptualization and dynamic hypothesis where as technical phase reflects the level and rate diagram and policy analysis (Yusuf & Azhar, 2022).

The modeling process uses two important schemes to highlight the dynamics of system i.e. thinking about how the quantities vary through time and thinking about whether a substantial feedback relationship exists (Richardson, 1981). System dynamic is the research methodology that is based on inductive logic from the case information and deductive inquiry assist to simulate computer model. Zagonel (2002) has mentioned modelling steps in system dynamics sharing the blend of qualitative reflection as well as quantitative inquiry that leads to policy design shown in figure 3.

Figure 3: Steps in System dynamics modeling (Zagonel, 2002)



A causal loop that characteristically tends to reinforce or amplify a change in any one of its elements is called a positive loop (Richardson, 1991). A positive loop is often defined by the fact that an initial change in any variable eventually brings self-change in the original direction. A causal loop that characteristically tends to diminish or counteract a change in any one of its elements is called a negative loop (Sterman, 2000). Causal loop diagrams are the powerful tool to capture the problem statement and conceive the problem properly. Causal loop is a closed sequence of causes and effects, a closed path of action and information. A decision is based on the observed state of the system. The decision produces action which alters the state of system and new state gives rise to new information as the input to further decisions. Behavior of the system is the result of interaction of positive and negative feedback control loops. The polarity of a circular causal loop reflects the loop's tendency either to reinforce or to counteract a change in any one of its elements (Abbasi et al, 2024). That connectivity and nexus appear in the form of the balancing and reinforcing loops that depict the underlying structure of the mental model. Positive loops are the reinforcing loops that amplify the change and increase in one variable brings increase in another variable. Positive sign between two variables indicates the link polarity positive sign (+) indicates direct link and (-) sign indicates the indirect link (increase in one variable bring decrease in another variable and two negatives become positive. (Yusuf, 2023)

Explanation of Feedback Loops

Figure 4 explains info-ware feedback loop. No one can deny the power of information. Information about new machine and its auxiliary equipment help to run the machine smoothly. Information and competency to operate the state-of-the-art machine is result of training, personal involvement to learn and learner's motivation. Better information about new technology (machine) yields high productivity. Another important aspect is management support to provide the learning opportunities and facilitate to change the mindset of the people. Higher productivity is the result of "Can Do Attitude" of the employee and his ability to handle the roadblocks and problem-solving attitude. Another element of management support is to provide the resources to eliminate the non-value-added activities from the process. Consequently, the management in terms of work order, raw material and labour are available as a good indicator of better management around the machine that enhances machine utilization in terms of reduction of down time.

Figure 4: Information Ware Feedback Loop Assessment Loop

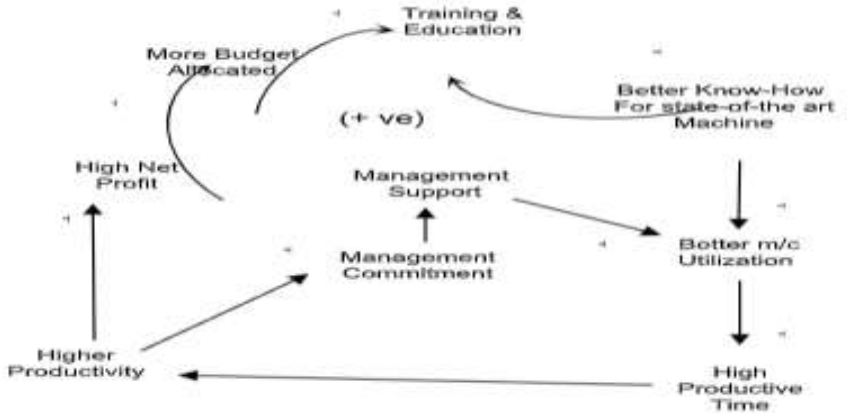


Figure 5 depicts the techno-ware feedback loop. This loop talks about the technology implementation. Higher productivity generates higher net profit that makes the management more comfortable to invest more in new technology. Deployment of new technology

encourages competitive edge in terms of better quality, high operational speed to meet on time demand and flexibility to capture the multiple sizes of orders. Higher customer satisfaction ends up more customer orders and consequently more production in the stipulated period of time raising productivity.

Figure 5: Techno-ware feedback loop

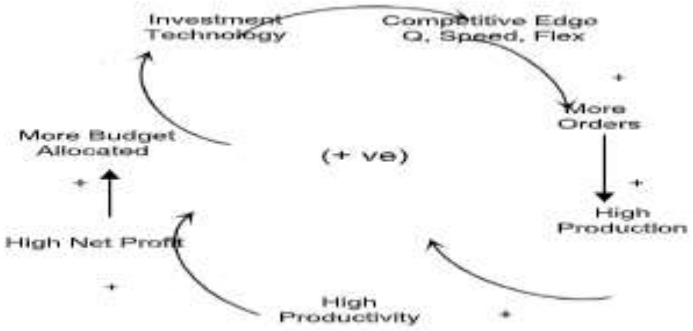


Figure 6 portrays the orga-ware feedback loop. High productivity is outcome of reduction in operational problems and better management around the machine. Reduction in down time and availability of the input materials are the added features for enhanced productivity. Low blame shifting among the related departments nourish the culture of team spirit and group work. The people working in multiple departments work as team and assist each other to coordinate with each other. Consequently, the availability of quality inputs is on time. Work order for production, raw materials, production resource tools and operational staff are all available to start the job on time. As a result, productivity goes up.

Figure 6: Orga-ware Feedback Loop

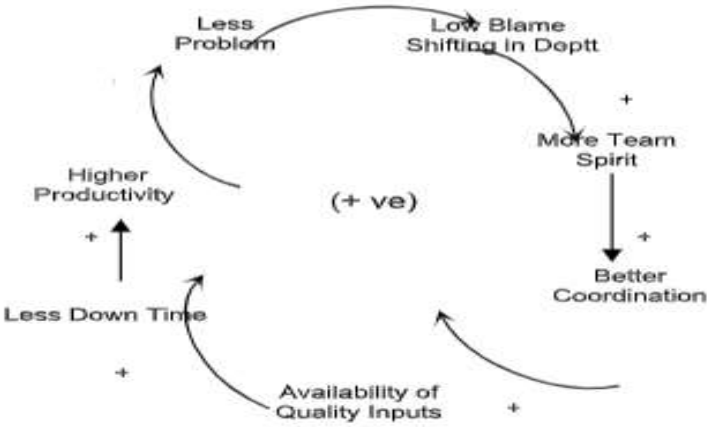
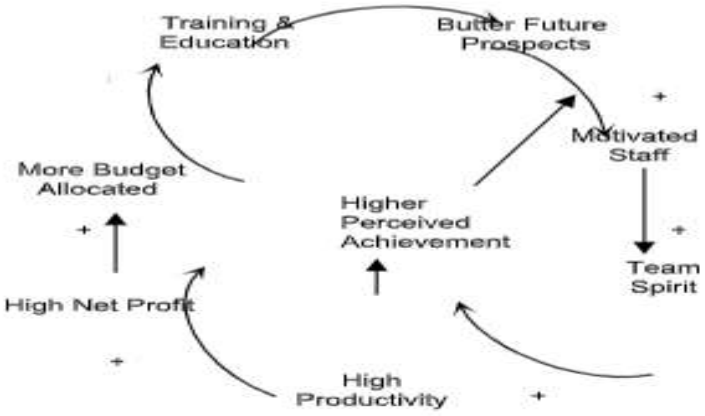


Figure 7 indicates the human-ware feedback loop. High productivity is outcome of reduction in operational problems and better management around the machine. More budget for training and education opens up the future prospects for staff. High motivation level encourages people work efficient for waste reduction activities. The group work assists each other to reduce non-value activities and down time. As a result, more running hours means more saleable units and more production that generates high productivity. Reduction in waste ends up rising the productivity, high productivity means more net profit and company has more budget for education and employee's training. Through education and training employee seeks more

future prospects that multiply his existing motivation. Motivated staff operates in teams to contribute more for higher productivity. Motivated staff, team work and learning attitude are the key elements of the organizational culture.

Figure 7: Human ware feedback loop



Integration of different loops shifting the polarity of one loop to another loop enhance the productivity of a production facility. The proposed productivity model is equally good for new technology, machine or production department of the company.

Figure 8: Mental Model of Productivity Improvement

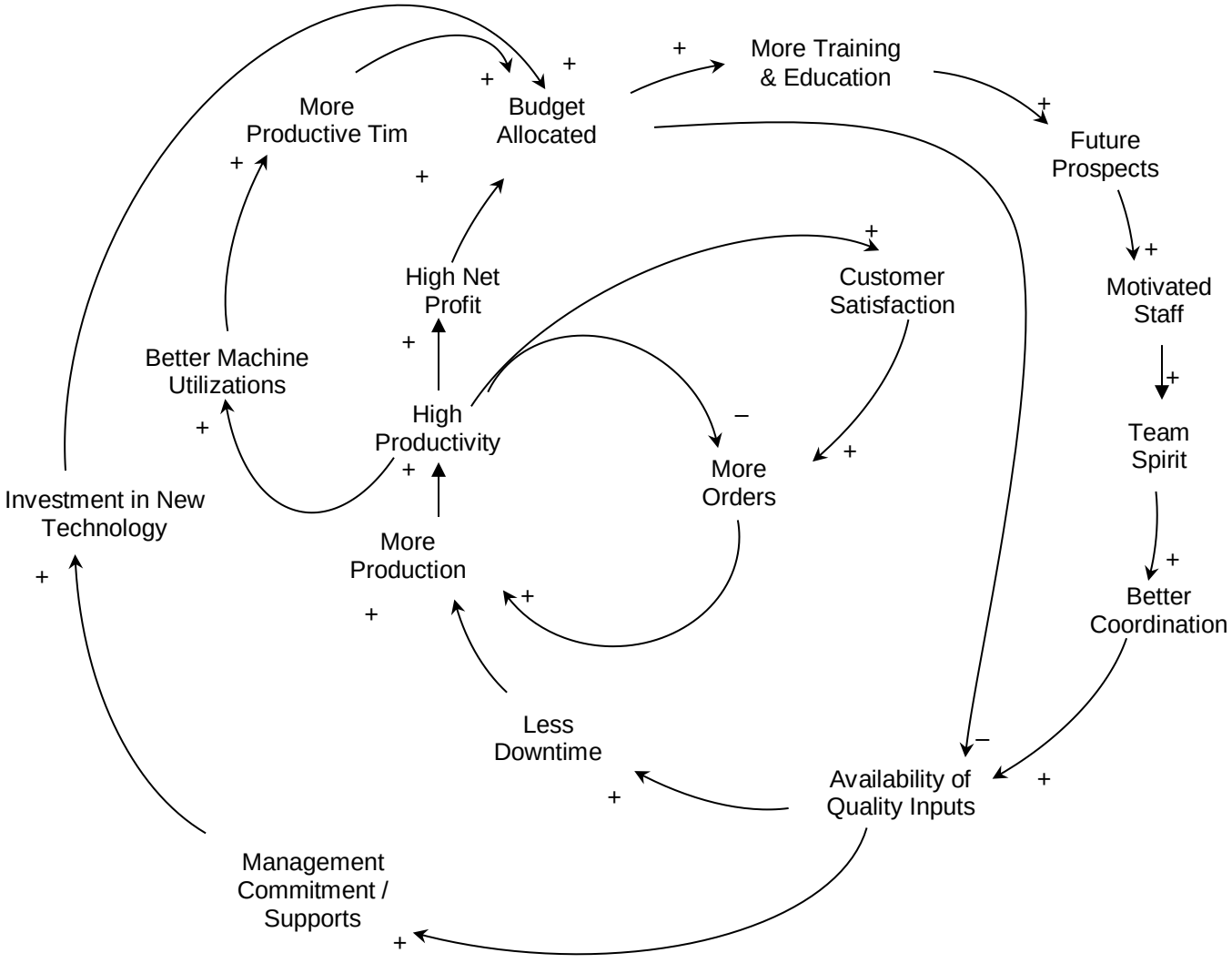


Figure 8 depicts the overall proposed mental model of productivity improvement based on systems thinking.

The proposed mental model of productivity is developed with the merger of feedback loops mentioned above. These loops represent the underlying structures of the problem under study of the case company: ABC printing. These loops have been developed based on experiential information and on data triangulation, company documents, participant observations and open-ended semi-structured interviews of the company staff of multiple levels.

The major elements of any productive system are four. The first element is company facilities like machine and auxiliary equipment that appear in the form of technology, the second one is the employees itself; the machine crew, middle management, supporting staff and employees of the related departments. The third element is organization culture that form the loop of orga-ware and fourth one is the information flow and ability to handle the state-of-art technology within the company premises.

Productivity has four embodiment forms as follows:

Table 1: Productivity forms

Technology (Techno-ware)	New Machine Unique feature of the machine Maintainability of the machine Computerized features (Computer Control Inking) Special Purpose Facilities (AUPASYS, PECOM)
Motivated Staff (Human-ware)	Machine crew able to operate machine trouble free Able to identify the faults Locate to fix the mechanical problems Able to fix the production faults Divisional head (DH) should help to overcome the interdepartmental problems DH must support the interrelated personnel for better coordination among different team members Marketing department should book the orders for new machine with economic run length Commercial deptt must ensure the timely provision of input raw materials DH should keep the harmony among the machine crew and other team members Electrical staff must be trained enough to diagnose the mal-functioning of the electrical gadgets and fix the problem Planners must sequence the jobs on the basis of reduced set up time and ink application pattern. DH should encourage research and development activities
Information (Infor-ware)	Equip the machine crew with new information about the state-of-the-art machine Educate the support staff about the new machine sensitivity regarding input materials Keep on exploring the new information for the acquisition of suitable technology to have competitive edge Collect facts and figures needed for the maintenance of machine and auxiliary equipment Institute training for skills Keep on working on employees for better attitude
Organization	Systematic approach for problem solving (Quality records/checklists and

(Orga-ware)	forms) Can Do Attitude for better productivity (support from inks and board supplies) Experience based traditional organized arrangement and practices Investing on a new support equipment for high productivity (Computer to plate technology) Joint teams among concerned department and support departments

Key Measuring Indicators

The degree of utilization is the import coefficient in the printing industry. According to the guidelines of the German Printing and Media Industries Federation, this is calculated as follows:

Degree of Utilization = Productive Time / (productive time + auxiliary time)

Productive Time = Make-ready time+ running time

Auxiliary Time = Non-productive time (disturbances, waiting time etc.)

The four above mentioned elements like techno-ware, human-ware. Infor-ware and orga-ware are the important to improve the degree of utilization and it is the degree of sophistication of technology that generates its impact in terms of high machine utilization. Since Techno-ware (T), Human-ware (H), Infor-ware (I) and Orga-ware (O) are the elements which jointly contribute to the productivity improvement coefficient (PIC); it is possible to state that a production facility component with high level of sophistication would be contributing more towards productivity than one element utilizing components with lower degree of sophistication. This can be expressed mathematically as under:

Productivity Improvement Coefficient (PIC) = (α) T^{β} *H^{β} * I^{β} * O^{β}

Where, Techno-ware, Human-ware, Infor-ware and Orga-ware represent the numerical values of the degree of sophistication of the four components at the production facility normalized with respect to the state-of-the-art technology. Alpha (α) is the productivity climate factor that depicts the management commitment, approach to handle the organizational challenges, issues and Beta (β) reflects the relative importance of each component whose summation is equal to one. Numbers have been intentionally ignored to hide the proprietary information of the company.

Productivity improvement coefficient value may be interpreted as the productivity added content per unit of output. The values of T, H, I and O for any firm/production facility/machine can be evaluated by the determining the minimum requirements and the position of the current practices with respect to the best practices elsewhere. The alpha and beta values can be estimated using the factor analysis and expert preference analysis (Ramanathan,1988). Productivity improvement model shows the hypothetical interdependent pattern among the four major component. The pattern could be useful in examining the interaction among the four components. In a highly complex and interdependent world, holistic view is more powerful than silo-based mechanism. For such analysis system dynamics approach is attractive because of its ability to deal with complex interacting and dynamic systems such as production system.

Value Adding Plausible Policies

- Impart education and training for the new technology
- Invest in staff motivation and team synergy
- Avoid blame shifting culture within organization.
- Keep on adding new methodologies and tools like computer to plate (CTP) for continuous improvement.
- Invest in people and institute auditing skills by ongoing training.

Conclusion

Such mental model of productivity improvement depicts the underlying structures of the organizational dynamics linking with information, culture, technology and human beings. The proposed policies are based on intuitive power and the wisdom gained through experience and deep observation while interacting with various printing and packaging enterprises. For future research, it is suggested to develop the system dynamics model based on mental model and the balancing and reinforcing feedback loops. There is a need to go for experimentation with the simulated computer model and explore the policies either through parametric changes or structural changes which may be compatible with the policies proposed through mental model.

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