Chapter 8
Modeling Maintenance Productivity Measurement

Christian A. Bolu
Federal University Oye-Ekiti, Nigeria

ABSTRACT
Modeling and simulation of industrial information communication systems and networks is one of the major concerns of productivity engineers for the establishment of productivity standards in virtually all functional areas of an industrial organization. Maintenance function is one of such areas that have always engaged the attention of engineering productivity practitioners. However, one of the basic problems is the difficulty in setting up integrated but easy and practical measurement schemes. Even where the measures are set up, the approaches to measurement sometimes are conflicting. Therefore the need for an integrated approach to optimize the basket of parameters measured remains.

In this chapter the author attempts to identify approaches in integrated and systematic maintenance productivity measurement and create models for optimising total productivity in maintenance systems. Visual yardstick, utility, queuing systems and simulations approaches for measurement of maintenance productivity are all discussed with a particular focus on markov chain approach for stochastic breakdowns in repairable systems. The chapter also shows how understanding the impact of plant failure and repair/service distributions assists in providing measures for maintenance productivity using discrete event system simulation.

INTRODUCTION
Modeling and simulation of industrial information communication systems and networks is one of the major concerns of productivity engineers for the establishment of productivity standards in virtually all functional areas of an industrial organization. Maintenance function is one of such areas that have always engaged the attention of engineering productivity practitioners. However, the basic problem, and indeed the most important one, is the difficulty in setting up integrated but easy and practical measurement scheme. Even where the measures are set up, the approaches to
measurement sometimes are conflicting. There 
is therefore the need to optimize the basket of 
parameters measured.

The overall objective of the maintenance func-
tion should be to support the operating department 
by keeping facilities in proper running condition 
at the lowest possible cost. In judging the produc-
tivity of the maintenance department one must 
consider not only the efficient use of manpower 
and material, but also how well production losses 
due to maintenance problems are controlled. The 
performance of the maintenance department is 
influenced by various factors such as business 
condition (e.g low and high profit times), main-
tenance philosophy (crises maintenance versus 
planned), extraneous factors (location, availability 
of skills and spare parts), and so forth.

This chapter discusses approaches in system-
atic maintenance productivity measurement and 
creating models for optimising productivity in 
maintenance systems. It discusses defects accu-
mulation, the manual visual yardstick, queuing 
systems and simulations approaches and highlights markov chain approach solution for stochastic 
breakdowns in repairable systems. Also it shows 
how understanding the impact of plant failure and 
repair/service distributions assists in providing 
measures for maintenance productivity using the 
simulation approach.

APPROACHES TO MODELING MAINTENANCE PRODUCTIVITY

The word productivity is used in a variety of sense 
some of which are conflicting or very qualitative 
(namely, “efficiency”, “overall effectiveness”, 
etc). Similarly, the definition of “productivity” 
is varied. Productivity is often confused with 
“output” or “profitability”. Whilst a good total 
productivity implies profitability, the converse 
does not hold. Profitability is affected by market 
prices and accounting practice. Productivity is 
defined simply as a relationship of output to input.

In sharp contrast to production, the perfor-
mance of maintenance activity does not lend itself 
easily to expression in simple or unified figures. 
However, in the last two decades, the measurement 
of maintenance performance and productivity has 
engaged the attention of productivity engineers. 
(Priel, 1974) has written on maintenance organi-
ization particularly on performance ratios. He has 
identified twenty of such maintenance ratios. Some 
of the ratios are useful in establishing the basis 
for incentive scheme for maintenance personnel. 
(Hamlin, 1979) has shown various methods and 
(Alli, Ogunwolu, & Oke, 2011) applied same to 
measure maintenance productivity through their 
case studies. (Chan, Lau, Ip, Chan, & Kong, 2005), 
applying total productive maintenance approach to 
the electronics industry, (Eti, Ogaji, Probert, 2004 
to the manufacturing industries in a developing 
country, (Lilly, Obiajulu, Ogaji, & Probert, 2007) 
to the petroleum-product marketing company and 
(Ahn & Abt, 2006), to the sawmills and planning 
mills industry provides examples of total produc-
tivity measurements in industry.

Another interesting point of view is provided 
by (Nanere, M, Fraser, I, Quazi, A, & D’Souza, 
C, 2007), who critically examines various meth-
ods for estimating productivity incorporating 
environmental effects and shows that adjusting 
for environmental impacts can result in higher 
and lower productivity depending on the assumed 
form of the damage. Although this was applies to 
the agriculture sector, this could be applicable to 
industrial environment, where work place hygiene 
and design could impact negatively or positively 
to productivity.

It can be seen that there are several ways of 
expressing maintenance productivity or perfor-
ance. The problem is how to model a working
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