Stages and Symptoms of Industrial Sickness- A Mathematical Model Applied to a Few Small Scale Industrial Units in NE Indian State of Assam

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Abstract: - Industrial sickness is one of the primary causes that slow down overall economic development of a state in particular and a country in general. This is a fact observed distinctly in India and more specifically in the north eastern (NE) state of Assam where industrial sickness in small scale sector has played havoc with far-reaching socio-economic consequences. Generally, industrial sickness is identified using some traditional techniques which rely upon a range of manual monitoring and compilation of financial records. It makes the process tedious, time consuming and at times are susceptible to manipulation. Here, we propose a mathematical model to represent various stages of sickness with different types of parameters clearly relating the causes to the different stages of sickness. In particular, we describe the formulation of a mathematical model which is based upon certain observations derived from field surveys of a few small scale industrial units in Assam. The proposed model is found to be suitable for study of sick industrial units particular for the identified cases in Assam.
Key-Words: - Industrial, sickness, mathematical, stages, insipient

1 Introduction

All the developing countries have assigned a very significant role to industrialisation in their programmes of economic development. The reason is that the industrial sector is recognised as an indispensable tool of a stable economy. India has been trying to accelerate the rate of economic development through industrialisation ever since the beginning of the planning era. In the wake of our industrial development, a large number of new industrial units have come up all over the country with a sizable number in the small scale sector. But unfortunately, sickness among small scale industries has been increasing in the country at an alarming rate since last three decades.

The industrial achievements in the State of Assam which is in the north eastern part of the country have been even less assuring. The major industries of the state have been tea, petroleum and coal, to which plywood, in particular, was added after independence. A large number of small scale industries have been set up during post-independence period. Despite governmental efforts in the form of various incentives, the rate of growth has failed to pick up [1]. What is more alarming is that some of the recently set up small scale industries have been plagued by sickness corroding the narrow industrial base and threatening the fragile industrial structure in the State. The increasing rate of industrial sickness has

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been a major cause for slowing down the industrial as well as the overall economic development of the state. This is predominant in the small scale sector. Thus, the need of the hour is to prevent and cure the onset of sickness in order that turn-over of new investment is manifested in the economy with minimum time-lag. Moreover, it is necessary to detect sickness at the earliest possible stage for avoiding wastage and under-utilisation of new investments in a capital scarce economy like Assam.

Generally, industrial sickness is identified using some traditional techniques which rely upon a range of manual monitoring and compilation of financial records. It makes the process tedious, time consuming and at times are susceptible to manipulation. Hence, decision makers, planners and funding agencies of such units are sometimes surrounded by uncertainty and unpredictable situations while taking decisions regarding the state of industrial health and the subsequent measures required. We here propose a mathematical model to represent various stages of sickness with different types of parameters clearly relating the causes to the different stages of sickness. In particular, we describe the formulation of a mathematical model which is based upon certain observations derived from field surveys of a few small scale industrial units in Assam. Data from concerned departments are scarcely available. As the requisite data for the analysis proved to be a precious commodity, most of the tabulated values are in normalized forms. The proposed model is found to be suitable for study of sick industrial units particular for the identified cases in Assam. The model also provides the basic framework for preparing a computational model which can be an effective management and support mechanism for planners and decision makers. Works of similar nature have not been reported in the Indian scenario till now, hence the reported concept is novel in nature atleast in the context of Assam's industrialization scenario. Some of the relevant literature is included in [2]-[9].

The rest of the paper is organized as follows: Section 2 deals with the primary notions related to the stages and symptoms of industrial sickness. The proposed model is described in Section 3. A few case studies are taken up to verify the effectiveness of the proposed model which constitutes the Section 4. The paper is concluded in Section 5.

2 Stages of Industrial Sickness

An individual unit passes through several stages before it becomes sick. The knowledge about the various stages of sickness is very essential for taking corrective and appropriate measures in appropriate time. The different stages of sickness along with the determinants which identify these stages as per the guidelines of Reserve Bank of India (RBI) are given below [2]:

Normal Unit - A normal unit is characterised by the efficient functioning of its functional areas like production, marketing, finance and personnel. In other words, a unit can be called healthy or in a normal state (NS) when it is earning profits,

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Table 1: Stages of industrial sickness and associated symptoms

Sickness States	Production x1	Profit x2	Working Capital x3	Loss x4	Marketing x5	Personnel x6	Net worth rise x7	Net worth decline x8
Normal (N)	↑	↑	↑	Nil	↑	↑	↑	Nil
Tending to Sickness (TS)	↑	↓	NC	↑	NC	NC	NC	↑
Incipient Sickness (IS)	↓	↓	↓	↑	↓	↓	↓	↑
Close (C)	↓	↓	↓	↑	Nil	Nil	Nil	↑

the current ratio is more than one, net worth is positive and debt-equity ratio is good.

Tending Towards Sickness- At this stage a unit shows certain initial aberration in any of its functional areas. In other words, the unit faces some environmental constraints. At this time, the unit is said to be tending towards sickness (TS). The distinctive features of this stage are decline in profit in
the last year as compared to the previous year and loss estimated in the current year.

Incipient Sickness - The continuation of the deterioration in the functional areas of the unit, results in the actual setting in of industrial sickness. This stage is termed as incipient sickness (IS). At this stage, the unit incurs cash losses but imbalance in the financial structure may not be apparent.

3 Proposed Mathematical Model to Study Industrial Sickness

The proposed mathematical model is based on certain theoretical considerations which are followed by decision makers while dealing with industrial sickness as per RBI guidelines. The related symptoms associated with the stages of industrial sickness is summarised in Table 1. These considerations are translated to certain functional notions to formulate the mathematical model. As shown in Table 1, four stages of industrial sickness as defined as normal (N), tending to sickness (TS), incipient sickness (IS) and closed (C) are defined. With these four stages, eight symptoms are related. These are represented as x_i where i while taking different values denoting various symptoms linked to industrial sickness stages. Let $f(x)$ represent an industrial sickness stage. With the assumed symptom parameters a functional relationship for the four sickness stages can be shown as

I. $f(x) = N, with\ f(x) = \sum a_i x_i,$ $i = 1\ to\ 8, with\ a_{i=1\ to\ 3,\ 5\ to\ 7} > 1,\ a_4, a_8 = 0.$ The coefficient terms a_i represents a scaling factor which determines rise and fall depending upon the value it takes.
This stage represents a healthy unit with all positive signs of growth and related factors.

II. $f(x) = TS, with\ f(x) = \sum a_i x_i,$ $i = 1\ to\ 8,\ with\ a_1,\ a_4, a_8 > 1,\ a_3, a_4, a_8 = NC\ and\ a_2 < 1.$
Here, NC means no change from previous years. In this stage sickness has started to creep into the unit and certain signs become visible. Here, profits start to fall and the net worth of the unit also begin to decrease.

III. $f(x) = IS,\ with\ f(x) = \sum_{i=1}^{8} a_i x_i,\ a_{i=1\ to\ 3\ and\ 5\ to\ 7} < 1\ and\ a_{4,\ 8} > 1.$ In this stage sickness has already occurred in the unit and it suffers heavy losses.

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IV. $f(x) = C,\ with\ f(x) = \sum_{i=1}^{8} a_i x_i\ ,\ a_{i=1\ to\ 3} < 1\ \ a_{4,\ 8} > 1\ and\ a_{5\ to\ 7} = 0.$

In this stage, the unit is affected by sickness and it closes down its operations.

4 Application of the Proposed Model to Study a Few Small Scale Units of Assam

The mathematical model described in Section 3, is used to generate industrial stages for three different cases. For normal condition, a set of graphs are generated with certain values taken such that these fall within the defined limits. Figure 1 shows a plot obtained from this process. Another plot obtained from expression II mentioned in Section 3 is shown in Figure 2. It represents a stage where the unit is tending towards sickness over a three year period. The plot clearly shows that while working capital remains constant, profit starts to fall. It is a sign of TS. Similarly, the expression also is used to generate the insipient sickness condition. Figure 3 shows such a condition. Here, clearly production, profit, working capital etc are showing a fall over the considered time period. The model can be also used to generate the condition of a closed unit arising out of sickness. These results are compared with certain data collected from surveys of atleast five normal, tending to sickness and insipient sickness units. Average and normalized values of five such units for each of the cases are shown in Tables 1 to 3. The trends of the variations as represented by the average data shown by the Tables 1 to 3 clearly indicate a similarity with the stages as indicated by the proposed mathematical model. This justifies the importance of the proposed mathematical model for study and analysis of industrial sickness.

5 Conclusion

Here, we propose a mathematical model to study and analyze industrial sickness by considering four different stages related to eight distinct symptoms and signs. The model is used to generate a few industrial sickness stages of certain small scale units of Assam in the NE region of India. The generated stages compare well with financial data obtained from field studies. The model may also be used to predict a certain microscopic picture within a macroscopic scenario showing distinct parametric association with the overall economic state of an industrial belt of a state or a country. The proposed approach also provides a basic framework for a computational approach to deal with industrial sickness which shall be a reliable mechanism for decision makers and planners.

6 Reference

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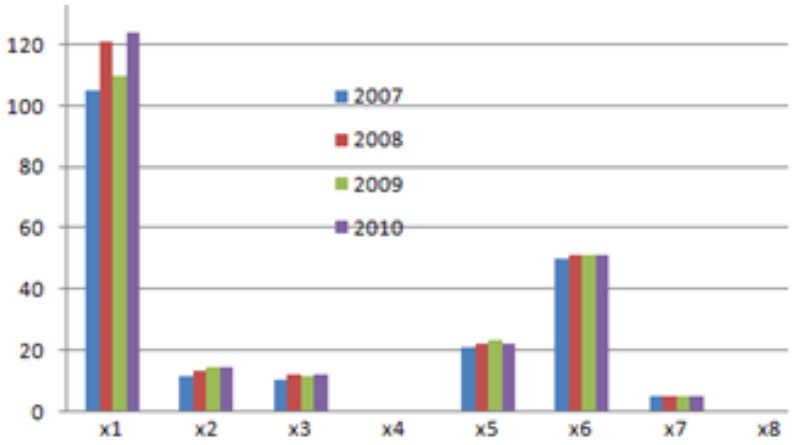

Figure 1: Sickness state as predicted by exp. (I)

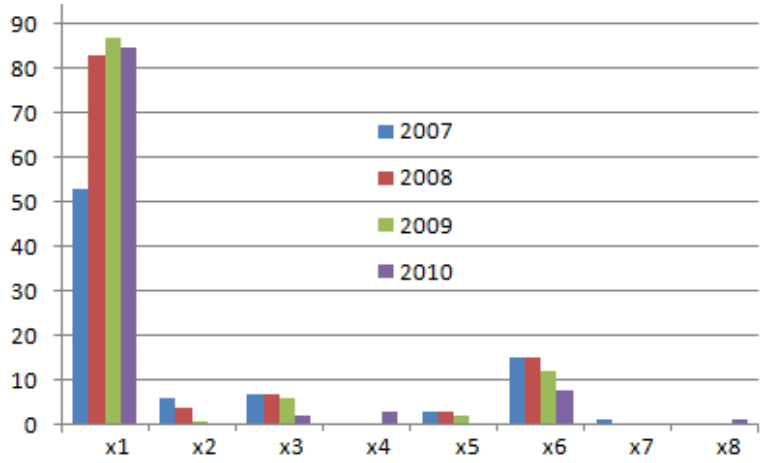

Figure 2: Condition of a unit tending towards sickness as obtained from the proposed method (exp. II)

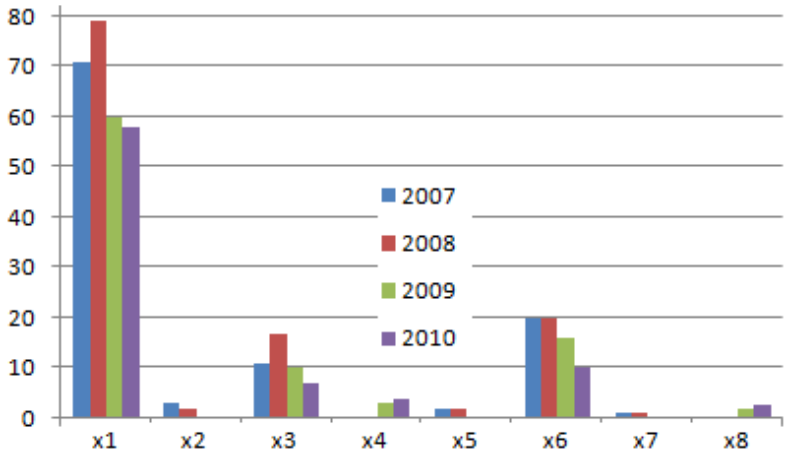

Figure 3: A unit suffering from sickness as obtained from the proposed method (exp. III)

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Table 1: Average values of five normal units showing similarity with expected outcomes as suggested by proposed mathematical model

Year	Production in Tons x1	Profit in % x2	Working Capital Rs. x 10^6 x3	Loss in % x4	Marketing in % x5	Personnel x6	Net worth rise in % x7	Net worth decline in % x8
2007	100	10.00	10	0	21	50	5	0
2008	120	12.00	12	0	22	51	4.5	0
2009	105	13.00	11	0	23	51	4.8	0
2010	121	13.00	12	0	22	51	4.8	0

Table 2: Data sets representing average states of five units tending towards sickness

Year	Production in Tons x1	Profit in % x2	Working Capital Rs. x 10^6 x3	Loss in % x4	Marketing in % x5	Personnel x6	Net worth rise in % x7	Net worth decline in % x8
2007	50	6.00	7	0	3	15	1.5	0
2008	80	3.70	7	0	3	15	0.5	0
2009	85	0.30	6	0	2	12	0.2	0
2010	81	0.00	2	3	0	8	0	1.5

Table 3: Average values of five units covered by insipient sickness stage

	Production in Tons x1	Profit in % x2	Working Capital Rs. x 10^6 x3	Loss in % x4	Marketing in % x5	Personnel x6	Net worth rise in % x7	Net worth decline in % x8
2007	70	3.00	12	0	2	20	1.1	0
2008	78	2.00	18	0	2	20	1	0
2009	62	0.00	11	3	0	16	0	1.9
2010	60	0.00	8	4	0	10	0	2.8

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