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Industrial Forecasting Support

Highlights

Proper Forecasting Technique

Productivity Improvement of Fan

Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 4 VERSION 1.0

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Productivity Improvement of a Fan Manufacturing Company by using DMAIC Approach: A Six-Sigma Practice

By Hemendra Nath Roy, Sudipta Saha, Prof. Dr. Tarapada Bhowmick & Sufal Chandra Goldar

Khulna University of Engineering & Technology, Bangladesh

Abstract - The research has carried out to introduce Six-Sigma philosophy in Bangladesh, especially in Manufacturing Industry. To show the technical pathway of implementing this technique in our industries for improving the productivity and quality was the main concern of this paper. Present Sigma Level is calculated as a part of the framework and total factors, which are directly related with the process, are taken under calculation. At the same time all the process related to production are clearly observe. As a whole, the total improvements of production system by implementing the Six-Sigma tools were our research goal. A Fan Manufacturing Company was our research area where it has possible to analyzed and implemented. In the thorough procedure, DMAIC is used as technical tools for developing the process. Finally, by changing the traditional layout to balanced layout model as per DMAIC approach, remarkable improvements have been achieved.

Keywords : *Six-Sigma, DMAIC, line balancing, quality control.*

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Productivity Improvement of a Fan Manufacturing Company by using DMAIC Approach: A Six-Sigma Practice

Hemendra Nath Roy [α], Sudipta Saha [σ], Prof. Dr. Tarapada Bhowmick [ρ] & Sufal Chandra Goldar [ω]

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I. Introduction

Six- Sigma is a statistical measurement of only 3.4 defects per million and regarded as a management philosophy focused on eliminating mistakes, waste and rework. It establishes a measurable status to achieve and embodies a strategic problem-solving method to increase customer. Satisfaction and dramatically reduce cost and increase profits. The real power of Six -Sigma is simple because it combines people power with process power. If an organization is focused on customer satisfaction, then Six-Sigma will offer a method and some tools for the identification and improvement of both internal and external process problems to better meet customer needs by identifying the variations in organization's processes that might influence the customer's point of view, negatively.

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There are countless benefits of having employees trained in the practices of Six-Sigma. Some of the benefits include the following: cost savings, increased productivity, and lower frequency of defects, shorter cycle time, and improved customer satisfaction. Below are just two success stories that had their own particular benefits after implementing Six-Sigma. Many more companies have also had positive results with Six Sigma. One of the earliest success stories begins with Motorola, the founders of Six-Sigma. At the Schaumburg, Illinois facility, ten years after implanting Six-Sigma, great successes were seen. Though Fredrick Taylor, Walter Stewart and Henry Ford played a great role in the evolution of Six-Sigma in the early twentieth century, it is Bill Smith, Vice President of Motorola Corporation, who is considered as the Father of Six-sigma.

M. Soković et al. undertook projects to identify areas in the process where extra expenses exist, identify the biggest impact on production expenses, introduce appropriate measurement system, improve process and reduce expenses on production times, and implement improvements [1]. Gustav Nyren represented the variables influencing the chosen characteristics variable and then optimized the process in a robust and repeatable way [2].John Racine focuses on what six-sigma is today and what its roots are both in Japan and in the west and what Six-Sigma offers the world today [3]. Zenon Chaczko et al. introduced a process for the module level integration of computer-based systems, which is based on the Six-Sigma Process Improvement Model, where the goal of the process is to improve the overall quality of the system under development [4]. Philip Stephen highlighted a distinct methodology for integrating lean manufacturing and Six -Sigma philosophies in manufacturing facilities [5].

This work is specially carried out to identify the problems that cause defects in various steps of production and to improve each step by increasing productivity and reducing cost. DMAIC is found as the solution maker in this paper. Lean Manufacturing has added an extra dimension in the productivity improvement approach in this research.

II. Methodology

To implement Six-Sigma it is needed to follow DMAIC approach step-by step. In the following sections, this approach is briefly described for the concerned organization. It is a very important stage to consider because lack of proper analysis may lead to the process to a wrong way, which will deviate, from the main function of improvement. In this stage, different basic tools of quality are preferably used to analyze the real condition of the processes. Every successful work goes on some specific sequence. This work also completes some specific step. After completing each successful, it is necessary to move next step. The steps that are followed for data analysis are:

Step 1- Find out the existing sigma level of the production shop.

Step 2- Analysis the existing layout of the production shop.

Step 3- Analysis the existing operation sequence by the process block diagram.

Step 4- Analysis the existing problem by cause and effect diagram.

Methodologically the total process of the work is divided into two basic stages, Measurements and Improve-ments. A systematic pathway is followed to meet up the goal. Firstly, the Sigma Level of the existing process of the Fan manufacturing company is measured and other related factors are calculated. Base on these measurements, secondly the improving tools and techniques are implemented. All the scope of implication of new philosophy and techniques are systematically identified.

The paper is discussed comparing the productivity and efficiency before and after applying the balancing technique. Considering experience, capacity, production line is selected. Two important attributes have been considered, one is possible standard method for each process and another is considerable time in between the input has been fed to actual individual capacity of each worker. The time is recorded to make each process for each worker to find out the number of operator and individual capacity. To find out the (standard allowable minute) S.A.M value, process wise capacity has been calculated, in addition to that the target, benchmark capacity, actual capacity, labor productivity and line efficiency are calculated. Line has been balanced considering the bottleneck and balancing process where the balancing process has shared the excess time after the benchmark production in the bottleneck process. After balancing, new workers have been proposed and final capacity of each worker has been reallocated. have compared the line graph after balancing the line, labor productivity, and line efficiency. Finally, a proposed production layout has been modeled with balanced capacity. Sigma value increases the process performance in a better way. Another way of measure the process capability and performance by the statistical measurements like Cp, Cpk, Pp and Ppk. The Six-Sigma means a 3.4 % defects part per million or yield of 99.9997% (perfect parts). Following is the table of comparison of different Sigma values at different defects part per million and capability of process here.

Table 1 : Six-Sigma value chart

SIGMA	DPMO
6 sigma	3.4 (World Class)
5 sigma	230
4 sigma	6200 (Industry Average)
3 sigma	67000
2 sigma	310000 (Not Competitive)
1 sigma	>310000

DPMO- Defects per Million Opportunities

The DMAIC is a basic component of Six-Sigma methodology- a better way to improve work process by eliminating the defects rate in the final product. The DMAIC methodology has five phases Define, Measure, Analysis, Improvement, and Control.

Figure 1 : DMAIC Methodology

Line balancing is the assignment of work to station in a line to achieve the desired output rate with the smallest number of workstations. Normally, one worker is assigned to a station. The line that produces at the desired pace with the fewest worker is the most efficient one. Achieving this goal is much like the theory of constraints, because both approaches are concerned about bottleneck. Line balancing differs in how it addresses bottlenecks. Rather than, (1) taking on new

customer orders to best use bottleneck capacity or (2) scheduling so that bottleneck resources are conserved, line balancing takes a third approach. It creates workstation with workloads as evenly balanced as possible. It seeks to create workstations so that the capacity utilization for the bottleneck is not for the higher than for the other workstations in the line. Another difference is that line balancing applies only to line processes that do assembly work or to work that can be bundled in many ways to create the jobs for each workstation in the line.

III. Research Outcomes

Sigma level is a procedure to know the existing condition of a production shop. The calculation of sigma level is based on the number of defects per million opportunities (DPMO). In order to calculate DPMO, three distinct pieces of information are required:

a) The number of units produced.

b) The number of defects opportunities per unit.

c) The number of defects.

$$\text{DMPO} = \frac{\text{(No. of Defects*100000)}}{\text{((No. of Defects opportunities per unit)*No of units)}}$$

For this purpose, the relevant data is collected. By using this data, the defect rate of each process is calculated and converted it into the total defect. From collected data, the number of units produced was 240 pieces per day, the number of defects opportunities per unit was 5 and the number of defects was average 18 pieces per day. Finally, this information is put into sigma level calculator. This automatically finds the DPMO of the production shop, which are 15000. After plotting the required information into sigma level calculator, the calculator shows that the sigma level of the production shop is 3.7, which was below average. At the Define phase of DMAIC, approach a major problem was found that was the existing layout. The layout problem was a challenge to management because of the complex interactions of several key factors and the difficulty in assessing their impact on the system performance. Maintaining best utilization of human resources by providing a comfortable and safe working environment an effective and efficient layout is mandatory.

The layout was analyzed based on:

- Placing equipment in a position resulting in its maximum utilization (adjusting machine capability and manpower utilization).
- Reducing congestion in the flow of materials or people through successive stages in the process (by applying supermarket).
- Providing easy access for equipment maintenance and repair.
- Creating efficient production lines for a smooth and rapid product flow.
- Suitable means for fast and safe materials handling.
- Maintaining best utilization of space.

Maintaining best utilization of human resources by providing a comfortable and safe working environment.

After completing the successful analysis of production layout further study was focused on process block diagram. To find out the existing problem of a complete production process, it is more preferable to represent the operation sequence by process flow diagram. For this purpose, the operation sequence is analyzed and obtained the flow chart.

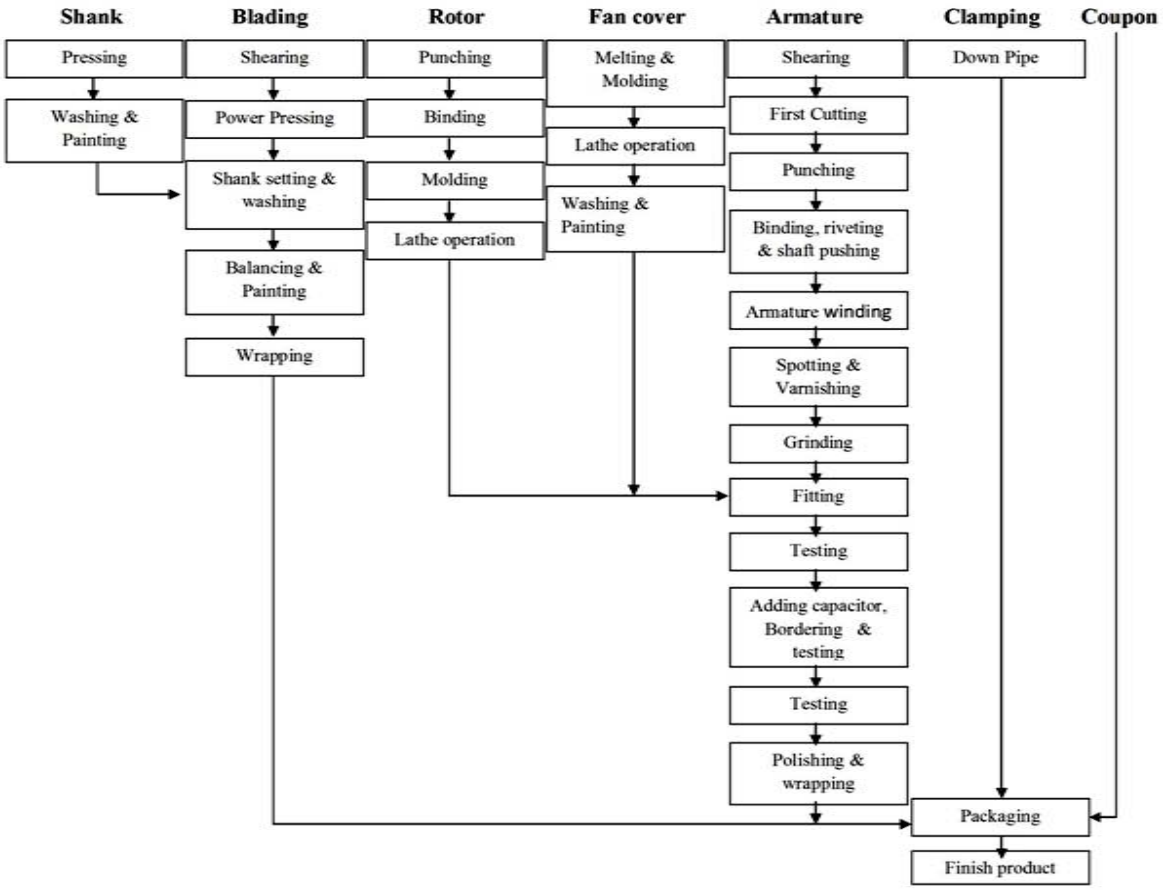

Figure 2 : Process flow chart of the production shop

The next step was to find the root cause and sub-cause of the existing process. The required cause & effect diagram is shown below:

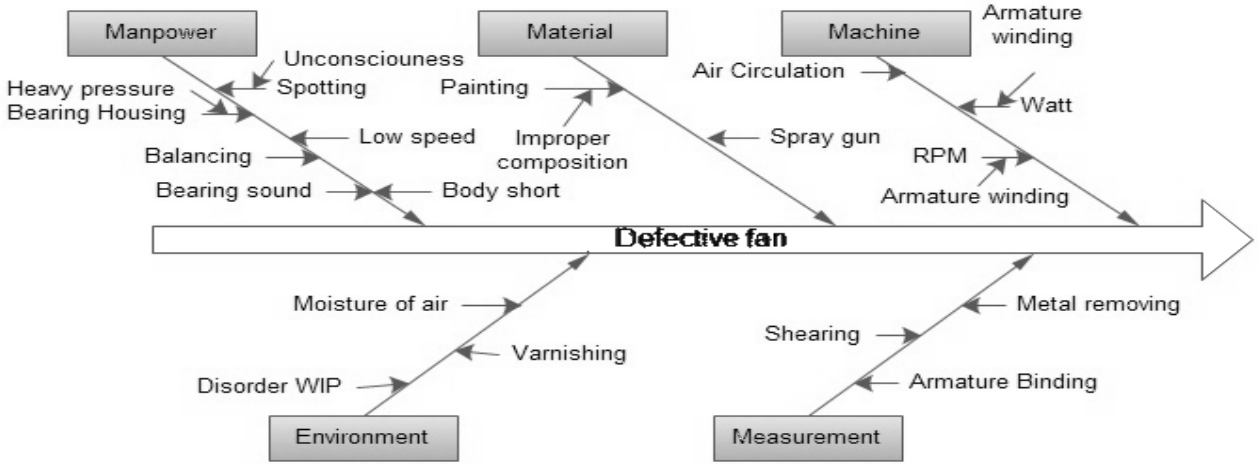

Figure 3 : Cause and Effect Diagram

Process wise capacity of each workstation has been found where Standard allowable minutes (S.A.M) has been calculated. The target per hour for the line calculating total 98 manpower worked on that line for 480 minutes with a S.A.M value of 126.05. The Benchmark target have standardized of 298 pieces of production at 80% efficiency. Observation before balancing the line has been reflected as labor and

machine productivity is 2.45 and 8.28, line efficiency is 64.31%. Some variations are identified in process capacity from the benchmark target and the lower capacity from the benchmark target is the bottleneck process, as production flow would stick on the bottleneck point. Comparing total capacity of each process to the 80% benchmark target, the bottleneck processes have identified named **Pressing 1, Pressing 2, Binding, and Grinding.**

a) Balancing Process

Balancing method is very essential to make the production flow. Considering working distance, type of machines and efficiency, workers who have extra time to work after completing their works, have been shared their work to complete the bottleneck processes.

Operator who work in Process no. 9 Hydraulic pressing, have been worked for 36 minutes per hour in her first process, capacity 42 pieces and then have been worked in the process no. 4 pressing 1 for last 24 minutes to make additional 12 pieces for overall capacity of 42 pieces on process no. 4. Similarly Process no. 10 shaft pushing have been worked for 42 minutes and rest 18 minutes have been worked on process no. 5 pressing 2 to make total capacity of 39 pieces which was originally 30 pieces. Process no.12 and 22 have been similarly worked on the process no.7 and 16 for the capacity of 43and 41 pieces per hour.

After considering all the factors and the balancing process, a layout was proposed.

Table 2 : Balancing Sheet

Shifted manpower	From		To	
	Process No	Time	Process No	Time
1	9	36	4	24
1	10	42	5	18
1	12	20	7	40
1	22	50	16	10

Balanced capacity	Previous capacity	Process Name	S.A.M	No. of worker	Process No		Process No	No. of worker	S.A.M	Process Name	Previous capacity	Balanced capacity
40	40	`Shearing	3	2	1		2	1	1.5	Ar. Parting	40	40
40	40	Ar. Punching	1.5	1	3		4	1	2	Pressing 1	30	42
39	30	Pressing 2	2	1	5		6	0		Pressing 3	0	0
50	50	Riveting	1.2	1	8		7	3	5.14	Binding	35	43
38	55	Shaft pushing	1.1	1	10		9	1	.86	Hyd. Pressing	70	42
42	42	Balancing	1.43	1	11		12	3	3.27	Shank Joining	55	42
65	65	Coiling	23	25	14		13	5	4.6	Winding	65	65
55	55	Spotting & varnishing	6.55	6	15		16	1	1.7	Grinding	35	41
40	40	Surface finishing 1	9	6	17		18	3	4.5	Drilling	40	40
40	40	Surface finishing 2	6	4	19		20	2	3	Washing	40	40
40	40	Painting	18	12	21		22	1	1.2	Fitting 1	50	42
40	40	Fitting 2	4.5	3	23		24	10	15	Quality Control	40	40
40	40	Packaging	6	4	25							

Figure 4 : Proposed Layout of the production process

After taking appropriate actions for improving the process, it has been checked again. Based on the results of this assessment, previous steps may be repeated to achieve the desired level. It is not possible always to get success at the first time, so recurring of all the steps will lead the process to be set at the preferred point.

IV. Result

Changing from traditional layout to balanced layout model, there are considerable improvements have moved. In a day we have boost up the production up to 312 and with manpower of 98, line efficiency has been improved from 64.31% to 83.60%, which is shown in above table. The Benchmark target have standardized of 298 pieces of production at 80% efficiency. There were some uncertainties in the validity and reliability of the sampled data. These were based on the assumption .As the main purpose of this research is to increase productivity, it has been tried to achieve this by improving the level of sigma. Though this case study has been conducted in a fan manufacturing organization, the procedures and the outcomes will be suitable for any manufacturing organization. During the study not all, the information was collected instantly, but some previous records have been also used for better understanding.

V. Conclusion

The six-sigma framework provides an impetus for establishing best practice with the company. It also provides the company with a performance benchmark on which it could base its future performance enhancement programs. As it has been observed that the level of its sigma is not satisfactory, there is no way to improve this by DMAIC. The implementation of six-sigma will save money, which will result higher profit of the organization. As the businesses are influenced by globalization, the competition is arising more and more and so, to sustain in the global business every organization needs to maintain appropriate quality level. This study will contribute to a new management approach on improving business process for both efficiency and consistent quality customer service. In the case organization, it is noted that the workers are very busy to produce their expected amount of fan. Almost all time they perform repetitive task, which waste time. As a result, sometimes they produce defective fan. Consequently, there is less possibility for producing defective fan, which is the main target of six-sigma by following DMAIC. On the other hand, by applying line balancing, productivity increases from 240 to 312 per day by reducing defect. Finally, it is said that, it is possible to improve productivity by using six-sigma, which is the main purpose of this research. In the future, it is likely that more changes will emerge; making Six Sigma an even more beneficial application for organizations of all types and sizes. It is believed that other companies can learn the insights from this study to identify further research areas for efficiency and quality services. To ensure this quality and the sustainability, six-sigma will no doubt play a vital role in the long run in our country.

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Is it Time for a Rocket Engine for Pile Driving Hammers?

By Petar Bodurov & Vasil Genchev

Abstract - Development of pile driving hammers in the recent 160 years is considered. It is established that only the equipment used for raising the impact body (ram) on a certain height was being changed, whereas the driving itself is performed through the free fall on the pile, e.g. the very driving technology has remained unchanged since almost 8 000 years. In this connection, an interesting relationship is discovered – a new way of powering the ram comes around every 40 years! Another established tendency is a periodical increase in the mass of the impact body. Authors propose a new way of powering the ram that will lead to radical changes in the hammer design and driving technology. First and foremost, the impact body is additionally activated when striking a blow, and does not only rely on earth gravity.

Keywords : *pile driving hammer (PDH), industrial rocket engine (IRE), impact body (RAM).*

GJRE-G Classification : *FOR Code: 850402*

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I. Introduction

An important stage in humankind's history is transition to living in pile dwelling. So, about 8 000 years ago, the driving of wooden piles began. The technology included use of an elementary device made of wooden beams upon which a wooden or stone weight was lifted by means of ropes and periodicaly released to drop onto the driven pile. This technology passed without any change through Ancient Egypt, Greece and Rome as well as through the whole Middle Ages. On Figure 1 we see a picture of a 16th Century Dutch painter(History of pile driving) showing a group of men pulling ropes in order to lift and drop a driving weight. In this way the piles of the foundations of Venice, Antwerp, Petersburg and other cities were driven into the soil.

Figure 1 : Driving a pile. Picture by Jan Luyken (1649-1712)

II. Mechanically Powered Pile Driving Hammers

In 1841, the Scottish inventor James Nasmyth built the first steam hammer, raising its ram in the upper position by means of a piston activated by steam in a cylinder. But this was a blacksmith hammer with a falling impact body used for forging metal things. Then, in a consistent manner, he built a steam-powered compactor applied to smooth road surfaces and then, in 1843, a steam-driven hammer for pile driving. We suppose that it was the lack of auto cranes for raising hammer on piles that is the reason why this device did not come into use. Some episodic efforts for using a steam hammer for pile driving were being made in the next years, for example during the construction of railways in USA, but not until 1883 the German company MENCK started to use regularly steam-powered pile driving hammers. The MENCK steam installation raises the ram with a rope and then allowed it to fall freely on the driven piles. But as early as in 1906 it was proposed to raise the hammer ram by explosion in a cylinder with a piston (Otto Ricklefs,1906). In 1923, the German company DELMAG launched an introduction of a simplified diesel engine for raising the impact body to a certain height. Evidences about a regular pile driving by a so called diesel hammer refer to 1936-1940. The diesel hammer proved to be a very convenient pile driving machine and quite soon it turned into the most popular and large-scale hammer for such activity. At the

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moment, more than 65 000 diesel hammers operated worldwide, from which about 40 000 have a ram with a mass of 2 200 kg. One disadvantage of diesel hammers proved to be the limited maximum mass of the impact part. The increased scale of the construction industry imposed the use of even greater piles with a diameter of 5,0 m and even 7,0 m, so their driving into the soil requires even greater mass of the impact parts. The biggest hammer ever built by DELMAG had a ram mass of 20 000 kg. Jet the German company Bauer succeeded in increasing the ram mass initially to 24 000 kg, and then - to 27 000 kg, which for the present seems to be the maximum possible for diesel hammers. In 1963, to meet the new demand of hammers with a greater ram, the German company KRUPP developed a concept for a so called hydraulic hammer for pile driving which used a hydraulic cylinder for raising the ram. In this way it became possible to built hydraulic driving hammers having rams with a mass of 50 000 kg, 97 000 kg (MENCK), 115 000 kg (IHC, Netherland) and 125 000 kg (MENCK). This sheer gigantism continues and at the beginning of 2012 the Dutch company Heerema Hammers & MENCK conducted tests of driving hammer with a ram mass of 192 000 kg. The tendency for increase in the ram mass is also observed in forging hammers. The Russians built in 1983 the world's largest forging hammer with two rams – each with a mass of 150 000 kg, and for several years now, the German company MÜLLER WEINGARTEN (MÜLLER WEINGARTEN, 2007) has been building even greater forging hammer with two rams – an upper body with a mass of 218 000 kg and a lower body with a mass of 230 000 kg.

Let us return to the pile driving hammer (PDH). The above mentioned types of PDH strike a blow at a maximum ram speed of up to 7 m/s. This is necessary for the sake of structural convenience-in order to conduct the fall from a smaller height and also to reduce the risk of destroying rams and driven piles. An additional restriction of the maximum impact speed probably imposes the use of rams which are castings or hollow bodies filled with metallurgical slag or metal small shot – this was introduced by some companies like MENCK. Due to the free fall of the ram, the most convenient is the vertical pile driving, but technology also enables a tilted pile driving – up to 30° towards the vertical. In 1994, we tried to illustrate the development of driving hammers during the last 160 years and the result is shown on Figure 2. Surprisingly, it turned out that every 40 years a new way of powering of PDH appears – for lifting and dropping the ram. So over the course of that development, in succession, after the steam-powered hammers there emerged diesel- and then hydraulically-powered hammers. Will this tendency continue in our days too? The elementary adding of another 40 years to the last date on Figure 2 - 1963 - gives us 2003 as the year when the next new powering of PDH ram should appear.

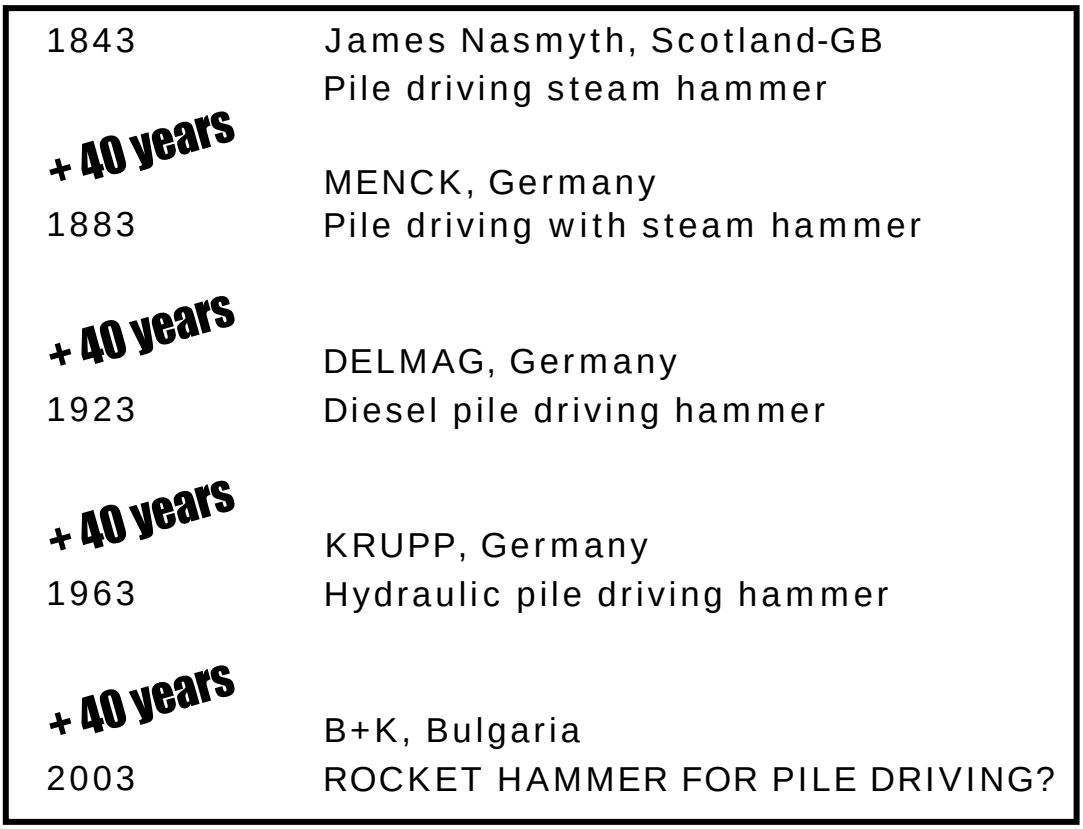


Figure 2 : Evolution of mechanically powered lifting of PDH ram in the last 160 years

III. What is the Next Ram Powering Engine?

We started to look for the next powering engine in succession. As it happened, one of the authors of this article already has been working for years on end on a new way to activate forging hammers and we assumed that most probably it is he who should be our „usual suspect". In 1976, the dipl. eng. Petar Bodurov, financially supported by the Technical University, Sofia, constructed 3 operating models of: rocket press, rocket hammer and installation for hot sheet metal forming with a rocket jet(Bodurov P.&Genov J., 1976). The Air Force School of the Bulgarian Air Force ensures 57 mm uncontrollable aviation rockets of the type "air-air", model C-5M (made in the ex-USSR) for powering the rocket engines with a solid fuel. All experiments started on 13.10.1976 have been successful and we suppose that those were the first deformations of metal stock material by means of rocket engines. For the present article, the results of the experiments with the rocket hammer are of primary interest.

a)

b)

Figure 3.a) : Dipl. eng. Petar Bodurov with the model of the rocket hammer, minutes before realization of the first rocket impact for deformation of ametal specimen - 22.10.1976, Air Force School, Dolna Mitropolia, Bulgaria
Figure 3. b) : Model of a rocket hammer – left to right: an already used rocket engine, an impact body, formed as a piston with a mounted on it rocket engine charged with a solid fuel, a housing of the hammer with a leading tube and devices for fixing the impact body in the upper (starting) position

The C-5M rocket engine charged with a solid fuel has a total mass of 3,5 kg, develops a thrust of about 350 kg (varying with about 10% depending on the ambient temperature) for 0,75 s. The engine is stationary mounted on a steel ram shaped as a piston, with a mass of 15 kg. The ram is held by fixing devices in a leading tube which ensures acceleration stroke of the ram of 0,9 m, moves under the action of the rocket engine and strikes the stock material. The rocket engine is switched on from a battery with a voltage of 27 V. The ram strikes with a speed of about 19 m/s (calculated).

The striking energy of the rocket hammer model corresponds to that of a forging hammer with a falling part of 80 kg at an impact speed of 9 m/s. The first successful strike with a rocket engine was realized on 22 October 1976 on the polygon of the Air Force School. Lead specimens were first deformed and then – specimens from aluminum alloys. Figure 4 shows a matrix, cylindrical stock material of aluminum alloy and a detail forged with a rocket hammer having a mass of 0,053 kg.

Figure 4 : Matrix, cylindrical stock material of aluminium alloy and detail forged with a rocket hammer model

The experimental results obtained gave us a confidence that the idea to construct a new industrial engine working on the principle of rocket engine is realizible. The rocket engine is the best energy transformer! In addition, it is without any competition in two areas(Barrere M., Jaumotte A. et al, 1960):

1. Space flights.

2. Where it is necessary to have a small-sized engine assembly with a big strength and a brief action.

It is obvious that the impact machines, or, rather, the hammers, are most suitable for powering by a rocket engine, which will be most effective when working at short pulses. The rocket engines used in the first experiments with a rocket hammer model are charged with a solid fuel of the type of colloidal gunpowder pressed in hollow cylinders. However, the solid rocket fuel is about 100 times more expensive than the liquid fuel and is extremely inconvenient for multiple charging – you will need to disassemble the engine after every start, clean it totally and recharge which is unacceptable for an industrial machine. Although the scheme described for multiple charging with a solid fuel was successfully experimentally tested on 21.09.1988, we took up developing a liquid-fuel-charged industrial rocket engine (IRE) which can activate industrial machines. The liquid fuel is cheaper and safer than the solid rocket fuel and allows convenient multiple charging of IRE. Also, the IRE has to endure the dynamic loading generated by the powered impact parts. Another important requirement is that IRE should have a multiple action – not less than 10 000 switching, because at the moment all rocket engines are only single-use machines. All these problems were solved and the first IRE was constructed in 1993 – the model IRE-1, Figure 5a. Technical data of IRE-1 are shown in Table 1, and the exhaust gases composition – in Table 2. It is obvious that the engine creates less contamination than the motorcars and this is due to the assured complete combustion of the fuel. In addition, a removal of the exhaust gases is foreseen, so that the rocket machines can work in production departments of the plants.

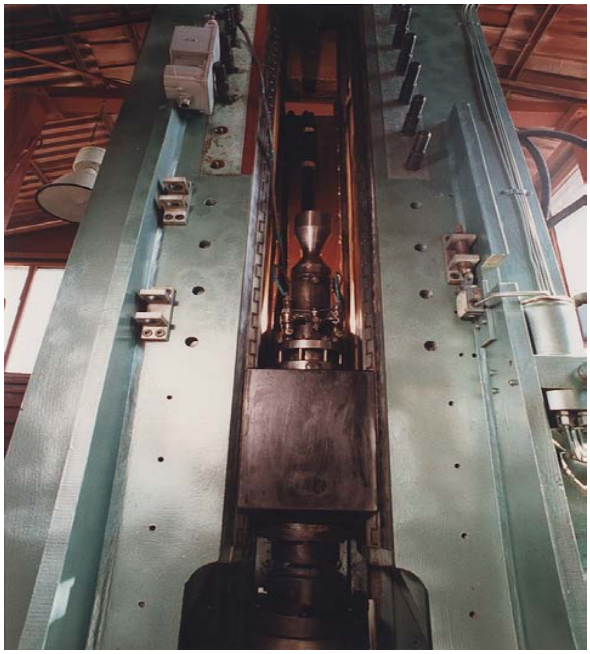
Table 1 : Technical Data of Industrial Rocket Engine model IRE-1

Thrust	5 to 20 KN (1 125 to 4 500 lbs)
Pressure in the Combustion Chamber	max 6 MPa (870 lbs/in^2)
Fuel	Kerosene
Oxidizer	Compressed air
Efficiency	0,92
Fuel consumption	max 0,62 kg/s (1,37 lbs/s)
Oxidizer consumption	max 8,90 kg/s (19,62 lbs/s)
Weight	25 kg (55 lbs)

Table 2 : Exhaust Gases of IRE-1 (mol %)

O – 0,0022	H2O – 0,1296	CO – 0,0059
H – 0,0010	N3 – 0,7264	CO2 – 0,1259
OH – 0,0012	NO – 0,0018	Ar – 0,0087

a)



b)

Figure 5.a) : First Industrial Rocket Engine, model IRE-1: hose tubes for air, 2 pieces, 1 hose tube for kerosene (with a smaller d), 2 pieces aviation sparking plugs

Figure 5. b) : Front view of the first Rocket Forging Hammer, model TWS-36 powered by IRE-1 (the front covers are removed): it is seen the impact body with an upper pressure forge mounted on the bottom face and the rocket engine IRE-1 mounted on it

In this way, we added a fifth industrial engine - IRE - to the already existing 4 industrial engines: steam engine, electrical engine, turbine engine and internal combustion engine. According to historians the rocket engine is the first engine made by man as early as about 2 000 years ago. But historically it so happened that it was only used as a transport vehicle rather than as a powering machine. And so is today - the rocket engines are used for transportation of 3 object types – explosion, apparatus and people. We are puzzled why during the past thousand years nobody noticed the ability of the rocket engine to operate also as an impact machine? Perhaps the reason is in the inertia of thinking and the opinion that when something flies it is bound to be light, tender and fragile? The rocket engine has extremely simple structure, can be produced as a single body, without any moving parts, which is a prerequisite for making a product resistant to impacts. Figuratively speaking, the rocket engine is one-profile tube which is closed from one end.

In 1994, we built the first forging rocket hammer model TWS-36 powered by IRE-1 (Figure 5 b, Table 3) (Bodurov P., 1978; Bodurov P. et al., 1999; Bodurov P. & Penchev T., 2005). After its creation it turned out that the mass of the rocket hammer is 35% less than this of an analogous pneumatic hammer – at equal impact energies. We forged on this hammer steel conic gearwheels with a mass of 0,810 kg. Based on the results obtained, we assumed that the rocket engine is the next engine which will gain ground for PDH (see Figure 2).

Table 3 : Technical data of the rocket forging hammer model TWS-36 powered by IRE-1

Maximum Striking Energy	36 KJ
Ram Speed	from 10 to 18 m/s
Stroke of the Ram	max 1 650 mm
Height Above Floor	3 350 mm
Width and Depth	1 250 x 800 mm
Weight (incl. anvil of 22 000 kg)	28 000 kg

IV. IRE-Powered PDH

We propose 3 main schemes for IRE-powered PDH:

A. Lifting the ram with IRE till reaching a set falling height(Bodurov P., 1978).

B. Lifting the ram to a set height (or at a given distance from the pile) by already existing powerings, such as steam, diesel and hydraulic, and striking with the ram under the action of IRE in combination with the earth gravity(Bodurov P., 2008).

C. Lifting the ram to a certain height (or at a given distance from the pile), as well as moving the ram for striking – and both movements are realized exceptionally by the action of IRE and the earth gravity(Bodurov P.&Genchev V., 2011).

A characteristic feature of the First scheme (A) is the condition that the IRE thrust should be higher with 20-30% than the mass of the ram. Otherwise it cannot be realized. This condition only restricts the pile driving vertically or with a slope up to 30˚ and does not have

any special advantages over the now operating hammers. For the present, construction of an IRE with a thrust higher than 6 000 kg is still a serious technical problem and this restricts the mass of the ram to max 5 000 kg, if only one IRE is used. However, there is no technical problem to activate the ram with more than one IRE.

The second scheme (B) is more prospective and allows not only to replace the now existing PDH, but also to improve them (see Figure 6), retaining the device for lifting the ram - steam, diesel or hydraulic - and introducing an active powering of the ram for striking a blow. In this way, the effect of the earth gravity is eliminated to a great extent – it is no more a determining factor for the impact speed of the ram and now there is a possibility that PDH can strike at any angle in the space. Another advantage is the possibility to obtain an equivalent increase in the ram mass and therefore – increase in the impact energy. The masses of the equivalent rams are given in Table 4 – they are calculated when the engine IRE-2 is mounted to the masses of three type sizes PDH, according to the scheme of Figure 6. The IRE-2 engine(Raketenantriebe, 2009) has the same parameters as the IRE-1engine, but it is structurally adjusted to the modernized PDH with a ram to 2 200 kg. It is well known that the piles driven at a higher speed have a higher bearing capacity – because of the better soil consolidation around the piles. The active effect of the IRE which is added to that of the earth gravity allows an alteration of the strike energy without any change of the falling height or the ram mass, and so larger piles will be driven with a smaller mass. Another advantage is the unique ability of the IRE to exert so called complex or combined impact and thus at the moment of impact the operating IRE exerts also a press effort (Bodurov P. & Penchev T., 2005). It is imminent to conduct a study of the new possibilities of the combined impact which will totally change the impact and turn it to a "controllable" impact. It is obvious that the so far used "simple impact" does not respond to the already changed requirements for pile driving. What is more, we should note that the introduction of mechanically powered lifting of the impact body 160 years ago resulted in certain change of the impact by which the piles are driven. The reason is that when moving down for striking, the shaped as a piston activation element pushes the respective fluid (water steam or hydraulic liquid) or compresses the air, which leads to striking at a decreasing speed. When the impact body of the elementary gravity hammers makes a free fall, it only encounters the air resistance which is insignificant because of the comparatively small speed of the free fall. So during the gravity fall the impact is carried out at a constantly growing speed. For the sake of mechanization and efficiency, we have made the impact "softer" thanks to introducing mechanically powered lifting of the impact part. Energy expenses are also increased but on account of this we can reach up to 100 impacts per minute, and also enormous in mass impact parts can be lifted. The IRE will allow, for the short haul, to bring back the advantages of the impact at a growing speed till the realization of the impact itself. Introduction of an active ram will allow also to revolutionize the PDH design and technology of driving. There is a real perspective to change and optimize the thousand-year technology of pile driving, adding to it new possibilities. To answer possible objections to introducing the rocket engine for driving, we will remind that more than 100 years ago the introducing of a steam-driven hammer was also considered a fanciful adventure.

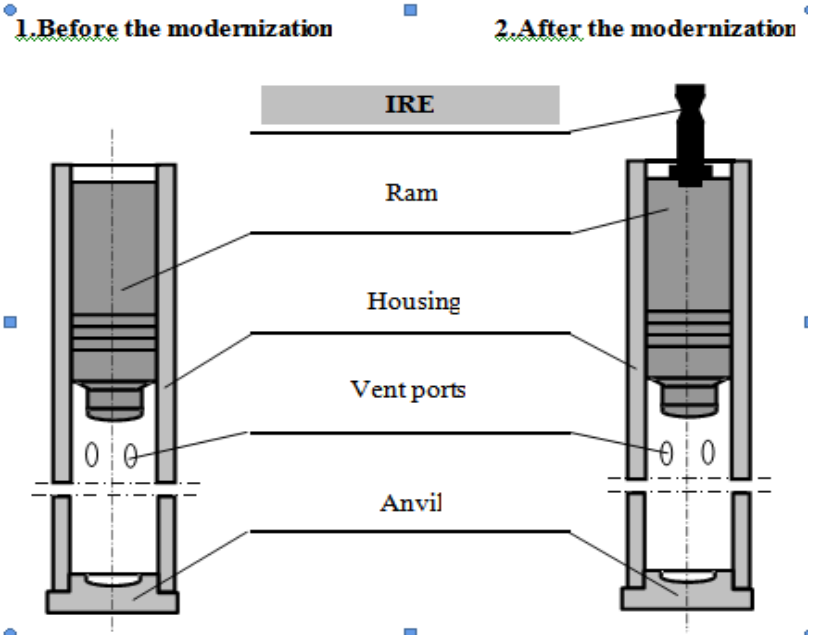


Figure 6 : Modernization of giesel hammer for pile driving

Table 4

Ram weight [kg] (lbs)	500 (1 102)	1 250 (2 756)	2 200 (4 851)
Power E before modernization [kgm] (ft.lbs)	1250(9 041)	3 120 (22 567)	5 500 (39 782)
Power E after modernization [kgm] (ft.lbs)	4 250(30 740)	6 360 (46 002)	8 800 (63 650)
Equivalent ram weight after modernization [kg] (lbs)	1800 (3 969)	2 540 (5 601)	3 250 (7 166)

Figure 7 : Shows the realized scheme ofthe IRE feeding with a fuel and oxidant(Bodurov P., 2011). Figure 8 b, c demonstrates a modernized tube diesel hammer model УР-2(USSR) with a ram of 500 kg. Possible angles of the pile driving can be seen on Figure 9. The possibility for vertical upward pile driving at an angle of 180˚ can also be used as a technology for removing of an already driven pile

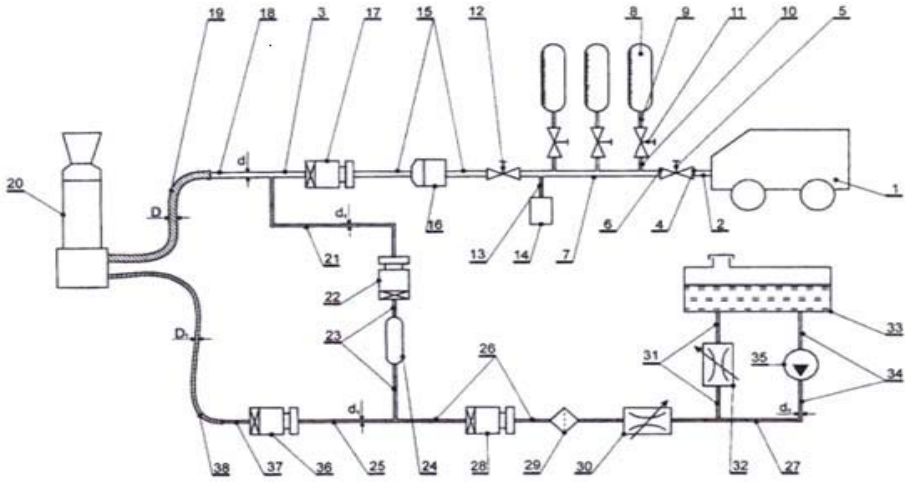
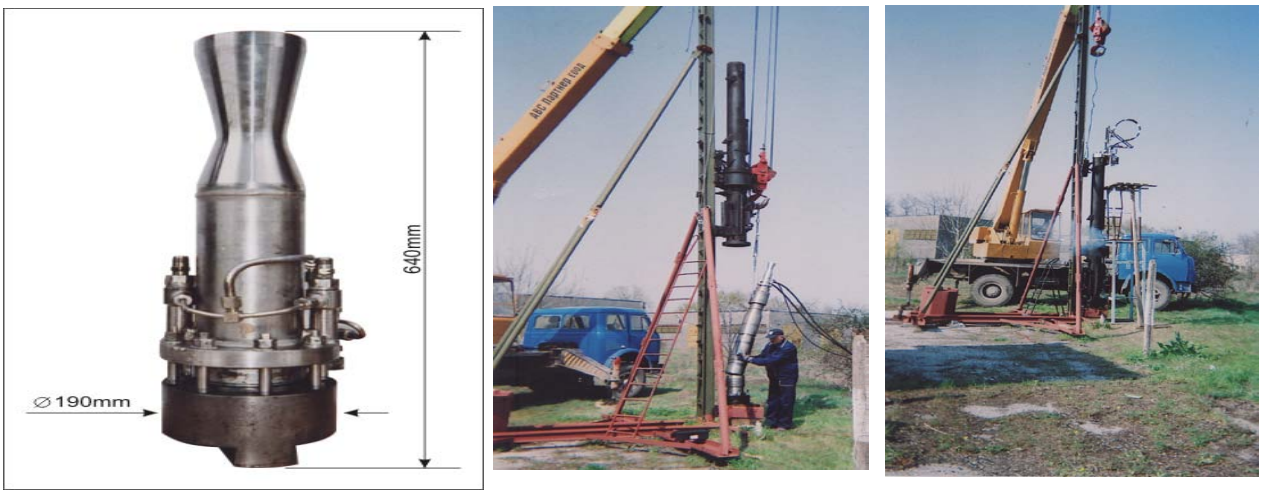


Figure 7 : Scheme of feeding the IRE-2 with fuel and oxidant

1 – compressor, 3 – oxidant (air) line, 5 - crane, 8 - receiver, 14 - safety relief valve, 16 – reductor, 17 – main electromagnetic valve, 19 – flexible hose for oxidant, 20 - rocket engine, 21- tube for air, 22, 28, 36 - electromagnetic valves, 24 –fuel dose, 25 – fuel (kerosene) line, 29 – filter, 30, 32 – throttles, 33 – fuel tank, 35 – pump, 38 – flexible hose for fuel



a) b) c)

Figure 8 : Hammer for pile driving model Ур-2, powered with IRE-2:a) IRE-2

b) Assembling of IRE-2, together with air hoses – 2 pcs. and 1 kerosene hose on the ram with a mass of 500 kg.
c) Surface tests of the hammer model УР-2 with a mounted IRE-2.

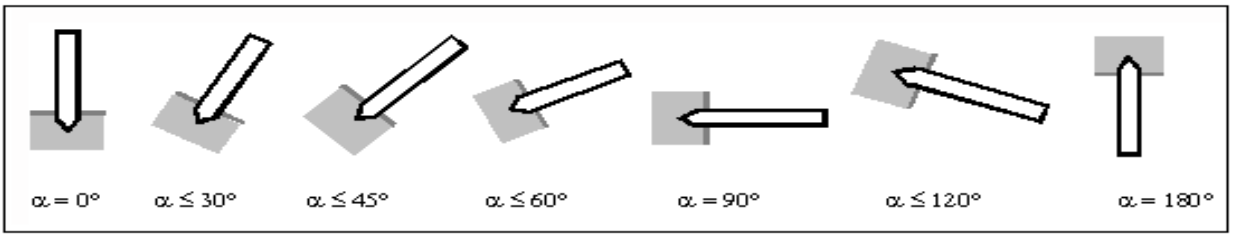
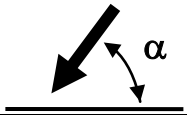
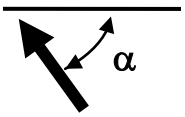


Figure 9 : Angles of pile driving with a rocket-powered hammer

Formulas for determination of the ram speed when striking on the pile are given in Table 5, with the basic 5 pile positions (Bodurov P. & Radev S., 191979). Speed V is given in *m/s*, at acceleration stroke S of the ram in *m*, with a mass of ram *G* and a thrust *R* of the rocket engine in *kg*, and the earth acceleration $g = 9{,}81\ m/s^2$. The formulas are derived by using the motion of material particle theorem from the Classical Theoretical Mechanics. It is assumed that the thrust *R* is constant during the whole acceleration stroke *S*, the mass *G* of the *Ram & IRE* set does not change and the friction in he hammer guide as well as the air resistance are neglected. These assumptions do not change the impact speed *V* by more than 1%, because structurally the stroke *S* is not greater than several meters, a small quantity of fuel is used and the friction is insignificant when lubrication is assured. The speed *V* is less than 20 m/s and so it is not substantially influenced by the air resistance. That is why the formulas given are fully reliable and convenient for application.

Table 5 : Formulas for determination the driving speed V

No.	Driving direction	Formulas for the impact speed
1.		$V=\sqrt{2gS(\frac{R}{G}+1)}$
2.		$V=\sqrt{2gS.\frac{R}{G}}$
3.		$V=\sqrt{2gS(\frac{R}{G}-1)}$
4.		$V=\sqrt{2gS(\frac{R}{G}+\sin\alpha)}$
5.		$V=\sqrt{2gS(\frac{R}{G}-\sin\alpha)}$

The evaluated speed *V* and the impact energy *E* of an IRE-2- modernized tube diesel hammer with a ram mass of 1 250 kg are given in Table 6, compared with the possibilities of non-modernized PDH. The total superiority of the modernized PDH is obvious.

Angle	α = 0°		α ≤ 30°		α ≤ 45°		α ≤ 60°		α = 90°		α ≤ 120°		α = 180°	
Parameters	V	E	V	E	V	E	V	E	V	E	V	E	V	E
	m/s	kgm	m/s	kgm	m/s	kgm	m/s	kgm	m/s	kgm	m/s	kgm	m/s	kgm
PDH	7,00	3120	6,50	2690	IMPRACTICABLE									
PDH+IRE	9,90	6360	9,61	6000	9,04	5310	8,60	4800	7,07	3240	5,76	2156	5,30	1825

Table 6 : Comparison between PDH (tube diesel pile hammer, ram of 1 250 kg or 2 756 lbs) and PDH+IRE

In 2001-2002, we proposed the project "Modernization of PDH" to a team of post-graduate students of the Wharton Business Faculty, University of Pennsylvania (USA). The students participated with this project under the name "Jet Technologies" in the Wharton Business Plan Competition and were ranked amongst the seven big finalists(Wharton, 2002). However, the comments of some PDH manufacturers in the press were that the IRE fixation to a ram is impossible (E. Schurenberg, 2002). The experiments and structures realized by us later disprove these statements. One of the arguments was that the ram speed is too big. For designers of the blacksmith and forging hammers such statements sound not seriously because the falling part of the PDH does not develop an impact speed greater than 7 m/s, and the hammers used in metal working usually work at speeds of 6-9 m/s. High-speed hammers which deform special alloys and sophisticated articles work at speeds of the impact body of about 16-22 m/s and even a hammer working at an impact speed of 40 m/s is constructed. All problems of fixing of the tools to their impact parts are solved and there is no problem connected with fixing the IRE to the ram of PDH which we have proved in practice. By our opinion, a pile driving at a speed of 6-7 m/s is wrong. An elementary increase of the driving speed with only 2 m/s, e.g. to increase it from 7 m/s to 9 m/s, will lead to reduction of the ram mass with about 40%. The use of metal piles makes it totally pointless to object to driving at higher velocities. We propose to go to driving at velocities of the order of 9-11 m/s, and even 12 m/s. In this way you can put an end to this unjustified and expensive gigantism in the production of impact parts. Of course, for higher impact velocities, single-piece forged impact parts are more suitable than castings. For reinforced concrete piles probably an additional strengthening and reinforcement of the steel fixture will be needed, but this is not an obstacle for the technology of their elaboration.

It is worth mentioning one more advantage of the IRE and this is the possibility to work even at the lowest temperature. This advantage is particularly important for fortifications in northern and polar regions where the whole construction lies exceptionally on piles and it can only be practiced during a small part of the year.

The third scheme (C)is the most complicated one but has the unique applicability. It is well known that the rocket engine is the only engine that is able to work independently from the environment. So the rocket engines today work without problems in airless space, air atmosphere and water. Due to this ability, the rocket engine nowadays is considered an ideal engine for powering of the ram in underground pile driving hammers at all existing depths. The fact that it will work in water environment is a possibility to use an electrical rocket engine whose working medium is the surrounding water (Bodurov P. &Genchev V., 2011). By heating and evaporating water in the rocket chambers, a jet thrust is generated which will move the ram up and down or forward-backward. The evaporation of water can happen in three ways:

- By using a high-frequency induction current – similar facilities are used in metallurgy. In this way a temperature of the order of 3 000˚C can be reached;
- By using a voltaic arc, similar to one used in electric welding – in this way a temperature of the order of 5 000˚C can be reached;
- By using a laser which will allow to reach a heating temperature of the order 4 000 - 10 000˚C.

We think that using a laser is the most suitable because it allows to obtain an instant evaporation of water in the rocket chambers by short pulses from nanoseconds to microseconds. The temperature of water evaporation increases with the increase in the depth. For example, at a depth of 7 000 m the temperature of evaporation is 730˚C and this is not a problem for the laser. We expect that in the forthcoming years it will be necessary to extract oil from ocean depths of 7 000 m and then the ram powered by electric rocket engine will have no alternative (Bodurov P. & Genchev V., 2012). The electric rocket engine can also be used for working on dry land.

V. Conclusion

The experimental results and information reported in the present article lead to the general conclusion that the time has come to accept the industrial rocket engine (IRE) as powering force for the PDH. Its introduction is logical in the context of the 40-years renovation cycle of the PDH and the new problems arising for its applications discussed by the authors. Implementation of the schemes for realization of the IRE-powered PDH will enable to create new possibilities and to solve important production problems such as:

- Pile driving at any angle in the space;
- Pile driving at higher speeds;
- Reduction of ram masses;
- Pile driving at lowest earth temperatures;
- Pile driving at any depths under water;
- Pile driving with combined ("controllable") impact.

Introducing the new ways of powering with unique qualities will lead to optimization and enhancement of the thousand-year technology for pile driving. With its help, we can better cope with the rapid increase of climate-related disasters worldwide, reclamation of the ocean floor and unique building projects on land.

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Industrial Forecasting Support Systems and Technologies in Practice: A Review

By Rakesh Kumar & Dalgobind Mahto
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Abstract - With the present changing and uncertain economic and marketing scenario the available resources must be utilised by the most optimum way, so that the predetermined goal is achieved. There are number of tools and techniques that are used directly and as support system in the business for success. Forecasting is also a powerful tool and technique which is used as support system to the industrial environment so that future of the business can be predicted accurately. It provides the basis to plan the future requirements for men, machine and materials, time, money etc. so that the wastage will be least.This paper presents the reviews of different works in the area of industrial forecasting support systems and tries to find out latest developments and technologies available in industries and show how they are beneficial to achieve an accurate forecasting.

Keywords : *forecasting, support systems, techniques*

GJRE-G Classification : *FOR Code: 290502*

Strictly as per the compliance and regulations of :

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Rakesh Kumar [α] & Dalgobind Mahto[σ]

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Keywords : forecasting, support systems, techniques.

I. Introduction

With the changing of the structure of business, reliable prediction of sales is of immense benefit to a business because it can improve the quality of the business strategy and decrease costs due to waste, thereby increasing profit. To improve an enterprise's competitiveness, we must make correct decisions using the available information. This "Forecasting" is viewed as an important part of decision making. It is defined as the estimation of future activities like the estimation of type, quantity and quality of future work. These estimates provide the basis to plan the future requirements for men, machine and materials, time, money etc. Forecasts are predictions or estimation of change, if any in characteristic economic phenomena which may affect one's business plans. Prediction is an estimate of future event through subjective considerations other than just the past data. For prediction good subjective estimation is based on managers' skill, experience and judgement. There is an influence of one's own perception and bias in prediction. So it is less accurate and has low reliability. Forecasts have great importance now days because:

- The forecasts are very important for organizations to help to meet the upcoming needs of their customers.
- Majority of the activities of the industries depends upon the future sales.
- Projected demand for the future assists in decision making with respect to investment in plant and machinery, market planning and programmes.
- To schedule the production department activity for effective utilisation of the plant capacity.
- To prepare material, tool and spare part planning so that it will be available at right place, at right quantity and at right place when desired.
- It provides information about the demand of the different products in order to obtain a balanced production in terms of quantity required of different product as a function of time.
- To provide a future trend,this is very much essential for product design and development.

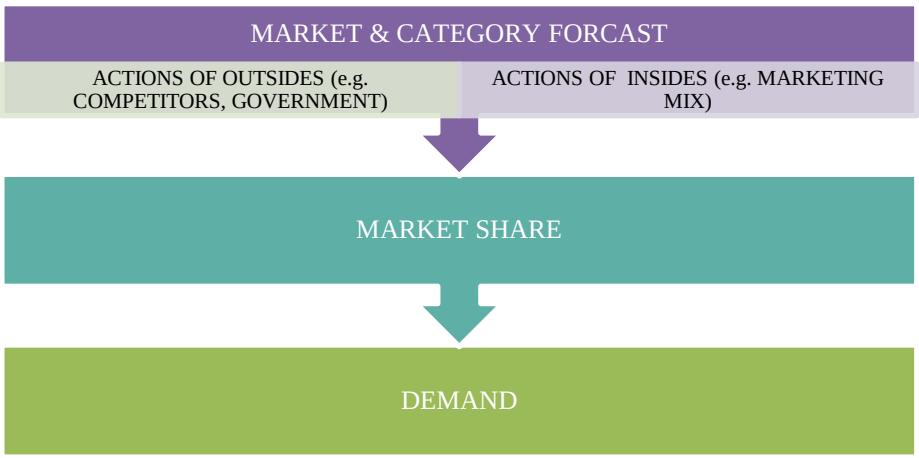

Figure 1 : Forecasting need and their relationships

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Thus, in this changing and uncertain economic and marketing scenario forecasting helps to predict the future with accuracy. Sometimes it is appropriate to forecast demand directly. When direct prediction is not feasible, or where uncertainty and changes are expected to be substantial, marketing managers may need to forecast the size of a market or product category. Also, they would need to forecast the actions and reactions of key decision makers such as competitors, suppliers, distributors, collaborators, governments, and themselves, especially when strategic issues are involved. These actions can help to forecast market share.

There are numerous ways to forecast, ranging from the simple, unsophisticated methods of intuition to complex approaches such as econometric models. However, the forecasting techniques can be divided into two types, namely:

a) Qualitative Forecasting Techniques

Qualitative forecasting techniques are subjective, based on the opinion and judgment of consumers, experts; appropriate when past data is not available. Qualitative forecasting analyses can be used to formulate forecasts for new products for which there are no historical data; to devise or adjust mid- or long-range forecasts for corporate planning. There are three situations in which qualitative methods are preferable to quantitative ones. These are when: 1) Data are insufficient or are known to be unreliable. 2) It is not possible to construct a suitable numerical model. 3). Time is insufficient to initiate and operate a quantitative analysis.

Table 1 : Different Qualitative Forecasting Techniques

S.No.	Techniques	Description
1.	Jury / Expert Evaluation Techniques	This method is based on judgment of the executives about the future. Expert evaluations use the experience of people, such as executives, sales people, marketing people, distributors, or outside experts, who are familiar with a product line or a group of products and estimates for future. The executives exercise their judgment and give their opinions. By rough averaging of these opinions, the final forecast is made.
2.	Survey of Experts Opinion	In the jury method opinions of executives gives rise to forecast. In survey of Experts Opinion method, experts in the concerned field inside or outside the organization are approached for making estimates. The opinions of outside expertise may include opinions given in newspapers, trade journals, Opinions of wholesalers and distributors, agencies etc.
3.	Sales Force Composite Method	In this method the sales forecasting is done by the sales force. Each salesman develops the forecast for his respective territory, the territory-wise forecasts are consolidated at each branch area level and the aggregate of all these forecast is taken as the corporate forecast. It is a grass root method.
4.	Consumers Opinion Method	In this method, actual users of the product are directly contacted by the investigators and their preferences and attitude towards the product as well as future requirements are ascertained.
5.	Market Share Method	The market share of the firm may also serve as a guide to sales forecasting. The firms first work out the industry forecast, apply the market share factor to estimate the company's sales forecast. The market share factor is developed based on past trend, company's present competitive position, brand preference etc.
6.	Delphi Method	Each member of the panel of experts who is chosen to participate writes an answer to the question being investigated and all the reasoning behind this forecast. The answers of the panel are summarized and returned to the members of the panel, but without the identification of which expert came up with each forecast

b) Quantitative Forecasting Techniques

Quantitative forecasting models are used to estimate future demands as a function of past data; appropriate when past data are available. The method is usually applied to short-intermediate range decisions. When a forecaster uses an endogenous quantitative forecasting technique, there is an implicit assumption that there will be no systematic changes or departures from previously occurring patterns. If there is reason to believe this assumption is no longer valid, qualitative techniques provide the means to adjust the

forecasts by tapping the experience and judgment of people knowledgeable about the product being forecast and the environment affecting the forecast. In other words, one could say that qualitative forecasting emphasizes predicting the future, rather than explaining the past.

Table 2 : Different Quantitative Forecasting Techniques

S.NO.	TECHNIQUES	DESCRIPTION
1.	Sales Trend Analysis	In this method the firm uses its own record of past several years' sales to estimate the future sales. It involves the plotting of the sales figures for the past several years and stretching of the line or the curve as the case may be. The extrapolation will give the figures for the coming years.
2.	Casual Method	This method tries to identify the factors which cause variation in the demand. There analyst tries to find out the method that best explain the level of sales of the product. This process called econometric forecasting.
3.	Time series	The variable to be forecast has behaved according to a specific pattern in the past and that this pattern will continue in the future. D = F(t)Where, D is the variable to be forecast and f(t) is a function whose exact form can be estimated from the past data available on the variable. The value of the variable for the future as a function of its values in the past $D_{t+1} = f(D_t, D_{t-1}, D_{t-2} ...)$
4.	Moving Average Method	A moving average may be defined as an average of some fixed or predetermined number of observations in a time series which moves through the series by dropping the top item of the previous averaged group and adding the next item below in each successive average. The calculation depends upon the period to be odd or even.
5.	Exponential Method	It is similar to moving average method and used fairly extensively. In fact it is an improvement over moving average method. It tries to overcome the limitations of moving average method and eliminates the necessity of keeping extensive records of past data. The fundamental concept of Exponential method is that new estimate=odd estimate of latest actual demand $+\alpha$ (latest demand-odd estimate of latest actual demand)
6.	Least Square Method	Under this method a mathematical relationship is established between the time factor x and the variable y. Let y denote demand and x the period of a certain product. Then relationship is given by $y = a + bx$.Where, a and b are constants.

II. Aims and Objectives

Organizations use forecasting methods of production and operations management to implement production strategies. Forecasting involves using several different methods of estimating to determine possible future outcomes for the business. Planning for these possible outcomes is the job of operations management. Additionally, operations management involves the managing of the processes required to manufacture and distribute products. Important aspects of operations management include creating, developing, producing and distributing products for the organization. The aims and objectives of the present study are as follows:

- To provide the business with valuable information that the business can use to make decisions about the future of the organization.
- To improve the accuracy and quality of the production forecast.
- To encourage and achieve a greater level of engagement in the production forecast process, by using data, where available and appropriate, as input to the forecast system.
- To plan production to meet customer requirements.
- To effectively correlate deliveries of materials and supplies with production schedules.
- To plan about the potential demands with the level of investment in plant, equipment and inventory to be created to manage the business.

III. Literature Review

The literature surveys have been done considering support systems and techniques prevalent in industries. The works of various authors from diverse fields have been referred from 1992 onwards. Some of the most important and relevant findings have been presented.

Mahmoud et al. (1992) [1] argue about the gap between forecasting theorists and practitioners and suggested the answers for the question for the successful implementation of forecasting in the organizations, which is hampered by gaps in communication and understanding between forecast preparers and forecast users. Two approaches of Rogers's and Bass models were compared by Wright and Charlett (1995) [2] and found that bass model is more successful forecasting tool than Rogers's approach. Similarly, Winklhoferet al. (1996) [3] worked on Forecasting practice and studiedvarious forecasting

application in industrial area and identified their major methodological characteristics.

Korpcla and Tuominen (1996) [4] worked onanalytic hierarchy process-based approach to demand forecasting and proposed decision support system which offers many improvements compared to traditional methods. Fleischmann et al. (1997) [5] surveyed the recently emerged field of reverse logistics. The management of return flows induced by the various forms of reuse of products and materials in industrial production processes has received growing attention throughout this decade. They subdivided the field into three main areas: distribution planning, inventory control, and production planning, and discussed the implications of the emerging reuse efforts, review the mathematical models proposed in the literature, and point out the areas in need of further research.

A work was presented by Diebold (1998)[6] on the macroeconomic forecasting, the Non-structural forecasting based largely on reduced-form correlations and Structural forecasting spects, which aligns itself with economic theory, and theirimpact on the product forecasting. Focussing on the inter department co–ordination of an organisation Celikbaset al. (1999)[7] considered two possible organizational structures centralized and decentralized. In the decentralized system, the marketing department provides a forecast to manufacturing. Whereas in the centralized system, marketing and manufacturing jointly decide on the production quantity. They showed that it is possible to set penalties so that a coordinated decentralized system outperforms a centralized system when there are no tangible costs to the firm for the efforts expended by the marketing department.

The various characteristics and effectiveness of the Delphi technique reviewed by Rowe and Wright (1999) [8]. They concluded that Delphi technique sometimes performs better than statistical groups and standard interacting groups. But, the technique has shown no clear advantages over other structured procedures. Sutanto (2000) [9] studied the role of Human resource management in supporting the production plan to achieve the target. The main task of human resource management is to support other departments to have the best people. Therefore, Forecasting helps to have the best people in the right place at the right time so that production does not suffer at any time.

By using winter's decomposition and Auto-Regressive Integrated Moving Average (ARIMA) forecasting models, Yenradeea et al. (2001)[10] discussed the demand forecasting and production planning for Highly Seasonal Demand Situations. It was found that the decomposition and ARIMA models provide lower forecast errors. The forecasted demand and safety stock were subsequently used as input to determine the production plan that minimize the total overtime and inventory holding costs based on a fixed workforce level and an available overtime and the total costs could be reduced by 13.2%.

A new systematic approach was presented by Svetinovic and Godfrey (2001)[11] based on the use of functional and quality attributes to recover, document, and apply knowledge about how and why software systems evolve. In this discussion was done on how the study of software evolution in terms of attributes makes it possible to draw parallels between software evolution and other types of evolution This help us to analyze their similarities and to map their results and methodologies from these other fields to software evolution and how the use of attributes can make knowledge about how a system has evolved more easily applicable to other attribute-based techniques of software engineering.

A comparison of the focus forecasting and exponential smoothing was done by Gardner et al. (2001) [12] and found that Exponential smoothing is substantially more accurate than Demand Solutions. Forecasting rules are arbitrary, with no statistical rationale therefore, users of Focus Forecasting have much to gain by adopting statistical forecasting methods. A work was presented by Smaros (2001)[13] on the support for Collaborative Planning, Forecasting and Replenishment offered by electronic marketplaces as well as distributed, peer-to-peer, information systems. When comparing the centralized market place model to the decentralized peer-to-peer model, it becomes clear that the market places are not the solution to CPFR. If the standardization considered, it appears that companies would be better off choosing a peer-to-peer solution for CPFR rather than relying on electronic marketplaces to provide the necessary support for their collaboration efforts.

A work was presented by Charles N. Smart(2002) [14] highlighting the importance of accurate demand forecasting for inventory planning to optimize stocking levels to ensure that the right service part or product is available at the right place at the right time, in the right quantity. Accurate demand forecasting results in the improved customer service and satisfaction. Out of stock and not having the right part in stock at the right time, can be costly, especially when the customers are an infrequent purchaser and thus accurate forecasting needed to control business. Smaros (2002) [15] focussed on the Collaborative Planning Forecasting and Replenishment (CPFR) process. In their study, more emphasis is given to exchange ideas among the different people to get a good forecast and finally the product life-cycle model can be used to select and combine the most suitable approach to collaboration in different market situations.

Choudhury et al.(2002)[16] worked on Forecasting of engineering manpower through fuzzy associative memory neural network with ARIMA: a comparative study, focussed on the requirement of

technical man power for the plant in next five years by using ARIMA and FAM Method. Karel van Donselaar (2002)[17] studied the Winters' method for forecasting of seasonal demand and found that the quality of the forecasts deteriorates, if the relative demand uncertainty increases or if the amount of historical demand data decreases. Mathematical modelling as well as simulation was used to assess the added value of product-aggregation. It turns out that impressive improvements can be achieved, especially in case demand uncertainty is high.

A work was presented by Winklhofer and Diamantopoulos (2002)[18] on A Multiple Indicators and Multiple Causes (MIMIC) model in which managerial evaluations of forecasting effectiveness are modelled as a function of different forecast performance criteria, namely, accuracy, bias, timeliness and cost. The data from a survey of export sales forecasting practices and several hypotheses linking the aforementioned criteria on effectiveness are tested and indicate that evaluations of forecasting effectiveness are equally influenced by short-term accuracy and absence of overestimating bias, while timely delivery of the forecast to management is somewhat less important, while in Long-term accuracy, underestimation and timing of production of the forecast are not found to impact on effectiveness.

The performance of a vendor managed inventory (VMI) supply chain with a traditional ''serially linked'' supply chain was compared by Disney and Towill (2003) [19]. They found that vendor managed inventory responds significantly better at responding to volatile changes in demand caused due to discounted ordering or price variations. A work was presented by Hsu et al. (2003) [20] on Litterman Bayesian vector auto regression (LBVAR) model for production prediction based on the interaction of industrial clusters. The LBVAR model possesses the superiority of Bayesian statistics in small sample forecasting and holds the dynamic property of the vector auto regression (VAR) model. Result showed, the LBVAR model was found to be capable of providing outstanding predictions for these two technology industries in comparison to the auto regression (AR) model and VAR model.

Siliverstovs and Dijk (2003)[21] compared the forecasting performance of linear autoregressive models, autoregressive models with structural breaks, self-exciting threshold autoregressive models and Markov switching autoregressive models in terms of point, interval and density. The results of point forecast evaluation tests support the established notion in the forecasting literature on the favourable performance of the linear AR model. The Markov switching models give more accurate interval and density forecasts than the other models, including the linear AR model. Thus the non-linear models may outperform linear competitors in terms of describing the uncertainty around future realizations of a time series.

A work was presented by G. Peter Zhang (2003) [22] on Time series forecasting using a hybrid ARIMA and neural network model, focussed on combined effect of ARIMA and ANN model and a model proposed to take advantage of the unique strength of ARIMA and ANN models in linear and nonlinear modelling. Timmermann and Granger (2004) [23] worked on Efficient market hypothesis and forecasting concluded that Forecasters constantly search for predictable patterns and affect prices when they attempt to exploit trading opportunities therefore stable forecasting patterns unlikely to persist for long periods of time and will self-destruct when discovered by a large number of investors this gives rise to non stationarities in the time series of financial returns and complicates both formal tests of market efficiency and the search for successful forecasting approaches.

A new approach presented by Smaros and Hellstrom (2004) [24]to reduce significantly time spent on forecasting by working with an entire assortment at a time instead of producing a forecast for each product individually. The implementation of a less time-consuming forecasting method has enabled the company to involve its salespeople in forecasting and in this way gain access to their product and market knowledge. Its forecasting accuracy and time spent on forecasting before and after the implementation are measured. The results demonstrate a remarkable increase in forecasting efficiency as well as improved communication. HuiZou, Yuhong Yang (2004) [25] worked on combining time series models for forecasting used an algorithm with ARIMA Model to improve prediction accuracy when there is much uncertainty in finding.

The performance of Artificial Neural Networks (ANN) and ARIMA models in forecasting of seasonal Time series compared by Kihoro et al.(2004)[26].The results showed that the ANN is relatively better than ARIMA models in forecasting ability but the nature of the data may influence the results. The main problem with ANN is the lack of explanation capabilities and of a proper building methodology to define the network architecture. Most of the ANN modelling process is basically empirical and proposed an easier ARD rule, which seems to be working well empirically. This rule may be investigated further and perhaps a theory developed to be included in Time Series modelling methodology for Artificial Neural Networks.

Onkal and Bolger (2004) [27] examined the potential differences in perceived usefulness of various forecasting formats from the perspectives of providers and users of predictions. Experimental procedure consists of asking participants to assume the role of forecast providers and to construct forecasts using different formats, followed by requesting usefulness ratings for these formats. 95% prediction intervals were considered to be the most useful format, followed by

directional predictions, 50% interval forecasts, and lastly, point forecasts.

A work on the effects of judges' forecasting on their later combination of forecasts for the same outcomes was published by Harvey and Harries (2004) [28]. The judges' ability to combine forecasts that they receive from more knowledgeable advisors is impaired when they have previously made their own forecasts for the same outcomes. Also, People responsible for integrating forecasts from more knowledgeable advisors should not explicitly include their own forecasts among those that they combine and should consider avoiding making their own forecasts altogether, the cognitive mechanisms responsible for these effects.

A work was presented by Marcellinoet al.(2005)[29] on the "Iterated" multi period-ahead time series forecast and compared the empirical iterated and direct forecasts from linear uni-variate and bi-variate models by applying simulated out-of-sample methods. Iterated forecasts was more efficient if the one-period ahead model is correctly specified, but direct forecasts are more robust to model misspecification. Wilson and Gilbert (2005) [30] in their paper great emphasis were given to the emotional, psychological effect on the future events. One cause of the impact bias was focalism, the tendency to underestimate the extent to which other events will influence our thoughts and feelings. Another was people's failure to anticipate how quickly they will make sense of things that happen to them in a way that speeds emotional recovery. Affective forecasts were important because people use many decisions on them. It may be overestimating the impact of negative events creates unnecessary dread and anxiety about the future and results in costs to affective forecasting errors.

Chandra and Grabis (2005) [31] focussed on the bullwhip effect. The results obtained do not provide evidence that magnitude of the bullwhip effect is larger for higher order autoregressive processes, but the magnitude of the bullwhip effect is similar for the first order and the seasonal autoregressive demand processes. A new methodology was presented by Horet al. (2006)[32] using Auto Regressive Integrated Moving Average (ARIMA) model to predict daily load pattern. The work served as an initial step to investigate the impacts of climate change and weather extremes on electricity demand patterns and the electricity network. The forecasted load will be used as input to transmission network model to study security and grid reinforcement of the power network as the result of climate change. The model has fitted to an in sample training data and the results were then verified with actual electricity data. The mean absolute percentage error (MAPE) for each month generally lies within 1-3%.

Robert Fildes(2006) [33] analysed the different journals and showed that the comparative approach to establishing improved forecasting methods through examining multiple hypotheses has been successfully adopted and was unusual when compared to other journals. There were little cross-fertilisation between journals. Organisational issues and the effects of forecast error have been ignored. These two issues directly impact the gap between theoretical contributions and forecasting practice, a gap that remains unbridged. Michael Lawrence et al. (2006) [34] reviewed the past 25 years has seen phenomenal growth of interest in judgemental approaches to forecasting and a significant change of attitude on the part of researchers to the role of judgement. Judgement is recognised as an indispensable component of forecasting and much research attention has been directed at understanding and improving its use. Human judgement can be demonstrated to provide a significant benefit to forecasting accuracy but it can also be subject to many biases. Syntetosa and Boylan (2006) [35] presented work on the stock control performance of intermittent demand estimators. The nature of the empirical demand data set evaluated and the stock control model specified for experimentation purposes. The performance of the new intermittent demand forecasting method was found better than the other forecasting methods.

A work on the long term forecasting was presented by Granger and Jeon (2007) [36]. Long-term forecasting is likely to be dominated by trend curves, particularly the simple linear and exponential trends. However, the forecasts will be unsatisfactory with breaks in their parameter values at some unknown points. They investigate whether or not simple methods of long-run forecasting can ever be successful, after one takes into account the uncertainty level associated with the forecasts.

A comparison of support vector regression (SVR) with the existing neural-network approaches and the autoregressive integrated moving average (ARIMA) model were done by Kuan-Yu Chen (2007) [37]to find out the feasibility of SVR and find out that SVR performs better than the ARIMA models. Similarly, A work was presented by Nikolopoulos et al.(2007) [38] on Forecasting with cue information: A comparison of multiple regression with alternative forecasting approaches done on Multiple linear regression (MLR) method and which was less accurate than a other methods when deals with the complex non-linearity's data.

Bianco et al. (2007) [39] used Ensemble Kalman Filter to calibrate porosity fields used in a model for oil reservoir production. The dependence of Ensemble Kalman Filter effectiveness on the number of fields included in the statistical ensembles was performed by using three ensembles of 50, 100 and 135 members and investigated the connection between Ensemble Kalman Filter effectiveness and the size of the ensemble for a real problem. The limited number of ensembles considered did not give the chance to lead

to some ultimate conclusion on key points like the number of fields required from a practical viewpoint.

Two time series forecasting techniques neural-network & fuzzy compared by Pandey et al. (2008) [40] for wheat production forecastingand proposed a model. By comparing the results it was found that proposed model yields better results than the other method. Guoet al. (2008) [41] studied the characteristic of the pre-processing of sample data using wavelet transformation for forecast. The experimental results suggested that the proposed hybrid method is typically a reliable forecasting tool for time series technique superior to standard SVM model. Two automatic forecasting algorithms were described by Hyndman and Khandakar (2008) [42].The first was based on innovations state space models that underly exponential smoothing methods and second is a step-wise algorithm for forecasting with ARIMA models. These algorithms are applicable to both seasonal and non-seasonal data, and compared using four real time series.

Datta et al. (2008)[43] focussed on the forecasting and risk analysis in supply chain. Advanced forecasting tools were applied for decision support in supply chain management and results suggest that advanced methods may be useful to predict oscillated demand but their performance may be constrained by current structural and operating policies as well as limited availability of data. Improvements to reduce demand amplification may decrease the risk of out of stock but increase operating cost or risk of excess inventory. A work was presented by Jushan and Serena (2008) [44] on forecasting economic time series using targeted predictors studied two refinements to the method of factor forecasting by applying the method of principal components to `targeted predictors' selected using hard and soft thresh holding rules. They considered the methodof quadratic principal components that allow the link function between the predictors and the factors to be non-linear. Second, the factors used in the forecasting equation were estimated.

A work on the long-term forecasting and trend forecasting was published by Dong and Pedrycz (2008) [45]. Technique based on the fuzzy clustering was used to construct information granules on a basis of available numeric data present in the original time series. A forecasting model developed which captures the essential relationships between such information granules and in this manner constructs a fundamental forecasting mechanism and yield better results when processing a large number of data. Eric Sucky (2009) [46] presented a work on the bullwhip effect in supply chains. The variability of orders increases as they move up the supply chain from retailers to wholesalers to manufacturers to suppliers. They showed that while analyzing the bullwhip effect in supply chains, the influence of risk pooling has to be considered, Otherwise bullwhip effect will overestimated.

Hamzacebi et.al (2009) [47] focussed on the two methods, first was iterative method, in which subsequent period information was predicted through past observations and then the estimated value was used as an input for the prediction of the next period. The process was carried out until the end of the forecast horizon in multi-periodic time series forecasting. In the second, direct forecast method, successive periods predicted all at once and yield better results as only observed data was utilized in order to predict future periods.

A work was presented by Goldstein and Gigerenzer (2009)[48] on forecasting rules and shown that simple statistical forecasting rules make better predictions than more complex rules, especially when the future values of a criterion is highly uncertain. They provide evidence that some of the fast and frugal heuristics that people use intuitively are able to make forecasts that are better than those of knowledge-intensive procedures. Petervon Stackelberg (2009)[49] studied Timelines when used to lay out historical data and cycles, and found that waves pattern along a common temporal scaleprovide a far deeper, more nuanced understanding of the dynamics of change. Timelines patterns can be used in a "hypothesis-to-forecast" process to identify potential long-term patterns of change and make long-range forecasts whereas, Traditional forecasts are well suited for relatively short-term futures but, exploratory forecasts are better suited to forecasting longer-term futures.

A work on forecasting aggregate demand was published by Widiarta et al. (2009) [50]. The aggregate demand series composed of several correlated sub aggregate components, each of which was assumed to follow a stationary time series process, which was correlated over time. They analytically showed that there is no difference in the relative performance of TD and BU forecasting strategies when the time series for all of the sub aggregate components follow a first-order univariate moving average process with identical coefficients of the serial correlation term.

Sanders et al. (2009) [51] investigate forecast smoothing in the USDA's cotton production forecasts and demonstrated how forecasting practitioners and farm managers should correct the forecasts. Forecasts provide an important and cost effective source of public forecast information, a graphical technique used for identifying and analyzing smoothing in forecast revisions. Simple scatter plots in Excel provide a test for the existence of smoothing, and the corresponding regression line provides the corrective adjustments needed to remove the impact of smoothing so that producers frequently can use agency forecasts to aid in planning and decision making.

A work was presented by Borade and Bansod (2009)[52] on the supply chain management practices for improving business or supply chain performance.

They discussed vendor managed forecasting with the help of case study. They showed how a small enterprise improves supply chain performance by using demand related information obtained from retailer. The results obtained in the study shows that vendor managed forecasting in supply chain reduces the demand variation and improves inventory management significantly.

Concentrated on the forecasting approach of foreign trade unit value indices Lutero and Marini (2010) [53] presented their work.In their work the automatic selection strategy of TRAMO evaluated in comparison with a standard ARIMA model and then, a direct forecasting approach experimented. They show that the automatic selection process of the ARIMA model carried out by TRAMO provides acceptable forecasts, on average better than those from the classical Airline model. .

Berlec(2010) [54] presented a procedure for forecasting the lead times of production orders on the basis of past actual lead time data. The proposed procedure for forecasting lead times was an empirical distribution of possible lead times for a production order. On the basis of this distribution, the probable lead time of a production order was forecast, taking into account a confidence interval. Subsornet al. (2010) [55] investigated the best-fitting forecasting model for national rubber production forecasting.The methods used in their study was based on non-neural network training and neural network training techniques and compared with the actual rubber production data for the best-fitting forecasting model.

A new version of support vector machine (SVM) was presented by Qi Wu(2010) [56] named v –SVM. The new proposed model construct the nonlinear system of product demand series by combining the chaos theory, evaluated and the simulation results demonstrated that Cv-SVM is effective in dealing with multi-dimension data and finite samples. Also, Cv-SVM has better MAE, MAPE and MSE than ARMA, GA v-SVM and ECGA v-SVM. Syntetos et al. (2010) [57] studied that the efficiency of inventory systems does not relate directly to demand forecasting performance, as measured by standard forecasting accuracy measures. It should always be evaluated with respect to its consequences for stock control through accuracy implications metrics, in addition to its performance on the standard accuracy measures. They addressed the issue of judgementally adjusting statistical forecasts for 'fast' demand items, and the implications of such interventions in terms of both forecast accuracy and stock control.

A work was presented by Smith and Mentzer (2010) [58] on the relationship between forecasting support system, the procedures that guide forecast creation, and their fit with the capabilities of the forecasting support system user. The results showed a positive relationship between the user's assessment of system quality and access and a dependent variable measuring forecast performance. Forecasting practitioners confirms a positive relationship between specific forecasting support system characteristics and the system user's perceptions of system quality and access.

A new approach named cycle forecasting EWMA (CF-EWMA) was published by Bing Ai et al. (2010) [59]. The new approach deal with the problem of large deviations in the first few runs of each cycle. In case of mixed-product drifted process, they concentrated on the time lost on irregular break down during the production time, these uneven breakdowns deviate the results from the target value which will lead to a possible high rework rate and lots of waste wafers.

A work on the trend and seasonality patterns of a selected product in a retail trading chain was presented by Hasinet al. (2011) [60]using traditional Holt-Winter's model, artificial neural network (ANN) with fuzzy uncertainty and then the errors, measured in terms of MAPE. The error level in Holt-Winter's approach was higher than those obtained through fuzzy ANN approach because of influence of several factors on demand function in retail trading system. It was also observed that as forecasting period becomes smaller, the ANN approach provides more accuracy in forecast.

A work was presented by Theodosiou (2011) [61] on hybrid forecasting method based on the disaggregation of time series components. The prediction of each component were done individually and the reassembling of the extrapolations to obtain estimation for the data. Generalized Regression Neural Networks (GRNN) used to perform out-of sample extrapolations of the seasonal and residual components and shown good results. Leitner and Leopold (2011) [62] reviewed several literatures and found that in most experiments the forecasting abilities of individuals were compared to rational forecasts or forecasts of statistical models. In such a way results were very poor and the inability to incorporate supportive information was the main cause of forecasting inefficiency.

Similarly, Polerand Mula(2011) [63] presented a new automatic selection procedure of time series forecasting model proposed and the selection criterion has been tested using the set of monthly time series of the M3 Competition and two basic forecasting models. Cardin and Castagna (2011) [64] presented a new application of discrete-event simulation as a forecasting tool for the decision support of the production activity control of a complex manufacturing system. The specificity of such an application of simulation is the short term of the forecast. This specificity implies that the initial state of the simulation takes into account the actual state of the system. The development on a real-size flexible manufacturing system shows the technical feasibility of the developed concepts and the potential benefits on the productivity of a single example.

A work was presented by Miranda and Lima (2011) [65] on the forecasting of the challenging world future scenarios discussed the behaviour of the supply and consumption of energy and food, two of the main commodities that drive the world system. They suggest that unless the currently prevailing focus on economic growth is changed into that of sustainable prosperity, human society may run into a period of serious economic and social struggles with unpredictable political consequences.

A new methodology was presented by Rossi and Sekhposyan (2011) [66] to identify the sources of models' forecasting performance. The methodology decomposed the models' forecasting performance into asymptotically uncorrelated components that measure instabilities in the forecasting performance, predictive content, and over-fitting. The results showed the new methodology is useful for understanding the causes of the poor forecasting ability of economic models for exchange rate determination.

A new hybrid SARIMA wavelet transform method for sales forecasting was presented by Choi et al. (2011) [67] combined the classic SARIMA method and wavelet transform (SW). Experiments were conducted by using real sales data, hypothetical data, and publicly available data sets and the time series features which influence the forecasting accuracy and new method shown good results. Petrie and Bannister (2011) [68] presented a method for merging flow-dependentfore cast error statistics from an ensemble with static statistics for use in high resolution variational data assimilation. In their study EnRRKF the forecast error statistics in a subspace defined by an ensemble of states forecast by the dynamic model and then merged in a formal way with the static statistics and then used in a variational data assimilation setting.

Mukhopadhyay et al. (2011) [69] presented aStackelberg model of pricing of complementary goods under information asymmetry. They show that information sharing benefit the leader firm but hurt the follower firm as well as the total system if the follower firm shares information unconditionally. They then devise a simple scheme which was beneficial for both the system. Babai et al. (2011) [70] analysed a single echelon single item inventory system. Where Demand was modelled as a compound Poisson process and the stock was controlled according to a continuous time order-up-to (OUT) level policy. They proposed a method for determining the optimal OUT level for cost oriented inventory systems and results showed that there was a significant difference in accuracy for slow moving items. Hsiao and Wan (2011) [71] suggested two modified simple averaging forecast combination methods—a mean corrected and a mean and scale corrected method. They concluded that due to the fact that real data was usually subjected to structural breaks, rolling forecasting scheme has a better performance than fixed window and continuously updating scheme and methods that use less information appear to perform better than methods using all the sample information about the covariance structure of the available forecasts.

Lee and Tong (2011) [72] worked on Forecasting time series using a methodology based on autoregressive integrated moving average and genetic programming. They proposed a hybrid forecasting model for nonlinear time series by combining ARIMA with genetic programming (GP) to improve upon both the ANN and the ARIMA forecasting models. Finally, some real data sets are adopted to demonstrate the effectiveness of the proposed forecasting model.

Xiang et al. (2011) [73] presented work on Multiagent Bayesian forecasting of structural time-invariant dynamic systems with graphical models. They proposed a model called dynamic multiply sectioned Bayesian network and showed that as long as the DMSBN is structural time-invariant (possibly parametric time-variant), the forecast is exact and its time complexity is exponentially more efficient than using dynamic Bayesian networks (DBNs). Cheikhrouhou et al. (2011) [74] presented a judgemental collaborative approach for demand forecasting in which the mathematical forecasts, considered as the basis, were adjusted by the structured and combined knowledge from different forecasters. Factors corresponding to these events were evaluated through a fuzzy inference system to ensure the coherence of the results. They show that by structuring and combining the judgements of different forecasters to identify and assess future events, companies can experience a high improvement in demand forecast accuracy.

A methodology was proposed by Chang et al. (2012) [75] to evaluate individual and alternative mean forecasts using efficient estimation methods, and compared individual replicable forecasts with alternative mean forecasts. The empirical analysis showed that replicable and non-replicable forecasts could be distinctly different from each other, that efficient and inefficient estimation methods, as well as consistent and inconsistent covariance matrix estimates, could lead to significantly different outcomes, alternative mean forecasts could yield different forecasts from their individual components, and the relative importance of econometric model versus intuition could be evaluated in terms of forecasting performance.

A work was presented by Xu Yaboaet al. (2012) [76] on the safety in combination with production. Combination forecasting model can be used to the actual forecast, in order to achieve the prior risk forecasting of production safety trends and has shown the good results. Obahet al.(2012)[77] working on Simplified Models for Forecasting Oil Production: Niger Delta Oil Rim Reservoirs Case, studied Many factors affect both the reliability and accuracy of production forecasts; the static or geological uncertainties, the

dynamic uncertainties and operational uncertainties. In their study a generic dynamic simulation study was carried out to generate oil production profiles from oil rim reservoirs in the Niger Delta.

Donate et al. (2012) [78] in this paper an novel Evolutionary Artificial Neural Networks (EANNs) approach used to build an ensemble of neural networks, under four different combination methods: mean, median, softmax and rank-based. Based on the experimental results they suggested that the fitness weighted n-fold ensemble improves the accuracy of the forecasts, outperforming both then no weight n-fold ensemble and the simpler hold out validation(0-fold) EANN. Also, advised the use of a 4-fold ANN ensemble that evolved using weighted cross- validation and that uses a rank-based combination method to build the final forecasts.

Lehneret al. (2012) [79] presented a method, the inferred probability method, for quantitatively measuring the accuracy of forecasts in documents that use imprecise language to describe both forecast events and forecast certainties. They applied the inferred probability method to 14 documents that examine significant and complex political events which were considered the premier analysis product. Test focused on three things: first, whether the inferred probability method yielded accuracy results that are in the same range as more traditional forecasting studies in the same general topic area. Second, whether the accuracy results were biased by a readers' knowledge of the topic area, and third whether the accuracy results were sensitive to errors in assigning ground truth.

Subramanian and Ramanathan (2012) [80] reviewed the applications of Analytic Hierarchy Process in operations management. AHP has been largely applied to macro and people oriented problems, the most addressed decision themes were product and process design and, managing the supply chain. They presented a comprehensive listing of AHP applications in operations management and develop a framework for identifying the decision areas that have better research gaps to be studied by future researchers. A two-step forecasting method separately updates the average number of parts needed per repair and the number of repairs for each type of component was proposed by Romeijnders et al.(2012) [81].The method was tested in an empirical, comparative study for a service provider in the aviation industry. They showed that proposed method performs considerably better than Croston's method and forecasts errors cab be reduced up to 20% by planned maintenance and repair operations.

Chan et al. (2012) [82] studied the factors that influence the diffusion of e-collaboration in SCM among the SMEs. They proposed a research model to examine a stage-based e-collaboration diffusion process in SMEs. An integration technology adoption model based on Technological- Organizational - Environmental framework, Interorganizational Relationships and Unified Theory of Acceptance and Use of Technology was proposed and empirically validated. Matteo Kalchschmidt (2012) [83] compared the different perspectives by designing and testing different sets of propositions that underline the aforementioned perspectives. More than 500 companies collecting data was analyzed via the 4th edition of the Global Manufacturing Research Group (GMRG IV) questionnaire and the results demonstrated that each perspective has some empirical support.Qin and Nembhard (2012) [84] worked on the stochastic diffusion of a product in the market as a geometric Brownian motion (GBM) process that has a time-varying drift rate. The model calibrated so that it was able to feature different product types and diffusion conditions. The model demonstrated robust performance over a wide range of conditions despite model uncertainty and gave both qualitative and quantitative information for manufacturers and service providers to design strategies for stochastic PLC conditions as well as dynamic production planning.

A work on Multi-objective integrated production and distribution planning of perishable products was presented by Amorim et al. (2012) [85]. They integrated production and distribution planning approaches at operational level and formulate a model for the case where perishable goods have a fixed and a loose shelf-life. The results showed that the economic benefits derived from using an integrated approach were much dependent on the freshness level of products delivered.Xu et al.(2012) [86]developed a product modularization model based on real options theory to determine the optimal modular production strategies under market uncertainty. They showed that when the market is more volatile, it is optimal for a firm to postpone modularization, and when a firm's investment efficiency at the preparation stage is higher, the firm can start modular production earlier with relatively low product modularity. An increase in market uncertainty will stimulate the firm to improve its product modularity.

Beutel and Minner (2012) [87] presented two data-driven frameworks to set safety stock levels when demand depends on several exogenous variables. The first approach used regression models to forecast demand and the second approach used Linear Programming. Both the methods exercised to a common problem and results were compared. They showed a considerable improvement of the overly simplifying method of moments is possible and the ordinary least squares approach yields a better performance than the LP-method. But, the LP approach provides more robust inventory levels, if some of the standard assumptions of ordinary least squares regression are violated. Money et al. (2012) [88] developed a baseline probabilistic model FINE (Forecasting the Impacts of Nanomaterials in the

Environment), was developed using expert elicitation techniques.a case of silver nano particles (Ag NPs) in aquatic environments studied. They showed that Bayesian networks provide a robust method for formally incorporating expert judgments into a probabilistic measure of exposure and risk to nanoparticles, particularly when other knowledge bases may be lacking, and Within the bounds of uncertainty as currently quantified, nanosilver may pose the greatest potential risk as these particles accumulate in aquatic sediments.

A work on Demand Forecasting of Supply Chain Based on Support Vector Regression Method was presented by WANG Guanghui (2012) [89]. They introduced the basic theory and computing process of time series forecasting based on Support Vector Regression (SVR), optimizing the parameters of SVR by Genetic Algorithm (GA) and then Applied SVR to forecast the demand and finally, compared to the RBF neural network method.. They showed that SVR is superior to RBF in prediction performance and the suitable and effective method for demand forecasting of supply chain.

Xu and Ouenniche (2012) [90] proposed a Multi-Criteria Decision Analysis (MCDA) based framework to address the problem of relative performance evaluation of competing forecasting models. They show that the multidimensional framework provides a valuable tool to apprehend the true nature of the relative performance of competing forecasting models and the ranking of the best and the worst performing models do not seem to be sensitive to the choice of importance weights or outranking methods. A review of literature on Sustainable business development (SBD) in manufacturing and services was done Gunasekar an and Spalanzani (2012) [91]. The papers on Sustainable business development were critically examined including tools, techniques and strategies that would be helpful for SBD in future.A work on Singular spectrum analysis (SSA) was presented by Claudio (2013) [92] to decompose and forecast failure behaviours, using time series related to time-to-failure data. Results were compared with previous approaches and show that SSA is a promising approach for data analysis and for forecasting failure time series.

Bao et al. (2013) [93] studied the forecasting and optimization decisions in an experimental cobweb economy. They performed experimental study on the basis of: (1) subjects form forecasts only, (2) subjects determine quantity only, (3) they do both and (4) they are paired in teams and one member was assigned the forecasting role while the other was assigned the optimization task. They showed that the performance was the best in treatment 1 and the worst in Treatment 3. Given a price forecast, subjects were less likely to make conditionally optimal production decisions in Treatment 3.

A work was presented by Douglas et al. (2013) [94] on Forecasting Innovation Pathways (FIP) for new and emerging science and technologies, offer a framework to analyze NESTs to help ascertain likely innovation pathways. They devised a 10-step framework based on extensive Future-oriented Technology Analyses ("FTA") experience, and describing the nanobiosensor experience in contrasted with that of deep brain stimulation in relative quantitative and qualitative emphases analytically in two case studies. The paper reflects on the systematic FTA framework for emerging science and technologies, for its intended goal, that is to support decision making.

Ubilavaand Helmers (2013) [95] examined the benefits of nonlinear time series modelling to improve forecast accuracy of the El Nino Southern Oscillation (ENSO) phenomenon. A smooth transition autoregressive (STAR) modelling framework was adoptedto assess the potentially smooth regime-dependent dynamics of the sea surface temperature anomaly. They showedthat the superiority of forecast performance of STAR over the linear autoregressive models, especially apparent in short- and intermediate-term forecasts. Fye et al. (2013) [96] evaluated technological forecasts to determine how forecast methodology and eight other attributes influence accuracy, also evaluated the degree of interpretation required to extract measurable data from forecasts. They found that quantitative forecast methods were more accurate than forecasts using qualitative methods, and forecasts predicting shorter time horizons were more accurate than predicting for longer time horizons. Forecasts about computers and autonomous or robotic technologies were more accurate than those about other technologies, and of the nine attributes, only methodology and time horizon had a statistically significant influence on accuracy. Gorr and Schneider (2013) [97] applied receiver operating characteristic analysis to micro-level, monthly time series from the M3-Competition. Forecasts from competing methods were used in binary decision rules to forecast exceptionally large declines in demand. Using the partial area under the ROC curve (PAUC) criterion, they found that complex univariate methods (including Flores-Pearce 2, Forecast PRO, Automat ANN, Theta, and Smart (FCS) perform best for this purpose. Thedecision-rule combination forecasts using three top methods generally perform better than the component methods. From the evidence M3-Competition suggests that practitioners should use complex univariate forecast methods for operations-level forecasting, for both ordinary and large-change forecasts. A work was presented by Heinecke et al. (2013) [98] on the categorisation of stock keeping units (SKUs) and apply the most appropriate methods in each category. A bias adjusted modification to CRO (Syntetos–Boylan Approximation, SBA) has been shown in a number of

empirical studies to perform very well and be associated with a very 'robust' behaviour. The solutions were compared by means of experimentation on more than 10,000 SKUs from three different industries. The results enable insights to be gained into the comparative benefits of these approaches.

Asimakopoulos and Dix (2013) [99] examined the critical factors for the effective adoption and use of forecasting support systems (FSS) in product forecasting. Using the technologies-in-practice model based on evidence from professional designers, users and organizational documents, found that FSS adoption and use depend on certain situational factors, such as organizational protocols, communication among stakeholders, and product knowledge availability and their outputs can be used as springboard for organizational actions. A work on forecast accuracy was presented by Davyden koand Fildes (2013) [100]. They showed that many existing error measures are generally not suited to the task, due to specific features of the demand data. A metric based on aggregating performance ratios across time series using the weighted geometric mean yield better results and has the advantage of treating over- and under-forecasting even-handedly, has a more symmetric distribution.

IV. Discussion

From the review of literatures it is found that the main purpose of forecasting is to estimate the upcoming demand in order for the organizations to make plan to create the products. The goal is to create as accurate forecasts as possible since accurate forecasts can be very profitable as forecasts help companies to meet the upcoming demand. If forecasts are too low, profits are most likely lower due to lost sales. Forecasts which are too high will create excess inventory which will increase the inventory carrying costs and products might have to be sold at a discount and discarded as obsolescence. From the literature surveys following points are considered:

- Traditional forecasting methods include a few explanatory variables, most of which can easily be expressed in quantitative terms.
- Classical forecasting methods are both deterministic and structurally stable leading to error in forecasting because of constant change which is selectively studied, and interpreted from a special view point.
- Traditional forecasting methods do not take into account the development of new relationships among variables and possible changes in trends.
- Management information system should be engineered to ensure that records of previous forecasts should be kept with outcome data so that people can easily compare the effectiveness of different types of forecast. It is important to keep records of forecasts and to use them appropriately to obtain feedback.
- Forecast can be improved by reducing bias and inconsistency in human judgement. Principles that have been formulated for doing this generally derive from research in cognitive psychology and allied subjects but have been validated within specific forecasting contexts.
- There are several other factors that affect the coordination including manufacturing capacity, information systems capabilities and organizational issues like single period analysis which is suitable for products with a very short life cycle.
- In case of Moving Average forecasting method, the more demandin formation is used to construct the forecast to keep the smaller the increase in variability. Similarly, in case of Exponential forecasting method, negatively correlated demands can lead to a larger increase in variability than positively correlated demands. The more weight the forecast places on a single observation, the larger the increase in variability.
- The ARIMA model provides more reliable demand forecasts but it is more complicated to apply than the decomposition model. Therefore the ARIMA model should be used only when the decomposition model is inadequate.
- The bullwhip effect is due to the retailer's need to forecast. It is clearly seen that the increase in variability will be greater for longer lead times. However, the size of the impact does depend on the forecasting methods. The bullwhip effect is larger in case of Exponential forecasting method than Moving Average with the same average data age and for certain demand processes.
- The experimental results show that the forecasting errors made by various neural-networks models used only data-driven methods without model identity, and that any prior assumptions about the properties of the data would be much smaller than that of traditional ARIMA model.
- The neural network method is objective as compared to subjective fuzzy time series methods, since in case of neural network interpretation is done by only designed artificial neural network model. It can easily handle the inaccuracy and any degree of nonlinearity in the data.
- Hybrid method is typically a reliable forecasting tool for application within the forecasting fields of time series from social system, while the one without wavelet analysis evaluated showed poor ability in forecast.

V. Conclusion

From the study of literature survey it has been observed that in order to reduce equipment costs, cycle

time, the correlation between task times and flexibility ratio needs a great attention on accurate forecasting. Forecast of manufacturing is a very complex problem, which is influenced by many factors. How to identify the factors such as technology, labour and investment, etc., and considers them into the forecast model is the problems which will be researched in the future. Success or failure of the project greatly depends upon the accurate forecasting; therefore method adopted must be perfect and best suited according to the circumstances. Because a wrong forecast may results in the total wastage of money, power and time.The inability to incorporate supportive information is the main cause of forecasting inefficiency and remains a clear challenge for all those engaged in the design of forecast support systems. Quantitative method produce better results than the Qualitative methods when rich historic data is available, simple, and accurate and less time consuming.

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Ergonomic Evaluation of Tasks Performed by Workers in Manual Brick Kilns in Karnataka, India

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Abstract - Brick industry in India is the second largest brick producer in the world after China. The industry is one of the largest employment generating industries employing millions of people. The present study focuses on the brick industries located in North Karnataka, India, where about 1500 brick kilns are operating employing thousands of workers. The main aim of this study is to investigate the self reported Workrelated Musculoskeletal Disorders (WRMSD) experienced by the workers during the raw brick making activities and to analyze the causes of discomfort related to various postures adopted by the workers. Sixty workers from 6 raw brick making units were randomly selected and a detailed work related musculoskeletal pain/discomfort were analyzed in different activities using the revised Nordic Questionnaire. All the selected workers had given their responses, which were analyzed. Majority of the respondents were feeling pain and discomfort in different body parts. It was also observed that the workers worked continuously in awkward postures during certain raw brick making activities. Consequently they may suffer from discomfort in different parts of the body. Postural analysis using RULA and REBA methods indicate that different parts of the body are vulnerable to injury and musculoskeletal disorders and require immediate ergonomics intervention.

Keywords : *ergonomics, musculoskeletal disorders, pain, discomfort, posture, brick making.*

GJRE-G Classification : *FOR Code: 670000*

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Qutubuddin S.M.[α], S. S. Hebbal [σ] & A.C. S. Kumar [ρ]

Abstract - Brick industry in India is the second largest brick producer in the world after China. The industry is one of the largest employment generating industries employing millions of people. The present study focuses on the brick industries located in North Karnataka, India, where about 1500 brick kilns are operating employing thousands of workers. The main aim of this study is to investigate the self reported Work-related Musculoskeletal Disorders (WRMSD) experienced by the workers during the raw brick making activities and to analyze the causes of discomfort related to various postures adopted by the workers. Sixty workers from 6 raw brick making units were randomly selected and a detailed work related musculoskeletal pain/discomfort were analyzed in different activities using the revised Nordic Questionnaire. All the selected workers had given their responses, which were analyzed. Majority of the respondents were feeling pain and discomfort in different body parts. It was also observed that the workers worked continuously in awkward postures during certain raw brick making activities. Consequently they may suffer from discomfort in different parts of the body. Postural analysis using RULA and REBA methods indicate that different parts of the body are vulnerable to injury and musculoskeletal disorders and require immediate ergonomics intervention.

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I. Introduction

Work-related Musculoskeletal Disorders (WMSDs) have become a major problem in many industrialized countries including India. Manual brick manufacturing in India is currently an extremely hazardous occupation. In the developed countries some mechanization was introduced but various studies show that the workers working in the brick manufacturing units suffer from musculoskeletal problems (Cook 1996, Chung and Kee, 2000; Trevelyan and Haslani, 2001).

Notwithstanding the technological advances, a large number of workers perform heavy manual material handling (MMH) jobs in developing countries, especially in the unorganized sectors. Studies from developing countries like India show that these workers suffer from assorted health problems due to awkward postures and carrying heavy loads (Mukhopadhyay, 2008; Sett and Sahu, 2008).

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The ergonomics of brick kiln involves the interaction of personal factors such as fatigue, fitness, age and experience and circumstantial factors such as work organization, work schedule, work load, factory layout, furniture, equipment and psychological support within the work team, which combine to affect the efficiency of work and working life. Analysis of the interaction of these factors influencing physical strain and cognitive strain is essential to improve the working conditions.(Manoharan 2012) The postures adopted by the workers in their working place depends upon the type of work, the design of the work place, personal characteristics, the tools required to perform the particular work and also the duration and frequency of the work cycle (Bridger, 1995). So, various techniques have been reported for postural analyses to identify the stress during different phases of work (Colombini et al., 1985).

a) The brick manufacturing scenario in India

Brick kiln, being a small scale industry has a very important role to play in Indian economy. Brick is one of the most important building material used in construction in India. The Indian brick industry, the second largest producer of brick in the world, is next to that of china. The brick industry in India falls into the small scale and unorganized sector with more than 100,000 brick kilns spread throughout the country, and each unit manufactures between 1 lakh to 1 million bricks every year. (Saidapur, 2012). There are around 1500 brick-kiln units operating in the north Karnataka State. These brick-kilns represent one of the major small-scale industries, which fulfill the ever growing demand of urban expansion.

In unorganized sectors, the workers are recruited temporarily on a seasonal basis for the entire season of brick making. The workers have no experience and they are not provided with any training. Therefore, they do not have any previous knowledge about unsafe acts and hazards related to this work, awkward postures, or they simply ignore the safe working process. Manual material handling (MMH) is the cheapest solution in developing countries (Maiti, 2008), so most of the brick manufacturing units in India perform the task of MMH.

The workers are recruited by employers on a seasonal basis, mainly from November to May. These workers come from nearby villages from the same or

sometimes different states of India. No work occurs during India's monsoon season (June to September). They then go back to their villages and engage themselves in some other work like agriculture or remain unemployed.

Jobs in brick kilns involve a very wide range of physical actions from postures and positions that may not be ideal and could place workers at risk for accidents and injuries. The common jobs in brick kilns comprises of pushing, pulling, bending, reaching, stretching, lifting, lowering, sitting, standing, walking and carrying, mining/rimming of clay, preparation of clay, molding of clay, drying of bricks, burning of bricks and the final product i.e. the brick. This stressful situation can be made worse by physical discomforts in the workplace and cause MSD's. The prolonged stresses and strains caused during the various activities with different load conditions is a cause for Work Related MSD's.

This exposure involves high physical workload which is assessed through the analysis of posture, movement, and cumulative load over time or through indirect approach of questionnaires or checklists. This paper focuses on assessment of physical risk factors among workers engaged in different processes of brick manufacturing through discomfort/pain that are experienced during job hours using interviewer-administered structured questionnaire, and postural analysis using the techniques of RULA and REBA.

II. Materials and Methods

The study was conducted on 60 workers (30 male and 30 female) selected randomly engaged in 6 different brick fields of North Karnataka. The workers with at least one year of experience were chosen. The workers carried out the following activities: (i) digging and crushing clay, (ii) wetting clay, (iii) mixing clay, (iv)loading and pushing the trolley or wheelbarrow, (v) molding raw bricks, (vi) arranging bricks to dry, (vii) moving the dried bricks to kiln for burning (viii) loading bricks on to the truck, tractor, and cycle or on others. To carry out such activities, workers most often have to adopt awkward postures for a longer period i.e. near about 11 hours that result in musculoskeletal pain/discomfort affecting different body parts.

a) Nordic Musculoskeletal Disorder Questionnaire

A modified Nordic Musculoskeletal Disorder Questionnaire was given to the workers. The questionnaire consisted of a series of objective questions with yes or no response and some were in multiple choice questions. To investigate discomfort, it included detailed questions on work-related pain in different body parts. Work-related pain/discomfort was reported in 12 month, one month and prevalence in 7 days. The participants were interviewed about any kind of discomfort affecting different body parts during every activity associated with raw brick making task.

b) Postural Analysis

Working postures were evaluated directly by visual observation as well as indirectly by using a still photography and video of the different activities performed by the workers. The photographs and video were later used to identify the different categories of work postures prone to injury such as bending, twisting, tilting the head forward. These were later used to evaluate the risk level by the techniques RULA and REBA.

c) Rapid Upper Limb Assessment (RULA)

RULA is a quick survey method for use in ergonomic investigations of workplaces where MSD's are reported (McAtamney, L. and Corlett 1993). It is a screening tool that assesses biomechanical and postural loading on the body. It focuses on the neck, trunk and upper limbs, and is ideal for sedentary workers. It is a simple, quick and easy to complete. RULA scores indicate the level of intervention required to reduce MSD risks. It compliments other ergonomic methods. RULA assesses the posture, force and movement associated with sedentary tasks such tasks include computer tasks, manufacturing or retail tasks where the worker is seated or standing without moving about. This tool requires no special equipment in providing a quick assessment of postures of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body. A coding system is used to generate an action list which indicates the level of intervention required to reduce the risks of injury due to physical loading on the operator (Table 1).

d) Rapid Entire Body Assessment (REBA)

REBA (Rapid Entire Body Assessment) was developed by (Hignett, S. and Mc Atamney, 2000), to provide a quick and easy observational postural analysis tool for whole activities (static and dynamic) giving musculoskeletal risk action level. The development of REBA is aimed to divide the body into segments to be coded individually with reference to movement planes. It provides a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures. It reflects that coupling is important in handling of the loads but may not always be via the hands. It also gives an action level with an indication of urgency. This method was specifically developed to be useful for assessing MSD risks/working postures found in healthcare and other service industries. However, it can be used to assess a variety of tasks, in any setting, where: the whole body is being used, the posture is static, dynamic, rapidly changing, or unstable, or animate or inanimate loads are being handled either frequently or infrequently. (Table 1)

Table 1 : Classification of Risks according to postural score

RULA		REBA		
Rula Score	Action Required	Action level (Risk level)	REBA Score	Corrective Measure
1-2	Acceptable	0 (Negligible)	1	None necessary
3-4	Change may be necessary	1 (Low)	2-3	May be necessary
5-6	Change necessary soon	2 (Medium)	4-7	Necessary
7	Change immediately	3 (High)	8-10	Necessary soon
		4 (Very High)	11-15	Necessary NOW

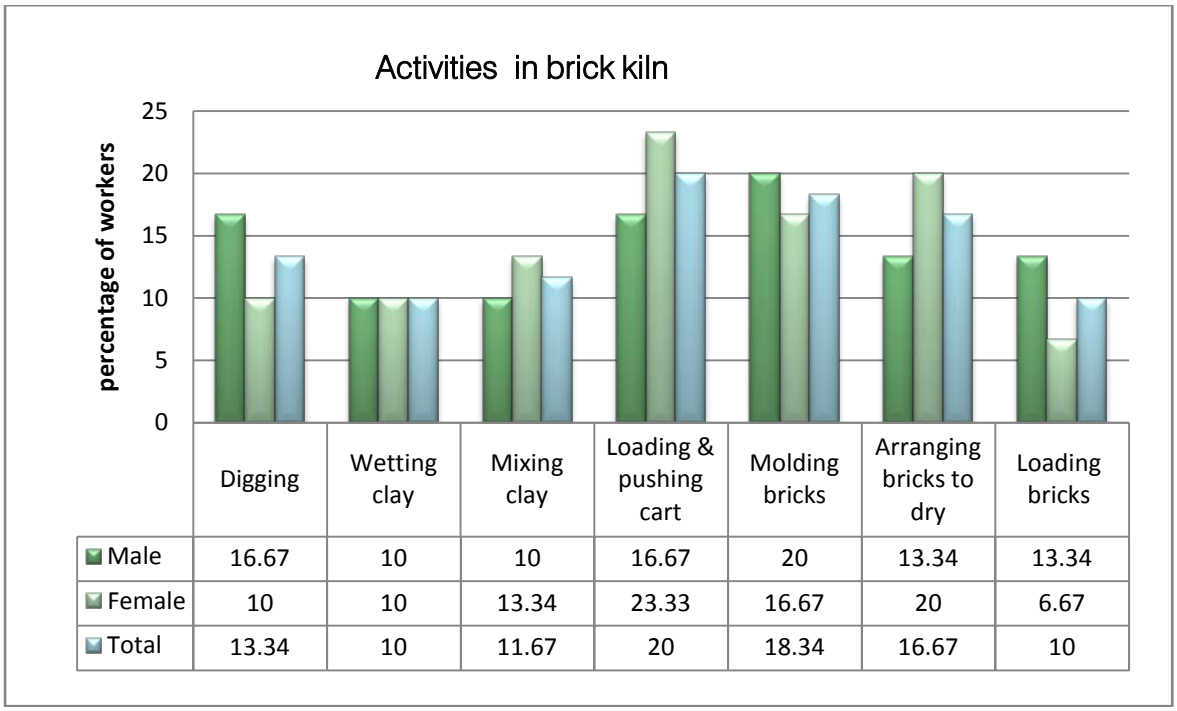
III. Results and Discussion

a) Work Process in Brick Kilns

The brick kilns located in north Karnataka were of open type as shown in Appendix A. The workers usually start work at 6 am in the morning and work till 11 am. They take rest and start work after lunch at 3 pm and work till 6 pm. The workers take rest in between for about 10-15 minutes under a shade of tree or a thatched roof hut. A group of 15-25 workers work in a brick kiln producing about 100,000 bricks.

There were two main steps observed in brick making. In the first step a brick is manufactured from mud with the help of a mould. The bricks are then dried in sunlight for 2-3 days. In the second stage the dried bricks are taken to the kiln and stacked on top of it for further curing and hardening. The bricks are burnt for about a week and then removed from the kiln and are ready to use in construction. Manual brick making in this part of the country is based on demand.

The different activities of workers in a brick kiln (figure 1) shows that 20% of workers are involved in loading of mud into a cart, pushing the cart and unloading the mud at the molding area. Molding activity involves 18.34% of workers and they work continuously until a batch of bricks is produced. About 23.3% of workers carryout the digging and wetting of clay. For loading and unloading the bricks on to kilns 10% of workers are involved. In most of the kilns, the workers work in groups and each group performs certain activities like a group of workers doing the digging and wetting clay activity do not mold the bricks.



	Digging	Wetting clay	Mixing clay	Loading & pushing cart	Molding bricks	Arranging bricks to dry	Loading bricks
Male	16.67	10	10	16.67	20	13.34	13.34
Female	10	10	13.34	23.33	16.67	20	6.67
Total	13.34	10	11.67	20	18.34	16.67	10

Figure 1 : Different activities in a brick kiln and the %age of workers doing each activity

b) Physical Characteristics of the Workers

The physical characteristics and experience of the workers was noted and shown in Table 2. The mean height of the workers were found to be 158 cms and the mean age was 26.4 years. The mean Body Mass Index (BMI), a measure of obesity and defined as weight in kilograms divided by height in metres squared was 21.92 kg/m^2 with a range of 17.2 and 33.6 kg/m^2. Using the criteria for obesity that for non-obese person, the BMI should lie between 18.5 and 24.9kg/m^2, 25 and

29.9 kg/m^2 as overweight, 30 and 39.9 kg/m^2 as moderate obese and more than 40kg/m^2 as extremely obese (Singh et.al., 2009),some of the female workers were found to be underweight while none was obese.

Table 2 : Physical characteristics of the workers

Variables	Mean (SD)
Age (yr)	26.4 (± 9.5)
Height (cm)	158.2 (± 11.3)
Weight (kg)	41.9 (± 9.7)
Years of Experience	3.7 (± 8.6)
Duration of work per day (hours)	9.5 (± 1.8)
Body mass index (BMI) (Kg/m^2)	21.92 (±3.35)

c) Discomfort and pain (Nordic Musculoskeletal Disorder Questionnaire)

The work related musculoskeletal disorders and the body pain perceived by the workers was determined by administering the standard Nordic musculoskeletal disorder questionnaire. The responses given by the workers were analyzed. The workers complained about the activities causing pain and discomfort. It was reported that 90% of the respondents complained pain in digging and crushing activities, while 72 % of workers said that the wetting of clay caused pain. All the workers who responded suffered from pain and discomfort in activities like mixing of clay, carrying in a trolley and pushing the trolley. Nearly 81% of workers felt pain during the molding of bricks. 28% of respondents experienced pain while arranging the bricks for drying. Another 88% of workers reported significant pain and discomfort while loading the bricks on to truck or tractor.

Table 3 : Discomfort feeling at different body parts among the workers (n=60)

Different body parts	No. of affected workers (%)		
	Male	Female	Total
Neck	19 (64)	17 (57)	36 (60)
Shoulder	22 (73)	20 (67)	42 (70)
Elbows	24 (80)	23 (76)	47 (78.33)
Wrist/hand	23 (76)	21(70)	44 (73.33)
Upper back	24 (80)	22 (74)	46 (76.67)
Lower back	26 (87)	23 (76)	49 (81.66)
Hips/thighs	18 (60)	20 (67)	38 (63.33)
Knees	21 (70)	20 (67)	41 (68.33)
Ankle/feet	25 (83.33)	26 (86.66)	51 (85)

Table 3 shows the pain and discomfort in different body parts and the number of workers affected, both male and female. It can be seen that 81.66% complain of low back pain and 76.67% complain of upper back pain. It is clear that brick molders have more pain in the back because they sit continuously in the awkward posture to mold the bricks. Almost 73% males and 67% females feel pain in the shoulders. Regarding pain and discomfort in the neck 60% reported pain. The workers involved in loading, unloading and carrying experience pain in the shoulder, neck, hand/wrist and elbows. Concerning pain in elbows 80% males and 76% females reported pain. On the other hand 73% respondents, 76% males and 70% females complained pain in the hand/wrists whereas 63% respondents reported pain in hips/thighs. Studies further show that 85% of respondents experienced pain in the ankle/feet, while 68% reported pain and discomfort in the knees.

d) Measurement of Environmental Parameters

The workers in brick kilns are exposed to heat and they work in direct sunlight. The temperatures in north Karnataka are quite high during the summer. The temperature were measured by using a whirling Psychrometer to record the Dry and Wet Bulb Temperature. The measurements were taken every 2 hours and the mean was calculated. The mean Dry Bulb temperature was 39.80 C (±0.37), and the Wet Bulb temperature was 29.70 C (±0.67). The Globe temperature was recorded as 43.90 C (±1.39).

e) Postural Analysis

The postural analysis of the workers while performing different activities in brick making task were observed and each posture was identified according to the risk involved. the position of the back, upper limbs, and lower limbs i.e. arms and legs as well as load or force used in carrying out the activities were considered for the analysis of posture. The postures adapted by the workers in digging clay, crushing clay, wetting clay, mixing clay, loading wheel barrow, molding raw bricks, arranging bricks to dry and loading bricks on the truck were carefully analyzed. It was found that most of the postures involve bending, twisting, standing or sitting in squatting position. The postures were analyzed using the RULA and REBA techniques. In Table 4 the total postural analysis for the different activities in brick making is represented. In almost all the activities, RULA posture scores are 7 indicating a postural change is needed immediately as the working postures are vulnerable to risks and warrant ergonomic intervention. REBA posture codes indicate that the postures for digging and molding bricks demands immediate attention with a score of 10 to 13. Other postures are also at high risk with a score of 9-10 and require intervention soon.

Table 4 : Maximum RULA and REBA scores for different postures

Posture and Activities	RULA Score	Action level RULA	REBA Score	Risk level REBA	Maximum discomfort in body parts
Digging	7	4	10	High	Low back, Upper back
Wetting and mixing clay	7	4	9	High	Low back, Shoulders
Carrying mud by pushing	7	4	9	High	Low back
Molding bricks	7	4	10-13	High to very high	Legs, low back,
Arranging bricks for drying	6-7	3-4	9-10	High	Low back, neck, shoulders
Loading and unloading	6,7	3,4	7,10	Medium, high	Low back, shoulders, upper back

IV. Conclusion

Manual brick manufacturing in open type of kilns in India is currently an hazardous occupation. There are numerous risks and hazards associated with working in high ambient temperature, working with manual load lifting and awkward postures in which the workers are engaged for long periods. As the workers continuously work in bent or stressful postures, they suffer from discomfort and pain in different parts of the body. The feeling of pain and discomfort is aggravated if the stressful postures are maintained for a long period. Postural analysis using RULA and REBA indicated that most of the postures were vulnerable to work related musculoskeletal disorders and this demands an immediate ergonomics intervention.

The relative duration of working in ambient temperatures exposed to sunlight was critical and it effects the physiological parameters well above the normal value. The external heat of the environment possibly was an important factor adding to the stress level of the workers. This was further substantiated by a increase in heat related symptoms and heat stroke.

The workers experienced injuries in different body parts due to the work process and management/owners inaction in providing safe work environment. There were no personal protective devices to wear, so this was a significant issue in the injuries sustained. The accidents at brick making sites included slips or falls, falls from height, cuts and burns. Surprisingly a few number of snake/scorpion bites were reported at some of the sites. The workers took shelter under a tree or a thatched roof hut during the periods of rest. Drinking water was made available through the tube wells but most of the sites lack proper sanitation facilities. In some sites medical facility was provided by the owners in case of an accident or injury. Most of the male workers were smokers or had habits of tobacco eating. At the end of the day a majority of the workers drink the locally available liquor to get relieved from the stress. Because of the economic conditions, unemployment, and illiteracy these workers are compelled to work under poor working conditions and follow unsafe practices. Sometimes the workers are exploited by the owners of the brick kilns due to unawareness of the legislations or labor laws on the part of the workers.

V. Recommendations

The brick kilns need a well designed comprehensive ergonomics plan and the necessary resources to support the same in order to improve the prevention of WRMSD's, health risks and improve the working conditions and productivity of the workers. Some of the improvements may be in the following directions:

a) Implement a continuous training programme so that each worker becomes aware of the relevant factors concerning postures/discomfort.
b) Improve the workplace and equipment by making minor changes to prevent awkward postures.
c) Considering anthropometry to determine minimum and maximum height to avoid bending and twisting.
d) Design of trolleys and truck for transportation of bricks and/or raw materials
e) Better organize the workplace layout to minimize movements, twisting and asymmetrical lifting or lowering.
f) Limit the height of brick stacking to avoid movements above the shoulder height
g) Various guidelines and measures should be formulated to prevent MSD's.
h) Illiteracy and unawareness emerged as the major constraints regarding workers involvement in different activities and adopting awkward postures.

Hence the role of the owners, developmental organizations,and ergonomists in educating the workers becomes more prominent.

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Appendix A : Brick making process

The mixture forms a dough like substance

The mud is now carried in a trolley to the moulding area .

A worker is assigned the job of moulding clay into bricks

On an average a worker moulds about 1500 bricks in a day. The batch is dried in open for 3 days in the same position.

Bricks ' position is changed to dry the beneath area for 2 days

Bricks are kept as these structures to aerate all surfaces equally. for 2 days

The bricks are carried to the kiln for heating process ina trolley (hand pulled). It carries 250 bricks at once.

A layer of coal pieces is spread after two layers of bricks.

This coal layer is heavily stuffed

Another layer of coal is spread on the 6th brick mat.

The batch of brciks is arranged as a heating hub

Brick pyramid is covered on the sides by faulty bricks or damaged bricks and sides are stuffed with coal.

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Application of Proper Forecasting Technique in Juice Production: A Case Study

By Rakesh Kumar & Dalgobind Mahto
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Application of Proper Forecasting Technique in Juice Production: A Case Study

Rakesh Kumar [α] & Dalgobind Mahto [σ]

Abstract - Every organisation that produces product evaluates their performance at certain intervals to keep the pace with the market. Forecasts are evaluated to improve models to achieve better policy and planning outcomes. The purpose of this study is to observe whether the forecast errors are within the reasonable limit of expectations or whether these errors are irrationally large and require an improvement in the statistical models and process of producing these forecasts. Statistical time series modelling techniques like – Moving Average, Simple Exponential Smoothing and Least Square methods are used for the study and their performance evaluated in terms of Mean Average Deviation (MAD), Mean Squared Error (MSE).

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I. Introduction

Modern production activities are becoming more complex technologically, the basic inputs are becoming expensive and there are lot of restrictions on them. The planning of the production activities is, therefore, essential to put the resources for best use. Planning is a fundamental activity of management. Forecasting forms the basis of planning and it enables the organisation to respond more quickly and accurately to market changes. It plays a crucial role in the development of plans for the future. It is essential for the organisations to know for what level of activities one is planning before investments in inputs i.e. men, machines and materials. It uses many statistical techniques. Therefore, it is also called as Statistical Analysis. It refers to a systematic analysis of past and present circumstances. It is essentially a technique of anticipation. Before making an investment decision, questions may arise like:

- What should be the size of the order and safety stock?
- What should be the capital cost required for the work?
- What should be the capacity of the plant?
- How much labour is required?

The answers to the above questions depend upon the forecast for the future level of operations. The success of a business greatly depends upon the efficient forecasting and preparing for future events. It should be no surprise that forecasts are not always accurate – they are essentially about predicting the future with incomplete information. Nevertheless, forecast inaccuracies, particularly consistent underestimation of revenues and budget surpluses generally draws intense criticism. Forecast accuracy has been a matter of concern and subject of review. In general, the reasons for inaccuracies may fall into the following categories:

- Technical issues, such as data accuracy, forecasting methodology, process and agency structures.
- Effects of fiscal objectives.
- The economic cycle.

Forecasting agencies generally review and improve data and models on an ongoing basis, and issues identified in major reviews are generally marginal.

II. Aims and Objectives

The main emphasis of this work is to compare the various forecasting techniques prevalent in the industries based on the data obtained from a juice producing factory. In this manuscript an attempt has been made to forecast juice production by using the Moving Average Method, Simple Exponential Smoothing and Least Square Method. The aim is to evaluate the performances in terms of

- Mean Average Deviation (MAD)
- Mean Squared Error (MSE)
- Mean Absolute Percentage Error (MAPE) and
- Finally, to compare the findings and decide the suitability among the methods MAD, MSE and MAPE.

III. Methodology

This study was carried out on the basis of juice production data collected for the period 2000 to 2011 as shown in the table 1.

Table 1 : Recorded juice production data of the company

S. No.	Year	Production (in millions)
1	2000-01	16.6
2	2001-02	19.3

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3	2002-03	20.8
4	2003-04	23.8
5	2004-05	26.5
6	2005-06	29
7	2006-07	31.1
8	2007-08	33.4
9	2008-09	36.4
10	2009-10	38.9
11	2010-11	40.7

a) Simple Moving Average Method

When demand for a product is neither growing nor declining rapidly and if it does not have seasonal characteristics, a moving average can be useful in removing the random fluctuations for forecasting. Although moving averages are frequently centered, it is more convenient to use past data to predict the following period directly. Although it is important to select the best period for the moving average, there are several conflicting effects of different period lengths. The different moving averages produce different forecasts. The greater the number of periods in the moving average, the greater the smoothing effect. If the underlying trend of the past data is thought to be fairly constant with substantial randomness, then a greater number of periods should be chosen. The formula for a simple moving average is

$$F_t = \frac{(A_{t-1} + A_{t-2} + A_{t-3} + A_{t-n})}{n} \quad (1)$$

Where,

F_t = Forecast for the coming period,

n = Number of period to be averaged n and

A_{t-1}, A_{t-2}, A_{t-3} = Actual occurrences in the in the past period, two periods ago, three periods ago and so on respectively.

Equal weighting is given to each of the values used in the moving average calculation, whereas it is reasonable to suppose that the most recent data is more relevant to current conditions. An n period moving average requires the storage of (n-1) value to which is added the latest observation. This may not seem much of a limitation when only a few items are considered. The moving average calculation takes no account of data outside the period of average, so full use is not made of all the data available. The use of the unadjusted moving average as a forecast can cause misleading results when there is an underlying seasonal variation.

b) Simple Exponential Smoothing Method

In the previous forecasting method, the major drawback is the need to continually carry a large amount of historical data. As each new piece of data is added in these methods, the oldest observation is dropped, and the new forecast is calculated. The reason this is called exponential smoothing is that each increment in the past is decreased by (1-α).This method provides short term forecasts. The simplest formula is

New forecast = Old forecast + α (Latest Observation – Old Forecast)

Or more mathematically,

$$F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1}). \quad (2)$$

Where,

Ft = The exponentially smoothed forecast for period t,

F_{t-1} = The exponentially smoothed forecast made for the prior period,

A_{t-1} = The actual demand in the prior period,

α = The desired response rate, or smoothing constant.

The value of smoothing constants α varies from 0 to 1. The higher value of α (i.e. the nearer to 1), the more sensitive the forecast becomes to current conditions, whereas the lower the value, the more stable the forecast will be, i.e. it will react less sensitively to current conditions. Here the value of alpha is taken as 0.3.Greater weight is given to more recent data. All past data are incorporated there is no cut-off point as with moving averages. Less data needs to be stored than with the longer period moving averages. Like moving averages it is an adaptive forecasting system. That is, it adapts continually as new data becomes available and so it is frequently incorporated as an integral part of stock control and production control systems. To cope with various problems (trend, seasonal factors, etc) the basic model needs to be modified. Whatever form of exponential smoothing is adopted, changes to the model to suit changing conditions can simply be made by altering the value of α. The selection of the smoothing constant α is done through trial-error by the researcher/analyst. It is done by testing several values of α (within the range 0 to 1) and selecting one which gives a forecast with the least error (one can take standard error). It has been found that values in the range 0.1 to 0.3 provide a good starting point.

c) Least Squares Method

This is the mathematical method of obtaining the line of best fit between the dependent variable and an independent variable. In this, the sum of the square of the deviations of the various points from the line of best fit is minimum or least. For straight line

$$y = a + b\,x \quad (3)$$

Where,

b is slope of the line,

a is the y – intercept.

The value of a and b is calculated by using following equations.

$$a = \bar{y} - b\bar{X} \quad (4)$$

$$b = \frac{\sum Xy - n\,\bar{X}.\bar{y}}{\sum X^2 - n\,\bar{X}^2} \quad (5)$$

These two equations are called normal equations. It is useful for long-term forecasting of major occurrences and aggregate planning. The major restriction in using linear forecasting is that past data and future projections are assumed to fall about a straight line. Although, this does limits its application.

d) Evaluating the Forecast Accuracy

There are many ways to measure forecast accuracy. Some of these measures are the mean absolute forecast error, called the MAD (Mean Absolute Deviation), the mean absolute percentage error (MAPE) and the mean square error (MSE). This error estimate helps in monitoring erratic demand observations. In addition, they also help to determine when the forecasting method is no longer tracking actual demand and it need to be reset. For this tracking signals are used to indicate any positive or negative bias in the forecast. The mean absolute deviation (MAD) is also important because of its simplicity and usefulness in obtaining tracking signals. MAD is the average error in the forecasts, using absolute values. It is valuable because MAD, like the standard deviation, measures the dispersion of some observed value from some expected value. The only difference is that like standard deviation, the errors are not squared. Standard error a square root of a function, it is often more convenient to use the function itself. This is called the mean square error (MSE) or variance. The mathematical formulas may be used while evaluating data are

$$\text{Error} = \text{Actual Observed value} - \text{Forecasted Value} \quad (6)$$

$$\text{Absolute Percentage Error} = (\text{Error} / \text{Actual Observed Value}) \times 100 \quad (7)$$

Where,

MAD = the average of the absolute errors.

MAPE = the average of the Absolute Percentage Errors.

MSE = the average of the squared errors.

Table 2 : Statistical Techniques for Error Measurement

Technique	Measures
Mean Squared Error (MSE)	The average of squared errors over the sample period
Mean Error (ME)	The average dollar amount or percentage points by which forecasts differ from outcomes
Mean Percentage Error (MPE)	The average of percentage errors by which forecasts differ from outcomes
Mean Absolute Error (MAE)	The average of absolute dollar amount or percentage points by which a forecast differs from an outcome
Mean Absolute Percentage Error (MAPE)	The average of absolute percentage amount by which forecasts differ from outcomes

IV. Result Analysis

In this study, we used the data for juice production for the period 2000-01 to 2010-2011. All the three methods are applied one by one and their performance evaluated in terms of MAD, MAPE and MSE.

a) Moving Average Method

Table 3 : Actual and Estimated values of juice production by Methed

S. No.	Year	Production (in millions) P	Forecast F	Error E	Squared Error E^2	Absolute Percentage Error (E/P)x 100
1	2000-01	16.6				
2	2001-02	19.3				
3	2002-03	20.8				
4	2003-04	23.8	18.9	4.9	24.01	20.59
5	2004-05	26.5	21.3	5.2	27.04	19.62
6	2005-06	29	23.7	5.3	28.09	18.28
7	2006-07	31.1	26.43	4.67	21.78	15.01
8	2007-08	33.4	28.87	4.53	20.55	13.57
9	2008-09	36.4	31.17	5.23	27.39	14.38
10	2009-10	38.9	33.63	5.27	27.74	13.54
11	2010-11	40.7	36.23	4.47	19.95	10.97

b) Simple Exponential Method

Table 4 : Actual and Estimated values of juice production by Simple Exponential Method

S. No.	Year	Production (in millions) P	Forecast F	Error E	Squared Error E^2	Absolute Percentage Error (E/P)x 100
1	2000-01	16.6				
2	2001-02	19.3	16.6	2.7	7.29	13.99
3	2002-03	20.8	16.87	3.93	15.44	18.89
4	2003-04	23.8	17.26	6.54	42.73	27.47
5	2004-05	26.5	17.92	8.58	73.67	32.39
6	2005-06	29	18.78	10.22	104.55	35.26
7	2006-07	31.1	19.80	11.30	127.75	36.34
8	2007-08	33.4	20.93	12.47	155.56	37.34
9	2008-09	36.4	22.17	14.23	202.35	39.08
10	2009-10	38.9	23.60	15.30	234.17	39.34
11	2010-11	40.7	25.13	15.57	242.50	38.26

c) Least Square Method

Table 5 : Actual and Estimated values of juice production by Least Square Method

X	Production (in millions) P	XP	X^2	P^2	Forecast F	Error E	Squared Error E^2	Absolute Percentage Error (E/P)x 100
1	16.6	16.6	1	275.56	16.52	0.08	0.01	0.48
2	19.3	38.6	4	372.49	18.98	0.32	0.10	1.69
3	20.8	62.4	9	432.64	21.43	0.63	0.40	2.94
4	23.8	95.2	16	566.44	23.88	0.08	0.01	0.34
5	26.5	132.5	25	702.25	26.33	0.17	0.03	0.65
6	29	174	36	841	28.78	0.22	0.05	0.76
7	31.1	217.7	49	967.21	31.23	0.13	0.02	0.42
8	33.4	267.2	64	1115.56	33.69	0.29	0.08	0.86
9	36.4	327.6	81	1324.96	36.14	0.26	0.07	0.72
10	38.9	389	100	1513.21	38.59	0.31	0.10	0.80
11	40.7	447.7	121	1656.49	41.04	0.34	0.12	0.83
∑X=66	∑P=66	∑XP=66	$\sum X^2$=66	$\sum P^2$=66	∑ F =66	∑E=2.83	$\sum E^2$=0.97	∑=10.48

Mean X = 6 Mean P = 28.77 a= 14.07 b= 2.45

Therefore general equation for forecast is F = 14.07 + 2.45X

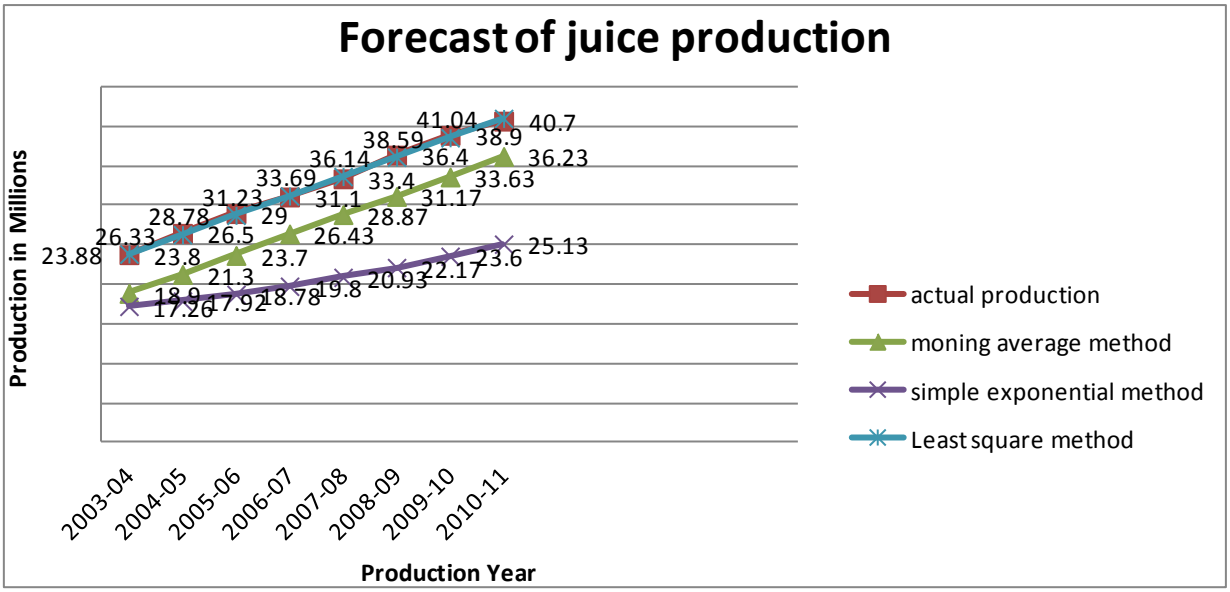

Figure 1 : Time series plot of juice production data

V. Discussion

Initially time series plot (Figure 1) was created to determine the trends in the juice production from 2003 to 2011, the graph shows an increasing trend in juice production during the study period and hence showed that the series was not stationary. It is very clear from the graph that the trend line of Least Square Average method flow on the actual trend line of juice production. The trend line of Simple exponential method is far away from the actual trend line. And finally the performance of the various methods evaluated on the basis of MAPE, MAD and MSE which is shown in the table 6.

Table 6 : Diagnostic measures for the selection of the best forecasting method for juice production

Measures of accuracy	Moving Average Method	Simple Exponential Method	Least Square Method
MAPE	15.74 %	31.83 %	0.95%
MAD	4.95	10.08	0.25
MSE	24.57	120.60	0.09

The data show that in case of moving average method, value of MAPE, MAD and MSE are 15.74%, 4.95 and 24.57 respectively. For Simple Exponential Method, value of MAPE, MAD and MSE are 31.83%, 10.08 and 120.60, respectively. Similarly, in case of Least Square Method value of MAPE, MAD and MSE are 0.95%, 0.25 and 0.09.

By comparing the performance of the methods, it was found that Least Square method have least value of MAPE (15.74%), MAD (0.25) and MSE (0.09) and hence the results produced by the least square method have less error and more accurate than the other method.

VI. Conclusion

Forecasting of juice production done by using statistical methods, (Moving Average method, Simple Exponential Method and Least Square Method). Statistical methods are chosen because for their rich historic data and ease of their use. Finally, their performance evaluated by comparing the MAPE, MAD and MSE obtained from the different methods. The results show that least Square method is more accurate than the other methods.

The forecasting technique may be different for different industries. It depends upon the variable factors like place, manpower skill, equipment capacity, raw material availability, inventory characteristics and management policies etc. Hence this work may be extended to other industries.

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To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

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All manuscripts submitted to Global Journals Inc. (US), ought to include:

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Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

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The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

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Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

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Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

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7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

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11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

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Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
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- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

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- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

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This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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