Chapter 4

Productivity through Productivity Indicators

4.1 Introduction

The concept of productivity is often confused with the wider and more common concept of performance and performance measurement. Productivity is one of the many ways in which performance may be measured and defined (Linna, Pekkola, Ukko, and Melkas, 2010). Productivity is the measure of the efficiency of production whereas performance refers to the means by which an objective can be judged to have been achieved or not achieved. Productivity refers to a purely physical phenomenon and must therefore be defined as one, despite the difficulty that even such a definition imposes for the measurement of different quantities that do not correspond to the same standard. Productivity is closely related to the use and availability of resources as well as to value creation. This means that an enterprise's productivity is reduced if its resources are not properly used or if there is a lack of resources (Pekuri, Haapasalo, and Herrala, 2011). Like performance, productivity may be analyzed by defining suitable productivity

indicators and then measuring them. As far as productivity analysis of ERP is concerned, no such productivity indicators have been found in the literature.

ERP users are central to the productivity that may be attributed to the use of ERP in an enterprise. Their opinion on measuring productivity vis-à-vis ERP is thus very significant in trying to define productivity indicators for productivity analysis of ERP.

4.2 ERP (SAP) Users in the Refineries of Assam

The implementation of an ERP system affects users at various levels of the organization since it cuts across all functional units. These users range from top management to low level users who use the system on their day-to-day operations (Matende and Ogao, 2013). This section gives a background of the respondents in terms of their SAP user level, SAP training, duration of SAP training, SAP modules used and their experience in using SAP. The different modules of SAP have been elaborated in section 1.3.1. SAP users are classified into different categories under a specific named user. The different types of SAP Users have already been elaborated in section 1.3.2. The different types of SAP Users classified here are Developer (Dev), Business Expert (BE), Professional (Pro), Limited Professional (LP), Business Information (BI) and Employee User (EU).

Two-thirds of the respondents (65 percent) are Limited Professional users. There are no developers in the refineries under IOCL because development is done at

the corporate headquarters. For the population, number of users under each SAP user level is not known.

Table 4.1: SAP User Level of Respondents

Name of the Refinery	Dev	BE	Pro	LP	BI	EU	Total
Bongaigaon Refinery	0	0	2	48	1	0	51
Digboi Refinery	0	2	19	46	9	5	81
Guwahati Refinery	0	0	8	31	7	6	52
Numaligarh Refinery	3	5	7	24	6	10	55
Total	**3**	**7**	**36**	**149**	**15**	**21**	**239**

Data Source: Concerned Refineries

Illustration 4.1: SAP User Level of Respondents (in percentage)

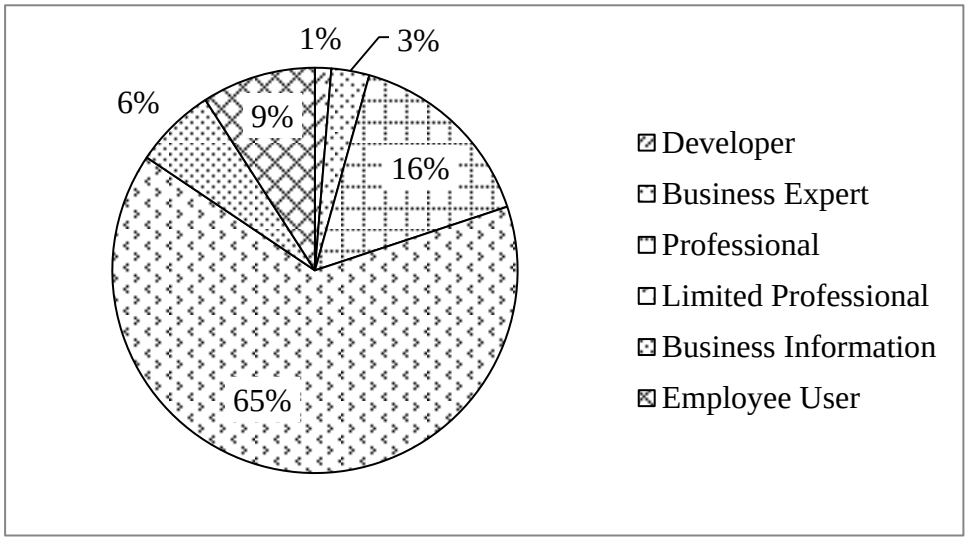
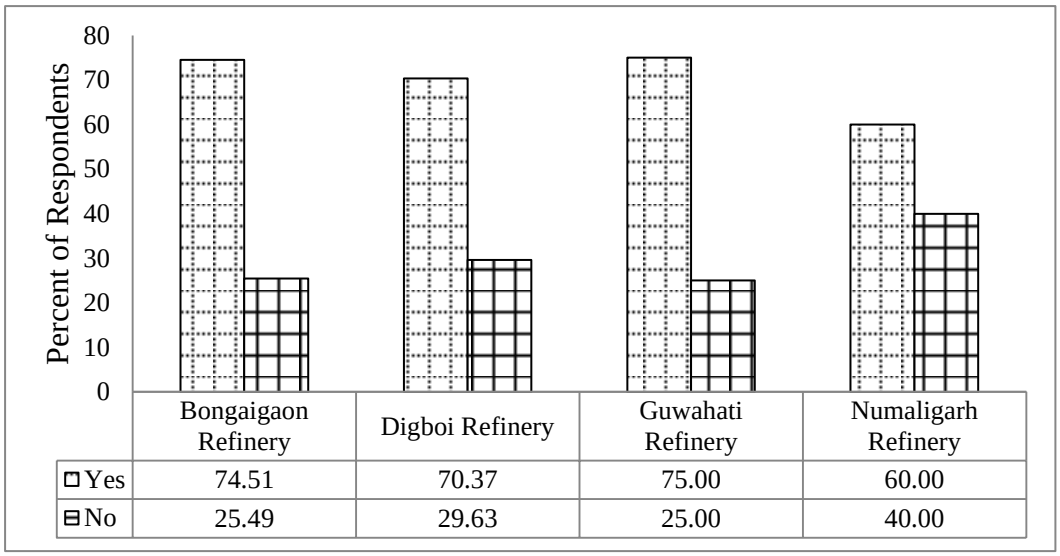


Table 4.2: Respondents who are SAP Trained

Name of the Refinery	Yes	No	Total
Bongaigaon Refinery	38	13	51
Digboi Refinery	57	24	81
Guwahati Refinery	39	13	52
Numaligarh Refinery	33	22	55
Total	**167**	**72**	**239**

Data Source: Concerned Refineries

Illustration 4.2: Respondents who are SAP Trained (in percentage)



One of the critical success factors (CSF) of an ERP implementation project is user training (Dorobăţ and Năstase, 2012). Training employees on ERP is not as simple as Excel training in which a few weeks of training is followed by putting employees on the job, after which they blunder their way through. ERP systems are extremely complex and demand rigorous training. It is difficult for trainers or consultants to pass on the knowledge to the employees in a short period of time

(Bingi, Sharma and Godla, 1999). SAP is a complicated system and users need sufficient training to use it. But it is observed that SAP training is inadequate in the refineries of Assam and leaves much to be desired. Inadequacy is seen both in the percentage of SAP users being trained as well as the duration of the SAP training. Nearly a third of the overall respondents (30.12 percent) are untrained. The situation is the worst in Numaligarh Refinery with 40 percent of the respondents being untrained. The refineries under IOCL are better off as far as the number of SAP users being trained is concerned. Out of the 167 respondents who are SAP trained, a whopping 81.44 percent have undergone training lasting less than 7 days (Table 4.3).

Table 4.3: Duration of SAP Training

Name of the Refinery	Less than 7 days	7 days to less than 15 days	15 days to less than a Month	Total
Bongaigaon Refinery	33	5	0	38
Digboi Refinery	45	6	6	57
Guwahati Refinery	30	9	0	39
Numaligarh Refinery	28	2	3	33
Total	**136**	**22**	**9**	**167**

Data Source: Concerned Refineries

Illustration 4.3: Duration of SAP Training (in percentage)

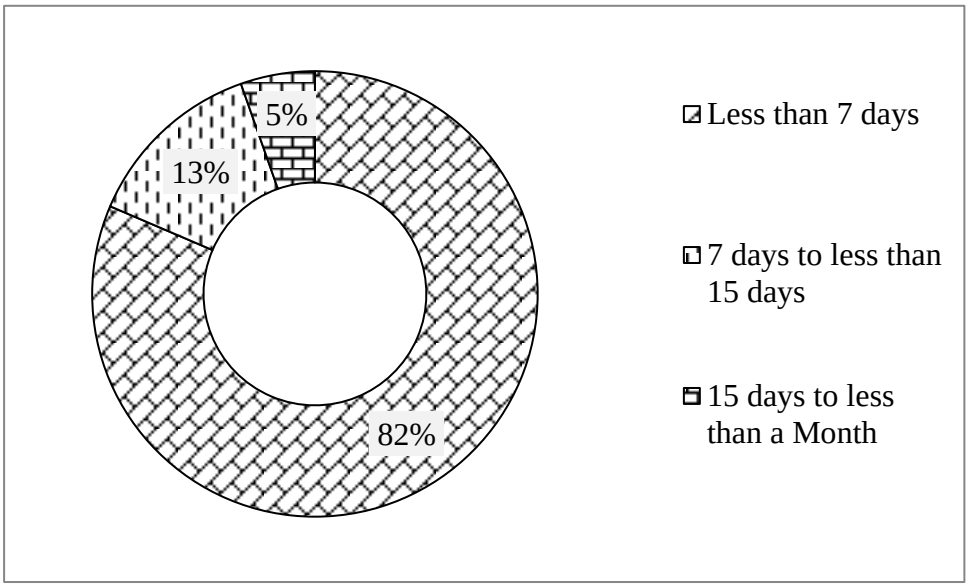


Table 4.4: SAP Experience of Respondents (in months)

Name of the Refinery	Maximum Experience	Minimum Experience	Mid-Point	Average Experience	Median Experience
Bongaigaon Refinery	122	6	64.0	73	80
Digboi Refinery	180	1	90.5	52	48
Guwahati Refinery	156	1	78.5	54	36
Numaligarh Refinery	120	2	61.0	63	72

Data Source: Concerned Refineries

The respondents have varied SAP experiences as illustrated in Table 4.4. Respondents of Bongaigaon Refinery have relatively more SAP experience as the average SAP experience shows. It was seen that in terms of work experience also, respondents of Bongaigaon Refinery were the most experienced (Table 3.9). In contrast, respondents of Digboi Refinery have the least SAP experience. SAP experience data is not available for the population under study.

Table 4.5: SAP Experience Groups of Respondents (in months)

Name of the Refinery	**0 – 36**	**37 - 73**	**74 – 110**	**111 – 147**	**148 – 184**	**Total**
Bongaigaon Refinery	14	10	25	2	0	**51**
Digboi Refinery	36	21	7	16	1	**81**
Guwahati Refinery	27	10	6	8	1	**52**
Numaligarh Refinery	14	17	23	1	0	**55**
Total	**91**	**58**	**61**	**27**	**2**	**239**

Data Source: Concerned Refineries

The SAP Experience Group data as reported in Table 4.5 will be used for analysis later on. The five experience groups correspond to the Novice (0 – 36), Somewhat Experienced (37 – 73), Experienced (74 – 110), Very Experienced (111 – 147) and Expert (148 – 184) groups respectively. The groups have been formed by looking at the maximum and minimum experience of the respondents

and forming equal class intervals. Maximum respondents (38.08 percent) in the sample belong to the Novice group only. This is because SAP is being implemented phase-wise and more employees are being given SAP login id in the recent past. With less than 1 percent of the respondents belonging to the Expert group, it holds no significance for the study.

Table 4.6: SAP Multiple Modules Used

Name of the Refinery	Yes	No	Total
Bongaigaon Refinery	9	42	51
Digboi Refinery	23	58	81
Guwahati Refinery	19	33	52
Numaligarh Refinery	31	24	55
Total	**82**	**157**	**239**

Data Source: Concerned Refineries

Illustration 4.4: SAP Multiple Modules Used (in percentage)

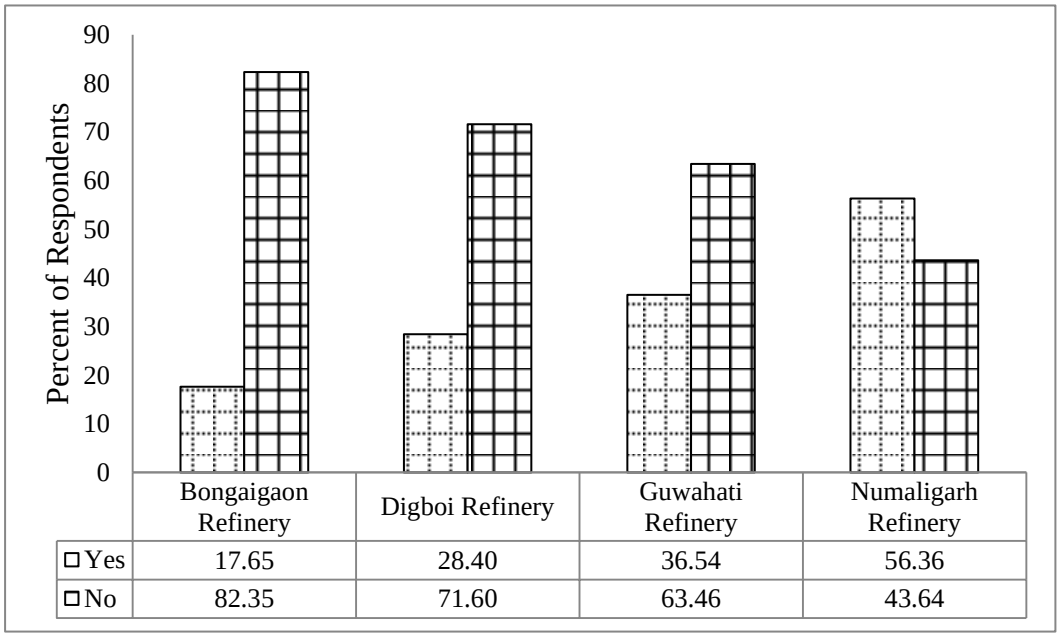


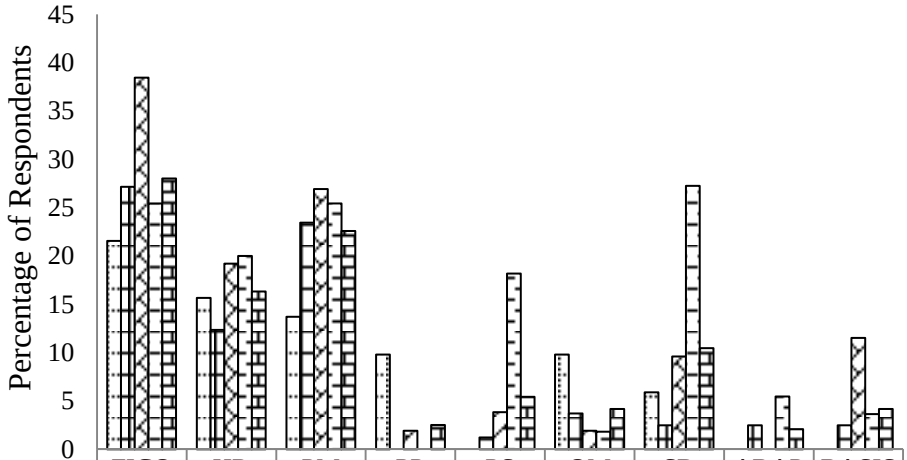
Table 4.6 gives the statistics about the use of multiple modules of SAP by the respondents. It is seen that about a third (34.31 percent) of the respondents use multiple modules of SAP. As far as the individual refineries are concerned, Numaligarh Refinery has the highest percentage of respondents who use multiple modules of SAP. The lowest is for Bongaigaon Refinery. Those who use multiple modules are bound to have better knowledge about SAP. Their opinion about the effectiveness of ERP in Enterprise Productivity is important.

Table 4.7: SAP Modules Used

Name of the Refinery	**FICO**	**HR**	**MM**	**PM**	**PP**	**PS**	**QM**	**SD**	**ABAP**	**BASIS**
Bongaigaon Refinery	11	8	25	7	5	0	5	3	0	0
Digboi Refinery	22	10	49	19	0	1	3	2	2	2
Guwahati Refinery	20	10	31	14	1	2	1	5	0	6
Numaligarh Refinery	14	11	43	14	0	10	1	15	3	2
Total	**67**	**39**	**148**	**54**	**6**	**13**	**10**	**25**	**5**	**10**

Data Source: Concerned Refineries

Illustration 4.5: SAP Modules used by Respondents (in percentage)



	FICO	HR	PM	PP	PS	QM	SD	ABAP	BASIS
Bongaigaon Refinery	21.57	15.69	13.73	9.80	0.00	9.80	5.88	0.00	0.00
Digboi Refinery	27.16	12.35	23.46	0.00	1.23	3.70	2.47	2.47	2.47
Guwahati Refinery	38.46	19.23	26.92	1.92	3.85	1.92	9.62	0.00	11.54
Numaligarh Refinery	25.45	20.00	25.45	0.00	18.18	1.82	27.27	5.45	3.64
Total	28.03	16.32	22.59	2.51	5.44	4.18	10.46	2.09	4.18

Table 4.7 gives the statistics about the use of different modules of SAP by the respondents. It is seen that the most used module is MM, followed by FICO and PM. The least used modules are ABAP, PP and BASIS. ABAP and BASIS are basically used for developing and customizing SAP and hence are least used.

4.3 Measuring Enterprise Productivity

Respondents' perception on Enterprise Productivity and how they look at it have already been detailed in sections 3.3 and 3.4. It was seen that the most preferred answer to the question, "What is Enterprise Productivity?" was given as "Efficiency & Working Smarter". This section now looks at the issue of measuring Enterprise Productivity from the ERP user's perspective in the refineries of Assam.

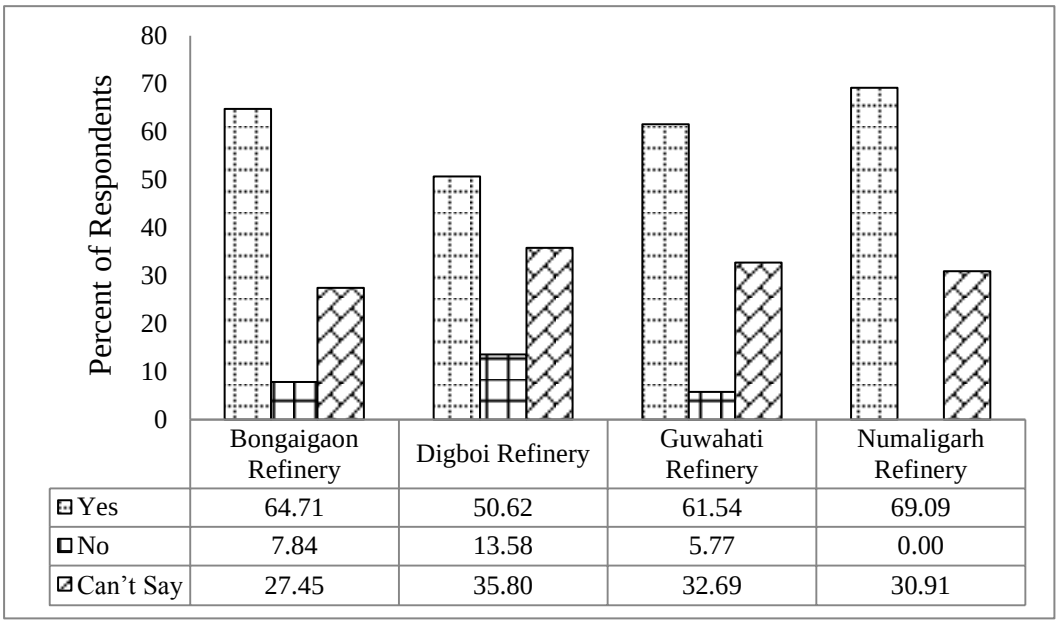
Table 4.8 shows that a third of the total sample (32.22 percent) are not sure as to whether Enterprise Productivity should be measured or not. It is also seen that a small minority of the overall sample respondents (7.53 percent) think that Enterprise Productivity should not be measured while 60.25 percent of the sampled respondents think that Enterprise Productivity should be measured. For the individual refineries, Digboi Refinery has the highest number of negative responses at 13.58 percent (Illustration 4.6). Numaligarh Refinery has the highest number of positive responses at 69.09 percent and zero negative responses.

Table 4.8: Responses on Necessity of Measuring Enterprise Productivity (Overall)

Name of the Refinery	Yes	No	Can't Say	Total
Bongaigaon Refinery	33	4	14	51
Digboi Refinery	41	11	29	81
Guwahati Refinery	32	3	17	52
Numaligarh Refinery	38	0	17	55
Total	**144**	**18**	**77**	**239**

Data Source: Concerned Refineries

Illustration 4.6: Responses on Necessity of Measuring Enterprise Productivity (Overall in percentage)



	Bongaigaon Refinery	Digboi Refinery	Guwahati Refinery	Numaligarh Refinery
Yes	64.71	50.62	61.54	69.09
No	7.84	13.58	5.77	0.00
Can't Say	27.45	35.80	32.69	30.91

Table 4.9: Responses on Necessity of Measuring Enterprise Productivity (SAP Trained)

Name of the Refinery	Yes	No	Can't Say	Total
Bongaigaon Refinery	26	4	8	38
Digboi Refinery	30	9	18	57
Guwahati Refinery	26	2	11	39
Numaligarh Refinery	23	0	10	33
Total	**105**	**15**	**47**	**167**

Data Source: Concerned Refineries

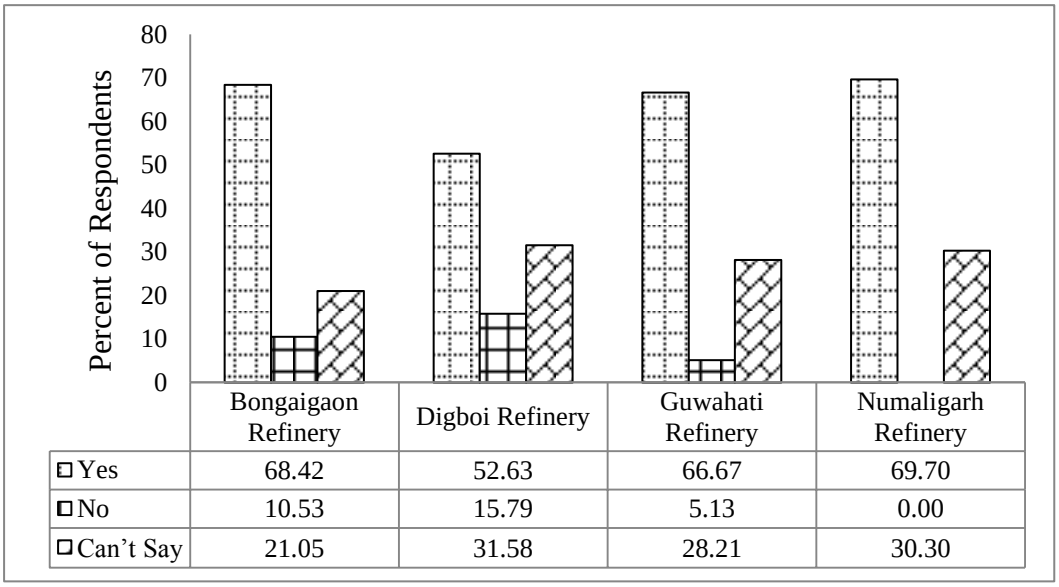
Table 4.9 shows the Necessity of Measuring Enterprise Productivity (NMEP) for the respondents who are SAP trained. It shows that among the SAP trained, 62.87 percent of the respondents respond positively to NMEP. This is a rise of more than 2.5 percent in contrast to the data for overall respondents. Negative responses account for 8.98 percent which is a rise 1.45 percent with respect to data for overall respondents. The percentage of undecided respondents is 28.15 which is a reduction of more than four percentage points from the data of overall respondents. This shows that SAP trained respondents are more sure when it comes to NMEP.

Table 4.10: Responses on Necessity of Measuring Enterprise Productivity (SAP Experience Groups – Overall)

SAP Experience Group (in months)	Yes	No	Can't Say	Total
0 – 36	47	7	37	91
37 – 73	34	5	19	58
74 – 110	47	3	11	61
111 – 147	16	3	8	27
148 – 184	0	0	2	2
Total	**144**	**14**	**77**	**239**

Data Source: Concerned Refineries

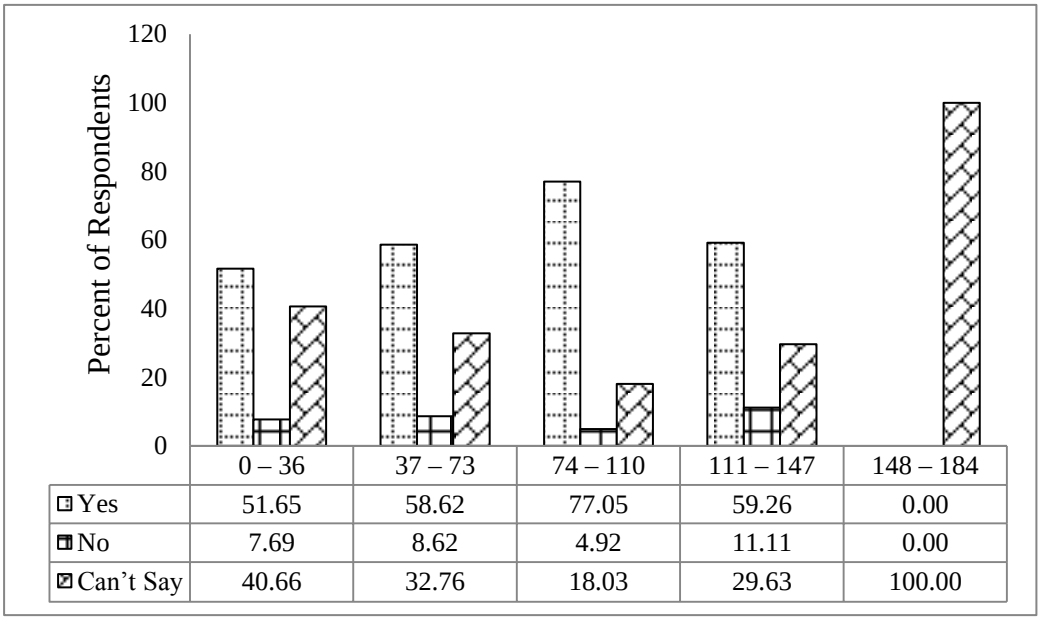
Illustration 4.7: Responses on Necessity of Measuring Enterprise Productivity (SAP Trained in percentage)



	Bongaigaon Refinery	Digboi Refinery	Guwahati Refinery	Numaligarh Refinery
Yes	68.42	52.63	66.67	69.70
No	10.53	15.79	5.13	0.00
Can't Say	21.05	31.58	28.21	30.30

Table 4.10 shows NMEP for the respondents according to their SAP usage experience in months. The corresponding illustration 4.8 shows that the percentage of respondents who think Enterprise Productivity should be measured is maximum for the Experienced (74 – 110) experience group. The maximum negative response is for the Very Experienced (111 – 147) experience group. It is thus difficult to infer if more SAP experience can lead to an affirmative answer as far as NMEP is concerned.

Illustration 4.8: Responses on Necessity of Measuring Enterprise Productivity (SAP Experience Groups – Overall in percentage)



	0 – 36	37 – 73	74 – 110	111 – 147	148 – 184
Yes	51.65	58.62	77.05	59.26	0.00
No	7.69	8.62	4.92	11.11	0.00
Can't Say	40.66	32.76	18.03	29.63	100.00

It is necessary to see if NMEP has some kind of association with some of the variables which have already been defined before in the context of the study: DTR (Department Type of Respondents), ETR (Employee Type of Respondents), HRE (Have Reporting Employees), TPPA (Training Programmes on Productivity Attended) and KEP (Knowledge about Enterprise Productivity). Measures of association can have two components – strength and direction. For nominal variables, there is only a value for the strength of the relationship, as there is no order to the values of these variables. A chi square based measure of association that can be used is Cramer's V. It is used when the number of rows is not equal to the number of columns. It is named after the Swedish mathematician and statistician Harald Cramér.

Cramer's V is defined as:

$$V = \sqrt{\frac{\Phi^2}{t}} = \sqrt{\frac{\chi^2}{nt}}$$

where *t* is the smaller of the number of rows minus one or the number of columns minus one. If *r* is the number of rows, and *c* is the number of columns, then

$$t = \text{Minimum } (r - 1; c - 1)$$

By using the information concerning the dimensions of the table, Cramer's V corrects for the problem that measures of association for tables of different dimension may be difficult to compare directly. Cramer's V equals 0 when there is no relationship between the two variables, and generally has a maximum value of 1, regardless of the dimension of the table or the sample size. This makes it possible to use Cramer's V to compare the strength of association between any two cross classification tables. Tables which have a larger value for Cramer's V can be considered to have a strong relationship between the variables, with a smaller value for V indicating a weaker relationship.

Table 4.11: Cramer's V between Selected Variables & NMEP

DTR	ETR	HRE	TPPA	KEP
0.1075	**0.1726**	**0.0896**	**0.1562**	**0.3125**

Data Source: Concerned Refineries

Table 4.11 shows the association between selected variables and NMEP (Need for Measuring Enterprise Productivity) through Cramer's V. It has been calculated for the entire sample and not for the individual refineries. This is

because a key requirement of Cramer's V, i.e., a minimum cell value of 5 for each cell is not met for the individual refineries. As is seen, Cramer's V is small except that of between KEP and NMEP. This suggests that there is some degree of association between KEP and NMEP indicating that those who know about Enterprise Productivity are more likely to feel the need for measuring Enterprise Productivity.

Table 4.12: Responses obtained as to how Enterprise Productivity may be measured?

Bongaigaon Refinery	**Digboi Refinery**	**Guwahati Refinery**	**Numaligarh Refinery**
Gross Refinery Margin (GRM) improvement	Gross Refinery Margin (GRM) improvement	Growth in value of the Company (market capitalization)	Following GRI G3 protocol
Meeting MOU targets	In terms of key parameter improvements. For examples, MBN, F&L, Yield, etc.		
In terms of variances with past or budgeted data	Operating Cost per unit production		

Data Source: Concerned Refineries

Table 4.12 shows only those responses which are specific and measurable.

The Gross Refining Margin (GRM) is the difference between the total value of petroleum products coming out of an oil refinery (output) and the price of the raw material (input), which is crude oil. The margins are calculated on a per-barrel basis. A barrel of crude, when cracked chemically, produces an entire range of fractionates like petrol, diesel, LPG and furnace oil, each having different applications.

MBTU/BBL/NRGF (MBN) is the amount of energy consumed in a refinery per barrel of crude processed per unit energy factor. MBTU refers to the total heat value of fuel and loss in thousand BTU (British Thermal Units), BBL refers to a barrel of crude processed and NRGF is the abbreviated form of Nelson's Refinery Grading Factor. NRGF is a composite energy factor of the refinery that depends upon actual intake in both primary and secondary processing units as per industry standards. F&L stands for Fuel and Lubricants, the outputs of a refinery.

All CPSEs (Central Public Sector Undertakings) sign MOUs with their administrative Ministries / Departments / Holding Companies. In case of Indian Oil Corporation Limited (IOCL), MOU (Memorandum of Understanding) is signed with the Ministry of Petroleum & Natural Gas (MoPNG), Government of India. In case of NRL, the MOU is signed with BPCL (Bharat Petroleum Corporation Limited), the largest stakeholder in NRL. It has a set of Criterions and Targets specified for a particular financial year which are selected by the respective entities from a set of parameters given by the Department of Public

Enterprises (DPE), Ministry of Heavy Industries and Public Enterprises, Government of India. Each of them has different weightages.

For the financial year, 2015 – 16 with respect to IOCL, the evaluation criteria are Static / Financial Parameters (50% weightage), Initiatives for Growth (19% weightage), Project Management and Implementation (10% weightage), Productivity and Internal Processes (7% weightage), Technology, Sector Specific / Enterprise Specific Parameter (6% weightage), Quality and Innovative Practices (4% weightage), Research & Development (3% weightage) and Dynamic / Non-financial Parameters (1% weightage). In case of NRL, for the financial year 2015 – 16, the evaluation criteria are Static / Financial Parameters (50% weightage), Initiatives for Growth (25% weightage), Project Management and Implementation (10% weightage), Productivity and Internal Processes (8% weightage), Sector Specific / Enterprise Specific Parameter (5% weightage) and Quality and Innovative Practices (2% weightage),

The Global Reporting Initiative (GRI) Reporting Framework is intended to serve as a generally accepted framework for reporting on an organization's economic, environmental, and social performance. It is designed for use by organizations of any size, sector, or location. It takes into account the practical considerations faced by a diverse range of organizations – from small enterprises to those with extensive and geographically dispersed operations. The GRI Reporting Framework contains general and sector-specific content that has been agreed by a

wide range of stakeholders around the world to be generally applicable for reporting an organization's sustainability performance.

GRI G3 Guidelines are made up of two parts. Part 1 – Reporting Principles and Guidance features guidance on how to report. Part 2 – Standard Disclosures features guidance on what should be reported, in the form of Disclosures on Management Approach and Performance Indicators ("Sustainability Reporting", 2011). Numaligarh Refinery comes out with a Sustainable Development Report (SDR) which details its compliance with GRI G3 guidelines. The level of reporting during the period 2013 – 14 and 2012 – 13 adhered to the A+ level as per GRI G3.1 guidelines whereas the report pertaining to 2011 – 12 was as per B+ level as per GRI G3 guidelines.

4.4 Conclusion

This chapter looked at the second objective of the present study, "To understand the use of productivity indicators for Enterprise Productivity analysis due to Enterprise Resource Planning (ERP) implementation from ERP user's perspective in the refineries of Assam".

The data reveals that the refineries in Assam have not given sufficient emphasis on training the SAP users. Only 70 percent of the SAP users are trained and out of these trained users, more than a whopping 81 percent have undergone training less than 7 days. The SAP users are thus grossly under-trained. Training in new

ERP systems is difficult for several reasons, including diversity, the complexity of the new system, and the variety of training methods available.

By their nature, ERP systems radically change how people do their jobs. The user needs to integrate SAP to all aspects of the business, which is not easy without proper training. These people also are busy, especially in coping with the requirements of the new system. Training users in new ERP systems can be extremely expensive also. Nevertheless, adequate training for all the SAP users should be an important priority in the refineries of Assam. Numaligarh Refinery which has the worst record as far as providing SAP training is concerned should put special focus in this regard. With better and comprehensive SAP training, the users will be in a better position to make proper and effective use of a complicated software like SAP which will have a positive impact on Enterprise Productivity.

It is seen that nearly two-thirds of the sampled SAP users in the refineries of Assam believe that there is a need to measure Enterprise Productivity. A sizeable percentage of the ERP users are also unsure about the need to measure Enterprise Productivity. The situation regarding the need for measuring Enterprise Productivity improves marginally for the SAP trained respondents. The uncertainty as to whether Enterprise Productivity should be measured is somewhat less among those respondents who are SAP trained in comparison to the overall sample. It is also seen that with more SAP usage experience amongst

the respondents, the trend of the need for measuring Enterprise Productivity increases before falling again.

Finally, it is observed that respondents who know about Enterprise Productivity are more likely to feel the need for measuring Enterprise Productivity. SAP users who feel that Enterprise Productivity should be measured will definitely welcome a productivity measurement initiative because of the use of SAP as and when it is undertaken.

When it comes to the actual measurement of Enterprise Productivity, the respondents were unable to come with specific measures on their part. A few productivity measures were spelt by the respondents which have been elaborated in the chapter. A majority of these productivity measures will be used as KPIs (Key Productivity Indicators) to develop a Measurement Framework which is elaborated in the next chapter.