CHAPTER 4

METHOD OF INVENTORY CONTROL AND FORECASTING

Data Collection from TOT

Ngamwongwan warehouse is the main source of data collection of the inventory under my study, type 5 inventory. Inventory cards, manually recorded any stock transactions by warehouse staffs, are the primary source of data collection. This card is recorded information regarding incoming, out going date of stock, department who make the requisition, and withdrawal/ deposited quantities.

The data collection process started in January 1997. The latest data would be available only to December 1996 while the first period would depend on the first time deposited of inventory.

Scope of this study is concentrated on 20 items, most valuable costs of type 5. Previously, these 20 items were coded under 10 figures. Each set of 10 figures represented one set of stock. However, code under 10 figures is no longer used due to the implementation of new computerize system, which required only 8 figures. Transition to new system causes difficulties to trace the record of items under 10-figure system. As a result, record keeping of three items, which are Fix Sub Equipment (DTMF) with Handbook, Mobile Telephone Coin Box, and TRP-1.5 GDMA 4 MB is unrecoverable.

From this point, 17 items was collected. To make reliable analysis, at least 12 months of information is required. By this criteria, three of 17 items failed to meet this time criteria. These three items are 8M Mux Equipment for NE 5520AA (2Sys/St), with four-month data, Base Station Multi-Access 8 RF to 16 RF, with three-month data, and 34 MBPS Digital Mux Equipment (Full Sys), with three-month data.

Fourteen items remaining for analysis are shown as follow:

1. Multi-Access Rural Radio Telephone (Subscriber)
2. First Order Digital Multiplex Equipment with 4W.E&M Sig
3. UHF Digital Radio Telephone Equipment 6Ch. (Sub & Ex)

4. 2GHz Digital Microwave Radio Equipment (8 MBPS)
5. Radio Set and Equipment for Microwave 13GHz 34MB
6. Hardware for Maintenance Center
7. 34M Mux Equipment for NE 5530AA (2Sys/St)
8. Digital Speech Interpolation (System Line double) 1Link
9. Digital Microwave Capacity 34MB with Multiplex Equipment
10. First Order Mux (N500 Series)
11. 2GHz. Digital Microwave Radio Equipment (34 MBPS)
12. 140 MBPS Digital Mux Equipment (Full System)
13. Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission
14. Microwave Minilink Equipment 13GHz 34MB

Data Analysis

Cumulative graph, the convenient and effective tool for inventory control, is employed for analyzing the collected data. The data required for the cumulative graph are the incoming-inventory quantities and the outgoing-inventory quantities. The example of the cumulative graph is shown in figures 4.1-4.2. The Y-axis is the quantity and the X-axis shows time starting from time zero. On the other hand, the graph showing cumulative incoming inventory starts from the initial stock level.

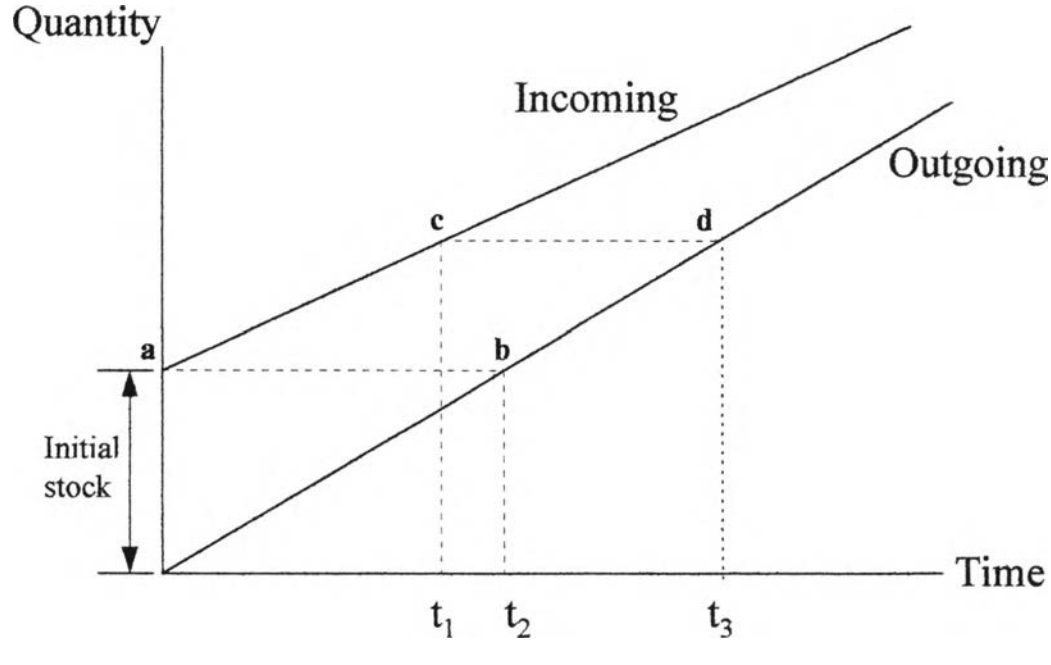

FIGURE 4.1 Inventory Time

From figure 4.1, the various kinds of information are gained. If the warehouse performs a perfect FIFO (First-In-First-Out system), the incoming inventory at time t_1 would be out of the warehouse by the time t_3 . Since this warehouse uses FIFO system, the initial stock would be used up some time after time zero. At the time of using up the initial stock, the quantity of the out going inventory, at point" b", must equal to the quantity of initial stock, at point "a". When passing point "b" that is time t_2, the incoming inventory since time zero is withdrawn from the warehouse.

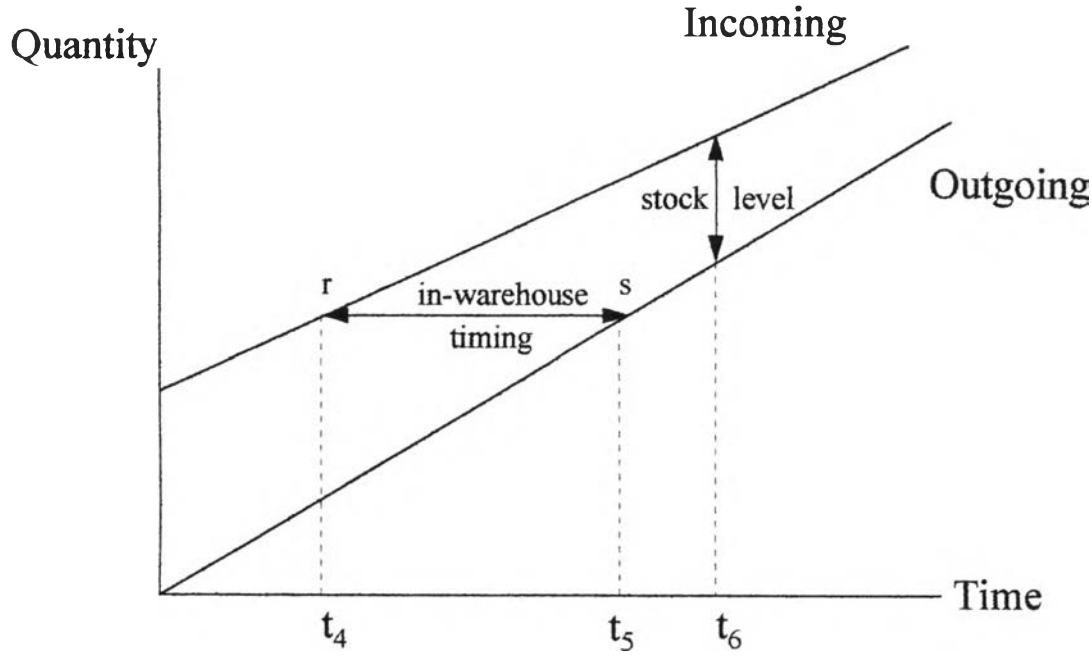

FIGURE 4.2 In-warehouse Timing and Stock Level

On figure 4.2, the length of time from t_4 to t_5 is the in-warehouse timing of the incoming-inventory at point "r". The stock level at time t_6 is simply known by drawing a line through t_6 parallel with the Y-axis. The distance between the cumulative incoming inventory and cumulative outgoing inventory shows the stock level at t_6.

Moreover, the area between the cumulative-incoming-inventory line and the cumulative-outgoing-inventory line represents the inventory level. In

general, the interest expense on the inventory cost vary through this inventory level. The effort must be put to keep this inventory level as small as possible.

For analyzing the collected data from TOT, the data are made in the cumulative data and then the cumulative graph of each item is drawn. From the graph, many information are gotten. The information are not only known from the graph, but also interviewing the person in charge to gain more details about each item.

The following pages are the cumulative graph of amount (quantity x purchase price) and time of each item of the inventory under my study. and the information getting from the graph and interviewing person in charge, presenting item by item. While the tables of data consisting of the incoming-inventory quantities and the outgoing-inventory quantities are shown in the appendix.

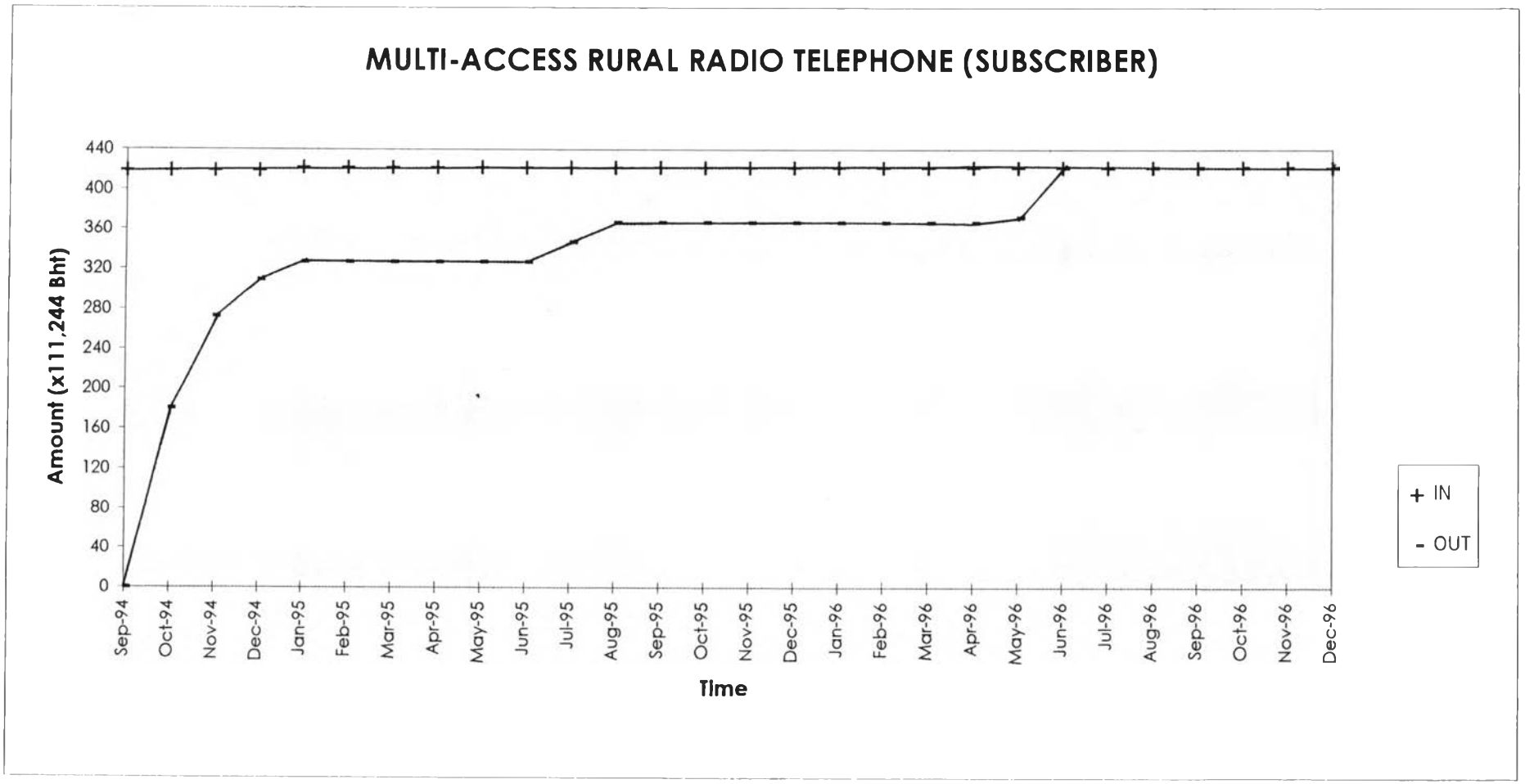

FIGURE 4.3 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR MULTI-ACCESS RURAL RADIO TELEPHONE (SUBSCRIBER)

Multi-Access Rural Radio Telephone (Subscriber)

Timing: September 1994 - June 1996

Incoming Inventory Quantity

Incoming inventory quantities started up at 419 sets. Additional 3 sets were replenished in January 1995.

Outgoing Inventory Quantity

Outgoing inventory quantities started up at zero level and then increased sharply from zero to 327 sets within four months. During February 1995 and June 1995, the outgoing rate remained in 327 sets without any movements. Outgoing quantities stepped up to new level which was 347 sets in August 1995 and remained constantly until May 1996. In June 1996, the outgoing quantity increased to 422 sets.

Stock Level

No stock available since June 1996.

Anticipation

From conducting interviews with responsible people, it is found that the Multi-Access Rural Radio Telephone (Subscriber) no longer be needed. This equipment was installed to use with analog system . Currently the system has been converted to digital, this equipment becomes obsolete and will not be ordered in the future. Therefore, it is not neccessary to forecast its demand.

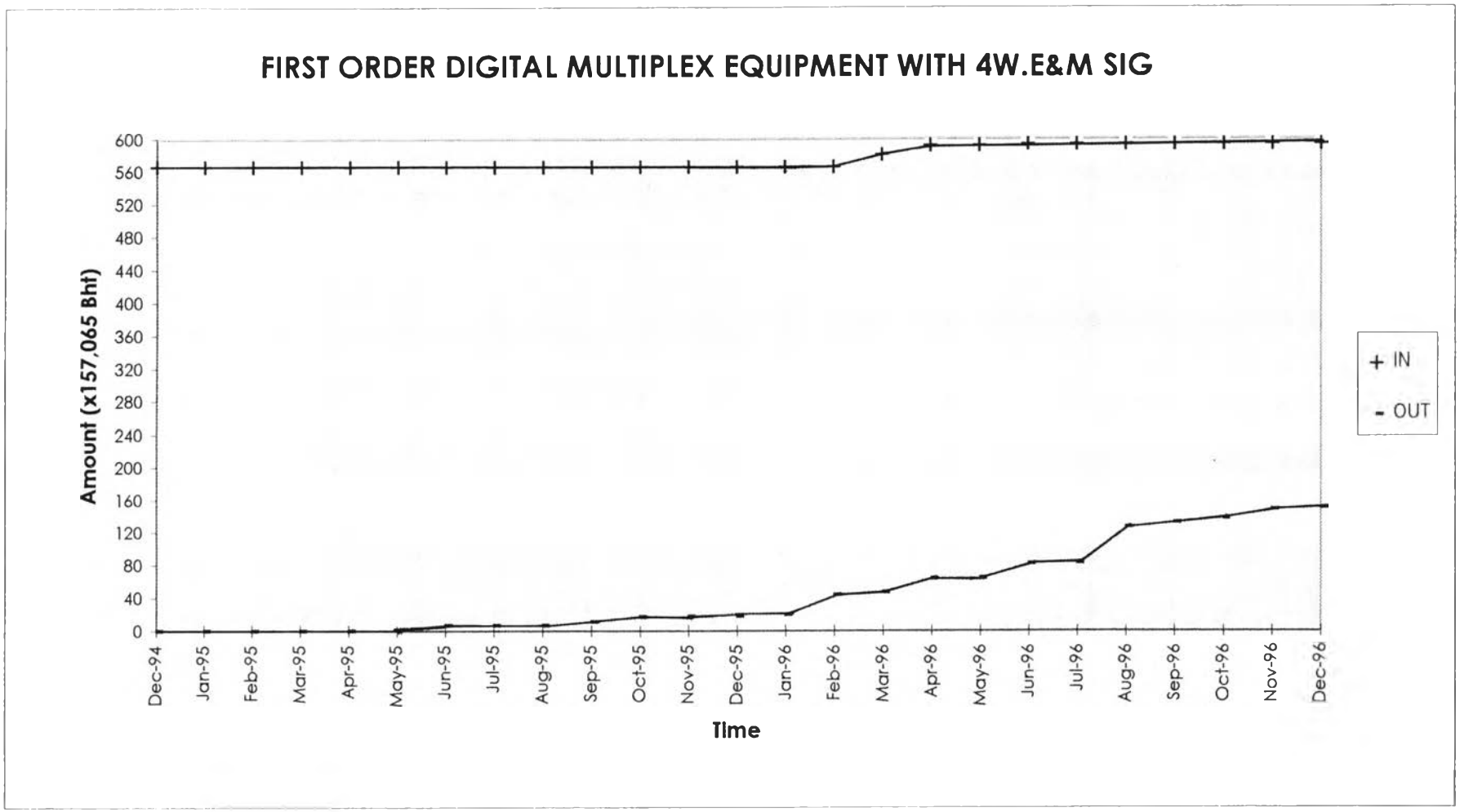

FIGURE 4.4 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR FIRST ORDER DIGITAL MULTIPLEX EQUIPMENT WITH 4W.E&M SIG

First Order Digital Multiplex Equipment with 4W. E&M Sig

Timing: December 1994 - December1996

Incoming inventory quantity

Incoming inventory quantity started up at 566 sets. There was an additional replenishment to 593.5 sets in June 1996.

Outgoing inventory quantity

Outgoing inventory quantity stayed at zero between December 1994 to May 1995. Outgoing rate increased slightly to 20 sets in January 1996. There has been a steady rise until the outgoing quantity reached 150.5 sets in December 1996. At this time, it can be seen that holding stock of the First Order Digital Multiplex Equipment with 4W. E&M Sig was high (443 sets), can also see from the gap between the incoming quantity line and the outgoing quantity line in figure 4.4.

Anticipation

From conducting interviews with persons in charge, it is found that all of the incoming items of the First Order Digital Multiplex Equipment with 4W. E&M Sig have already been possessed by the department responsible for the installation work. Withdrawal rate was low due to the limited number of installation operators.

Outgoing quantities for this item did not reflect the real quantities in some months. To investigate this outgoing quantity, the department that withdraw these items from warehouse have been asked. The following are the explanation from these departments.

In February 1996: outgoing quantities = 24 sets
The Special Service department withdrew 15 sets holding for projected installation usage. Therefore, actual outgoing quantities equal to 9 sets.

In April 1996, outgoing quantities = 16.5 sets
The Special Service department withdrew 10 sets holding for projected installation usage. Therefore, actual outgoing quantities equal to 6.5 sets.

In June 1996: outgoing quantities = 17 sets
Khon Khen Exchange (one of the main exchange in north eastern part of Thailand) withdrew 11 sets for holding. Therefore, actual outgoing quantities equal to 6 sets.

In August 1996: outgoing quantities 44 sets

Chiengmai Exchange, main exchange in northern Thailand, withdrew 30 sets for holding. Therefore, actual outgoing quantities equal to 14 sets.

Table of actual outgoing quantities of First Order Digital Multiplex Equipment with 4W. E&M Sig is in the following section.

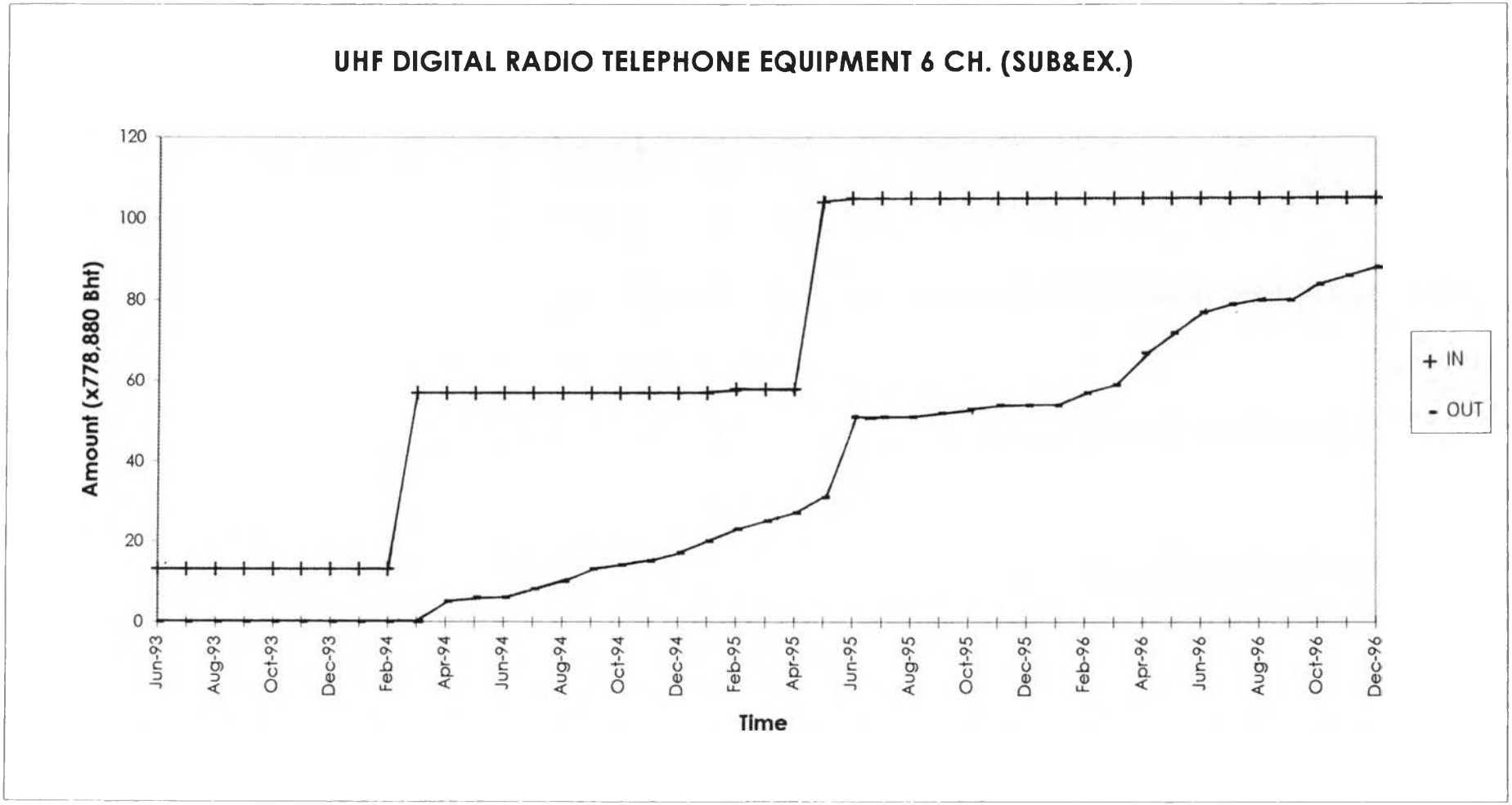

FIGURE 4.5 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR UHF DIGITAL RADIO TELEPHONE EQUIPMENT 6CH (SUB & EX)

UHF Digital Radio Telephone Equipment 6Ch (Sub & Ex)

Timing : June 1993 - December 1996

Incoming inventory quantity

The starting level of incoming inventory was at 13 sets. There was a sharp rise to 57 sets in March 1994 ,then remained at that level. In May 1995, incoming quantity went up sharply again to 105 sets.

Outgoing inventory quantity

Between June 1993 and March 1994, outgoing inventory level stayed at zero and then rose gradually to 88 sets in December 1996.

Stock level

The holding stock of UHF Digital Radio Telephone Equipment 6Ch (Sub & Ex) was approximately high which can be seen from the area between incoming quantity line and outgoing quantity line in figure 4.5.

Anticipation

From conducting interviews with persons in charge, it is found that demand of UHF Digital Radio Telephone Equipment 6Ch (Sub & Ex) is high. This equipment is used to link the communication system between users' homes and exchange. Accordingly, the demand depends directly on the number of users and the needs of communication facilities.

The outgoing quantities for this item did not reflect the real quantities in some months. To investigate this outgoing quantity, the departments that withdraw these items from warehouse have been asked. The following are the explanation from these departments.

In June 1995 : outgoing quantities = 20 sets

Region one Exchange withdrew 15 sets for holding. Therefore, actual outgoing quantities equal to 5 sets.

In May 1996 : outgoing quantities = 5 sets

Suratthani Exchange, the main exchange in southern Thailand, withdrew 3 units for holding. Therefore, actual outgoing quantities equal 2 sets.

Table of actual outgoing quantities of UHF Digital Radio Telephone Equipment 6Ch (Sub & Ex) is in the following section.

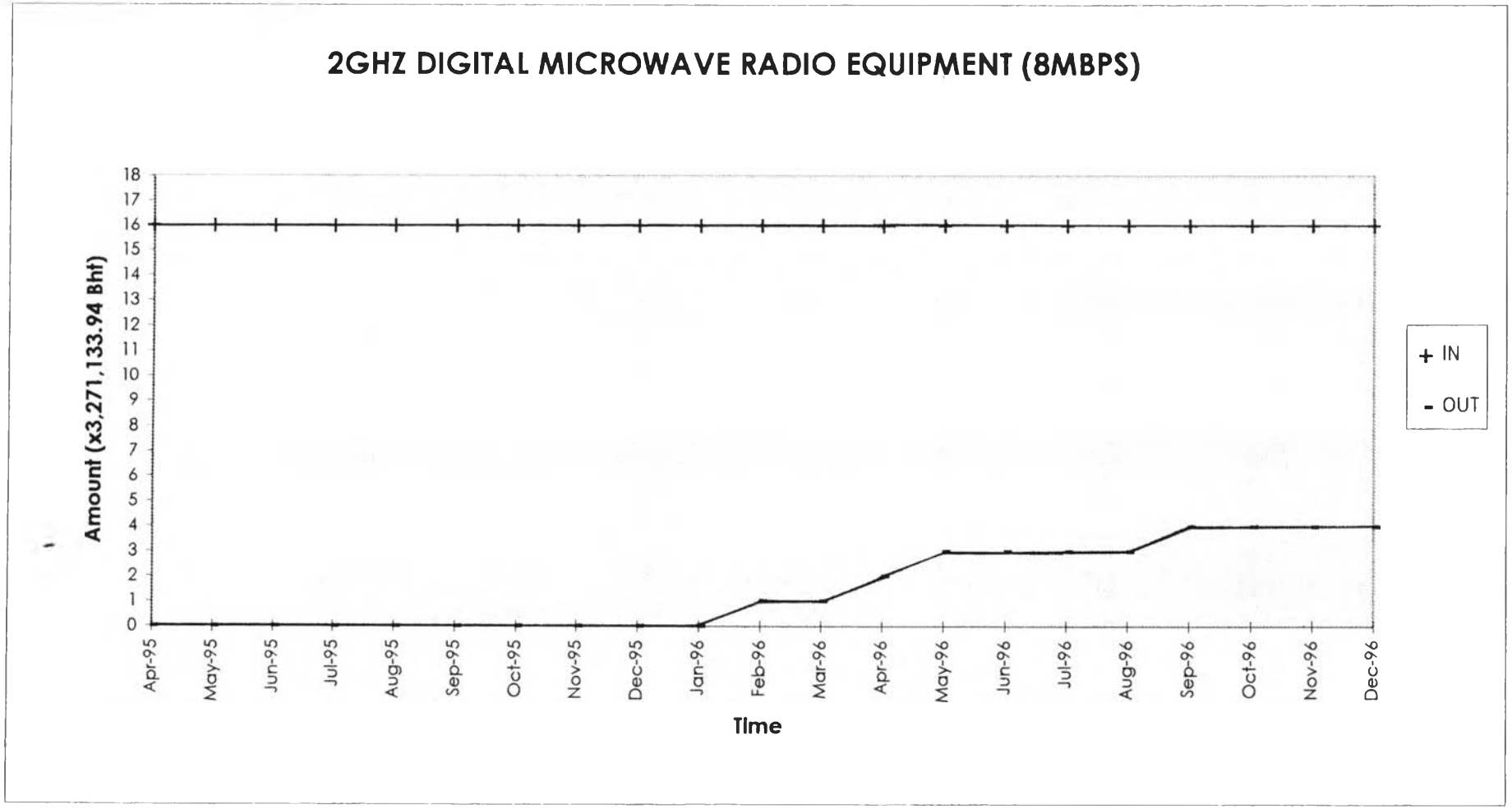

FIGURE 4.6 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR 2GHZ DIGITAL MICROWAVE RADIO EQUIPMENT (8MBPS)

2 GHz Digital Microwave Radio Equipment (8 MBPS)

Timing : April 1995 - December 1996

Incoming inventory quantity

Inventory card shows that 16 sets of 2 GHz Digital Microwave Radio Equipment (8 MBPS) has been in this warehouse since April 1995 and remained at that level until December 1996.

Outgoing inventory quantity

Outgoing inventory quantity has stayed at zero until January 1996. One set was withdrawn in February 1996, April 1996, May 1996, and September 1996.

Stock level

Stock is high because 16 sets deposited in the warehouse had been stored for a long time before the first withdrawal process was made in February 1996 and the outgoing rate was quite low.

Anticipation

From conducting interviews with persons in charge, it is found that 2 GHz Digital Microwave Radio Equipment (8 MBPS) is installed between exchange and subscribers, users, for telecommunication purposes. Before installing, the frequency used in communication area has to be checked. For example, if the 2 GHz frequency has already been used, this equipment is not capable to install in that area. This frequency limitation causes low rate of outgoing quantity. Another reason for slow moving rate is the limited number of installation operators.

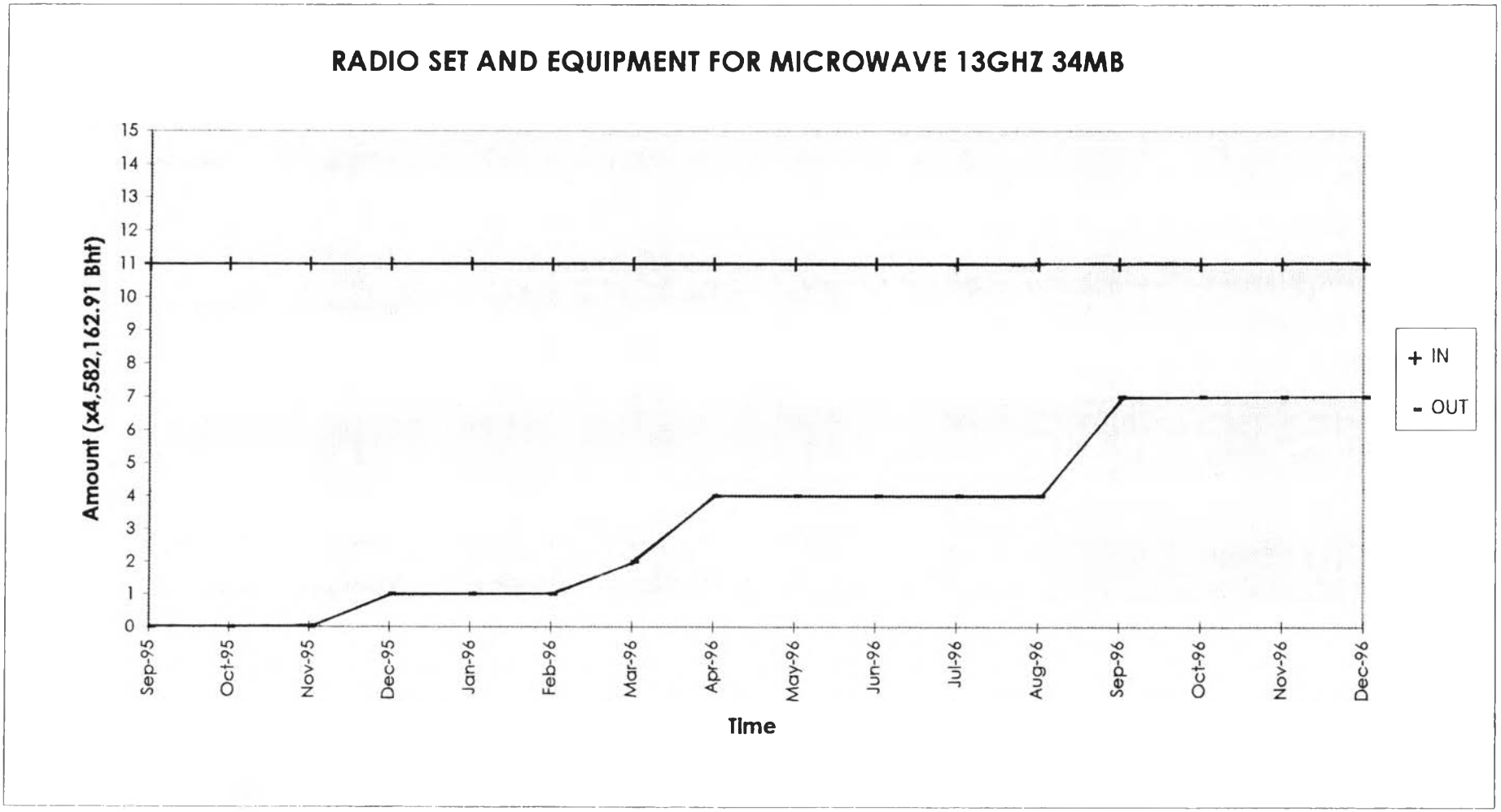

FIGURE 4.7 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR RADIO SET AND EQUIPMENT FOR MICROWAVE 13GHZ 34MB

Radio Set and Equipment for Microwave 13 GHz 34MB

Timing : September 1995 - December 1996

Incoming inventory quantity

In September 1995, 11 sets were deposited and no more replenishment.

Outgoing inventory quantity

There was a slight increase to 4 sets in April 1996 after no movement from September 1995 to November 1995. Outgoing quantity then rose to 7 sets in September 1996.

Stock Level

Stock level of Radio Set and Equipment for Microwave 13 GHz 34MB has been decreased due to no replenishment of incoming inventory and a rise of outgoing inventory.

Anticipation

From conducting interviews with persons in charge, it is found that this equipment is installed for telecommunication purpose in rural area. The demand of this equipment depends on users' needs and work expansion.

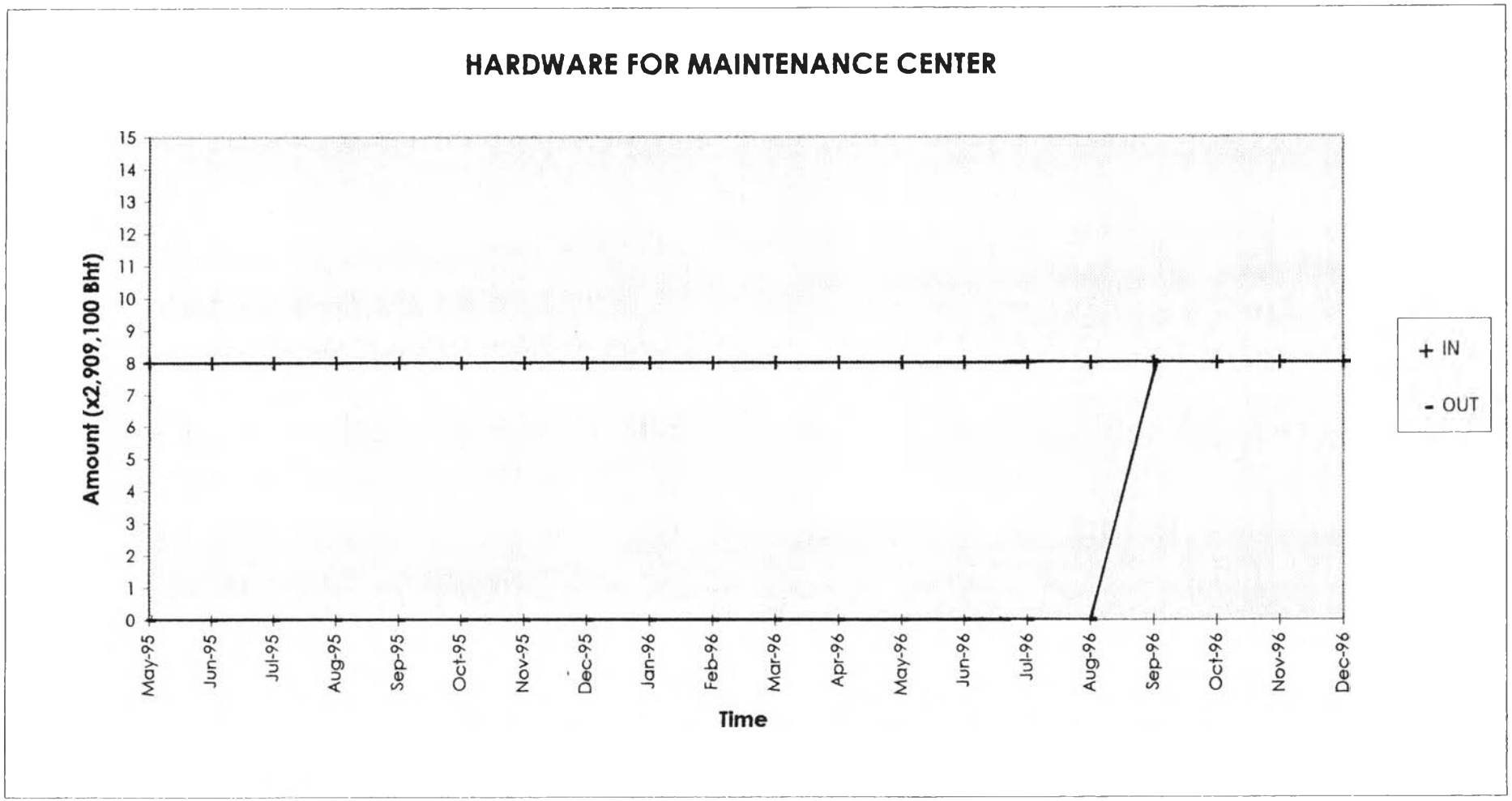

FIGURE 4.8 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR HARDWARE FOR MAINTENANCE CENTER

Hardware for Maintenance Center

Timing : May 1995 - September 1996

Incoming Inventory Quantity

Eight sets of Hardware for Maintenance Center have been deposited into the warehouse since May 1995.

Outgoing Inventory Quantity

Outgoing Inventory Quantity was zero until September 1996 when there was a sharp rise to 8 sets.

Stock Level

No stock available since September 1996.

Anticipation

From conducting interviews with persons in charge, it is found that this quipment is hardware for the computerize-maintenance center in 8 main exchanges all over Thailand. There will be no further order of the Hardware for Maintenance Center in the future. Accordingly, it is not neccessary to forecast its demand.

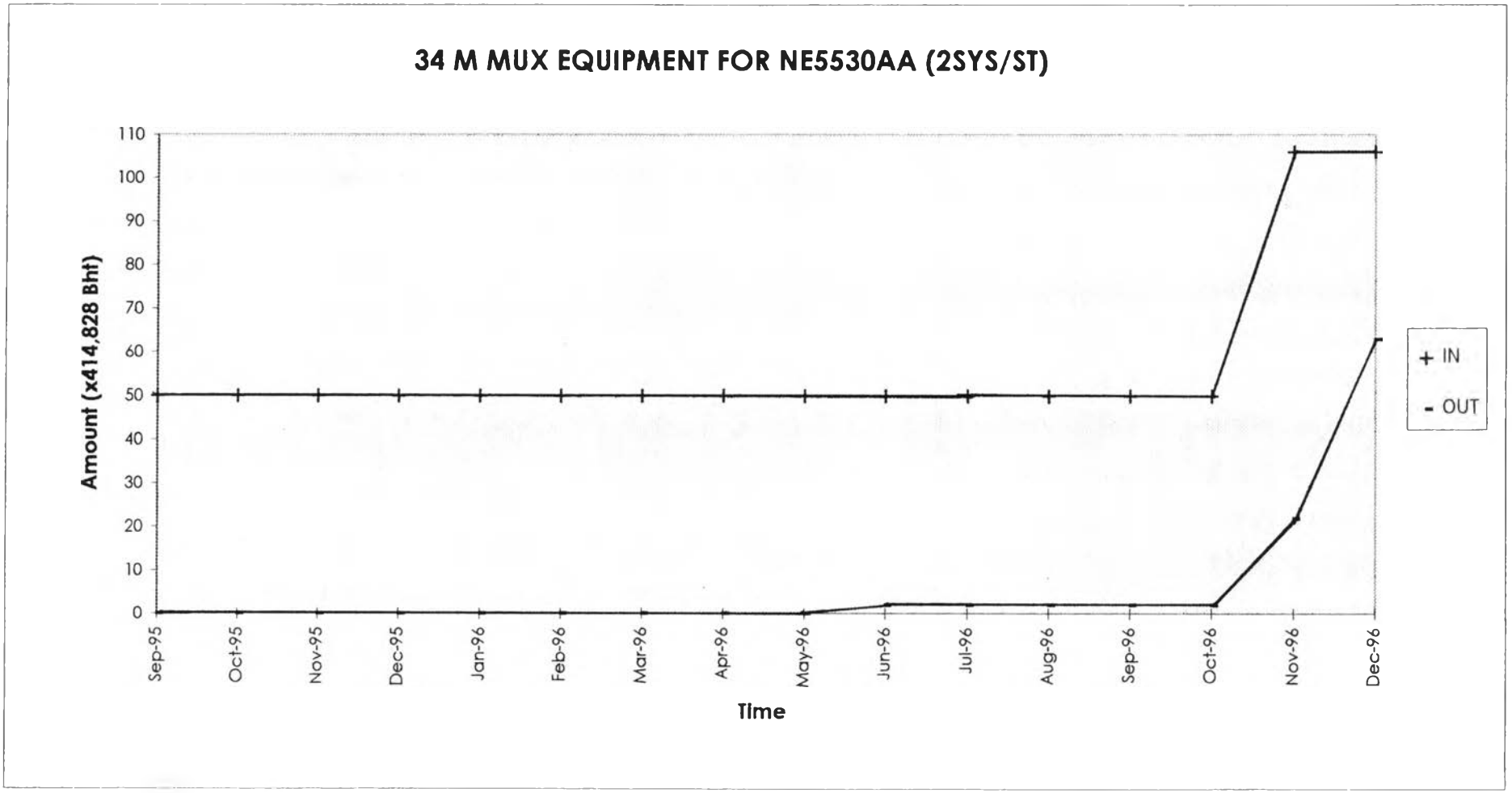

FIGURE 4.9 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR 34M MUX EQUIPMENT FOR NE 5530 AA (2SYS / ST)

34M Mux Equipment for NE 5530AA (2 Sys / St)

Timing : September 1995 - December 1996

Incoming Inventory Quantity

Incoming inventory quantity started at 50 sets. Additional 56 sets were replenished in November 1996.

Outgoing Inventory Quantity

There was no movement of outgoing quantity until June 1996 when 2 sets were withdrawn. The outgoing level remained at 2 sets until a sharp increase to 63 sets in December 1996.

Stock Level

Holding stock of 34M Mux Equipment for NE 5530AA (2 Sys / St) is high, approximately 50 sets.

Anticipation

From conducting interviews with persons in charge, it is found that 34M Mux Equipment for NE 5530AA (2 Sys / St) is the specific equipment for the NEC system. It was ordered for use in project setting in a specific time. There will not be any order in the future after stock is used up. Thus,it is not neccessary to forecast its demand.

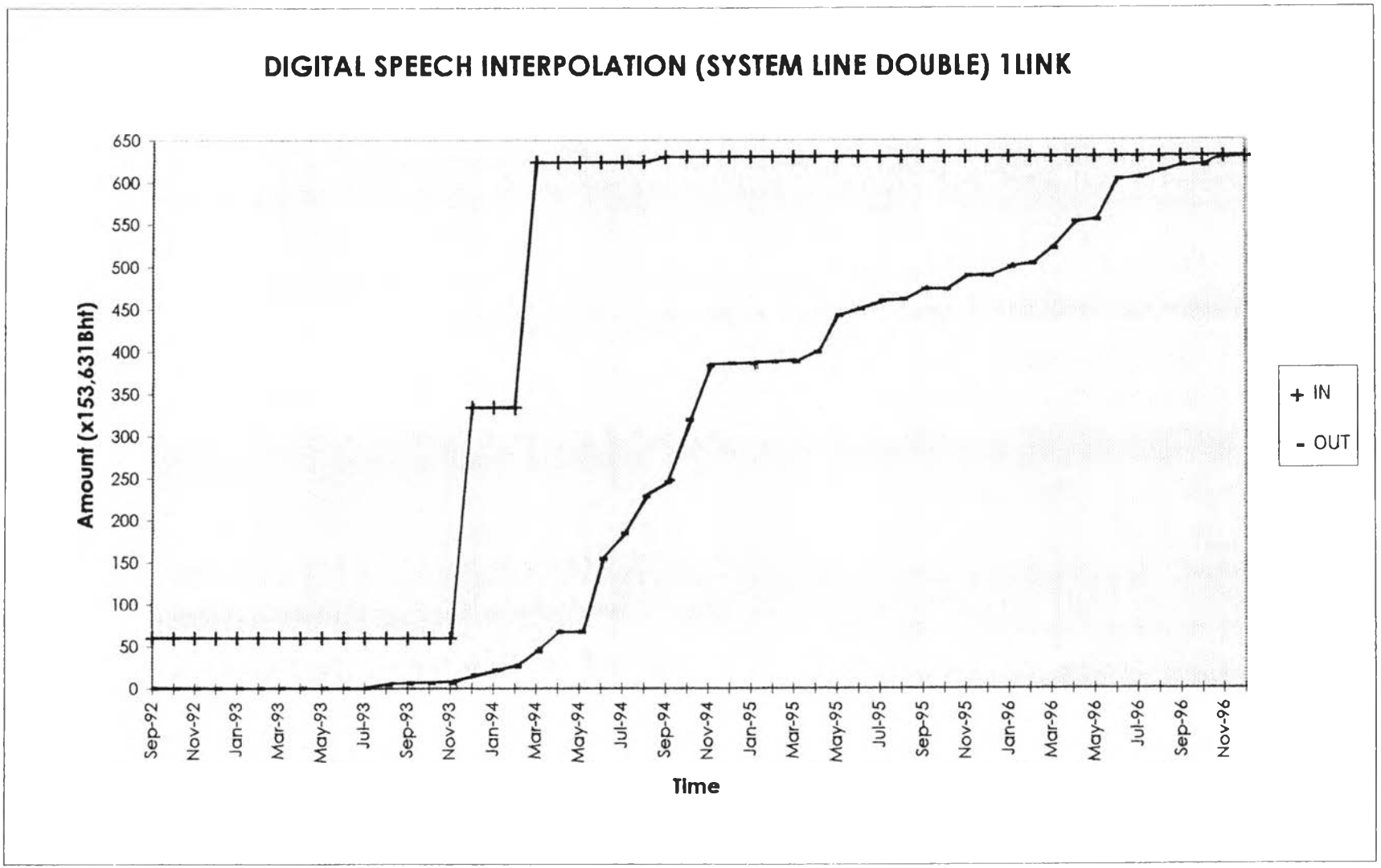

FIGURE 4.10 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR DIGITAL SPEECH INTERPOLATION (SYSTEM LINE DOUBLE) 1LINK

Digital Speech Interpolation (System Line Double) 1 Link

Timing : September 1992 - December 1996

Incoming Inventory Quantity

Incoming quantity started up at 60 sets and remained at that level to November 1993. After that, there was a dramatically increase to 624 sets in March 1994. Additional 6 sets were replenished in September 1994 making incoming quantity step to 630 sets.

Outgoing Inventory Quantity

Outgoing quantity has been zero until July 1993 when there was a steady rise to 67 sets in May 1994. Dramatically increase occured to meet 629 sets level in November 1996.

Stock Level

There was 1 set available in stock.

Anticipation

From conducting interviews with persons in charge, it is found that Digital Speech Interpolation (System Line Double) 1 Link is the equipment for changing voice signal, analog data, to digital data before connecting to the multiplex equipment. Unlike voice signal, this equipment is not capable for converting other signals to digital data. Due to low capability, TOT will not consider to order this equipment anymore. This equipment is no need for forcasting process as there will be no future demand.

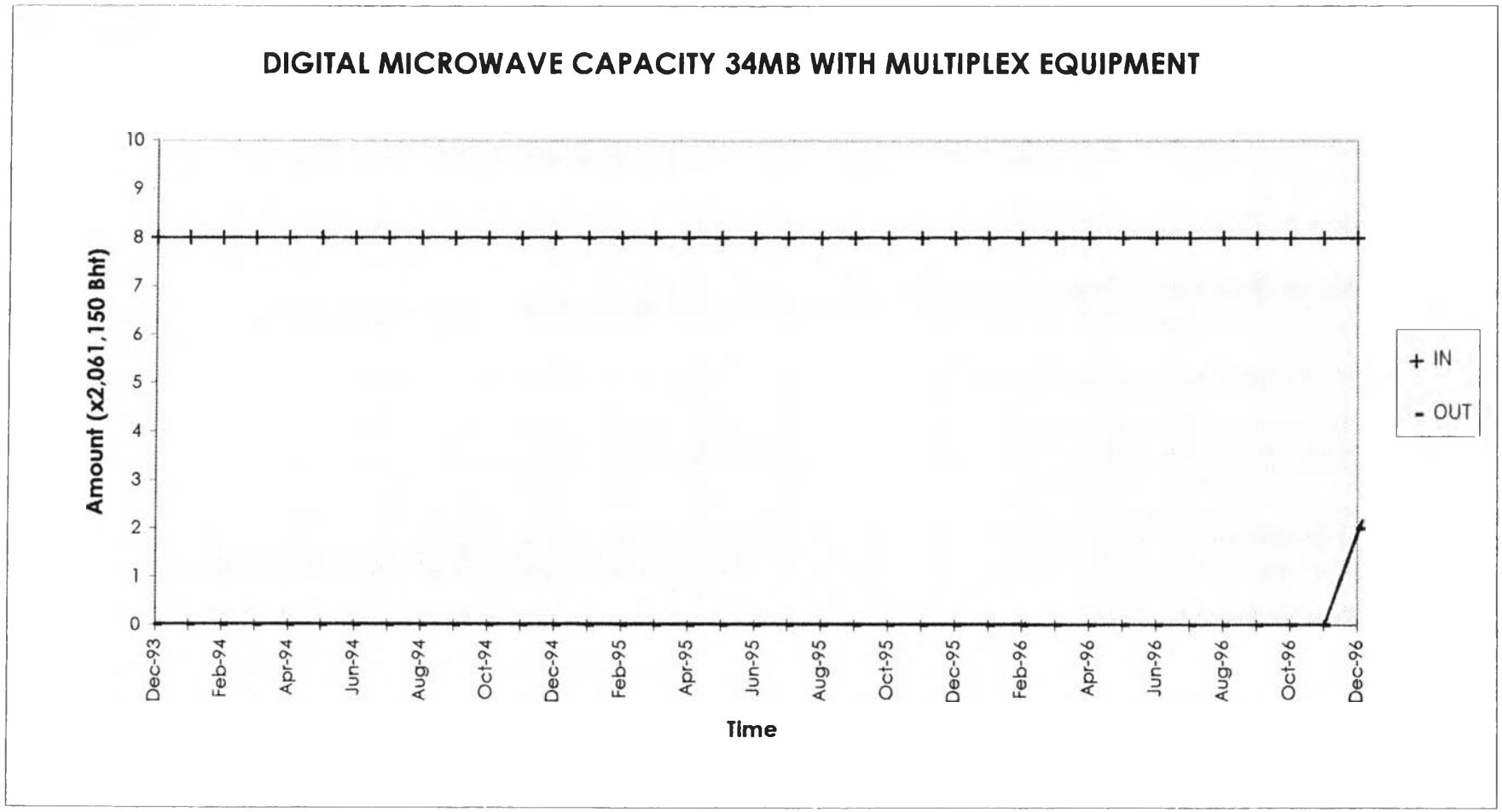

FIGURE 4.11 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR DIGITAL MICROWAVE CAPACITY 34MB WITH MULTIPLEX EQUIPMENT

Digital Microwave Capacity 34MB with Multiplex Equipment

Timing : December 1993 - December 1996

Incoming Inventory Quantity

Eight sets of Digital Microwave Capacity 34MB with Multiplex equipment were deposited in the warehouse in December 1993 and there has been no replenishment eversince.

Outgoing Inventory Quantity

Outgoing quantity started at zero and remained at that level until December 1996 when 2 sets were withdrawn.

Stock Level

The holding stock is high due to 8 sets deposited have been stored in the warehouse for a long time.

Anticipation

From conducting interviews with persons in charge, it is found that Digital Microwave Capacity 34MB with Multiplex Equipment was stored to be spare parts for " Digital Transmission System Project " , master plan. This project was planned for the main telecommunication system in Thailand. It is a long-term project and all equipment (including spare parts) was bought at the same time due to budgetting process. There will not be any further order for this equipment in the future. Hence, Digital Microwave Capacity 34MB with Multiplex Equipment needs no forecasting.

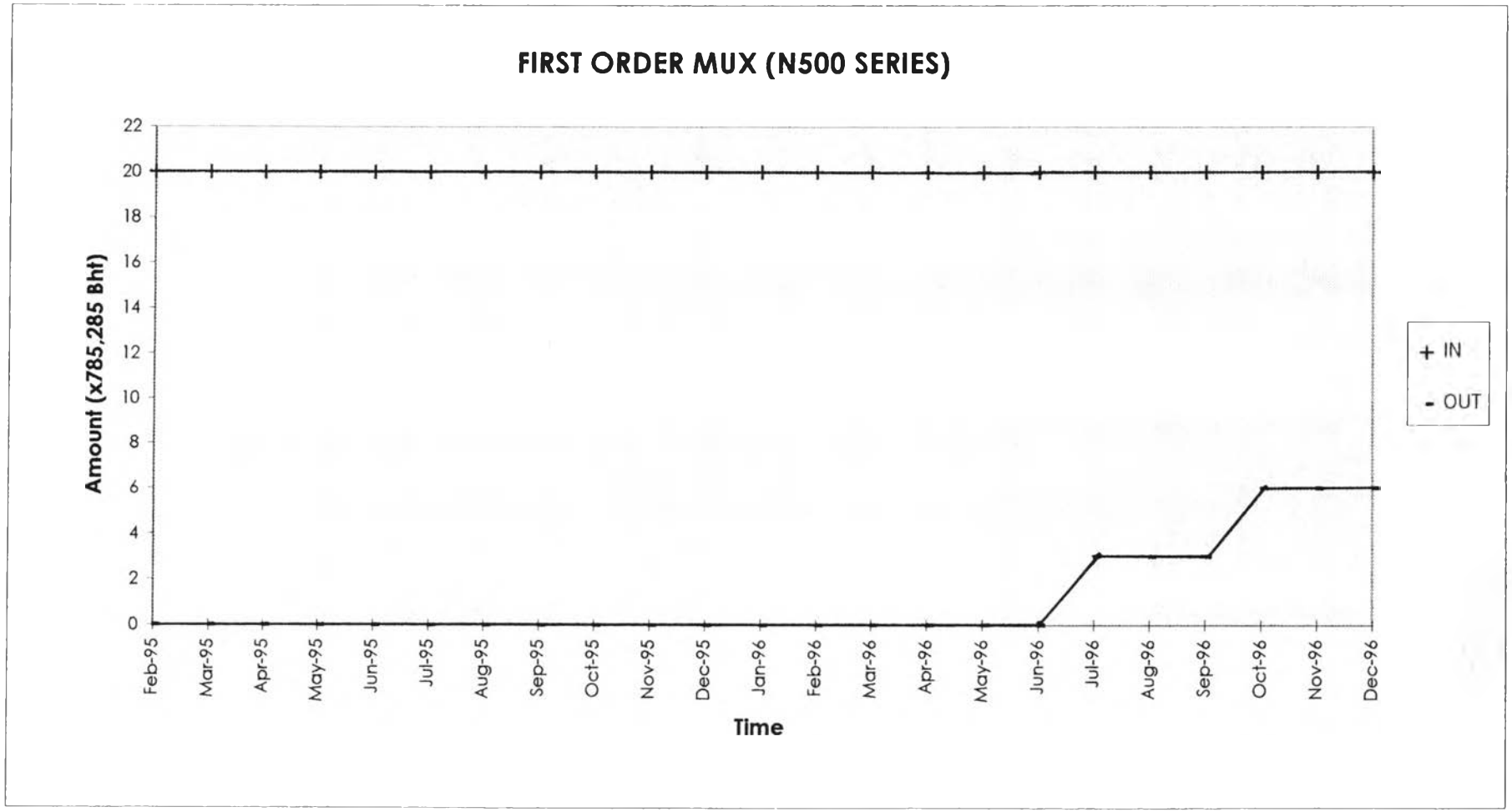

FIGURE 4.12 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR FIRST ORDER MUX (N500 SERIES)

First Order Mux (N500 Series)

Timing : February 1995 to December 1996

Incoming Inventory Quantity

Twenty sets of First Order Mux (N500 Series) were deposited to the warehouse and there has been no replenishment.

Outgoing Inventory Quantity

There was no movement of outgoing quantity until June 1996 when a slight increase occured to 6 sets level in October 1996.

Stock Level

The holding stock is high.

Anticipation

From conducting interviews with persons in charge, it is found that First Order Mux (N500 Series) is multiplex equipment used for cost effective transmission. The demand of this equipment depends on users' needs which are high in the current communication situation.

The outgoing quantity was shown the slow-moving situation because of the limitation of installation operators.

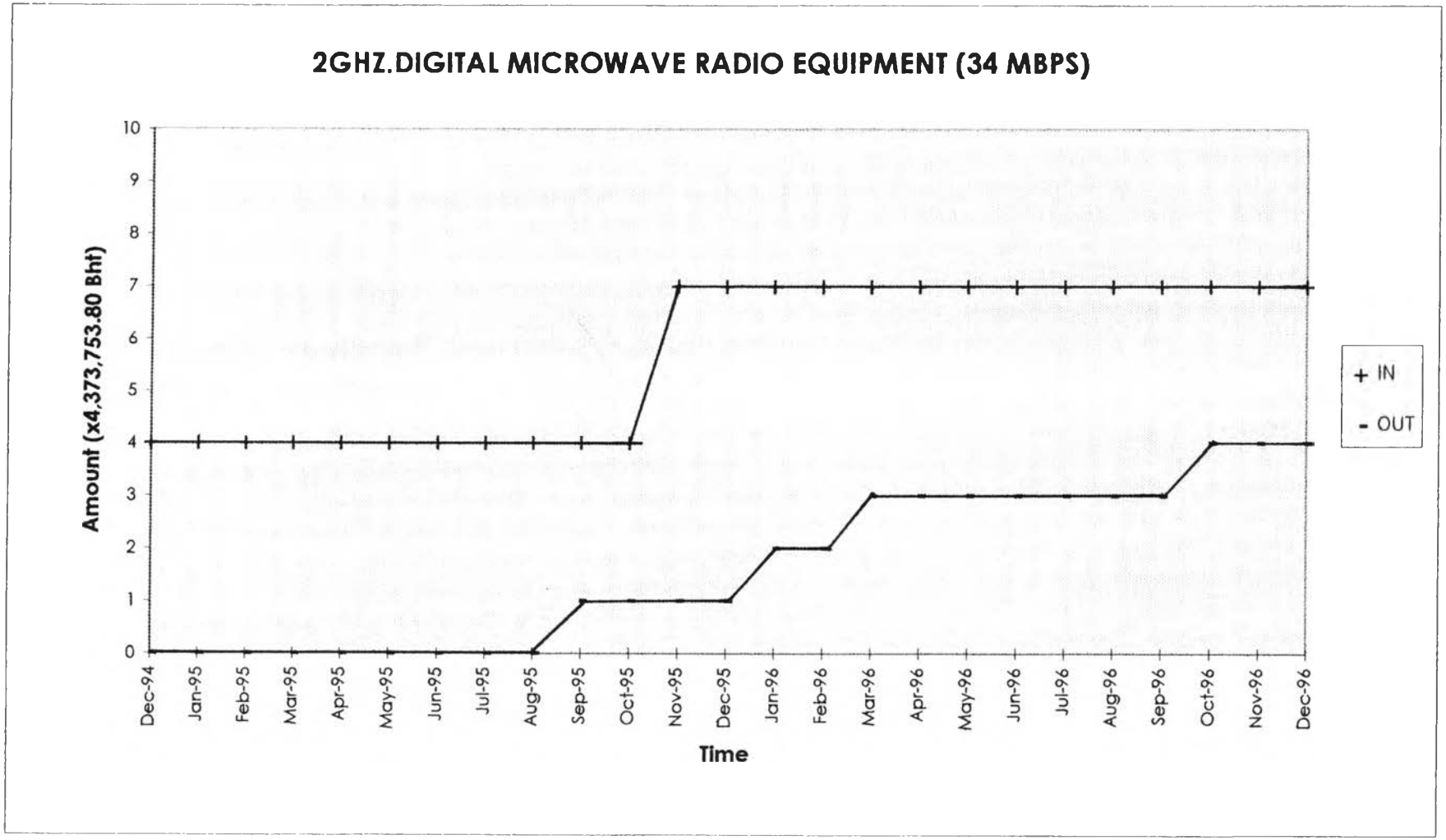

FIGURE 4.13 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR 2GHZ. DIGITAL MICROWAVE RADIO EQUIPMENT (34 MBPS)

2 GHZ Digital Microwave Radio Equipment (34 MBPS)

Timing : December 1994 - December 1996

Incoming Inventory Quantity

Four sets of 2 GHZ Digital Microwave Radio Equipment (34 MBPS) were deposited to warehouse in December 1994 and 3 sets were replenished in November 1995.

Outgoing Inventory Quantity

The outgoing quantity started at zero and stayed that way until August 1995. After that,there was a slight increase to 4 sets in October 1996.

Stock Level

Approximately 4 sets have been stored in the warehouse.

Anticipation

From conducting interviews with persons in charge, it is found that this equipment functioned as same as 2 GHZ Digital Microwave Radio Equipment (8 MBPS) but has better capacity of transmitting data. Its usage is to install between user and exchange for telecommunication purposes. Therefore, its demands depend on users' needs.

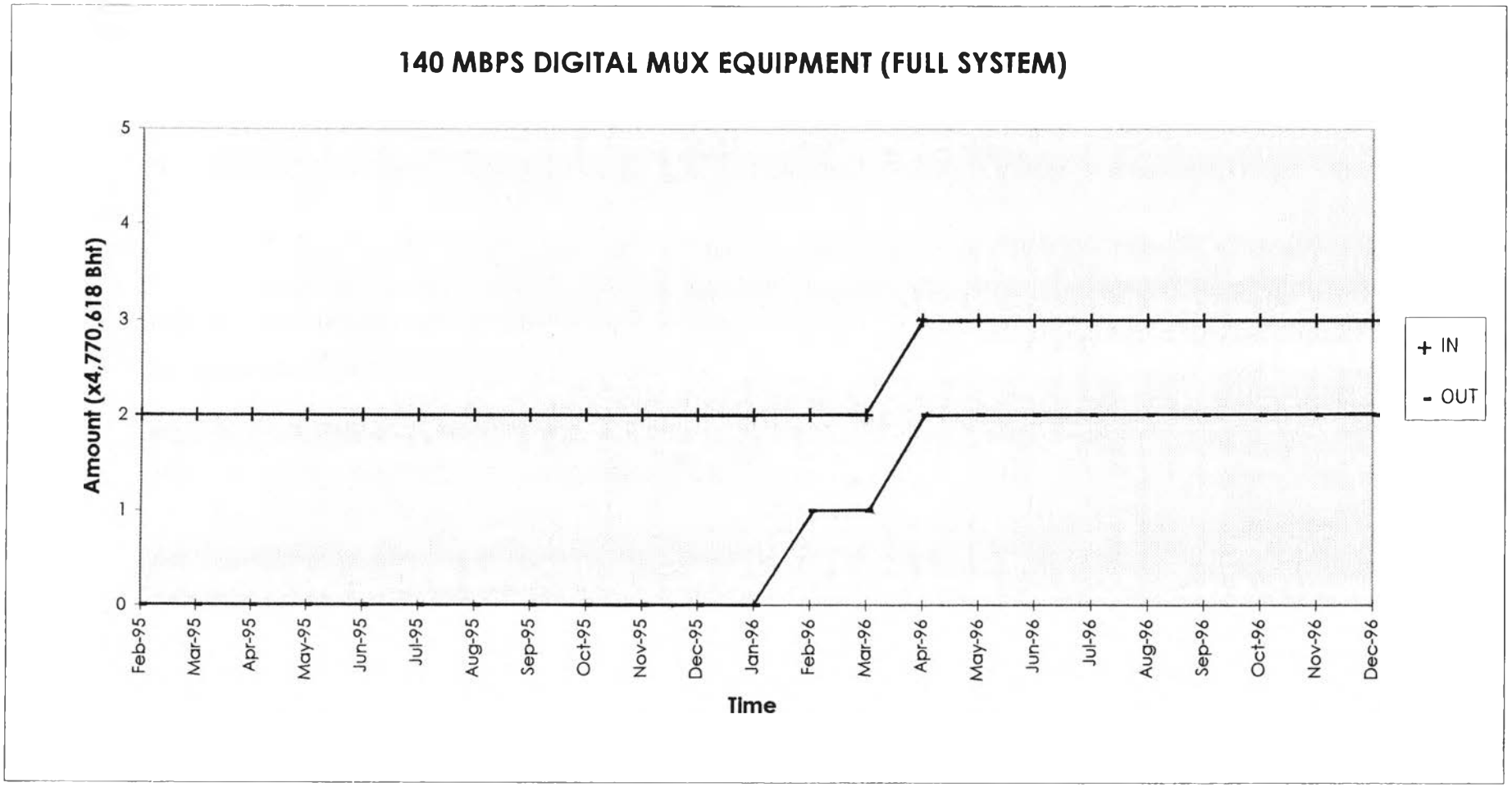

FIGURE 4.14 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR 140MBPS DIGITAL MUX EQUIPMENT (FULL SYSTEM)

140 MBPS Digital Mux Equipment (Full System)

Timing : February 1995 - December 1996

Incoming Inventory Quantity

Incoming quantity started up at 2 sets. Another set was replenished in April 1996.

Outgoing Inventory Quantity

There was no movement of outgoing quantity until January 1996 when a steady increase made the level step up to 2 sets in April 1996.

Stock Level

One set was available in the warehouse.

Anticipation

From conducting interviews with persons in charge, it is found that 140 MBPS Digital Mux Equipment (Full System) was ordered for use in special project-Royal duty work, for instance. Accordingly, the demand of this equipment depends on the number of special projects in the future.

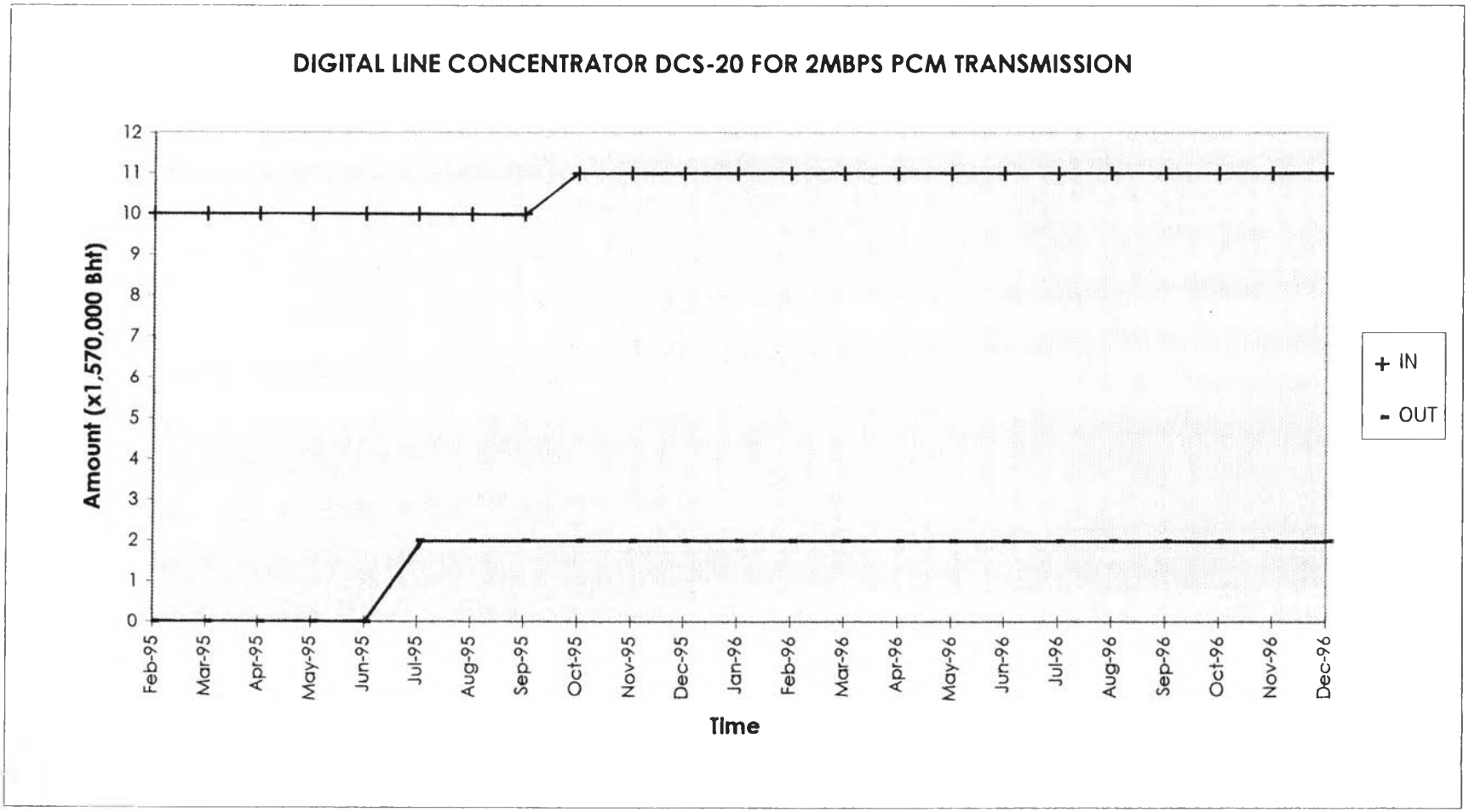

FIGURE 4.15 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR DIGITAL LINE CONCENTRATOR DCS-20 FOR 2MBPS PCM TRANSMISSION

Digital Line Concentrator DCS-20 for 2 MBPS PCM Transmission

Timing : February 1996 - December 1996

Incoming Inventory Quantity

Ten sets of Digital Line Concentrator DCS-20 for 2 MBPS PCM Transmission were deposited to the warehouse in February 1996. An additional 1 set was replenished in October 1995.

Outgoing Inventory Quantity

There was no movement of outgoing quantity except in July 1995 when 2 sets were withdrawn.

Stock Level

The holding stock is high which can be seen from the area difference between the incoming quantity line and the outgoing quantity line in figure 4.15.

Anticipation

From conducting interviews with persons in charge, it is found that Digital Line Concentrator DCS-20 for 2 MBPS PCM Transmission is the equipment used in special projects and expansion work in rural area. Therefore, its demand depends on number of projects scheduled in the future.

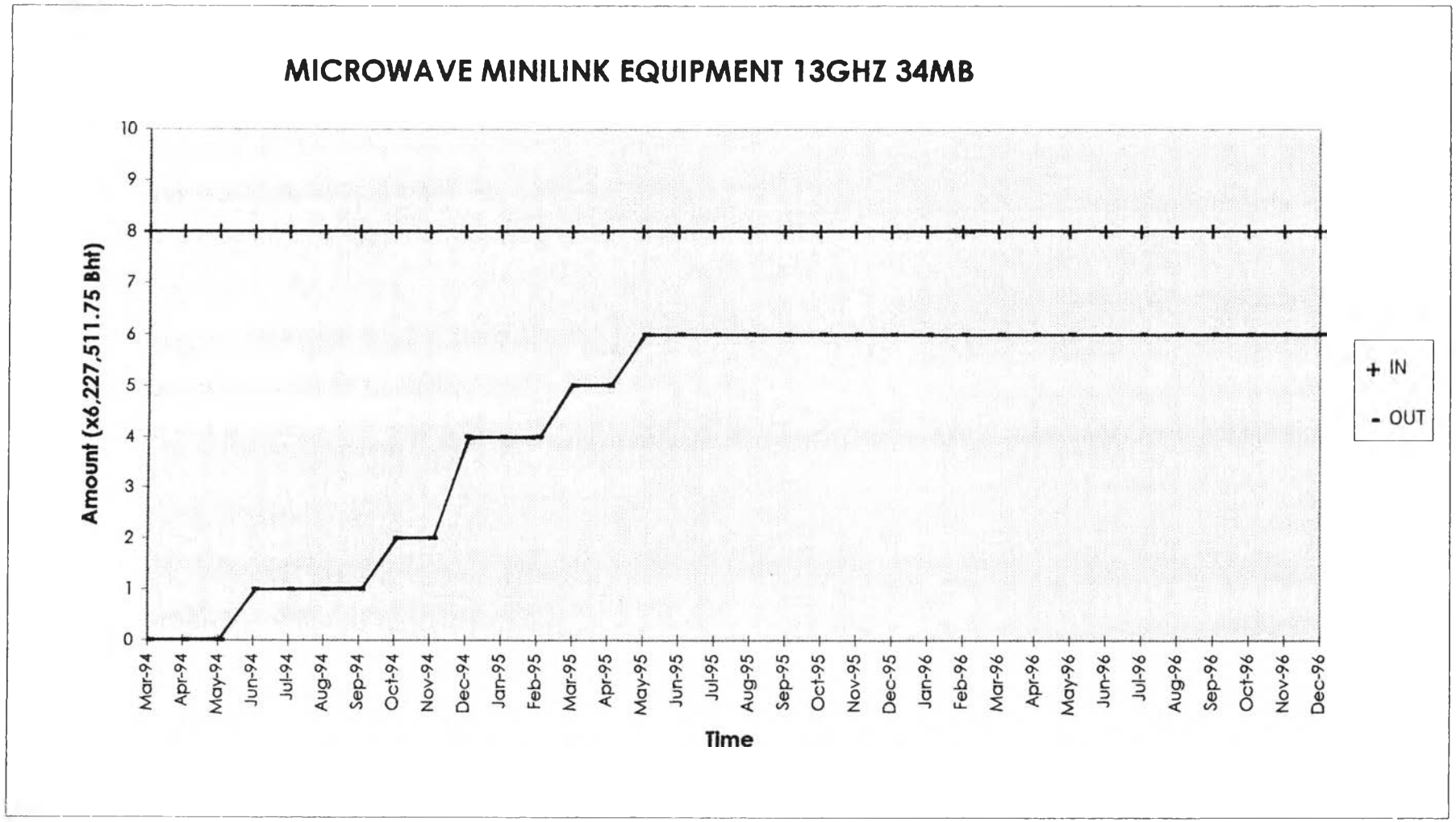

FIGURE 4.16 CUMULATIVE GRAPH OF INCOMING-INVENTORY QUANTITY AND OUTGOING-INVENTORY QUANTITY FOR MICROWAVE MINILINK EQUIPMENT 13GHZ 34MB

Microwave Minilink Equipment 13GHZ 34MB

Timing : March 1994 - December 1996

Incoming Inventory Quantity

Inventory card indicates that 8 sets of Microwave Minilink Equipment 13GHZ 34MB had been in the warehouse since March 1994 and remained at that level until December 1996.

Outgoing Inventory Quantity

The outgoing quantity started at zero and gradually increased to 6 sets in May 1995 and there was no movement of the outgoing rate eversince.

Stock Level

Two sets of Microwave Minilink Equipment 13GHZ 34MB have been stored in the warehouse.

Anticipation

From conducting interviews with persons in charge, it is found that Microwave Minilink Equipment 13GHZ 34MB is to be installed in the area where there is no telephone line for telecommunication; for example, projects in the remote area where infrastructure is not yet readily available 0 such as an airport, an industrial estate. The demand of this equipment depends on users' needs which will be high in the future.

Figure 3.14.1 showed no movement of the outgoing quantity during June 1995 to December 1996. This was caused by the tardiness in processing document of the responsible department.

Demand Forecasting

Analyzing indicates that some of the equipment stays in the warehouse for a period of time and once it has been all withdrawn, there will be no further orders due to the following reasons

- The equipment used in the system is obsolete
  - Multi Access Rural Radio Telephone (Subscriber)
- The equipment is a one time order
  - Hardware for Maintenance Center
- There is a substitute with better capability
  - Digital Speech Interpolation (system line double) 1 link
- The equipment is ordered to use only in certain project, it will not be applied to other projects
  - Digital Microwave Capacity 34 MB with Multiplex Equipment
  - 34 M Mux Equipment for NE 5539 AA (2 Sys/st)

Since there will be no more order for such equipment, forecasting for the demand is not required.

The other nine sets of equipment to forecast demand are classified into one of these two cases.

1. The equipment which demand depending on users' needs
2. The equipment which demand depending on specific needs.

The equipment which demand depending on user's needs consist of

- First Order Digital Multiplex Equipment 4W. E&M Sig
- UHF Digital Radio Telephone Equipment 6Ch (Sub&Ex)
- 2GHZ Digital Microwave Radio Equipment (8 MBPS)
- Radio Set and Equipment for Microwave 13GHZ 34MB
- 2GHZ Digital Microwave Radio Equipment (34 MBPS)
- Microwave Minilink Equipment 13GHZ 34MB.

According to the previous section on data analysis, the outgoing quantities for first order digital multiplex equipment 4 w E&M sig and UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex) must be actual data for

using in forecasting process. The following tables illustrate the adjusted data for them.

TABLE 4.1 ADJUSTED OUTGOING-INVENTORY QUANTITY OF FIRST ORDER DIGITAL MULTIPLEXEQUIPMENT WITH 4W.E&M SIG

Time	Outgoing Quantity	
Dec-94	0	0
Jan-95	0	0
Feb-95	0	0
Mar-95	0	0
Apr-95	0	0
May-95	1	1
Jun-95	6	7
Jul-95	0	7
Aug-95	0	7
Sep-95	4	11
Oct-95	6	17
Nov-95	1	18
Dec-95	0	18
Jan-96	2	20
Feb-96	**9**	29
Mar-96	3	32
Apr-96	**6.5**	38.5
May-96	1	39.5
Jun-96	**6**	45.5
Jul-96	1	46.5
Aug-96	**14**	60.5
Sep-96	6	66.5
Oct-96	4.5	71
Nov-96	11.5	82.5
Dec-96	2	84.5

TABLE 4.2 ADJUSTED OUTGOING-INVENTORY QUANTITY OF UHF DIGITAL RADIO TELEPHONE EQUIPMENT 6CH (SUB&EX)

Time	Outgoing Quantity	
Jun-93	0	0
Jul-93	0	0
Aug-93	0	0
Sep-93	0	0
Oct-93	0	0
Nov-93	0	0
Dec-93	0	0
Jan-94	0	0
Feb-94	0	0
Mar-94	0	0
Apr-94	5	5
May-94	1	6
Jun-94	0	6
Jul-94	2	8
Aug-94	2	10
Sep-94	3	13
Oct-94	1	14
Nov-94	1	15
Dec-94	2	17
Jan-95	3	20
Feb-95	3	23
Mar-95	2	25
Apr-95	2	27
May-95	4	31
Jun-95	**5**	36
Jul-95	0	36
Aug-95	0	36
Sep-95	1	37
Oct-95	1	38
Nov-95	1	39
Dec-95	0	39
Jan-96	0	39
Feb-96	3	42
Mar-96	2	44
Apr-96	8	52
May-96	**2**	54
Jun-96	5	59
Jul-96	2	61
Aug-96	1	62
Sep-96	0	62
Oct-96	4	66
Nov-96	2	68
Dec-96	2	70

Using the historical cumulative outgoing quantities of each equipment, graphs of the outgoing quantity for each month can be constructed.

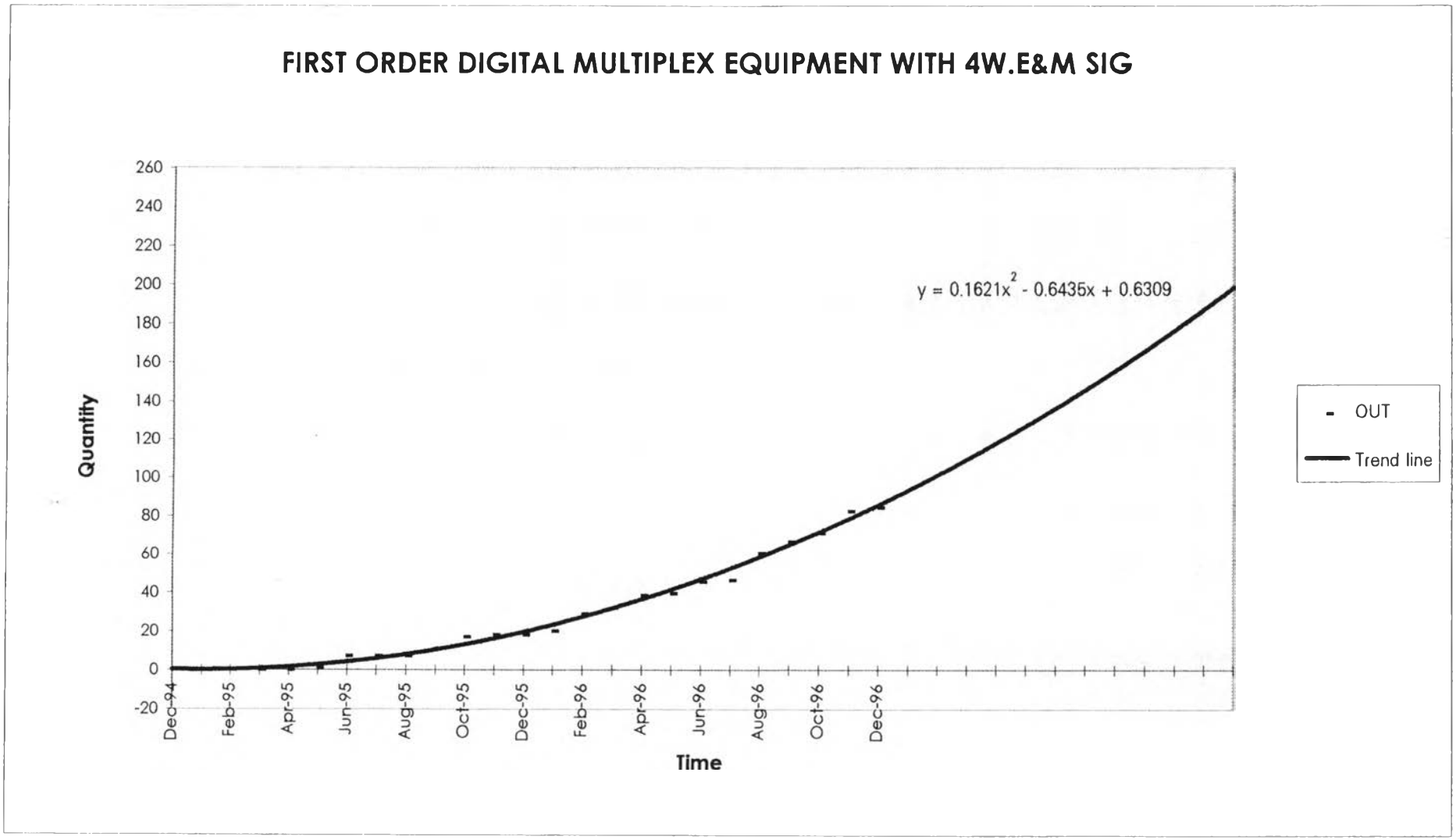

FIGURE 4.17 FUTURE-DEMAND TREND FOR FIRT ORDER DIGITAL MULTIPLEX EQUIPMENT 4W. E&M SIG

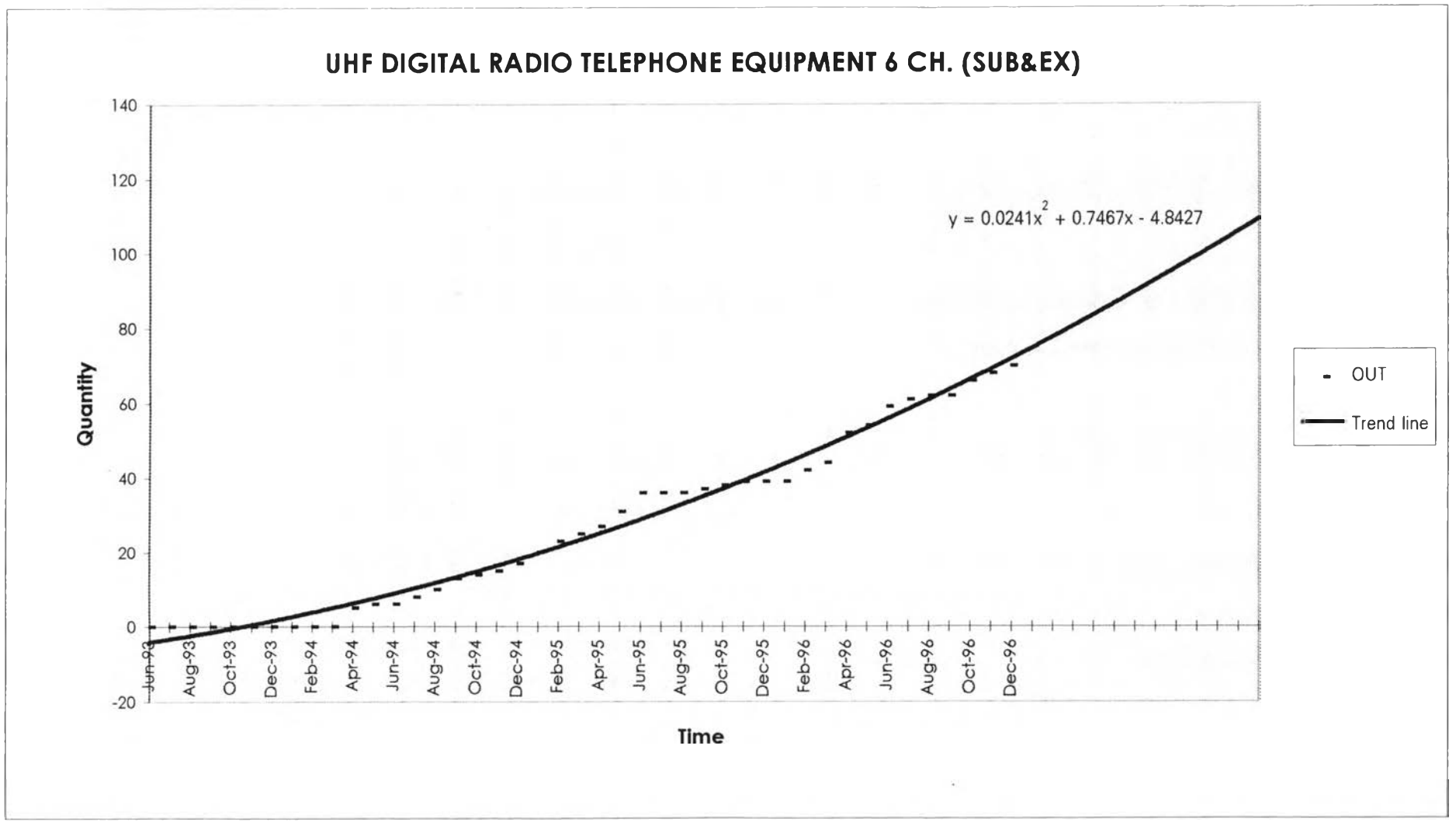

FIGURE 4.18 FUTURE-DEMAND TREND FOR UHF DIGITAL RADIO TELEPHONE EQUIPMENT 6CH (SUB&EX)

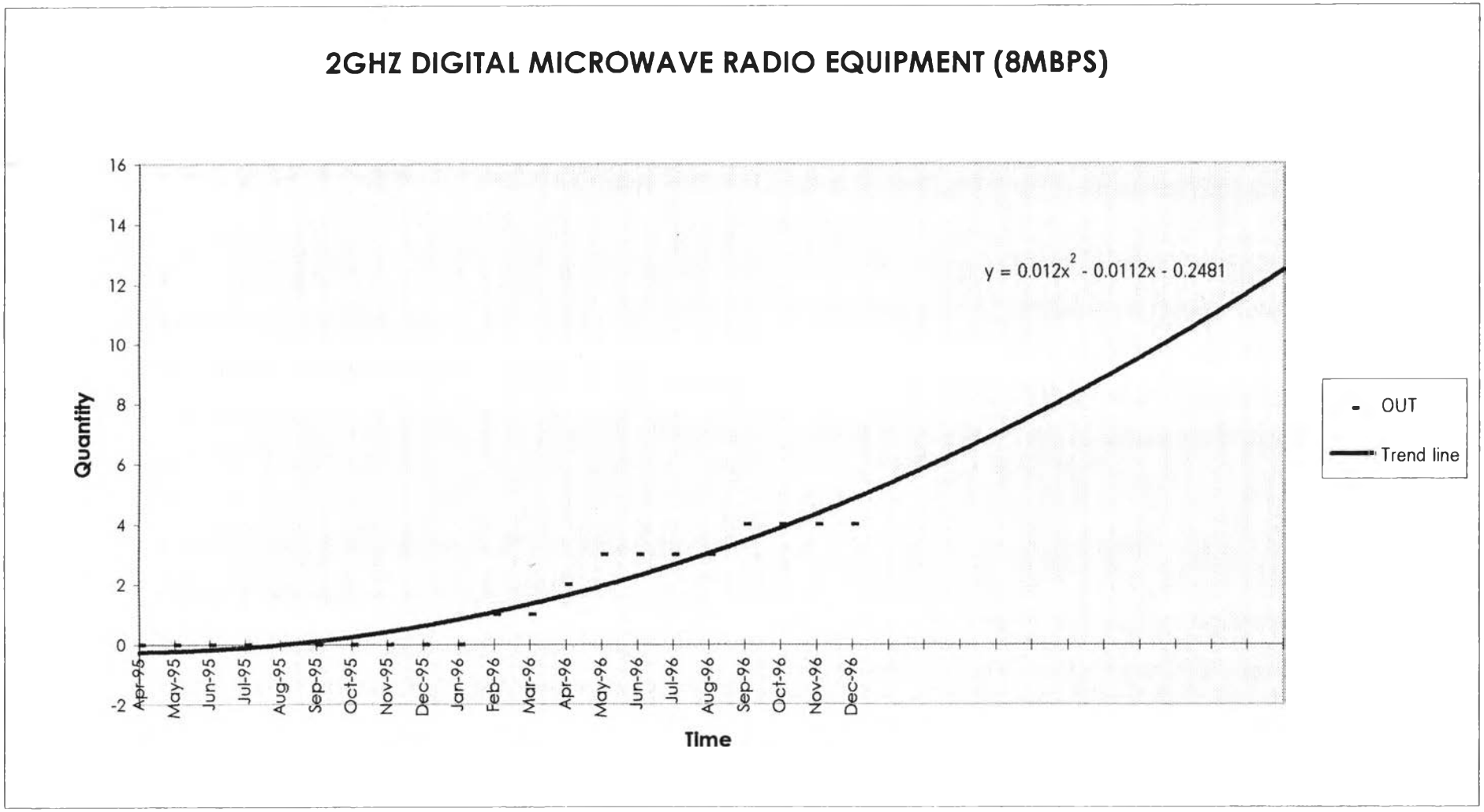

FIGURE 4.19 FUTURE-DEMAND TREND FOR 2GHZ DIGITAL MICROWAVE RADIO EQUIPMENT (8 MBPS)

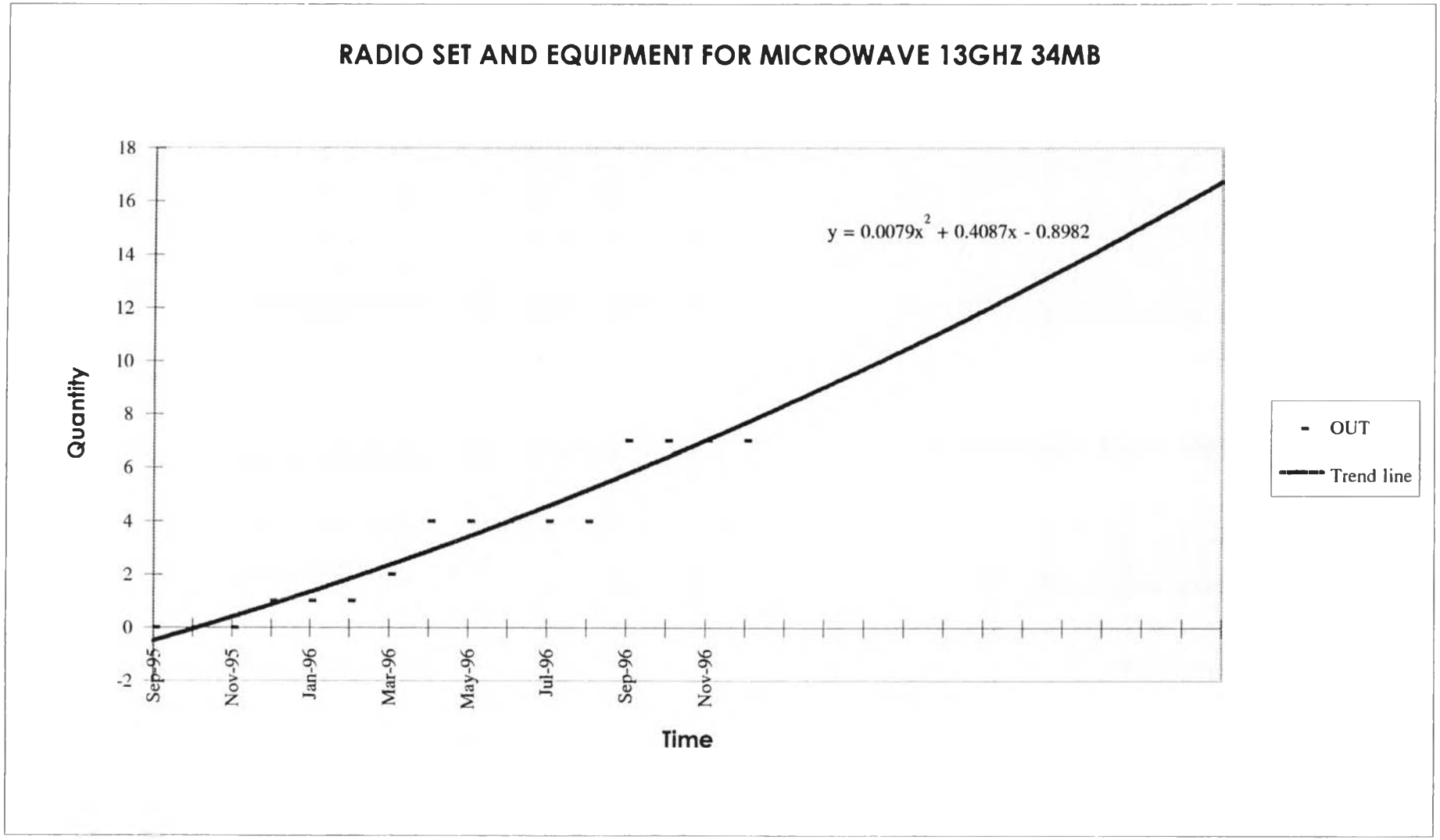

FIGURE 4.20 FUTURE-DEMAND TREND FOR RADIO SET AND EQUIPMENT FOR MICROWAVE 13GHZ 34MB

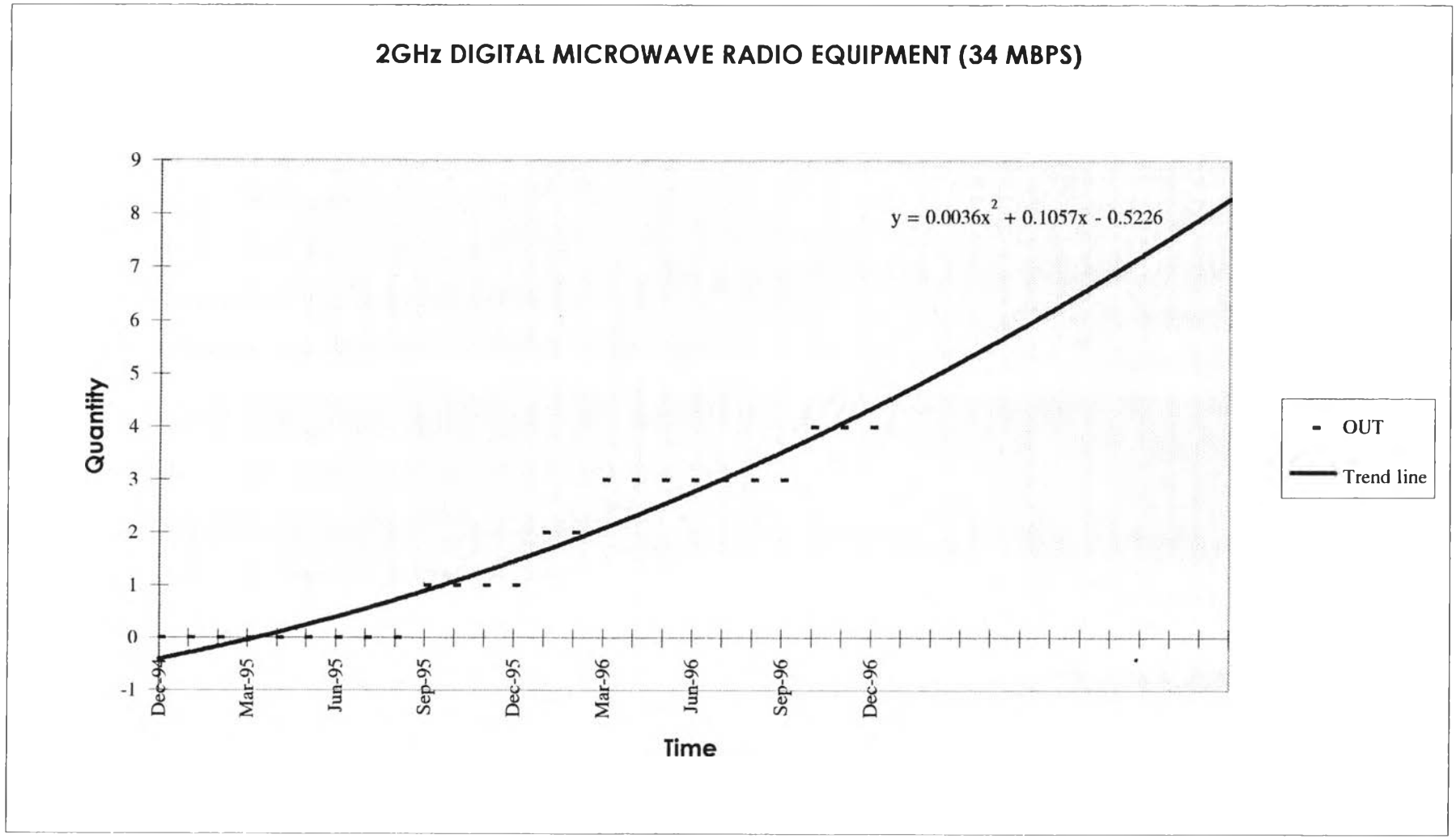

FIGURE 4.21 FUTURE-DEMAND TREND FOR 2GHZ DIGITAL MICROWAVE RADIO EQUIPMENT (34 MBPS)

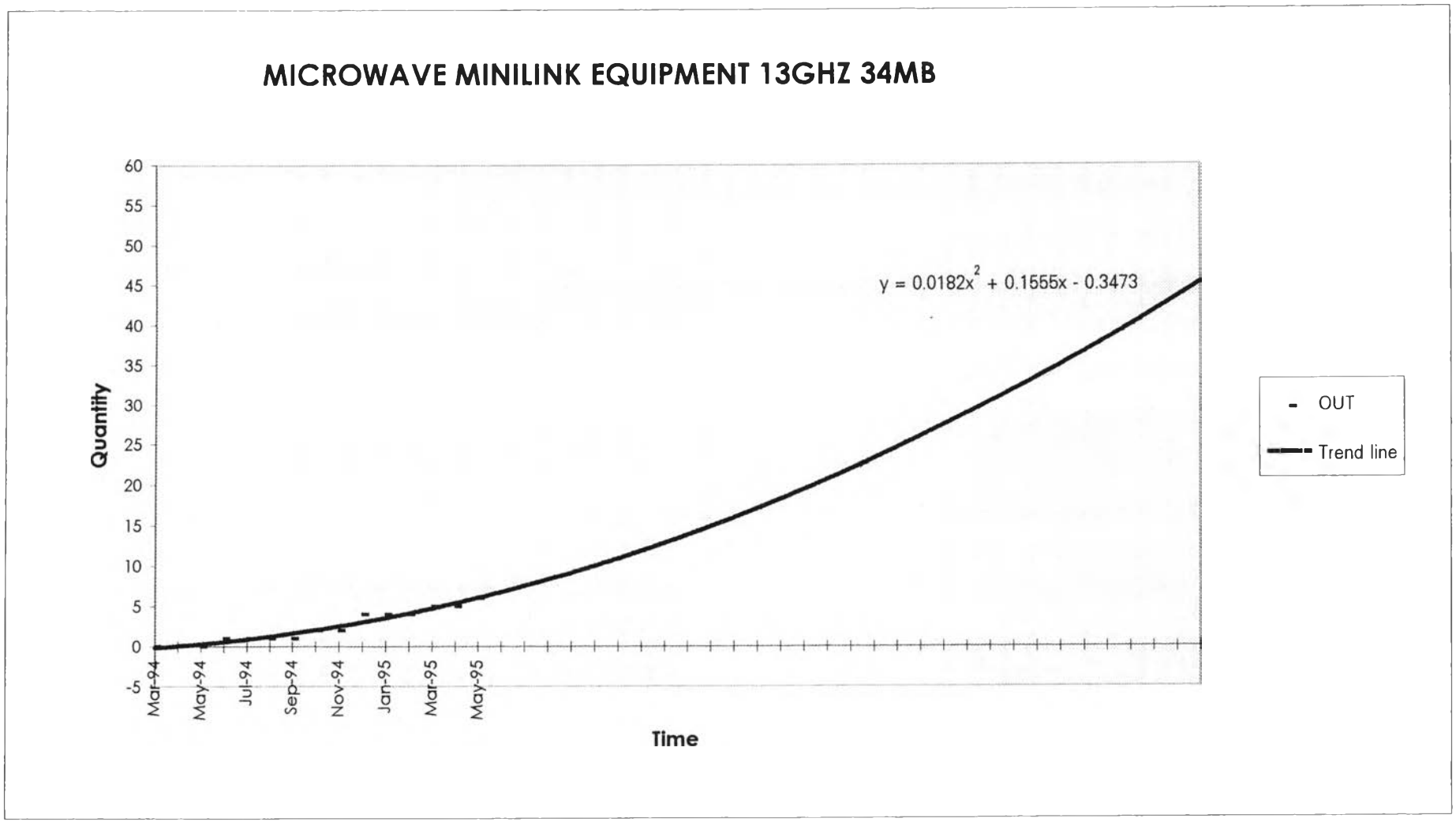

FIGURE 4.22 FUTURE-DEMAND TREND FOR MICROWAVE MINILINK EQUIPMENT 13GHZ 34MB

The graph predicts the trend of the future demand. The demand growth profile fits the polynomial degree 2 equation, $y=ax^2+bx+c$. The value of a, b, and c can be obtained as shown in figures 4.17-4.22,

The equipment which demand depending on specific needs consists of 3 items. Their forecasting methods were conducted through interviewing persons in charge.

- First Order Mux (N500 series). The average demand is 1 set per month for either a spare part or expansion work.

- 140 MBPS Digital Mux Equipment(full system). The demand depend on ad hoc projects. Average from annual schedule, six sets of this equipment are needed per year (0.5 set per month).

- Digital Line Concentrator DCS-20 for 2 MBPS PCM Transmission . The demand depend on expansion work in rural area in a few years. Ten sets of this equipment are required each year(0.83 set/month)

Source:

Forecasting Process

In case of the equipment which demand depending on users' needs, the procedures are as follow.

From the equation derived from the graph, substitute a period for X in the equation to calculate y, the projected value of cumulative demand. Projected values of demand in 1997 are done in the study. Period 1 represents the first month of the data in the inventory cards. Period 2 represents the second month and so on.

Calculation Example

Equation for first order Digital Multiplex Equipment with 4 W E&M sig is $Y=0.1621x^2 - 0.6435x + 0.6309$

The first month of collected data was December 1994, so x for this month is 1. Projected demand have been calculated since January 1997 and this valued is calculated by cumulative demand of January 1997 subtracts with cumulative demand of December 1996. Hence, cumulative demand of December 1996 x for this month is 25, and cumulative demand of January 1997, x for this month is 26, are required.

Substitute x in the equation

Cumulative demand of Dec 96 = $0.1621(25)^2 - 0.6435(25) + 0.06309 = 85.86$ sets.
Cumulative demand of Jan 97 = $0.1621\ (26)^2 - 0.6435(26) + 0.06309 = 93.48$ sets.

Therefore, demand in Jan 97 = 93.48 - 85.86 = 7.62 sets. To calculate for monthly projected demands of the equipment which demand depending on users' needs can be done in the same manner. The values of them are illustrated in Table 4.3-4.8.

TABLE 4.3 PROJECTED DEMAND OF 2GHZ DIGITAL MICROWAVE RADIO EQUIPMENT (8MBPS)

Time	CumulativeDemand (E)	Demand (E)
Dec-96	5.81	
Jan-97	6.36	0.55
Feb-97	6.94	0.58
Mar-97	7.54	0.60
Apr-97	8.16	0.62
May-97	8.81	0.65
Jun-97	9.48	0.67
Jul-97	10.18	0.70
Aug-97	10.89	0.72
Sep-97	11.64	0.74
Oct-97	12.40	0.77
Nov-97	13.20	0.79
Dec-97	14.01	0.82
	Annual demand =	8.20

Remark : (E) = Estimated Value

TABLE 4.4 PROJECTED DEMAND OF RADIO SET AND EQUIPMENT FOR MICROWAVE 13GHZ 34MB

Time	CumulativeDemand (E)	Demand (E)
Dec-96	7.66	
Jan-97	8.33	0.67
Feb 97	9.02	0.69
Mar-97	9.72	0.70
Apr-97	10.44	0.72
May-97	11.17	0.73
Jun-97	11.92	0.75
Jul-97	12.68	0.76
Aug-97	13.46	0.78
Sep-97	14.26	0.80
Oct-97	15.07	0.81
Nov-97	15.90	0.83
Dec-97	16.74	0.84
	Annual demand =	9.08

Remark : (E) = Estimated Value

TABLE 4.5 PROJECTED DEMAND OF 2GHZ DIGITAL MICROWAVE RADIO EQUIPMENT (8MBPS)

Time	CumulativeDemand (E)	Demand (E)
Dec-96	5.81	
Jan-97	6.36	0.55
Feb-97	6.94	0.58
Mar-97	7.54	0.60
Apr-97	8.16	0.62
May-97	8.81	0.65
Jun-97	9.48	0.67
Jul-97	10.18	0.70
Aug-97	10.89	0.72
Sep-97	11.64	0.74
Oct-97	12.40	0.77
Nov-97	13.20	0.79
Dec-97	14.01	0.82
	Annual demand =	8.20

Remark : (E) = Estimated Value

TABLE 4.6 PROJECTED DEMAND OF RADIO SET AND EQUIPMENT FOR MICROWAVE 13GHZ 34MB

Time	CumulativeDemand (E)	Demand (E)
Dec-96	7.66	
Jan-97	8.33	0.67
Feb-97	9.02	0.69
Mar-97	9.72	0.70
Apr-97	10.44	0.72
May-97	11.17	0.73
Jun-97	11.92	0.75
Jul-97	12.68	0.76
Aug-97	13.46	0.78
Sep-97	14.26	0.80
Oct-97	15.07	0.81
Nov-97	15.90	0.83
Dec-97	16.74	0.84
	Annual demand =	9.08

Remark : (E) = Estimated Value

TABLE 4.7 PROJECTED DEMAND OF MICROWAVE MINILINK EQUIPMENT 13GHZ 34MB

Time	CumulativeDemand (E)	Demand (E)
Dec-96	6.08	
Jan-97	6.80	0.72
Feb-97	7.56	0.76
Mar-97	8.35	0.79
Apr-97	9.18	0.83
May-97	10.04	0.87
Jun-97	10.94	0.90
Jul-97	11.88	0.94
Aug-97	12.86	0.97
Sep-97	13.87	1.01
Oct-97	14.92	1.05
Nov-97	16.00	1.08
Dec-97	17.12	1.12
	Annual demand =	11.04

Remark : (E) = Estimated Value

TABLE 4.8 **PROJECTED DEMAND OF 2GHZ. DIGITAL MICROWAVE RADIO EQUIPMENT (34 MBPS)**

Time	CumulativeDemand (E)	Demand (E)
Dec-96	4.37	
Jan-97	4.66	0.29
Feb-97	4.96	0.30
Mar-97	5.26	0.30
Apr-97	5.57	0.31
May-97	5.89	0.32
Jun-97	6.21	0.33
Jul-97	6.55	0.33
Aug-97	6.89	0.34
Sep-97	7.23	0.35
Oct-97	7.59	0.35
Nov-97	7.95	0.36
Dec-97	8.32	0.37
	Annual demand =	3.95

Remark : (E) = Estimated Value

In case of the equipment which demand depending on specific needs, the number of projected demand rearranged into the table format as shown in Table 4.9-4.11.

TABLE 4.9 PROJECTED DEMAND OF FIRST ORDER MUX (N 500 SERIES)

Time	Demand (E)
Dec-96	
Jan-97	1.00
Feb-97	1.00
Mar-97	1.00
Apr-97	1.00
May-97	1.00
Jun-97	1.00
Jul-97	1.00
Aug-97	1.00
Sep-97	1.00
Oct-97	1.00
Nov-97	1.00
Dec-97	1.00
Annual demand =	12

Remark : (E) = Estimated Value

FIGURE 4.10 PROJECTED DEMAND OF 140 MBPS DIGITAL MUX EQUIPMENT (FULL SYSTEM)

Time	Demand (E)
Dec-96	
Jan-97	0.50
Feb-97	0.50
Mar-97	0.50
Apr-97	0.50
May-97	0.50
Jun-97	0.50
Jul-97	0.50
Aug-97	0.50
Sep-97	0.50
Oct-97	0.50
Nov-97	0.50
Dec-97	0.50
Annual demand =	6

Remark : (E) = Estimated value

TABLE 4.11 PROJECTED DEMAND OF DIGITAL LINE CONCENTRATOR DCS-20 FOR 2MBPS PCM TRANSMISSION

Time	Demand (E)
Dec-96	
Jan-97	0.83
Feb-97	0.83
Mar-97	0.83
Apr-97	0.83
May-97	0.83
Jun-97	0.83
Jul-97	0.83
Aug-97	0.83
Sep-97	0.83
Oct-97	0.83
Nov-97	0.83
Dec-97	0.83
Annual demand =	10.00

Remark : (E) = Estimated Value

Define the optimum stock level

In order to define the optimum stock level, the current status of the TOT order process should be known before discussing the recommended order process and order quantity.

Current status of the TOT order process

Each responsible department estimates the demand of the equipment in advance so as to submit a recommended budget of the following fiscal year. Once the budget has been approved, the purchasing inquiry document will be passed on to the Purchasing department. Purchasing Order will then be executed. The lead time for ordering is approximately 3 months.

Order must be placed in accordance with the budget recommended which can be made only once a year. This causes enormous quantity of the equipment holding in the warehouse.

The cost of holding inventory in this warehouse can be estimated from the following items.

- Costs of storage space are approximately 1.5% of the inventory value.

- Fixed overhead costs of the warehouse are about 1% of the inventory value.
- Costs of insurance are about 2.2% of the inventory value.
- Interest on capital invested in inventory is about 9% of the inventory value.

Therefore, the holding costs of the inventory are approximately 13.7% of the inventory value.

To perform the effective-order process, the costs increase with the number of orders placed, ordering costs, should also be clarified. Follow the TOT order process, the ordering costs are the costs that occurred in each step below.

-Preparation of the purchase requisition by the responsible department, this step requires 8 man hours.

-Sending the purchase requisition to the Purchasing department, this step requires 0.5 man hour.

-Putting on a notice for suppliers tendering, this step requires 3 man hours.

-Comparing the price and the specifications of goods which are submitted by the suppliers, this step requires 20 man hours.

-Preparation of the purchase order, this step requires 1 man hour.

-Sending the purchase order to suppliers, this step requires 0.5 man hour.

-Receiving the goods and Inspection, this step requires 9 man hours.

-Putting the received goods away, this step requires 4 man hours.

The total man hours required for the ordering process are (8+0.5+3+20+1+0.5+9+4) = 46 man hours.

The average salary for the operators is 10,000 baht.

There are 20 working days in one month and 7 working hours in one day (office hour of TOT is 8a.m. to 16p.m. , 1 hour for lunch time).

Costs per hour are about 10,000/(20 x 7) = 71.43 baht

Costs of the operators working in this process = 71.43 x 46 = 3,285.78 baht

Costs of document in this process are about 800 baht.

Other costs are about 500 baht.

Order costs = 3,285.78 + 800 + 500 = 4585.78 baht.

Therefore, the ordering costs are about 4,600 baht per one order placed.

Practically, lead time can be positive and demand can be fluctuated. Safety stocks, to protect against the positive lead time and excessive shortages, must be stored in the warehouse just in case.

Safety stocks of each item can be calculated from the product of a decision variable which can be selected to achieve desired results in term of frequency of stockouts and standard deviation of demand during lead time, expressed mathematically as.

Safety stocks = $K\sigma_L$

where K = Safety factor

σ_L = Standard deviation of demand during lead time (3 months)

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}$$

if the calculated σ is the standard deviation per n, n is the number of months which are shown in the Data Analysis section,

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}}$$

First Order Digital Multiplex Equipment 4W.E&M Sig

m	X	X^2
1	0	0.00
2	0	0.00
3	0	0.00
4	0	0.00
5	0	0.00
6	1	1.00
7	6	36.00
8	0	0.00
9	0	0.00
10	4	16.00
11	6	36.00
12	1	1.00
13	0	0.00
14	2	4.00
15	9	81.00
16	3	9.00
17	6.5	42.25
18	1	1.00
19	6	36.00
20	1	1.00
21	14	196.00
22	6	36.00
23	4.5	20.25
24	11.5	132.25
25	2	4.00
Total	84.5	652.75

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{25(652.75) - (84.5)^2}{25(24)}} = 3.91$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{3.91\sqrt{3}}{\sqrt{25}} = 1.35$$

UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex)

m	X	X^2
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	5	25
11	1	1
12	0	0
13	2	4
14	2	4
15	3	9
16	1	1
17	1	1
18	2	4
19	3	9
20	3	9
21	2	4
22	2	4
23	4	16
24	5	25
25	0	0
26	0	0
27	1	1
28	1	1
29	1	1
30	0	0
31	0	0
32	3	9
33	2	4
34	8	64
35	2	4
36	5	25
37	2	4
38	1	1
39	0	0
40	4	16
41	2	4
42	2	4
Total	70	254

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{42(254) - (70)^2}{42(41)}} = 1.83$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{1.83\sqrt{3}}{\sqrt{42}} = 0.49$$

2GHz Digital Microwave Radio Equipment (8 MBPS)

m	X	X^2
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	1	1
12	0	0
13	1	1
14	1	1
15	0	0
16	0	0
17	0	0
18	1	1
19	0	0
20	0	0
21	0	0
Total	4	4

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{21(4) - (4)^2}{4(3)}} = 0.402$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{0.402\sqrt{3}}{\sqrt{21}} = 0.15$$

Radio Set and Equipment for Microwave 13GHz 34MB

m	X	X^2
1	0	0
2	0	0
3	0	0
4	1	1
5	0	0
6	0	0
7	1	1
8	2	4
9	0	0
10	0	0
11	0	0
12	0	0
13	3	9
14	0	0
15	0	0
16	0	0
Total	7	15

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{16(15) - (7)^2}{16(15)}} = 0.89$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{0.89\sqrt{3}}{\sqrt{16}} = 0.38$$

First Order Mux (N 500series)

m	X	X^2
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	3	9
19	0	0
20	0	0
21	3	9
22	0	0
23	0	0
Total	6	18

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{23(18) - (6)^2}{23(22)}} = 0.86$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{0.86\sqrt{3}}{\sqrt{23}} = 0.31$$

2GHz Digital Microwave Radio Equipment (34 MBPS)

m	X	X^2
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	1	1
11	0	0
12	0	0
13	0	0
14	1	1
15	0	0
16	1	1
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	1	1
24	0	0
25	0	0
Total	4	4

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{25(4)-(4)^2}{25(24)}} = 0.37$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{0.37\sqrt{3}}{\sqrt{25}} = 0.13$$

140 MBPS Digital Mux Equipment (Full System)

m	X^2	X
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	1	1
14	0	0
15	1	1
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
Total	2	2

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{23(2)-(2)^2}{23(22)}} = 0.29$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{0.29\sqrt{3}}{\sqrt{23}} = 0.105$$

Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

m	X	X^2
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	2	4
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
Total	2	4

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{23(4)-(2)^2}{23(22)}} = 0.417$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{0.417\sqrt{3}}{\sqrt{23}} = 0.15$$

Microwave Minilink Equipment 13GHz 34MB

m	X	X^2
1	0	0
2	0	0
3	0	0
4	1	1
5	0	0
6	0	0
7	0	0
8	1	1
9	0	0
10	2	4
11	0	0
12	0	0
13	1	1
14	0	0
15	1	1
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
28	0	0
29	0	0
30	0	0
31	0	0
32	0	0
33	0	0
34	0	0
Total	6	8

$$\sigma = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}} = \sqrt{\frac{34(8)-(6)^2}{34(33)}} = 0.46$$

$$\sigma_L = \frac{\sigma\sqrt{3}}{\sqrt{n}} = \frac{0.46\sqrt{3}}{\sqrt{34}} = 0.137$$

The safety factor value (K) that give the probability of a stockout equals to 0.0016 from the table 2.1 is 3.0.

Safety stocks = $K \sigma_L$

Calculation for safety stocks of each equipment are as follow.

- First Order Digital Multiplex Equipment 4W.E&M Sig

Safety stock = 3.0 (1.35) = 4.05

- UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex)

Safety stock = 3.0 (0.49) = 1.47

- 2GHz Digital Microwave Radio Equipment (8 MBPS)

Safety stock = 3.0 (0.15) = 0.45

- Radio Set and Equipment for Microwave 13GHz 34MB

Safety stock = 3.0 (0.38) = 1.14

- First Order Mux (N 500series)

Safety stock = 3.0 (0.31) = 0.93

- 2GHz Digital Microwave Radio Equipment (34 MBPS)

Safety stock = 3.0 (0.13) = 0.39

- 140 MBPS Digital Mux Equipment (Full System)

Safety stock = 3.0 (0.105) = 0.315

- Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

Safety stock = 3.0 (0.15) = 0.45

- Microwave Minilink Equipment 13GHz 34MB

Safety stock = 3.0 (0.137) = 0.411

Recommended order process

The initial-stock level, holding stock at December 1996 is the important thing to realize before placing the order. That stocks must be used up. If the initial stocks are more than the annual demand, cumulative demand in 1997, plus safety stocks, the ordering process must not be done in this year.

Subtracting the sum of the annual demand and safety stocks with the initial-stock level resulting the quantities that require the replenishment. The following shows the annual demand, safety-stock level and the initial-stock level of the inventory under my study.

- First Order Digital Multiplex Equipment 4W.E&M Sig
annual demand = 112.88 sets
safety stocks = 4.05 sets
annual demand + safety stocks = 116.93 sets
initial stocks = 443 sets
The initial stocks are more than 116.93, it is not necessary to order the First Order Digital Multiplex Equipment 4W.E&M Sig in this year,1997.

- UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex)
annual demand = 37.30 sets
safety stocks = 1.47 sets
annual demand + safety stocks = 38.77 sets
initial stocks = 17 sets
Replenishment quantity = 38.77 - 17 = 21.77 sets

- 2GHz Digital Microwave Radio Equipment (8 MBPS)
annual demand = 8.20 sets
safety stocks = 0.45 sets
annual demand + safety stocks = 8.65 sets
initial stocks = 12 sets
The initial stocks are more than 8.65, it is not necessary to order the 2GHz Digital Microwave Radio Equipment (8 MBPS) in this year.

- Radio Set and Equipment for Microwave 13GHz 34MB

annual demand = 9.08 sets
safety stocks = 1.14 sets
annual demand + safety stocks = 10.22 sets
initial stocks = 4 sets
Replenishment quantity = 10.22 - 4 =6.22 sets

- 2GHz Digital Microwave Radio Equipment (34 MBPS)
annual demand = 3.95 sets
safety stocks = 0.39 sets
annual demand + safety stocks = 4.34 sets
initial stocks = 3 sets
Replenishment quantity = 4.34 - 3 = 1.34 sets

- Microwave Minilink Equipment 13GHz 34MB
annual demand = 11.04 sets
safety stocks = 0.411 sets
annual demand + safety stocks = 11.45 sets
initial stocks = 2 sets
Replenishment quantity = 11.45 - 2 = 9.45 sets

- First Order Mux (N 500series)
annual demand = 12 sets
safety stocks = 0.93 sets
annual demand + safety stocks = 12.93 sets
initial stocks = 14 sets
The initial stocks are more than 12.93, it is not necessary to order the First Order Mux (N 500series) in this year.

- 140 MBPS Digital Mux Equipment (Full System)
annual demand = 6 sets
safety stocks = 0.32 sets
annual demand + safety stocks = 6.32 sets
initial stocks = 1 set
Replenishment quantity = 6.32 - 1 = 5.32 sets

- Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

annual demand = 10 sets

safety stocks = 0.45 sets

annual demand + safety stocks = 10.45 sets

initial stocks = 9 sets

Replenishment quantity = 10.45 - 9 = 1.45 sets

The items which are stored in the warehouse at the adequate quantities to serve the annual demand and the safety stocks are the First Order Digital Multiplex Equipment 4W.E&M Sig, the 2GHz Digital Microwave Radio Equipment (8 MBPS), and the First Order Mux (N 500series). Therefore, there will be no order placed for these equipment in this year, 1997.

One of the Economic Order Quantity (EOQ) assumption is the demand is deterministic with a constant rate. But the demand trend of the inventory under my study increase when the time go by. Therefore, the order quantity each time is not equivalent. The number of the orders placed is considered instead.

The recommended order process is done under these conditions.

1. Ordering costs = 4,600 baht per one order placed (details are in the previous section).
2. Holding costs = 13.7 percent of the inventory value (details are in the previous section).
3. Shortage colts are not allowed.

One approach to select the number of the orders placed would be to select a different numbers of the order placed , determine the total cost for each, and choose the number that give the lowest total cost.

Total cost = Ordering costs + Holding costs

when Ordering costs = 4,600 baht/one order placed.

Holding costs = 13.7 % of (Average inventory * purchase price)

Average inventory is approximately one-half of an order quantity.

The following tables 4.12-4.20 illustrate the total costs, for each number of the order placed, of each equipment.

TABLE 4.12 Total Costs of First Order Digital Multiplex Equipment with 4W.E&M Sig

Annual demand = 113 sets
Purchase price = 157,065 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	56.50	1,215,761.63	1,220,361.63
2	9200	28.25	607,880.82	617,080.82
3	13800	18.83	405,253.88	419,053.88
4	18400	14.13	303,940.41	322,340.41
5	23000	11.30	243,152.33	266,152.33
6	27600	9.42	202,626.94	230,226.94
7	32200	8.07	173,680.23	205,880.23
8	36800	7.06	151,970.20	188,770.20
9	41400	6.28	135,084.63	176,484.63
10	46000	5.65	121,576.16	167,576.16
11	50600	5.14	110,523.78	161,123.78
12	55200	4.71	101,313.47	156,513.47
13	59800	4.35	93,520.13	153,320.13
14	64400	4.04	86,840.12	151,240.12
15	69000	3.77	81,050.78	150,050.78
16	73600	3.53	75,985.10	149,585.10
17	78200	3.32	71,515.39	149,715.39
18	82800	3.14	67,542.31	150,342.31
19	87400	2.97	63,987.45	151,387.45
20	92000	2.83	60,788.08	152,788.08
21	96600	2.69	57,893.41	154,493.41
22	101200	2.57	55,261.89	156,461.89
23	105800	2.46	52,859.20	158,659.20
24	110400	2.35	50,656.73	161,056.73

TABLE 4.13 Total Costs of UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex)

Replenishment quantity = 21.77 sets
Purchase price = 778,880 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	10.89	1,161,500.91	1,166,100.91
2	9200	5.44	580,750.45	589,950.45
3	13800	3.63	387,166.97	400,966.97
4	18400	2.72	290,375.23	308,775.23
5	23000	2.18	232,300.18	255,300.18
6	27600	1.81	193,583.48	221,183.48
7	32200	1.56	165,928.70	198,128.70
8	36800	1.36	145,187.61	181,987.61
9	41400	1.21	129,055.66	170,455.66
10	46000	1.09	116,150.09	162,150.09
11	50600	0.99	105,590.99	156,190.99
12	55200	0.91	96,791.74	151,991.74
13	59800	0.84	89,346.22	149,146.22
14	64400	0.78	82,964.35	147,364.35
15	69000	0.73	77,433.39	146,433.39
16	73600	0.68	72,593.81	146,193.81
17	78200	0.64	68,323.58	146,523.58
18	82800	0.60	64,527.83	147,327.83
19	87400	0.57	61,131.63	148,531.63
20	92000	0.54	58,075.05	150,075.05
21	96600	0.52	55,309.57	151,909.57
22	101200	0.49	52,795.50	153,995.50
23	105800	0.47	50,500.04	156,300.04
24	110400	0.45	48,395.87	158,795.87

TABLE 4.14 Total Costs of 2 GHz Digital Microwave Radio Equipmennt (8 MBPS)

Annual demand = 8.2 sets
Purchase price = 4,582,162.91 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	4.10	2,573,800.91	2,578,400.91
2	9200	2.05	1,286,900.45	1,296,100.45
3	13800	1.37	857,933.64	871,733.64
4	18400	1.03	643,450.23	661,850.23
5	23000	0.82	514,760.18	537,760.18
6	27600	0.68	428,966.82	456,566.82
7	32200	0.59	367,685.84	399,885.84
8	36800	0.51	321,725.11	358,525.11
9	41400	0.46	285,977.88	327,377.88
10	46000	0.41	257,380.09	303,380.09
11	50600	0.37	233,981.90	284,581.90
12	55200	0.34	214,483.41	269,683.41
13	59800	0.32	197,984.69	257,784.69
14	64400	0.29	183,842.92	248,242.92
15	69000	0.27	171,586.73	240,586.73
16	73600	0.26	160,862.56	234,462.56
17	78200	0.24	151,400.05	229,600.05
18	82800	0.23	142,988.94	225,788.94
19	87400	0.22	135,463.21	222,863.21
20	92000	0.21	128,690.05	220,690.05
21	96600	0.20	122,561.95	219,161.95
22	101200	0.19	116,990.95	218,190.95
23	105800	0.18	111,904.39	217,704.39
24	110400	0.17	107,241.70	217,641.70
25	115000	0.16	102,952.04	217,952.04
26	119600	0.16	98,992.34	218,592.34
27	124200	0.15	95,325.96	219,525.96
28	128800	0.15	91,921.46	220,721.46
29	133400	0.14	88,751.76	222,151.76
30	138000	0.14	85,793.36	223,793.36
31	142600	0.13	83,025.84	225,625.84
32	147200	0.13	80,431.28	227,631.28

TABLE 4.15 Total Costs of Radio Set and Equipment for Microwave 13GHz 34MB

Replenishment quantity = 6.22 sets
Purchase price = 4,582,162.91 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	3.11	1,952,322.15	1,956,922.15
2	9200	1.56	976,161.08	985,361.08
3	13800	1.04	650,774.05	664,574.05
4	18400	0.78	488,080.54	506,480.54
5	23000	0.62	390,464.43	413,464.43
6	27600	0.52	325,387.03	352,987.03
7	32200	0.44	278,903.16	311,103.16
8	36800	0.39	244,040.27	280,840.27
9	41400	0.35	216,924.68	258,324.68
10	46000	0.31	195,232.22	241,232.22
11	50600	0.28	177,483.83	228,083.83
12	55200	0.26	162,693.51	217,893.51
13	59800	0.24	150,178.63	209,978.63
14	64400	0.22	139,451.58	203,851.58
15	69000	0.21	130,154.81	199,154.81
16	73600	0.19	122,020.13	195,620.13
17	78200	0.18	114,842.48	193,042.48
18	82800	0.17	108,462.34	191,262.34
19	87400	0.16	102,753.80	190,153.80
20	92000	0.16	97,616.11	189,616.11
21	96600	0.15	92,967.72	189,567.72
22	101200	0.14	88,741.92	189,941.92
23	105800	0.14	84,883.57	190,683.57
24	110400	0.13	81,346.76	191,746.76

TABLE 4.16 Total Costs of 2 GHz Digital Microwave Radio Equipmennt (34 MBPS)

Replenishment quantity = 1.34 sets
Purchase price = 4,373,753.8 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	0.67	401,466.86	406,066.86
2	9200	0.34	200,733.43	209,933.43
3	13800	0.22	133,822.29	147,622.29
4	18400	0.17	100,366.72	118,766.72
5	23000	0.13	80,293.37	103,293.37
6	27600	0.11	66,911.14	94,511.14
7	32200	0.10	57,352.41	89,552.41
8	36800	0.08	50,183.36	86,983.36
9	41400	0.07	44,607.43	86,007.43
10	46000	0.07	40,146.69	86,146.69
11	50600	0.06	36,496.99	87,096.99
12	55200	0.06	33,455.57	88,655.57
13	59800	0.05	30,882.07	90,682.07
14	64400	0.05	28,676.20	93,076.20
15	69000	0.04	26,764.46	95,764.46
16	73600	0.04	25,091.68	98,691.68
17	78200	0.04	23,615.70	101,815.70
18	82800	0.04	22,303.71	105,103.71
19	87400	0.04	21,129.83	108,529.83
20	92000	0.03	20,073.34	112,073.34
21	96600	0.03	19,117.47	115,717.47
22	101200	0.03	18,248.49	119,448.49
23	105800	0.03	17,455.08	123,255.08
24	110400	0.03	16,727.79	127,127.79

TABLE 4.17 Total Costs of Microwave Minilink Equipment 13GHz 34MB

Replenishment quantity = 9.45 sets
Purchase price = 6,227,511.75 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	4.73	4,031,224.04	4,035,824.04
2	9200	2.36	2,015,612.02	2,024,812.02
3	13800	1.58	1,343,741.35	1,357,541.35
4	18400	1.18	1,007,806.01	1,026,206.01
5	23000	0.95	806,244.81	829,244.81
6	27600	0.79	671,870.67	699,470.67
7	32200	0.68	575,889.15	608,089.15
8	36800	0.59	503,903.01	540,703.01
9	41400	0.53	447,913.78	489,313.78
10	46000	0.47	403,122.40	449,122.40
11	50600	0.43	366,474.91	417,074.91
12	55200	0.39	335,935.34	391,135.34
13	59800	0.36	310,094.16	369,894.16
14	64400	0.34	287,944.57	352,344.57
15	69000	0.32	268,748.27	337,748.27
16	73600	0.30	251,951.50	325,551.50
17	78200	0.28	237,130.83	315,330.83
18	82800	0.26	223,956.89	306,756.89
19	87400	0.25	212,169.69	299,569.69
20	92000	0.24	201,561.20	293,561.20
21	96600	0.23	191,963.05	288,563.05
22	101200	0.21	183,237.46	284,437.46
23	105800	0.21	175,270.61	281,070.61
24	110400	0.20	167,967.67	278,367.67
25	115000	0.19	161,248.96	276,248.96
26	119600	0.18	155,047.08	274,647.08
27	124200	0.18	149,304.59	273,504.59
28	128800	0.17	143,972.29	272,772.29
29	133400	0.16	139,007.73	272,407.73
30	138000	0.16	134,374.13	272,374.13
31	142600	0.15	130,039.49	272,639.49
32	147200	0.15	125,975.75	273,175.75
33	151800	0.14	122,158.30	273,958.30
34	156400	0.14	118,565.41	274,965.41
35	161000	0.14	115,177.83	276,177.83

TABLE 4.18 Total Costs of First Order Mux (N500 series)

Annual demand = 12 sets
Purchase price = 785,285 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	6.00	645,504.27	650,104.27
2	9200	3.00	322,752.14	331,952.14
3	13800	2.00	215,168.09	228,968.09
4	18400	1.50	161,376.07	179,776.07
5	23000	1.20	129,100.85	152,100.85
6	27600	1.00	107,584.05	135,184.05
7	32200	0.86	92,214.90	124,414.90
8	36800	0.75	80,688.03	117,488.03
9	41400	0.67	71,722.70	113,122.70
10	46000	0.60	64,550.43	110,550.43
11	50600	0.55	58,682.21	109,282.21
12	55200	0.50	53,792.02	108,992.02
13	59800	0.46	49,654.17	109,454.17
14	64400	0.43	46,107.45	110,507.45
15	69000	0.40	43,033.62	112,033.62
16	73600	0.38	40,344.02	113,944.02
17	78200	0.35	37,970.84	116,170.84
18	82800	0.33	35,861.35	118,661.35
19	87400	0.32	33,973.91	121,373.91
20	92000	0.30	32,275.21	124,275.21
21	96600	0.29	30,738.30	127,338.30
22	101200	0.27	29,341.10	130,541.10
23	105800	0.26	28,065.40	133,865.40
24	110400	0.25	26,896.01	137,296.01

TABLE 4.19 Total Costs of 140 MBPS Digital Mux Equipment (Full System)

Replenishment quantity = 5.32 sets
Purchase price = 4,770,618 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	2.66	1,738,508.61	1,743,108.61
2	9200	1.33	869,254.31	878,454.31
3	13800	0.89	579,502.87	593,302.87
4	18400	0.67	434,627.15	453,027.15
5	23000	0.53	347,701.72	370,701.72
6	27600	0.44	289,751.44	317,351.44
7	32200	0.38	248,358.37	280,558.37
8	36800	0.33	217,313.58	254,113.58
9	41400	0.30	193,167.62	234,567.62
10	46000	0.27	173,850.86	219,850.86
11	50600	0.24	158,046.24	208,646.24
12	55200	0.22	144,875.72	200,075.72
13	59800	0.20	133,731.43	193,531.43
14	64400	0.19	124,179.19	188,579.19
15	69000	0.18	115,900.57	184,900.57
16	73600	0.17	108,656.79	182,256.79
17	78200	0.16	102,265.21	180,465.21
18	82800	0.15	96,583.81	179,383.81
19	87400	0.14	91,500.45	178,900.45
20	92000	0.13	86,925.43	178,925.43
21	96600	0.13	82,786.12	179,386.12
22	101200	0.12	79,023.12	180,223.12
23	105800	0.12	75,587.33	181,387.33
24	110400	0.11	72,437.86	182,837.86

TABLE 4.20 Total Costs of Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

Replenishment quantity = 1.45 sets
Purchase price = 1,570,000 Baht/set

NUMBER ORDERS PER YEAR	ORDERING COST PER YEAR (Bht)	AVERAGE INVENTORY UNIT	HOLDING COST PER YEAR (Bht)	TOTAL COST (Bht) PER YEAR
1	4600	0.73	155,940.25	160,540.25
2	9200	0.36	77,970.13	87,170.13
3	13800	0.24	51,980.08	65,780.08
4	18400	0.18	38,985.06	57,385.06
5	23000	0.15	31,188.05	54,188.05
6	27600	0.12	25,990.04	53,590.04
7	32200	0.10	22,277.18	54,477.18
8	36800	0.09	19,492.53	56,292.53
9	41400	0.08	17,326.69	58,726.69
10	46000	0.07	15,594.03	61,594.03
11	50600	0.07	14,176.39	64,776.39
12	55200	0.06	12,995.02	68,195.02
13	59800	0.06	11,995.40	71,795.40
14	64400	0.05	11,138.59	75,538.59
15	69000	0.05	10,396.02	79,396.02
16	73600	0.05	9,746.27	83,346.27
17	78200	0.04	9,172.96	87,372.96
18	82800	0.04	8,663.35	91,463.35
19	87400	0.04	8,207.38	95,607.38
20	92000	0.04	7,797.01	99,797.01
21	96600	0.03	7,425.73	104,025.73
22	101200	0.03	7,088.19	108,288.19
23	105800	0.03	6,780.01	112,580.01
24	110400	0.03	6,497.51	116,897.51

The number of the order placed that give the lowest total costs of each item is as follow.

- 16 times for First Order Digital Multiplex Equipment 4W.E&M Sig
- 16 times for UHF Digital Radio Telephone Equipment 6 Ch (Sub & Ex)
- 24 times for 2GHz Digital Microwave Radio Equipment (8 MBPS)
- 21 times for Radio Set and Equipment for Microwave 13 GHz 34 MB
- 12 times for First Order Mux (N 500series)
- 9 times for 2 GHz Digital Microwave Radio Equipment (34 MBPS)
- 30 times for Microwave Minilink Equipment 13 GHz 34 MB
- 19 times for 140 MBPS Digital Mux Equipment (Full System)
- 6 times for Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

Order Quantities for each Order Placed

The order quantities for each order placed can be easily found from the graph of cumulative-estimated demand in 1997. And the following items must be considered in the graph.

- Safety stocks
- Stock level at December 1996
- Economic number of order placed
- Constraint that the order quantities must be discrete unit

The processes to find the order quantities are

1. Draw the graph of cumulative-estimated demand and time
2. Draw the curve of the sum of cumulative-estimated demand and safety stocks parallel to the curve in No1.
3. Plot the stock-level quantity at December 1996, initial stocks, on the Y-axis, then project that quantity parallel to the X-axis until crossing the curve of No.2, resulting point A. If the stock level at December 1996 is higher than the cumulative demand at December 1997, the order must not be placed because the inventory holding in the warehouse can serve the annual demand.
4. Project the crossing point on to the X-axis, time axis, resulting point B. B represents the time when incoming inventory must deposit to the warehouse. According to the three-month lead time, this incoming inventory quantities must be ordered 3 months prior, at T_1.

5. From the time B to December 1997, divide the range of time into n parts, when n equals to the economic number of order placed, resulting point C,D,E,F,G, and H (if n = 7) in figure 4.23.

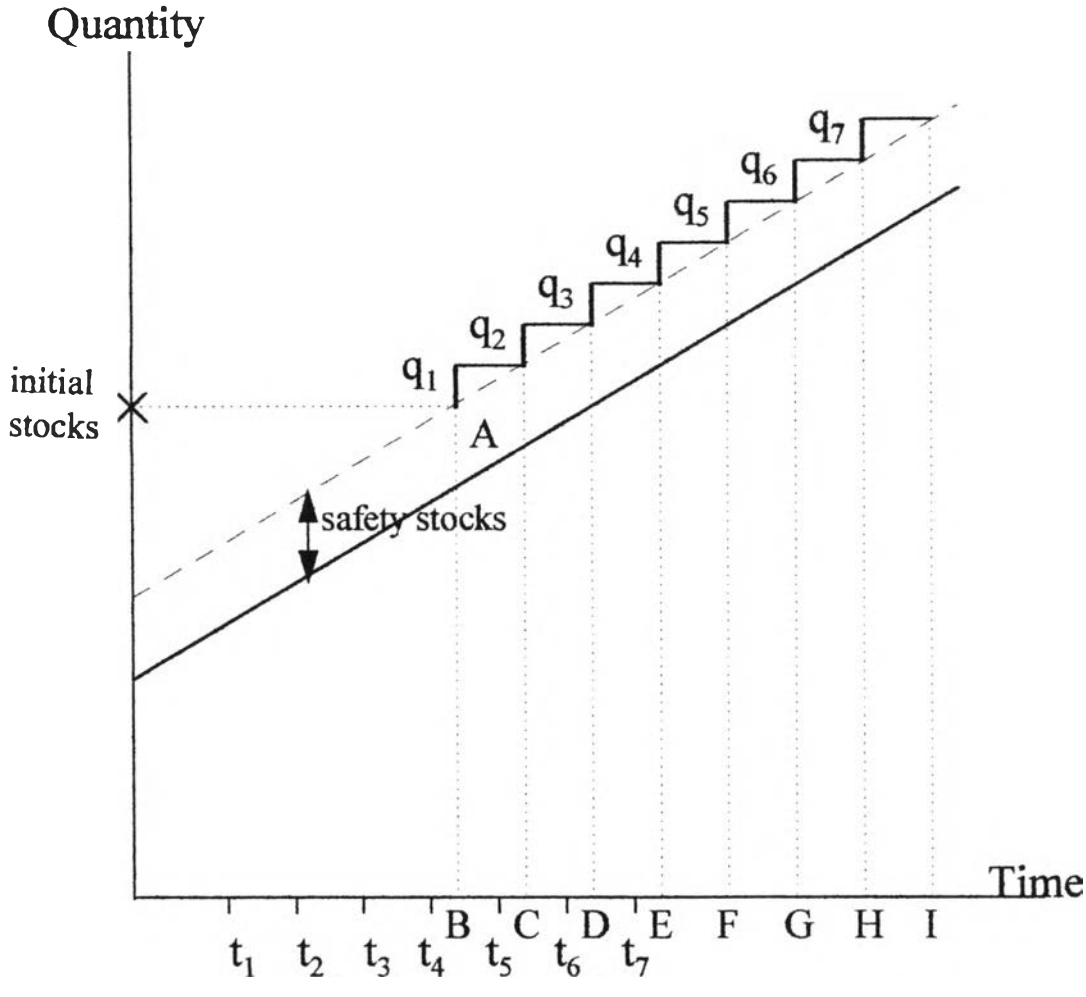

FIGURE 4.23 Order Quantities and Time from Graph

6. The order for quantity q_1 must be placed at t_1 (3 months prior to B)
   The order for quantity q_2 must be placed at t_2 (3 months prior to C)
   The order for quantity q_3 must be placed at t_3 (3 months prior to D)
   The order for quantity q_4 must be placed at t_4 (3 months prior to E)
   The order for quantity q_5 must be placed at t_5 (3 months prior to F)
   The order for quantity q_6 must be placed at t_6 (3 months prior to G)
   The order for quantity q_7 must be placed at t_7 (3 months prior to H)

Following the processes above, the graphs of each item are constructed as shown in figures 4.24-4.29.

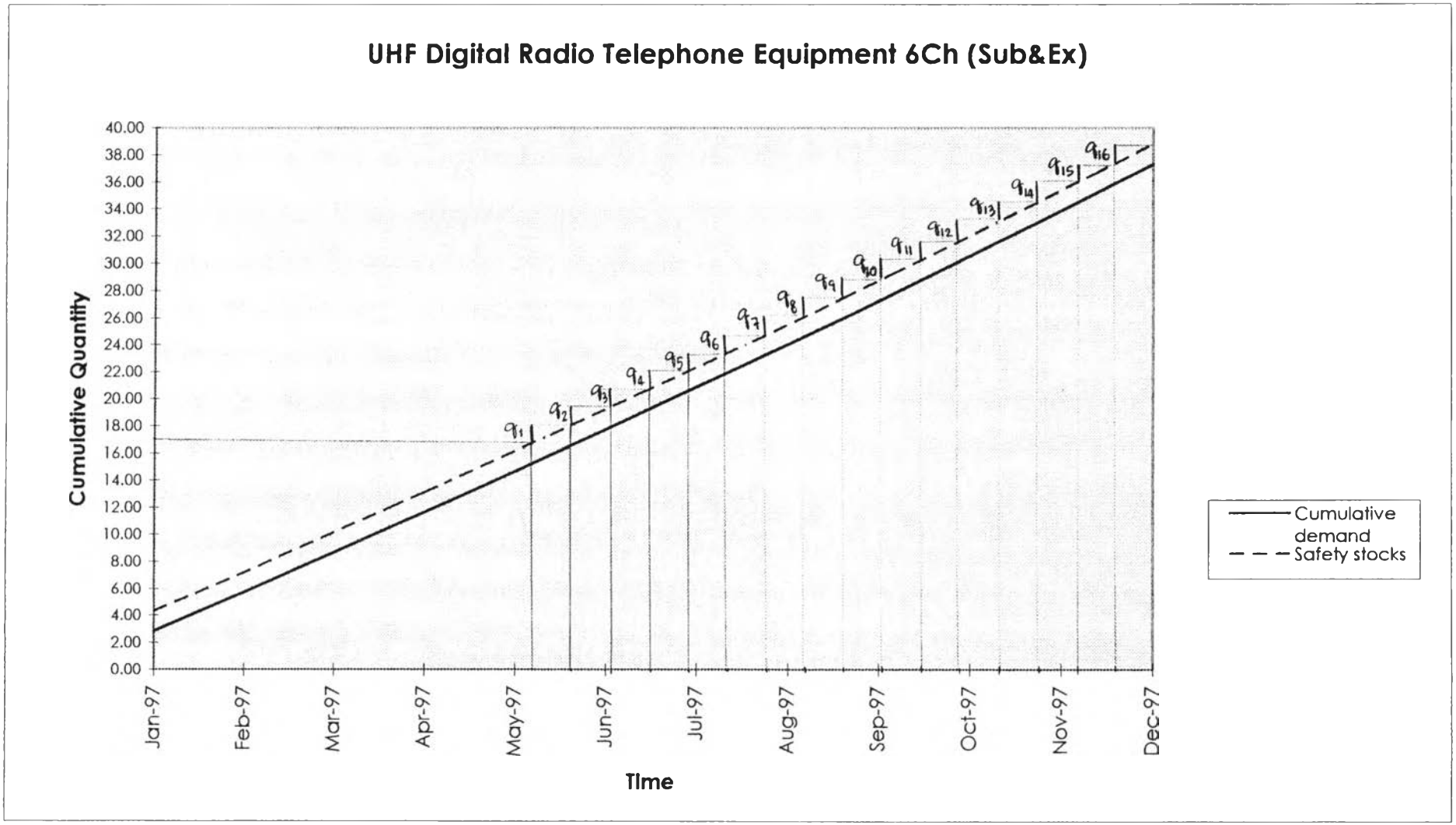

FIGURE 4.24 Order Quantity for each Order Placed of UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex)

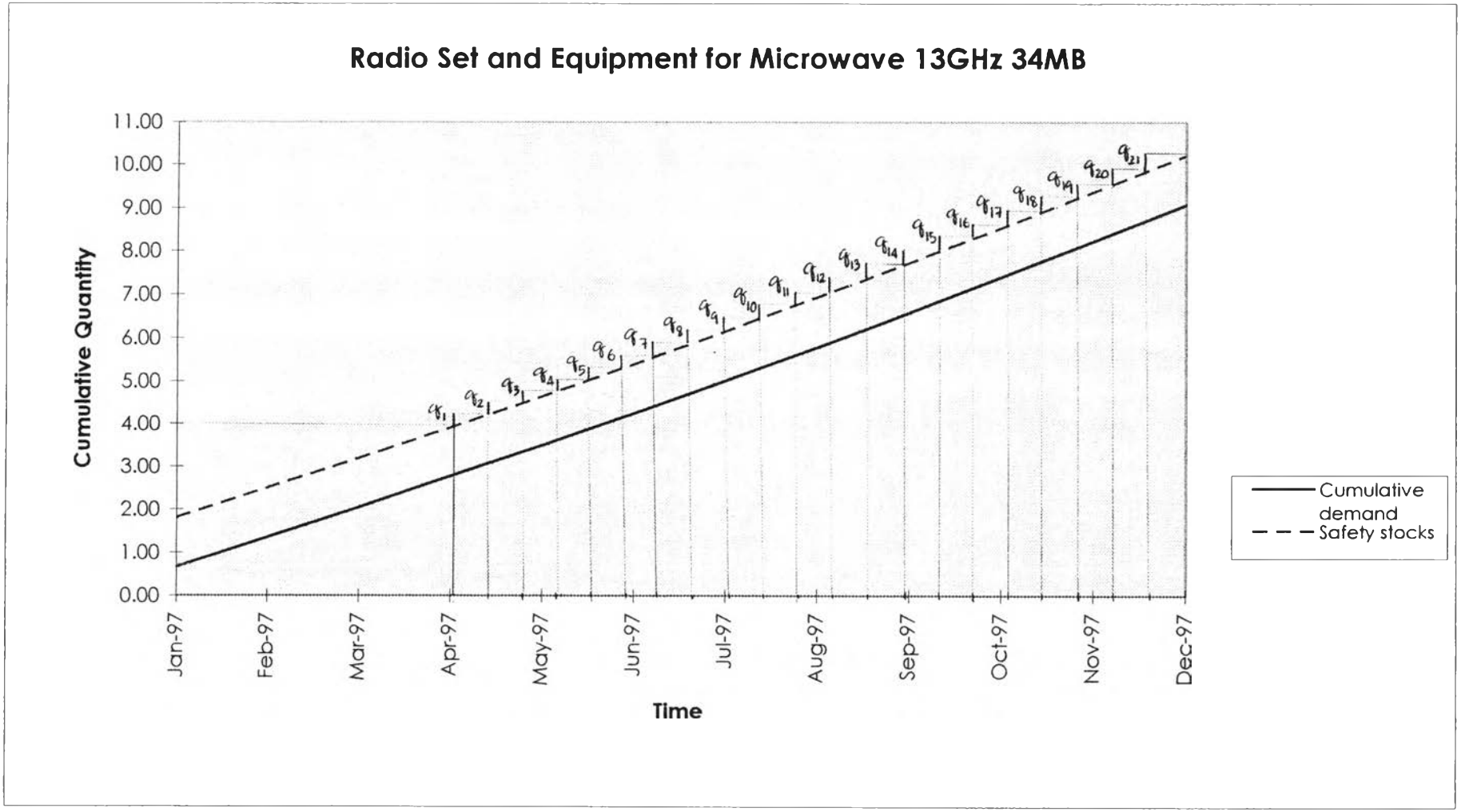

FIGURE 4.25 Order Quantity for each Order Placed of Radio Set and Equipment for Microwave 13GHz 34MB

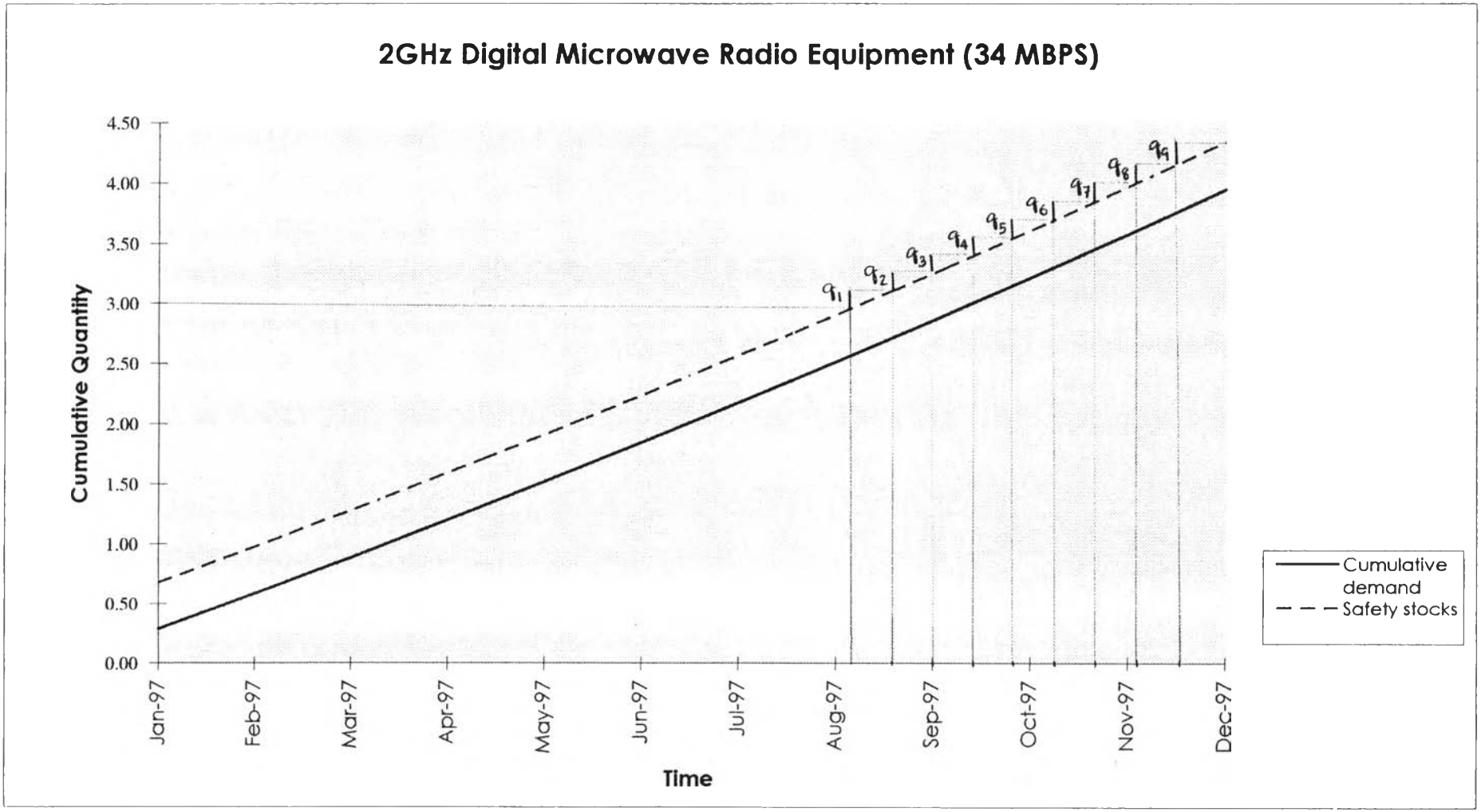

FIGURE 4.26 Order Quantity for each Order Placed of 2GHz Digital Microwave Radio Equipment (34 MBPS)

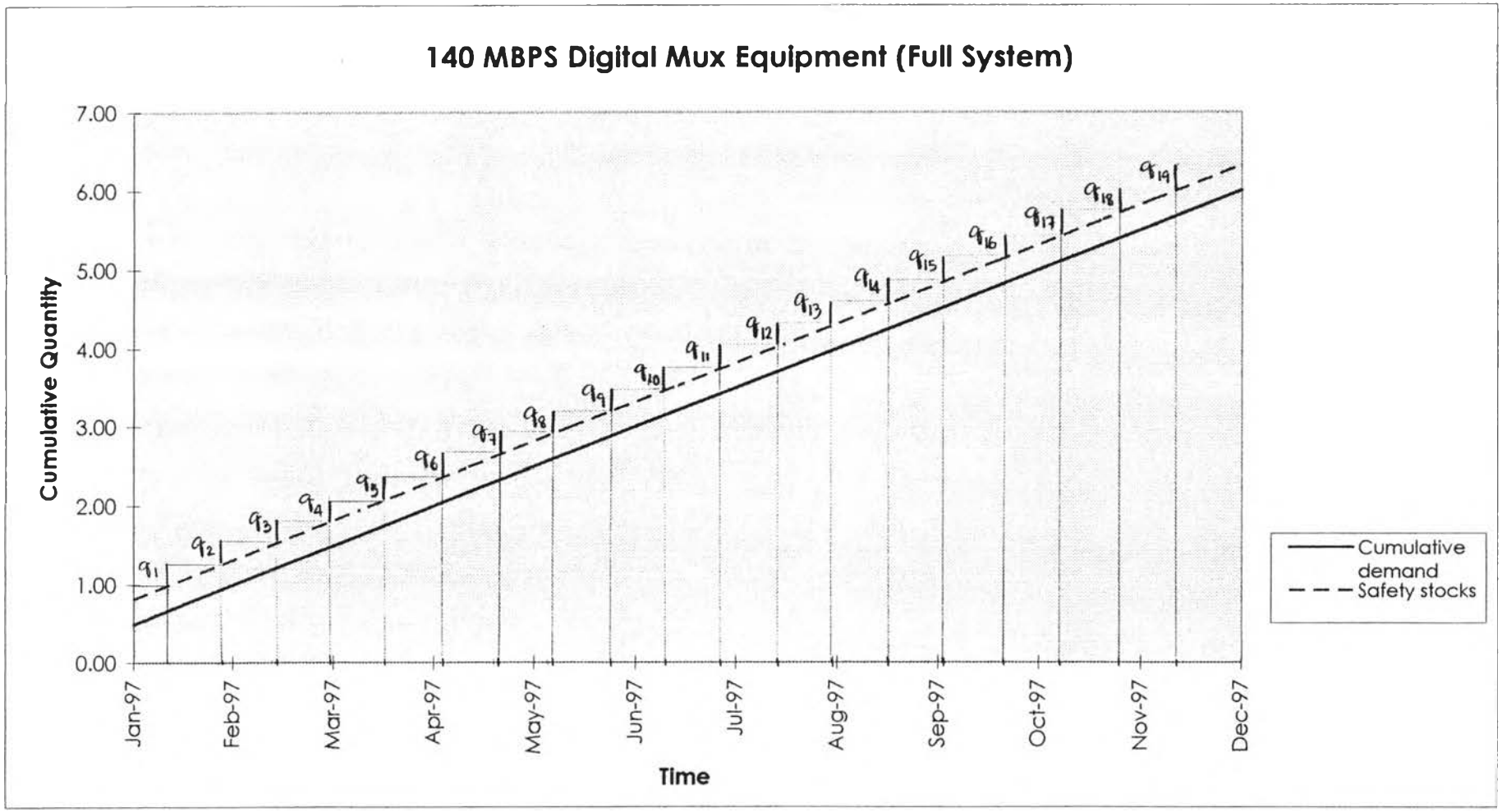

FIGURE 4.27 Order Quantity for each Order Placed of 140 MBPS Digital Mux Equipment (Full System)

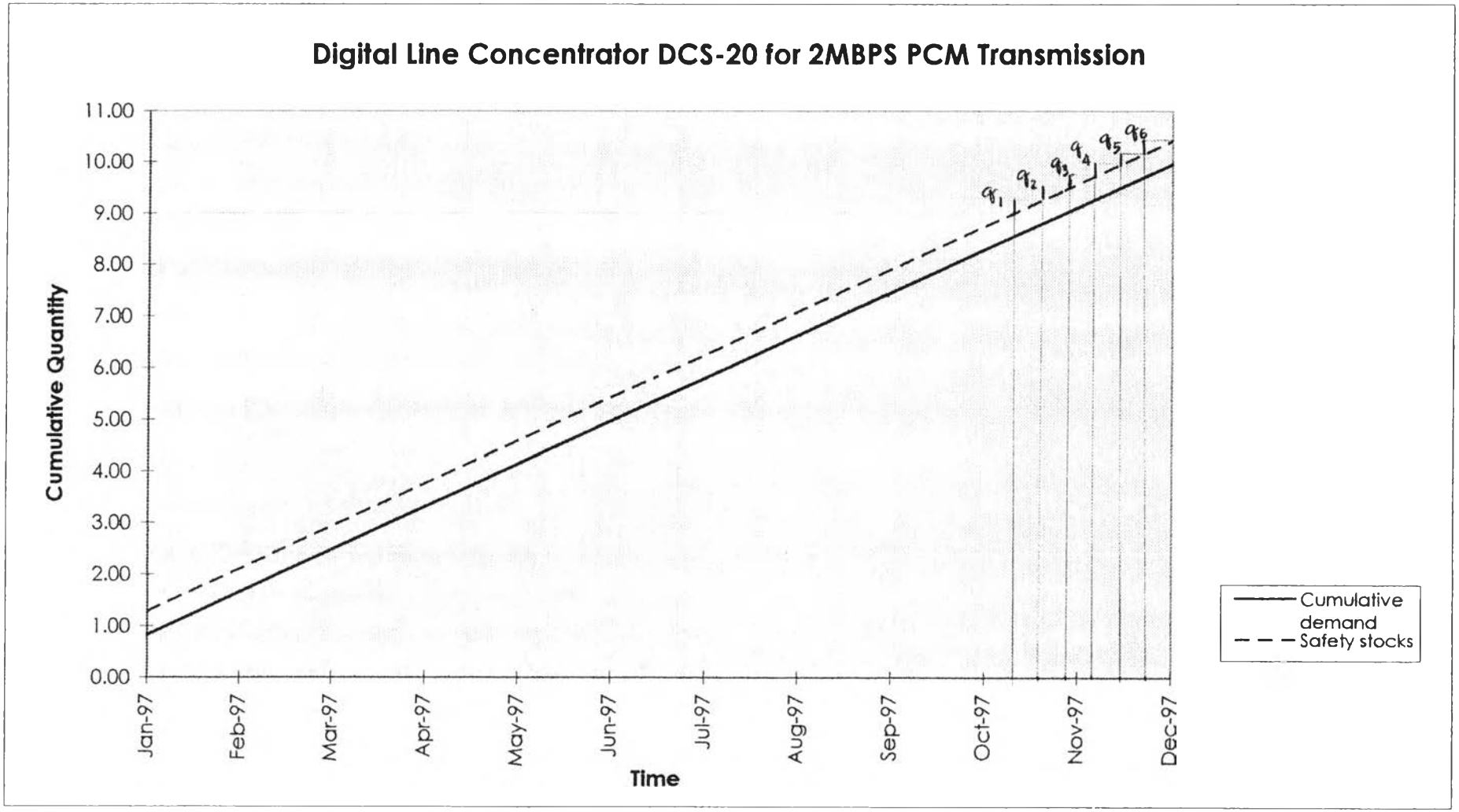

FIGURE 4.28 Order Quantity for each Order Placed of Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

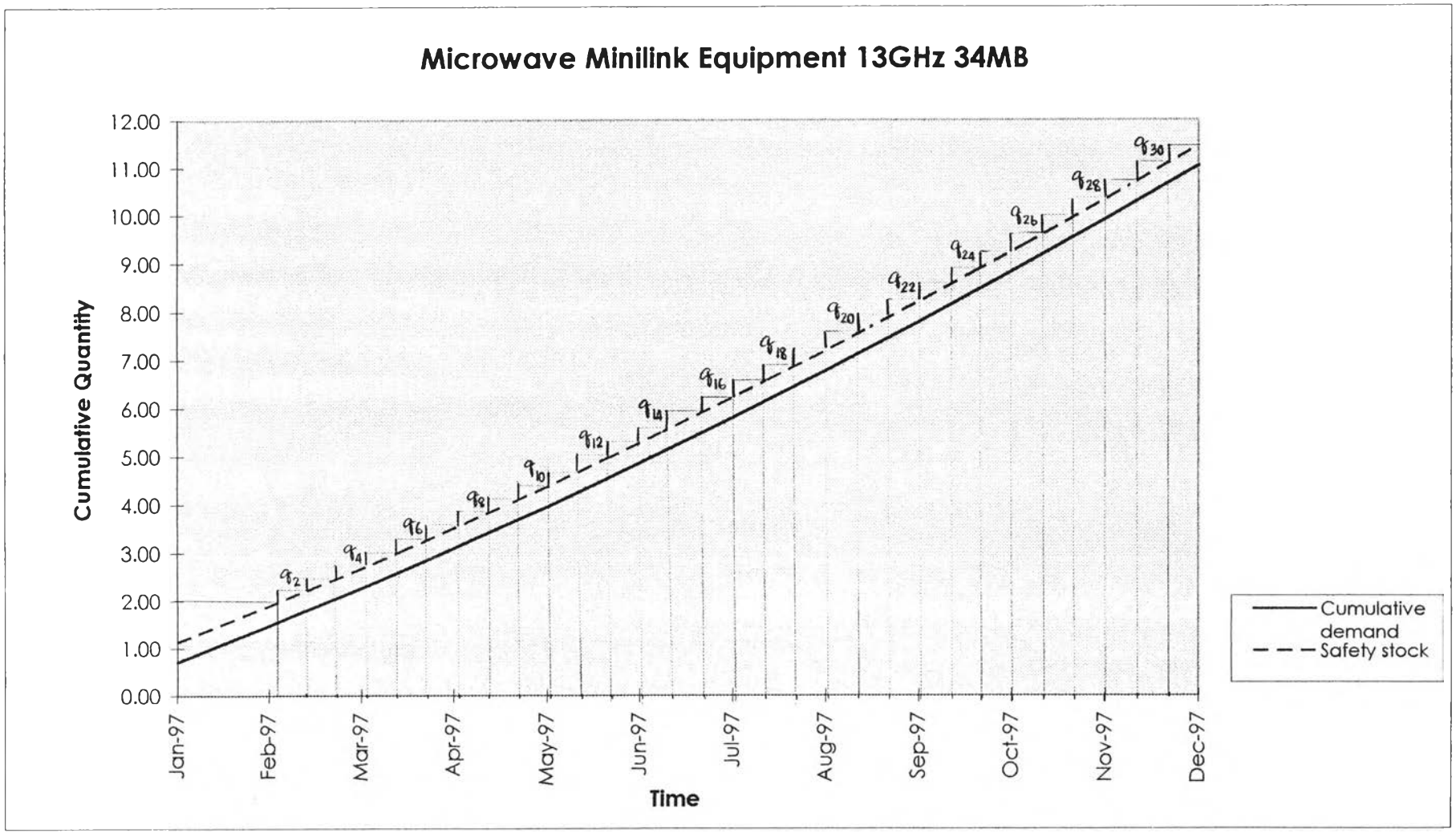

FIGURE 4.29 Order Quantity for each Order Placed of Microwave Minilink Equipment 13GHz 34MB

From figures 4.24-4.29, the order quantities and the time for placing the order of each item are known.

- UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex)

q_1 = 1.30
q_2 = 1.31
q_3 = 1.31
q_4 = 1.32
q_5 = 1.33
q_6 = 1.34
q_7 = 1.35
q_8 = 1.36
q_9 = 1.37
q_{10} = 1.37
q_{11} = 1.38
q_{12} = 1.39
q_{13} = 1.40
q_{14} = 1.41
q_{15} = 1.42
q_{16} = 1.42

- Radio Set and Equipment for Microwave 13GHz 34MB

q_1 = 0.27
q_2 = 0.28
q_3 = 0.28
q_4 = 0.28
q_5 = 0.28
q_6 = 0.28
q_7 = 0.29
q_8 = 0.29
q_9 = 0.29
q_{10} = 0.29
q_{11} = 0.30
q_{12} = 0.30
q_{13} = 0.30
q_{14} = 0.30
q_{15} = 0.30
q_{16} = 0.31
q_{17} = 0.31
q_{18} = 0.31
q_{19} = 0.31
q_{20} = 0.32
q_{21} = 0.32

- 2GHz Digital Microwave Radio Equipment (34 MBPS)

q_1 = 0.14
q_2 = 0.14
q_3 = 0.15
q_4 = 0.15
q_5 = 0.15
q_6 = 0.15
q_7 = 0.15
q_8 = 0.15
q_9 = 0.15

- 140 MBPS Digital Mux Equipment (Full System)

$q_1 = 0.28$
$q_2 = 0.28$
$q_3 = 0.28$
$q_4 = 0.28$
$q_5 = 0.28$
$q_6 = 0.28$
$q_7 = 0.28$
$q_8 = 0.28$
$q_9 = 0.28$
$q_{10} = 0.28$
$q_{11} = 0.28$
$q_{12} = 0.28$
$q_{13} = 0.28$
$q_{14} = 0.28$
$q_{15} = 0.28$
$q_{16} = 0.28$
$q_{17} = 0.28$
$q_{18} = 0.28$
$q_{19} = 0.28$

- Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

$q_1 = 0.24$
$q_2 = 0.24$
$q_3 = 0.24$
$q_4 = 0.24$
$q_5 = 0.24$
$q_6 = 0.24$

- Microwave Minilink Equipment 13GHz 34MB

$q_1 = 0.26$
$q_2 = 0.26$
$q_3 = 0.27$
$q_4 = 0.27$
$q_5 = 0.27$
$q_6 = 0.28$
$q_7 = 0.28$
$q_8 = 0.29$
$q_9 = 0.29$
$q_{10} = 0.29$
$q_{11} = 0.30$
$q_{12} = 0.30$
$q_{13} = 0.31$
$q_{14} = 0.31$
$q_{15} = 0.31$
$q_{16} = 0.32$
$q_{17} = 0.32$
$q_{18} = 0.32$
$q_{19} = 0.33$
$q_{20} = 0.33$
$q_{21} = 0.34$
$q_{22} = 0.34$
$q_{23} = 0.34$
$q_{24} = 0.35$
$q_{25} = 0.35$
$q_{26} = 0.36$
$q_{27} = 0.36$
$q_{28} = 0.36$
$q_{29} = 0.37$
$q_{30} = 0.37$

There is a constrain that the order quantities must be discrete unit but the order quantities gotten from the graphs are continuous unit. Accordingly, the order quantities must be adjusted to be the discrete unit. The results are as follow.

- UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex)

q_1 = 2 sets

q_2 = 2 sets

q_4 = 2 sets

q_5 = 2 sets

q_7 = 2 sets

q_8 = 2 sets

q_9 = 2 sets

q_{11} = 2 sets

q_{12} = 2 sets

q_{13} = 2 sets

q_{15} = 2 sets

The replenishment-quantities needed for the UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex) are 21.77 sets. Eleven-time ordering, 2 sets per one order placed, is enough in this case.

The sum of the incoming quantities of q_1 and q_2 can serve the demand at q_3, it is not necessary to order q_3.

The sum of the incoming quantities of q_4 and q_5 can serve the demand at q_6 ,it is not necessary to order q_6.

The sum of the incoming quantities of q_7 , q_8 , and q_9 can serve the demand at q_{10}, it is not necessary to order q_{10}.

The sum of the incoming quantities of q_{11} ,q_{12}, and q_{13} can serve the demand at q_{14} , it is not necessary to order q_{14}.

Eleven-time ordering, including q_{15} is enough, it is not necessary to order q_{16}.

- Radio Set and Equipment for Microwave 13GHz 34MB

q_1 = 1 set

q_4 = 1 set

q_7 = 1 set

q_{10} = 1 set

q_{13} = 1 set

q_{16} = 1 set

q_{19} = 1 set

The replenishment-quantities needed for the Radio Set and Equipment for Microwave 13GHz 34MB are 6.22 sets, seven-time ordering is enough.

The incoming quantitiy of q_1 can serve the sum of demand of q_1, q_2, and q_3

The incoming quantity of q_4 can serve the sum of demand of q_4, q_5, and q_6

The incoming quantity of q_7 can serve the sum of demand of q_7, q_8, and q_9

The incoming quantity of q_{10} can serve the sum of demand of q_{10}, q_{11}, and q_{12}

The incoming quantity of q_{13} can serve the sum of demand of q_{13}, q_{14}, and q_{15}

The incoming quantity of q_{16} can serve the sum of demand of q_{16}, q_{17}, and q_{18}

The incoming quantity of q_{19} can serve the sum of demand of q_{19}, q_{20}, and q_{21}.

- 2GHz Digital Microwave Radio Equipment (34 MBPS)

q_1 = 1 set

q_7 = 1 set

The replenishment-quantities needed for 2GHz Digital Microwave Radio Equipment (34 MBPS) are 1.34 sets, two-time ordering is enough in this case

The incoming quantity of q_1 can serve the sum of demand at q_1, q_2, q_3, q_4, q_5, and q_6

The incoming quantity of q_7 can serve the sum of demand of q_7, q_8, and q_9

So, it is not necessary to place the order for q_2, q_3, q_4, q_5, q_6, q_8 and q_9 .

- 140 MBPS Digital Mux Equipment (Full System)

q_1 = 1 set

q_4 = 1 set

q_7 = 1 set

q_{10} = 1 set

q_{13} = 1 set

q_{16} = 1 set

The incoming quantity of q_1, 1 set, can serve the sum of demand of q_1, q_2 and q_3, it is not necessary to order q_2 and q_3.

The incoming quantity of q_4, 1 set, can serve the sum of demand of q_4 , q_5 and q_6, it is not necessary to order q_5 and q_6.

The incoming quantity of q_7, 1 set, can serve the sum of demand of q_7 , q_8 and q_9, it is not necessary to order q_8 and q_9.

The incoming quantity of q_{10}, 1 set, can serve the sum of demand of q_{10} , q_{11} and q_{12}, it is not necessary to order q_{11} and q_{12}.

The incoming quantity of q_{13}, 1 set, can serve the sum of demand of q_{13} , q_{14} and q_{15}, it is not necessary to order q_{14} and q_{15}.

The replenishment-quantities needed for the 140 MBPS Digital Mux Equipment (Full System) are 5.32 sets. Six-time ordering, including q_{16} is enough in this case.

- Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

q_1 = 1 set

q_5 = 1 set

The incoming quantity of q_1 is sufficient for the sum of demand at q_1 , q_2, q_3 and q_4 .

The replenishment-quantities required for the Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission are 1.45 sets. Two-time ordering, including q_5 is enough in this case.

- Microwave Minilink Equipment 13GHz 34MB

q_1 = 1 set

q_4 = 1 set

q_7 = 1 set

q_{10} = 1 set

q_{13} = 1 set

q_{16} = 1 set

q_{19} = 1 set

q_{22} = 1 set

q_{25} = 1 set

q_{28} = 1 set

The replenishment-quantities required for the Microwave Minilink Equipment 13GHz 34MB are 9.45 sets, ten-time ordering is sufficient in this case.

The incoming quantity of q_1 is enough for the sum of demand of q_1 , q_2, and q_3, it is not necessary to order q_2 and q_3

The incoming quantity of q_4 is enough for the sum of demand of q_4 , q_5, and q_6, it is not necessary to order q_5 and q_6

The incoming quantity of q_7 is enough for the sum of demand of q_7, q_8, and q_9, it is not necessary to order q_8 and q_9.

The incoming quantity of q_{10} is enough for the sum of demand of q_{10} , q_{11}, and q_{12} it is not necessary to order q_{11} and q_{12}.

The incoming quantity of q_{13} is enough for the sum of demand of q_{13} , q_{14}, and q_{15} it is not necessary to order q_{14} and q_{15}.

The incoming quantity of q_{16} is enough for the sum of demand of q_{16} , q_{17}, and q_{18} it is not necessary to order q_{17} and q_{18}.

The incoming quantity of q_{19} is enough for the sum of demand of q_{19} , q_{20}, and q_{21} it is not necessary to order q_{20} and q_{21}.

The incoming quantity of q_{22} is enough for the sum of demand of q_{22} , q_{23} and q_{24} it is not necessary to order q_{23} and q_{24}.

The incoming quantity of q_{25} is enough for the sum of demand of q_{25} , q_{26}, and q_{27} it is not necessary to order q_{26} and q_{27}.

The incoming quantity of q_{28} is enough for the sum of demand of q_{28} , q_{29}, and q_{30} it is not necessary to order q_{29} and q_{30}.

The stock level of the mentioned inventories would be decreased after implementing this inventory-control method. The recommended inventory-level, only the maximum stock level holding to serve the demand for a period of time and the safety stocks, is stored in the warehouse instead of the huge level of inventory.

When the stock level is minimized, it means that TOT can save cost regarding inventory value. Table 4.35 illustrates the inventory value that can saved, comparing the value at December 1996 and the value of the recommended inventory-level.

- First Order Digital Multiplex Equipment 4W.E&M Sig

  maximum stock level / a period of time = 113/9 = 12.6 = 13 sets

  safety stocks = 4.05

  Recommended inventory-level = 13 + 4.05 = 17.05 = 17 sets

- UHF Digital Radio Telephone Equipment 6 Ch (Sub&Ex)

  maximum stock level / a period of time = 2 sets

  safety stocks = 1.47

  Recommended inventory-level = 2 + 1.47 = 3.47 = 4 sets

- 2GHz Digital Microwave Radio Equipment (8 MBPS)

  maximum stock level / a period of time = 8.2/13 = 0.63 = 1 set

  safety stocks = 0.45

  Recommended inventory-level = 1 + 0.45 = 1.45 = 2 sets

- Radio Set and Equipment for Microwave 13GHz 34MB

  maximum stock level / a period of time = 1 set

  safety stocks = 1.14

  Recommended inventory-level = 1 + 1.14 = 2.14 = 3 sets

- First Order Mux (N 500series)

  maximum stock level / a period of time = 12/7 =1.71 = 2 sets

  safety stocks = 0.93

  Recommended inventory-level = 2 + 0.93 = 2.39 = 3 sets

- 2GHz Digital Microwave Radio Equipment (34 MBPS)

  maximum stock level / a period of time = 1 set

  safety stocks = 0.39

  Recommended inventory-level = 1 + 0.39 = 1.39 = 2 sets

- 140 MBPS Digital Mux Equipment (Full System)

  maximum stock level / a period of time = 1 set

  safety stocks = 0.32

  Recommended inventory-level = 1 + 0.32 = 1.32 = 2 sets

- Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission

  maximum stock level / a period of time = 1 set

  safety stocks = 0.45

  Recommended inventory-level = 1 + 0.45 = 1.45 = 2 sets

- Microwave Minilink Equipment 13GHz 34MB

  maximum stock level / a period of time = 1 set

  safety stocks = 0.41

  Recommended inventory-level = 1 + 0.41 = 1.41 = 2 sets

Name	Price (Baht)	Stock Level (Set)		Inventory Value (Baht)	
		Dec-96	Dec-97	Before	After
First Order Digital Multiplex Equipment 4w. E&M sig	157,065.00	443	17	69,579,795.00	2,670,105.00
UHF Digital Radio Telephone Equipment 6Ch (Sub&Ex)	778,880.00	17	4	13,240,960.00	3,115,520.00
2 GHZ Digital Microwave Radio Equipment (8 MBPS)	3,271,133.94	12	2	39,253,607.28	6,542,267.88
Radio Set and Equipment for Microwave 13GHz 34MB	4,582,162.91	4	3	18,328,651.64	13,746,488.73
First Order Mux (N500 series)	785,285.00	14	3	10,993,990.00	2,355,855.00
2 GHZ Digital Microwave Radio Equipment (34 MBPS)	4,373,753.80	3	2	13,121,261.40	8,747,507.60
140 MBPS Digital Mux Equipment (Full System)	4,770,618.00	1	2	4,770,618.00	9,541,236.00
Digital Line Concentrator DCS-20 for 2MBPS PCM Transmission	1,570,000.00	9	2	14,130,000.00	3,140,000.00
Microwave minilink Equipment 13GHz 34MB	6,227,511.75	2	2	12,455,023.50	12,455,023.50
Total				195,873,906.82	62,314,003.71

TABLE 4.21 Cost Saving Regarding Inventory Value

The cost saving = 195,873,906.82 - 62,314,003.71

= 133,559,903.11 baht

= 68.19%