Original Article
Basic Science

Machinery and Equipment Valuation

Rowland JO EKEOCHA

ABSTRACT [ENGLISH/ANGLAIS]

Valuation (appraisal) gives an unbiased opinion of value or other physical attributes of identified property. Value, on the other hand, is the monetary worth of property, goods or services. The Machinery and Technical Specialties (MTS) Committee of the American Society of Appraisers (ASA) established methods for valuation of property including machinery and equipment. These methods conform to the Uniform Standards of Professional Appraisal Practice (USPAP). Valuation of property and indeed machinery and equipment is necessary for various purposes including ownership change, partnerships, mergers and acquisitions. The Industrial Inspectorate Department (IID) of the Federal Ministry of Industry in conformity with the Institute of Appraisers and cost Engineers (IACE) of the Nigerian Society of Engineers (NSE) Internalized the valuation process in carrying out the mandate of determining the investment valuation of capital undertakings with the view to issuing acceptance certificate for capital allowance purposes and certificate of value for equity contribution. This paper sets out to streamline the various valuation methods as a way of complementing the existing valuation process. The application of a combination of these valuation methods is recommended to arrive at an unbiased opinion of value of any property and indeed machinery and equipment.

Keywords: Machinery valuation, valuation process, capital undertaking

RÉSUMÉ [FRANÇAIS/FRENCH]

Evaluation (évaluation) donne une opinion impartiale de la valeur ou d'autres attributsphysiques de la propriété identifiée. Valeur, d'autre part, est la valeur monétaire des biens, des biens ou des services. Les Spécialités de machines et de techniques (MTS)Comité de l'American Society of Appraisers (ASA) a établi les méthodes d'évaluationde la propriété y compris les machines et l'équipement. Ces méthodes sont conformes aux normes uniformes de pratique professionnelle (évaluation USPAP). Évaluation des biens et même la machinerie et l'équipement est nécessaire à des fins diverses, y compris le changement de propriété, des partenariats, des fusions et acquisitions. LeDépartement Inspection industrielle (IID) du Ministère fédéral de l'Industrie en conformité avec l'Institut des évaluateurs et des ingénieurs de coûts (IACE) de la Nigerian Society of Engineers (NSE) intériorisé le processus d'évaluation dans l'exécution du mandat dedéterminer la valeur d'investissement de des projets d'immobilisations en vue de la délivrance du certificat d'acceptation pour les fins de la déduction des capitaux et le certificat de valeur de la contribution de l'équité. Ce document vise à rationaliser lesdifférentes méthodes d'évaluation comme un moyen de compléter le processus d'évaluation existant. L'application d'une combinaison de ces méthodes d'évaluation est recommandé d'arriver à une opinion impartiale de la valeur de tout bien et en fait des machines et équipements.

Mots-clés:L'évaluation de machines, de processus d'évaluation, entreprise de capital

Affiliations:
Department of Mechanical Engineering, University of Nigeria, Nsukka, NIGERIA

Address for Correspondence/ Adresse pour la Corresponda nce: ekeochaj@yahoo.com

Accepted/Accepté: February, 2012

Citation: Ekeocha RJO.Machinery and Equipment Valuation World Journal of Engineering and Pure and Applied Sciences 2012;2(2):45-50.

INTRODUCTION

The goal of the valuation process is to produce an unbiased opinion of value showing that the appraiser has considered all factors that may affect the value of the subject assets. The American Society of Appraisers (ASA) through the Machinery Technical Specialties (MTS) Committee [1] formulated a valuation process that conforms to the uniform standards of Professional Appraisal Practice (USPAP).

The valuation process involves the following steps: assembling of relevant data (definition of problem), conduction of market survey, application of appropriate analytical techniques, knowledge, experience and judgment to reach conclusions, formation of values and the preparation of an appraisal report. The definition of the problem includes the identification of the property (assets) to be appraised, purpose and the intended use of the appraisal, premise of value, effective date and limiting conditions. Appraisals can be performed for individual pieces of equipment, a production line, a complete operating facility or multiple operating facilities. The client establishes the intended use of an appraisal to enable the appraiser to identify the premise of value and the appropriate value concepts and

approaches. The purpose of equipment appraisal includes accounting, financing, insurance, leasing, liquidation and bankruptcy, management planning, transfer of ownership and tax issues [2]. The premise of value includes the fair market value in continued use, fair market value installed; fair market value – removal, orderly liquidation value in place, orderly liquidation value, forced liquidation or auction value, salvage value, scrap value, insurance replacement cost and insurance value depreciated (see appendix I for the definition of these terms) [1]. The valuation (effective) date is important because it sets the exact date at which the value is determined and establishes the context for the opinion of value. The limiting conditions are also important because they state, among others; the limits to the appraiser's liability. The next step in the valuation process is the application of the appropriate value concepts/techniques.

The value concepts/approaches include the cost approach, sales comparison approach and the income approach [1]. The cost approach is based on the proposition that an informed purchaser would pay no more for an asset than the cost of producing a substitute with the same utility as the subject asset. This concept is known as the principle of substitution. The cost approach assumes that the maximum value of an asset to a knowledgeable buyer is the amount currently required to purchase or construct a new asset of equal utility. When the asset is not new, the current cost is adjusted for all forms of depreciation attributable to the asset as of the date of valuation. In its simplest form, the cost approach is represented as follows:

Cost New – Depreciation = Value.

The starting point of the cost approach is reproduction cost new, replacement cost new or a combination of both. The sales comparison approach considers market data in determining the value of the subject assets. The purpose is to determine the desirability of the subject assets through an analysis of recent sales or offering of similar assets to arrive at an indication of the most probable price for the subject assets. If the comparable from the market is superior to the subject asset regarding specific characteristics, the comparable is adjusted downward or upward if otherwise. In its simplest form, the sales comparison approach can be represented as follows:

Comparable Sale + or – Adjustment = Value range.

The income approach considers values to be represented by the present worth of future benefits derived from ownership typically measured by the capitalization of a specific level of income. The basic premise of the income approach is that a purchaser expects to receive a certain rate of return on the income stream attributable to the subject assets. It can be stated as follows:

Value x Rate = Income

Or

Income = Rate x Value (IRV)

Or

Income ÷ Capitalization Rate = Value.

The income approach may possibly be used to value machinery and equipment that typically produce income such as rail cars, airplanes and heavy construction equipment. The final step in the valuation process is the preparation of an appraisal report highlighting salient issues leading to the determination of value for the subject assets.

The Industrial Inspectorate Department (IID) [3] of the Federal Ministry of Industry (now Trade and Commerce) adapted the valuation process to suit the administration of its mandate. The mandate of IID includes the investigation of capital undertakings with the view to issuing acceptance certificate for capital allowance purposes and certificate of value for equity contribution of foreign technical partner in the form of machinery and equipment. In addition, the certificate of value is used for deferred payments for imported machinery and equipment. The steps involved in IID investigation include the review of supporting documents for the capital expenditure items, physical inspection of the assets (capital expenditure items), writing of technical report giving technical details of the assets, valuation of the assets in the report and making recommendation and finally, issuing the relevant certificate to the applicant usually a corporate body/business after approval by the head of the department (Director).

There are five different methods of valuation by IID namely capacity adjustment by exponential method using available price data, unit price method, order of magnitude approach using established cost profiles of project already investigated, direct price comparison/cost auditing and market data, income and cost approaches [3]. These methods are applied individually or collectively to four categories of assets namely plant/process equipment, standard machines, custom-built machines and civil engineering works. The capacity adjustment by exponential method computes the cost of the subject plant of known capacity from the following formula.

$$\frac{CA}{CB} = \left(\frac{PA}{PB}\right)^{x}$$

Where CA = Cost of subject Plant A
CB = Known cost of Plant B
PA = Known annual capacity of Plant A
PB = Known annual capacity of Plant B
X = Exponential factor appropriate for the type of plant
(Average value of x is 0.67)

The unit price method is simply multiplying the annual plant capacity by a unit cost derived from the known cost of a similar plant. A typical unit cost is expressed as installed capital cost per ton of annual production. This method does not yield an accurate result but helps to give an insight into the price of the plant or equipment. However, if the result obtained is used in conjunction with the order of magnitude approach, a more accurate and quite acceptable value could be reached.

The order of magnitude approach is the use of established cost profiles or modules from similar and investigated projects to check the acceptable range of cost ratios for new projects.

Capital cost auditing (Direct price comparison) is the satisfactory matching and justification of the various capital expenditure claims with actualized project scope and content (specification).

The market data, income and cost approaches are as earlier presented under valuation process by ASA [1].

The premise of value for the valuation by IID is the first cost (historical cost) for new assets and fair market value (FMV) for secondhand assets.

As stated earlier, the starting point for the cost approach is the reproduction cost new, the replacement cost new or a combination of both. The first cost (historical cost) determined by valuation techniques adopted by IID in its investigation of capital undertakings provides the starting point for the cost approach.

The fair market value (FMV) for secondhand assets by IID techniques gives an indication of values similar to values derived by the sales comparison approach. It is therefore necessary to combine these techniques in any valuation process to arrive at a well-supported opinion of value for the subject assets.

METHODOLOGY

A combination of the valuation methods is applied in two examples as follows:

IID valuation methods are used to determine the first cost (historical cost) which serves as the starting point for the cost approach. Then the cost approach, the sales comparison approach and the income approach are used to determine the value for the subject assets. Comparison and analysis of the result lead to the formulation of an unbiased opinion of value for the subject assets

RESULTS

Consider the following examples:

Examples 1

You are to appraise an X company model Y front-end loader built in 1995 at a cost of $50,000 freight on board (FOB) manufacturer. The current replacement cost new is $60,000. You have estimated all forms of depreciation to be 25% and capitalization rate of 40%. The Brown guide (hypothetical) indicates that similar 1995 machines, similarly equipped are readily available in the used market with significant number of sales, selling for $35000 to $40000. The ABC market survey report (hypothetical) indicates very few model Y machines are available for rent but when they are available, the gross rent is $20000 per year less 10% for lessor expenses. What is the fair market value (FMV) using the cost, sales comparison and income approaches. What conclusion can be made as the FMV for the subject asset?

[Source: Institute of Appraisers and Cost Engineers (IACE), 2005] [4].

Solution

Name of Company	:	X
Name of Machine	:	Front-End Loader
Type	:	Model Y
Year of Manufacture	:	1995
Cost of Machine	:	$50000 (FOB)
Replacement cost new	:	$60000
Resale value (resale market)	:	$35000 - $40000
Depreciation rate	:	25%
Capitalization rate	:	40%
Annual gross rent	:	$20000
Lessor expenses	:	10%

a. **Cost approach**

Value = Cost new minus Depreciation
= 60000 – [0.25 x 50000]
= 60000 – 12500
= 47500

b. **Sales Comparison Approach**

Value = Comparable sale ± Adjustment
= 35000 (40000) + [0.25 x 50000]
= 350000 (40000) + 12500
= 47500 (52500)

The comparable is adjusted upwards due to depreciation in age. It is built in 1995 similar to the subject machine. It is likely to be inferior to the subject machine.

c. **Income approach**

Value = Income ÷ Rate

= [20000 – 0.10 x 20000] ÷ 0.40
= 18000 ÷ 0.40
= 45000

The Fair market value (FMV) of the front-end loader is about $47500.

Example 2

A plant has numerous machines but the backbone of the production is made up of four Numerically Controlled (NC) machines. These consist of two identical ABC Manufacturing company Model 40 machining centres and two identical XYZ manufacturing company Model ZZ20 turning centres. All these machines were purchased 15 years ago in April. The effective appraisal date is April 1 of the current year. It has been determined that the normal life for the equipment is 20 years and that straight line depreciation is to be used. To determine cost, the appraiser called the ABC manufacturing company and spoke with a salesperson who has been there for more than 20 years. The salesperson stated that the Model 40 machining centre was no longer made and has been replaced by a Model 50 five years ago. This person was familiar with both models and said that, by comparing specifications for both machines, the Model 50 had 20% more productive capacity, reflected by a coinciding 20% increase in cost which is represented by the $240000 replacement cost new of a Model 50. The appraiser called the XYZ Manufacturing Company and was told that the Model ZZ20 turning centre was still in production but that the sales price had dropped to $65000 from $80000. The sales price dropped because the controls for this machine were now less costly due to an improved design that made it cheaper to manufacturer but did not affect its output. Also, the Model ZZ20 is going to be replaced by a Model ZZ25 within the next six months with the same production capacity as the ZZ20. Three different used machinery dealers were contacted. All had one or more identical ABC Model 40 machines in stock and in good condition. They were offering these machines at a reasonably consistent price of $26500 but were having trouble selling them due to the older type configuration. Two dealers each had one XYZ machine Model ZZ20 for sale. One was offered at $22000 and the other at $18000. Both dealers felt that if they could not sell the machine before the new Model ZZ25 was introduced, they would have to drop the price drastically. The assessor and taxing guidelines instruct an assessor to apply a trend factor to the historical cost of the item and then depreciate that amount on a straight line basis to arrive at a fair market value in continued use. The trend factor is determined to be 1.45. The historical cost includes all of the direct and indirect installation costs. The current cost of installation is $25000 for the ABC Model 40 and $15000 for the XYZ Model ZZ20.

What is the fair market value (FMV) in continued use, using the cost, sales comparison and income approaches? Reconcile the value using the most applicable approach or combination of approaches. What is the reproduction cost new?

[Source: Institute of Appraisers and Cost Engineers (IACE), 2005] [4]

Solution

1.Name of Company	:	ABC
Name and type of Machine	:	Model 40 Machining Centre
Age of Machine	:	15 Years
Normal life of Machine	:	20 years
Historical Cost of Machine	:	$200000 (Installation included)
Resale value of Machine	:	$26500
Depreciation rate (secondhand)	:	6% (Generated – Appendix 2) [5]
Current Installation Cost	:	$25000
Depreciation rate	:	75% (straight line)
Lessor expenses	:	10%
2. Name of Company	:	ABC
Name and type of Machine	:	Model 50 Machining Centre
Current Replacement Cost New	:	$240000
Age of Machine	:	5 years
Normal life of Machine	:	20 years
Depreciation Rate	:	25% (straight line)
Depreciation Rate (Secondhand)	:	5% (Generated – Appendix 2) [5]
3. Name of Company	:	XYZ
Name and type of Machine	:	ZZ20 Turning Centre (Lathe)
Age of Machine	:	15 years
Normal life of Machine	:	20 years
Historical Cost	:	$80000(installation included)
Depreciation Rate	:	75% (straight line)
Current Replacement Cost New	:	$65000
Resale Value	:	$18000 and $22000

Depreciation Rate (Secondhand) : 6% (Generated – Appendix 2) [5]
Current Installation Cost : $15000
Trend Factor for the Machines : 1.45

1. **ABC Model 40**
   a. **Cost approach**
   Value = 240000 – (0.75 x 200000)
   = 240000 – 15000
   = 9000
   FMV in continued use = 9000 + 25000
   = 34000
   b. **Sales comparison approach**
   Value = 26500 – (0.06 x 200000)
   = 26500 – 12000
   = 14500
   FMV in continued use = 14500 + 25000
   = 39500

2. **XYZ Model ZZ20**
   a. **Cost approach**
   Value = 65000 – (0.75 x 80000)
   = 65000 – 60000
   = 5000
   FMV in continued use = 5000 + 15000
   = 20000
   b. **Sales comparison approach**
   Value = 18000 – (0.06 x 80000)
   = 18000 – 4800
   = 13200
   FMV in continued use = 13200 + 15000
   = 28200

3. **ABC Model 50**
   a. **Cost approach**
   Value = 240000 – (0.25 x 200000)
   = 240000 – 50000
   = 190000
   FMV in continued use = 190000 + 25000
   = 215000
   b. **Sales comparison approach**
   Value = 240000 – (0.05 x 200000)
   = 240000 – 10000
   = 230000
   FMV in continued use = 230000 + 25000
   = 255000

4. Reproduction Cost New (Model 40)
   = 200000 x 1.45
   = 290000

5. Reproduction Cost New (Model ZZ20)
   = 80000 x 1.45
   = 116000

The income approach is not applicable because there is no income stream associated with the machines.

DISCUSSION

The cost, sales comparison and income approaches are applicable in the first example. The income approach is not feasible in the second example because there is no income stream generated by the machines. In the two examples, the derived values are highest with the sales comparison approach and least with the income approach. This may be attributed to the uncertainties in the resale market. The sales comparison approach is most reliable when there is an active resale market providing sufficient number of sales of comparable property that can be verified independently through reliable sources. The cost approach is reliable when all forms of depreciation can be determined accurately. The use of the income approach, on the other hand, depends on accurate determination of the expected income stream and the rate of return (capitalization rate) of a property. The results of the examples show that fair market value (FMV) is within acceptable limits. The replacement cost new is provided in the examples. Otherwise the first cost (historical cost) which is the starting point of the cost approach, would have been determined by an appropriate IID technique [3].

CONCLUSION

The study concludes that it is advisable to apply all the approaches or a combination of the approaches in the valuation of machinery and equipment to arrive at an unbiased opinion of value because each approach has its strong area of suitability. This fact is corroborated by the results of the examples demonstrated in the study

REFERENCES

[1] The Machinery and Technical Specialties (MTS) Committee of the American Society of Appraisers (ASA), Valuing machinery and equipment: The fundamentals of appraising machinery and technical assets; 2000. ASA , 2000; Washington DC.
[2] Machinery and Equipment Appraisals. Available from: http://www.appraisaleconomics.com/machinery.html Last accessed: December 2011

[3] Industrial Inspectorate Department (IID) of the Federal Ministry of Industry (FMI), Standard work procedure. Government Press, Lagos. 1999.
[4] Institute of Appraisers and Cost Engineers (IACE) of the Nigerian Society of Engineers (NSE), Machinery and Equipment Appraisal Accreditation course, part 1. ACE. Abuja. 2005.
[5] Ekeocha RJO Generation of machinery deterioration rates. International Journal of Research in Engineering 2010;2:109-11.

ACKNOWLEDGEMENT / SOURCE OF SUPPORT

Nil

CONFLICT OF INTEREST

No conflicts of interests were declared by authors.

SUPPLEMENTARY INFORMATION

DEFINITIONS OF SOME TERMS

The following definitions are given by the Machinery and Technical Specialties (MTS) Committee of the American Society of Appraisers (ASA) [1]

1. Fair Market Value (FMV) is the estimated amount, expressed in terms of money that may be reasonably expected for a property in an exchange between a willing buyer and a willing seller, with equity to both, neither under any compulsion to buy or sell and both fully aware of all relevant fact, as of a specific date.
2. Fair Market Value – Removal is the estimated amount, expressed in terms of money that may reasonably be expected for a property, in an exchange between a willing buyer and a willing seller, with equity to both, neither under any compulsion to buy or sell and both fully aware of all relevant facts as of a specific date, considering the cost of removal of the property to another location.
3. Fair Market Value in continued use is the estimated amount, expressed in terms of money, that may reasonably be expected for a property in an exchange between a willing buyer and a willing seller, with equity to both, neither under any compulsion to buy or to sell and both fully aware of all relevant facts including installation as of a specific date and assuming that the business earnings support the value reported. This amount includes all normal direct and indirect costs such as installation and other assemblage cost to make the property fully operational.
4. Fair Market Value – Installed is the estimated amount expressed in terms of money that may reasonably be expected for an installed property in an exchange between a willing buyer and a willing seller with equity to both, neither under any compulsion to buy or sell and both fully aware of all relevant facts including installation as of a specific date. This amount includes all normal direct and indirect costs necessary to make the property operational.
5. Orderly Liquidation Value is the estimated gross amount expressed in terms of money that could be typically realized from liquidation sale, given a reasonable period of time to find a purchaser with the seller being compelled to sell on an as-is, where-is basis as of a specific date.
6. Forced Liquidation Value is the estimated gross amount, expressed in terms of money that could typically be realized from a property advertised and conducted in public auction with the seller being compelled to sell with the sense of immediacy on an as-is, where – is basis as of a specific date.
7. Liquidation Value in Place is the estimated gross amount, expressed in terms of money that could typically be realized from a failed facility, assuming that the entire facility would be sold intact with a limited time to complete the sale as of a specific date.
8. Salvage Value is the estimated amount, expressed in terms of money that may be expected for a whole property or a component of the whole property that is retired from service for use elsewhere.
9. Scrap Value is the estimated amount expressed in terms of money that could be realized for a property if it were sold for its material contents, not for a productive use.
10. Insurance Replacement Cost is the replacement cost new as defined in the insurance policy less the replacement cost new of the items specifically excluded in the policy, if any.
11. Insurance Value Depreciated is the insurance replacement cost new less accrued depreciation considered for insurance purposes, as defined in the insurance policy or other agreements.

    The following definitions are given by the Industrial Inspectorate Department (IID) of the Federal Ministry of Industry (FMI) [3].
12. Capital Undertaking means an undertaking carried on by way of trade or business for the production of goods or services for sale and requiring the use of industrial machinery or other equipment, plants, building and other permanent or temporary fixtures on land.

    Ordinarily, capital undertaking means any grouping of capital expenditure items acquired within a defined expenditure plan (project) which when operated makes a desired profit contribution to the enterprise.

13. Capital Expenditures are expenditures financed through equity contribution, medium to long term loans or through reserved earnings of an operating enterprise for the acquisition and installation of fixed assets or acquisition of movable assets whose useful service lives at least equal or exceed one accounting period (financial year). These expenditures are usually amortized or recovered over a period of time, which approximates to the normal useful lives of the assets.
14. Process Plants/Equipment are groups of system related units of machinery, equipment and accessories whose sole functions of production are achieved through continuous operation or in stages of the component machinery, equipment and accessories in which the input materials undergo various processes to yield the required end product.
15. Standard Machines are machinery and equipment designed and produced by a manufacturer for sale to customers. (off shelf)
16. Customs – Built Machines are non standard machines manufactured to meet the customer's special needs. The prices of custom-made machines are usually negotiated between the buyer and the designer/manufacturer.

TABLE OF MACHINERY DETERIORATION RATES

The table shows the generation of deterioration rates for the machining/turning machines with 20 years normal life from 50 random numbers [5]

Random No. (Years)	Frequency	Deterioration Rate	Probability
1	3	0.05	0.06
2	2	0.10	0.04
3	2	0.15	0.04
4	1	0.20	0.02
5	1	0.25	0.02
6	1	0.30	0.02
7	3	0.35	0.06
8	1	0.40	0.02
9	4	0.45	0.08
10	4	0.50	0.08
11	4	0.55	0.08
12	2	0.60	0.04
13	1	0.65	0.02
14	3	0.70	0.06
15	4	0.75	0.08
16	3	0.80	0.06
17	2	0.85	0.04
18	4	0.90	0.08
19	2	0.95	0.04
20	3	1.00	0.06
Total	50		1.00

SUPPLEMENTARY INFORMATION