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# Financial feasibility analysis of small industry of mathematical manipulative

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**Abstract**. Learning Mathematics effortlessly and pleasantly is one of the strategies for children to master concepts, mathematical principles, and be capable of solving mathematical problems. In accordance with children mental development, the existence of manipulatives (concrete) is required by children to fulfill the above objectives. Along with technology development, manipulatives have also been developed to support students' thinking abilities based on the demands of the ongoing curriculum. One of the objectives of this study was to conduct a financial feasibility analysis of commercial of mathematical manipulatives. Indicators of commercial feasibility used in this study were Break Event Point (BEP) analysis, Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit Cost Ratio (B / C Ratio), and Pay Back Period (PBP) ). The steps in analyzing financial feasibility of manipulatives production business in this study were to calculate: (1) Fix Cost, (2) Variable Cost, (3) Production Cost, (4) Cost of Goods Manufactured and BEP Analysis (5) Investment Feasibility (IRR analysis, NPV, B / C Ratio, and PBP). The results of the analysis showed that the production of manipulatives in this study was feasible as a commercial business with BEP occurred when sales of manipulatives made from wood were 3 sets, Evafoam were 18 sets, and paper were 7 sets, NPV was 574,126,261 per year, IRR 50% > interest level at 12%, B / C ratio of 1.50247> 1 (profitable), and PBP occurred 2 years 11 months 29 days.

## 1. Introduction

Learning Mathematics at the level of primary education (Primary school and Junior High School) in Indonesia still requires the existence of manipulatives. This is proven by the results of research on the effectiveness of mathematical manipulatives usage at these levels [1-2]. Along with the science and technology development, mathematical manipulatives research has also been carried out to meet the students' need so that Mathematics learning is able to undergo according to the demand of the ongoing curriculum. In certain group of students with concrete manipulative obtained better scores than using virtual manipulative [3].

The manipulative existence in Mathematics learning does not guarantee the effectiveness of learning, the use of manipulatives in learning also requires the teacher's ability to creatively assist students' thinking, connect manipulatives and mathematical concepts learned [4]. Research related to the manipulatives development that has been conducted with one of the supporting media is the student activity sheet. The student activity refers to a printed media containing a series of questions or instructions that require students to answer or do activities so that students find mathematical concepts or principles. A series of questions that guide students thinking to construct mathematical concepts /

principles can be realized in written form in the form of student activity sheets. This student activity sheet assists the teacher because if a series of questions are done verbally by the teacher, it is possible that there are lost questions as the teacher forgets and will interfere achievement of the manipulatives connection with the concepts or principles learned. It is said by Ball [5] as cited in Furner [4] that the use of manipulatives is widely accepted as an effective way in Mathematics learning, although teachers must strive to make connections between manipulatives and mathematical concepts in students properly. In addition, the use of manipulatives in Mathematics learning also requires teachers to be able to manage these manipulatives appropriately. Teachers need to practice before using manipulatives; learning management is also significant in the use of manipulatives in Mathematics learning [6-7].

An analogous thing was said by McDermott as cited in Barniol [8] that in the instructor's tutorial does not provide answers, but rather assists students to raise with their own answers by asking questions that guide students through the necessary reasoning [8-9]. Guiding questions assists on several levels to help students who are unsure about their reasoning to get the right answer [10]. Active thinking is important component in Mathematics learning [4].

The results of the study [11] have shown that student learning increases when students are actively involved. Exercises using simple manipulative to represent complex molecules have proven a useful additions. The use of manipulative in learning also assists students understand the processes and concepts learned. Likewise in Mathematics learning, Mathematics props are used to understand Mathematics [4]. This is consistent with Brunner and Ausubel's learning theory, that learning by doing makes a meaningful learning for students. The result of previous studies show The results that the props usage in Mathematics learning in addition to assist students comprehend Mathematical concepts or principles, making students active, enjoy, also educates students to be discipline. [7], even [12] conveyed there is existence of added values from various learning factors that might go along with the manipulatives usage in Mathematics learning. Each type of manipulatives has different impacts on Mathematics learning [13].

The importance of using manipulatives in Mathematics learning and is still required for students in Indonesia to aid students mastery in mathematical concepts or principles, as well as the character values of their participants, is significant to guarantee their presences in the field or in the market. Manipulatives role in learning Mathematics is not as a magic manipulatives, but requires the teacher's ability to be creative and innovative in developing students' thinking abilities, making the existence of such manipulatives important. Marley & Carbonneau [12] stated that teachers can use manipulatives for learning Mathematics in the form of manipulative using commercial business made, homemade, or help students make them. Furthermore, the facts on the ground show that there are many commercial business manipulatives displayed on school shelves. This reinforces the development of mathematical manipulatives that are carried out, so that it is possible to become commercial business manipulatives. The problem that arises is: how is financial feasibility analysis of manipulatives products into a commercial business?

## 2. Research Methods

### 2.1. Research Design
This research is an experimental research. In this experiment, manipulatives have been developed with the stages of designing manipulatives referring to the results of curriculum mapping, manipulatives production, expert validation, limited trials in learning, and marketing. Furthermore, with this experiment, the needed data is obtained for the financial feasibility analysis of the production of manipulatives for Mathematics learning in primary education student. The production of manipulatives is carried out with small industry partners' educative props for early childhood, where partners have the basic knowledge and skills needed in manipulatives productions that have been studied. The design of manipulatives is carried out by researchers; the production is carried out

together with partners in partner locations, manipulatives products' setting and finalization are carried out in Mathematics laboratory.

Commercial business feasibility indicators used in this study are Break Event Point (BEP) analysis, Net Present Value (NPV), Incremental Rate of Return (IRR), Net Benefit Cost Ratio (B / C Ratio), and Pay Back Period (PBP) ) [14]. The steps in analyzing financial feasibility of manipulatives production business in this study were to calculate: (1) Fix Cost, (2) Variable Cost, (3) Production Cost, (4) COGM and BEP Analysis (5) Investment Feasibility (IRR analysis, NPV, B / C Ratio, and Pay Back Period).

*2.2. Participants*
There are several data sources in this study. Data sources coming from partner, CV. Children Toys during collaboration with researchers in producing manipulative Mathematics props. All equipment and materials are used to produce manipulatives to marketing, including labor. Mathematical manipulatives produced and are ready to sell as subjects in this study are manipulatives for both classical and individual with different raw materials.

There were three types of manipulatives products according to raw materials, such as raw materials MDF / wood, Evafoam or ati sponge, and ivory paper. Manipulatives for classical learning are bigger than individual props. Manipulatives arere produced in the form of props for mathematical concepts or principles, as well as puzzles to train students' creativity. Individual manipulatives are not only intended for students to have opportunities to use them not limited in class with the teacher, but also could be used anywhere, anytime when students needed them as reinforcement of learning in school. While sales that have occurred are made to schools and the society (individuals). The manipulatives are detailed as in Table 1 below.

**Table 1.** List of Manipulatives as Subjects for Financial Feasibility Analysis

| No. | Manipulatives Name | Material | Note |
|---|---|---|---|
| 1 | APM Squares, Regional Squares, and its various kinds | Evafoam | For Primary and Junior High School Students |
| 2 | APM Triangles, Regional Triangles and its various kinds | Evafoam | For Primary and Junior High School Students |
| 3 | APM Total Triangle Angle Size | Evafoam | For Primary and Junior High School Students |
| 4 | APM Area Rectangle | Evafoam | For Primary and Junior High School Students |
| 5 | APM Area of Triangle | Evafoam | For Primary and Junior High School Students |
| 6 | APM Area of Parallelogram | Evafoam | For Primary and Junior High School Students |
| 7 | APM Area of Rhombus | Evafoam | For Primary and Junior High School Students |
| 8 | APM Area of Trapezoid | Evafoam | For Primary and Junior High School Students |
| 9 | APM Circle Circumference | Evafoam | For Primary and Junior High School Students |
| 10 | APM Area of Circle | Evafoam | For Primary and Junior High School Students |
| 11 | APM many Diagonal Triangle and Number of Angle Sizes in n-angle | Evafoam | For Junior High School Students |
| 12 | APM Pythagorean Theorem | Evafoam | For Junior High School Students |
| 13 | TANGRAM-7 | Evafoam | For Primary and Junior High School Students |
| 14 | APM Cuboids and Cubes Volume | Wood-Acrylic | For Primary and Junior High School Students |
| 15 | APM Individual Geometry | Ivory Paper | For Primary and Junior High School Students |
| 16 | Drawing & Sticking Book | CTS Paper | Pre-school & Primary School Students (Tangram-7 Application) |

| 17 | APM Geometry Concepts, Geometry Surface Area, Geometry Volume (Classical) | MDF/Wood  For Primary and Junior High School Students |

### 2.3. Data Collection Procedure

Data collection procedures refer to commercial business feasibility indicators used in this study, namely Break Even Point (BEP) analysis, Net Present Value (NPV), Incremental Rate of Return (IRR), Net Benefit Cost Ratio (B / C Ratio), and Pay Back Period (PBP) [14-15]. Data on investment tools used in manipulatives production are obtained from partner information, and from researchers for materials and tools research procurement. Production costs are calculated together with partners. Production capacity is recorded when producing.

### 2.4. Data Analysis

The data obtained are then analyzed in accordance with the stages in analyzing the financial feasibility of the manipulatives production business, namely calculating: (1) Fix Cost, (2) Variable Cost, (3) Production Cost, (4) Analysis of COGS, BEP, (5) Investment Feasibility (IRR analysis, NPV, B / C ratio, and Pay Back Period). Data analysis is performed according to the financial feasibility analysis of the business as mentioned above using Excel.

Fix Cost and Variable Cost are used to calculate the cost of production. Fix Cost (FC) is calculated from the price of equipment and depreciation of equipment. Meanwhile, Variable Cost (VC) covers production costs (materials), labor, and overhead. FC + VC = TC, total cost or total operational costs [14]. Cost Of Goods Manufactured (COGM) analysis and Break Event Point (BEP). The amount of Cost Of Goods Manufactured (COGM) is determined by the cost of production divided by the amount of production. From COGM analysis, next selling price per unit per product type can be determined (made from MDF, Evafoam, or paper. COGM = production cost / production amount. COGM multiplied by the assumption of profit / unit (50%) found by selling price. BEP is a condition where the sale does not suffer losses, but also does not make a profit BEP = FC / (P-VC), [14]. FC is a fixed cost, P is the selling price of the unit, and VC is the variable cost per unit.

Investment Feasibility (IRR analysis, NPV, B / C ratio, and Pay Back Period). IRR is an interest rate that shows the net present value (NPV) equal to the total investment of the project [15]. IRR is obtained by the formula IRR = I1-NPV1 ((I2-I1) / (NPV1-NPV2)). The measurement criteria in this analysis are using a rate of interest of 12%. IRR is considered feasible, if it is> interest rate. NPV (Net Present Value) analysis is a method for obtaining net benefits received by mathematical manipulatives practitioners. NPV is the difference between PV proceeds and PV outlays. PV proceed is income PV and PV outlays is initial capital of the business. If PV proceeds> PV outlays, then it is said that investment in mathematical manipulatives is feasible. B / C ratio is obtained from total revenue divided by expenses, if the B / C ratio is more than 1, then the mathematical manipulatives product is profitable. Pay Back Period (PBP) is obtained by the investment formula or initial capital divided by the acquisition of the first year multiplied by 12.

## 3. Results and Discussion

In Fixed Cost calculation, total fixed cost of mathematical manipulatives for MDF / wood materials was Rp. 76,230,000, FC: Rp. 1,871,750 with annual production estimate of 644 and tool depreciation cost was Rp. 2,906.44. Total fixed cost of mathematical manipulative for Evafoam materials was Rp. 36,452,500, FC Rp. 1,139,163 with an estimated production of 2,242 per year and tool depreciation cost was Rp. 508.10. Total fixed cost of mathematical manipulatives for paper materials was Rp. 9,340,000, FC Rp 297,500 with production estimate of 19,760 per year and tool depreciation cost was Rp 15.06. Each unit of mathematical manipulatives made of MDF / wood, evafoam, paper were produced sequentially bore required depreciation or FC costs of Rp. 2,906.44, Rp. 508.10, Rp. 15.06.

From variable costs calculation, planned production/ sale of mathematical manipulatives with MDF / wood, evafoam, paper materials for 3 months in a row were 162 sets, 561 sets, and 4440 sets.

Production cost of mathematical manipulatives made from MDF / wood, eva foam, and paper were presented in tables 2, 3 and 4, respectively.

**Table 2.** Analysis result of mathematical manipulatives production costs made from MDF / wood materials

| Fixed Cost | | |
|---|---|---|
| Depreciation of Equipment | Rp | 1,871,750 |
| Operational Cost (Variable) | | |
| Production Cost | Rp | 383,130,000 |
| Labor | Rp | 194,400,000 |
| Overhead | Rp | 470,843 |
| Operational Cost Total | **Rp** | **579,872,593** |

**Table 3.** Analysis result of mathematical manipulatives production costs made from evafoam

| Fixed Cost | | |
|---|---|---|
| Depreciation of Equipment | Rp | 1,139,163 |
| Operational Cost (Variable) | | |
| Production Cost | Rp | 162,580,917 |
| Labor | Rp | 48,246,000 |
| Overhead | Rp | 285,044 |
| Operational Cost Total | **Rp** | **212,251,123** |

**Table 4.** Analysis result of mathematical manipulatives production costs made from paper

| Fixed Cost | | |
|---|---|---|
| Depreciation of Equipment | Rp | 297,500 |
| Operational Cost (Variable) | | |
| Production Cost | Rp | 909,378,866 |
| Labor | Rp | 66,600,000 |
| Overhead | Rp | 66,866 |
| Operational Cost Total | **Rp** | **976,343,233** |

The results of COGM and BEP analysis were presented in Tables 5 and 6 below.

**Table 5.** Cost of goods manufactured analysis result of mathematical manipulatives

| Material: MDF/ Wood | | | | | |
|---|---|---|---|---|---|
| COGM = | | Production Cost/Amount of Production | | | |
| = | Rp | 3,579,460 | | | |
| Selling Price = | Rp | 5,369,191 | Rp | 5,370,000 | |
| Material: Evafoam | | | | | |
| COGM = | | Production Cost/Amount of Production | | | |
| = | Rp | 378,344 | | | |
| Selling Price = | Rp | 567,516 | Rp | 570,000 | |
| Material: Paper | | | | | |
| COGM = | | Production Cost/Amount of Production | | | |
| = | Rp | 219,897 | | | |
| Selling Price = | Rp | 329,846 | Rp | 330,000 | Total = Rp 6,270,000 |

**Table 6.** Results of bep analysis of mathematical manipulatives production

| Material: MDF/Wood | | | For 3 months |
|---|---|---|---|
| BEP = | FC/(P-VC) | | |
| = | 1 | set | 3 |
| Material: Evafoam | | | |
| BEP = | FC/(P-VC) | | |
| = | 6 | set | 18 |
| Material: Paper | | | |
| BEP = | FC/(P-VC) | | |
| = | 2.32 | set | 7 |

Investment Feasibility Analysis Result

**Table 7.** IRR analysis result

| Year | Net Income | | 40% |
|---|---|---|---|
| 1 | 887,886,274 | 0.7143 | 634,204,481 |
| 2 | 976,674,901 | 0.5102 | 498,303,521 |
| 3 | 1,074,342,391 | 0.3644 | 391,524,195 |
| 4 | 1,181,776,630 | 0.2603 | 307,626,153 |
| 5 | 1,299,954,293 | 0.1859 | 241,706,263 |
| | PV Proceeds | | 2,073,364,613.60 |
| | PV Outlays | | 330,000,000 |
| | NPV | | 1,743,364,613.60 |

\* 150% increase in income per year
IRR = 50%

**Table 8.** Results of NPV analysis

| Year | Proceed | Interest Rate | Current Values |
|---|---|---|---|
| 1 | 887,886,274 | 0.8929 | 792,755,601.48 |
| 2 | 887,886,274 | 0.7972 | 707,817,501.32 |
| 3 | 887,886,274 | 0.7118 | 631,979,911.89 |
| 4 | 887,886,274 | 0.6355 | 564,267,778.47 |
| 5 | 887,886,274 | 0.5674 | 503,810,516.49 |
| **PV PROCEEDS** | | | 3,200,631,310 |
| **PV OUTLAYS** | | | 330,000,000 |
| **NPV** | | | 2,870,631,310     5 years |
| | | | 574,126,261.93 Per year |

Through the financial statement analysis, it was found that the amount of income was Rp 2,654,910,000 and expenditure was Rp 1,767,023,725, so that the B / C ratio was obtained for 1,5025. Pay Back Period analysis results: Initial investment: IDR 330,000,000; Year 1 value: Rp. 792,755,601; Balance: Rp (462,755,601). Calculating PBP: 2,99 years; The return of capital will occur after 2 years 11 months 27 days.

To meet BEP, at least be able to sell products made from MDF, evaform, and paper consecutively 3 sets, 18 sets, and 7 sets, then one of the determining factors is promotion. Important things to be the determining factor for the effectiveness of Mathematics manipulatives use (concrete) are manuals (instructions for product use) and teachers' training on how to use manipulatives so as to facilitate

children's exploration, develop thinking skills, and do the activities according to curriculum demands [16-20,7]. Teacher's Manual and Training becomes a form of manipulatives product promotion.

## 4. Conclusion

As previously explained in introduction, mathematical manipulatives in Mathematics learning for students in primary education level could be developed in accordance with the demands of the curriculum and student needs. Also, it could assist students in constructing mathematical concepts or principles or help students' thinking abilities. Based on financial analysis result of mathematical manipulatives, the calculation result of BEP (Break Even Point) or return conditions, where the sale did not suffer losses but also did not make a profit, if the sale of mathematical manipulatives of MDF / wood material was 3 sets, manipulative of Evafoam material were 18 sets, and manipulatives of paper material were 7 sets. The selling price of mathematics manipulatives in MDF / wood, evafoam, and paper materials were Rp. 5,370,000, Rp. 570,000 and Rp. 330,000 per set, respectively. The production of mathematical manipulatives with 3 types of products based on the raw materials used was feasible to be developed. This was supported by feasibility analysis result of NPV (Net Present Value) that was PV proceed > PV outlays (3,200,631,310> 330,000,000), so it was said that investment in mathematical manipulatives was feasible. Likewise, B / C ratio was 1.5025 because it was more than 1, it was said that the mathematical manipulatives product was profitable. Based on financial statements, cost of goods manufactured (COGM) of mathematical manipulative commercial business in 2019 was that total revenue / sales of Rp.2,654,910,000 required cost of goods sold (COGS) of Rp1,767,023,726 (66.56%). Profits obtained amounted to Rp887,886,274 (50.25%) from COGS and 33.44% from turnover (total sales). Based on Financial Statements analysis above, it was feasible and good to run considering that the business being run generated profits. If profits would be used for investment, then the payback period would require 2.99 years or 2 years 11 months 27 days. Hence, it could be concluded that the production of manipulative mathematical props could be continued as a commercial business.

## Acknowledgement

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