

## Simulation and Implementation Model of Productivity Measurement Internet Bandwidth Usage

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### Abstract

*The Internet is used by a very large number of users, from the ordinary user community, through special users, like people with high intellectual level. The growth in the number of users is increasing very fast. Internet has also been used by multi-sector businesses with multi profession. It makes information the internet usage something very strategic, one of which information is productivity internet bandwidth usage. Therefore the research are needed a simulation and implementation model to be able to measure the productivity of the internet bandwidth usage, which can later become the basis of the measurement of productivity. This paper describes a model implementation and simulation of productivity measurement internet bandwidth usage, which describes all possible measurement values obtained, and is a continuation of previous research, which is the basic concept of productivity in the use of internet bandwidth and how to measure it, so that the measuring results can be used as a guide in determine the direction of policy and the provision of productive Internet bandwidth usage.*

**Keywords:** internet measurement, internet productivity, productivity measurement

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### 1. Introduction

Internet has been known to the public at large, especially since the popularity of Facebook (FB), people in Jakarta are among the largest internet users-especially on twitter-in Asia and are number 4 in the world [1]. IT development has triggers the occurrence of a major revolution, the information revolution name. Internet has been used everywhere and has been used by anyone, from the elite to the lower classes. Internet can be accessed from a variety of devices, from the personal computer at home or in the office until the mobile is a laptop, I-Pad, Smart Phone.

The Internet is easy, cheap and mass, making the internet a very strategic something that must be controlled, the problem is how to measure productive our internet usage, either by personal, especially by government institutions. Internet will bring a broad impact (multi-sector) in this life and the future; it is the need for a framework that can measure the productivity of Internet bandwidth usage.

Based on the above background, this paper describes a model implementation and simulation of productivity measurement internet bandwidth usage, which describes all possible measurement values obtained, and is a continuation of previous research. The result of previous research is the basic concept of productivity in the use of internet bandwidth and how to measure it. Implementation and simulation are performed in this research using the framework of previous research that productivity measurement framework without regard to internet bandwidth usage coefficient variable, the variable value is taken through the process of Analytical Hierarchy Process (AHP).

The results of this research, simulation and implementation conducted proof productivity of Internet bandwidth usage can be measured.

The importance of productivity [2, 3] is on a micro scale enterprises, will increase the company's profits and the macro scale of a country will increase the GDP (Gross Domestic Product), which means increasing the welfare of the community.

For a comprehensive understanding of the productivity of the internet bandwidth usage, of course, must understand the meaning and definition of the word "productivity" in general as the word "productivity", and the meaning of "productivity" in the use of internet bandwidth, as well as the meaning of "productivity internet bandwidth usage" as a single entity, it has been described in previous studies [4-6], and the basis for the development of models and simulations.

Productivity is the ratio of output divided by input based on economic theory. Meanwhile, according to Mali in 1978 that productivity is as follows [7, 8]. Productivity internet bandwidth usage can be measured by looking at the factors effectiveness and efficiency of the Internet bandwidth usage.

Variable productivity internet bandwidth usage at the moment there are 14 study variables, described in Table 1. The following:

Table 1. Variable Productivity Measurement Internet Bandwidth Usage

No	Variable Name	Description	Variable Type	Unit
1	P	Productivity	Quantitative	% Level Degree
2	U	User Competency	Qualitative	Level
3	Up	User Price	Quantitative	Cost Factor Level
4	G	Goal	Qualitative	Goal Level
5	P	Place	Qualitative	Place Level
6	T	Slot Time	Qualitative	Slot Time Level
7	T	Time Duration	Quantitative	Hour
8	C	Contents	Qualitative	Content Level
9	F	Fast Speed	Quantitative	Device Level
10	Fp	Fast Price	Quantitative	Cost Factor Level
11	V	Volume	Quantitative	Mbyte
12	B	Bandwidth	Quantitative	Mbyte
13	Bp	Bandwidth Price	Quantitative	Cost Factor Level
14	Rc	Reliability Connect	Quantitative	%Reliability
15	Bu	Bandwidth Utility	Quantitative	%Utility

Variable measurement of current research has increased when compared to the previous research variables [4, 5], which adds Variable Cost Factor, which consists of a variable Fp: Computer Cost Factor, Bp: Bandwidth Cost Factor, Up: User Cost Factor. While a detailed explanation of other variables have been described in previous studies [5].

## 2. T-Framework Measurement

Addition of Fp, Bp, and Up resulted in changes in the function of variable input and output functions, see the measurement framework in Figure 1, the so-called T-Framework: (T-Framework is a Framework to measure productivity internet bandwidth usage using variables and indicators which have been determined, and it has been suggested in previous studies [4]).

### 2.1. Measurement Formula

The picture above Figure 1 measurement framework, obtained the following functions:

$$\text{Actual Productivity (PA)} = \frac{U.G.P.T.C.F.B}{V.t.Fp.Bp.Up} Rc. Bu \quad (1)$$

PA, Actual Productivity is a massive productivity value of the formulated mathematical calculations described above functions, having regard to units on each variable.

$$\text{Productivity Index P(\%)} = \frac{PA}{P(\text{Max})} \times 100\% \quad (2)$$

P%, Productivity Index in percent, is the division between the PA and the value of measuring the value of maximum productivity measure P (max) multiplied by 100%.

$$P(\text{max}) = \text{Maximum Value of Measuring} \quad (3)$$

P(max) is a measure of the value of measuring the maximum productivity obtained when measuring all variables are best positioned optimally.

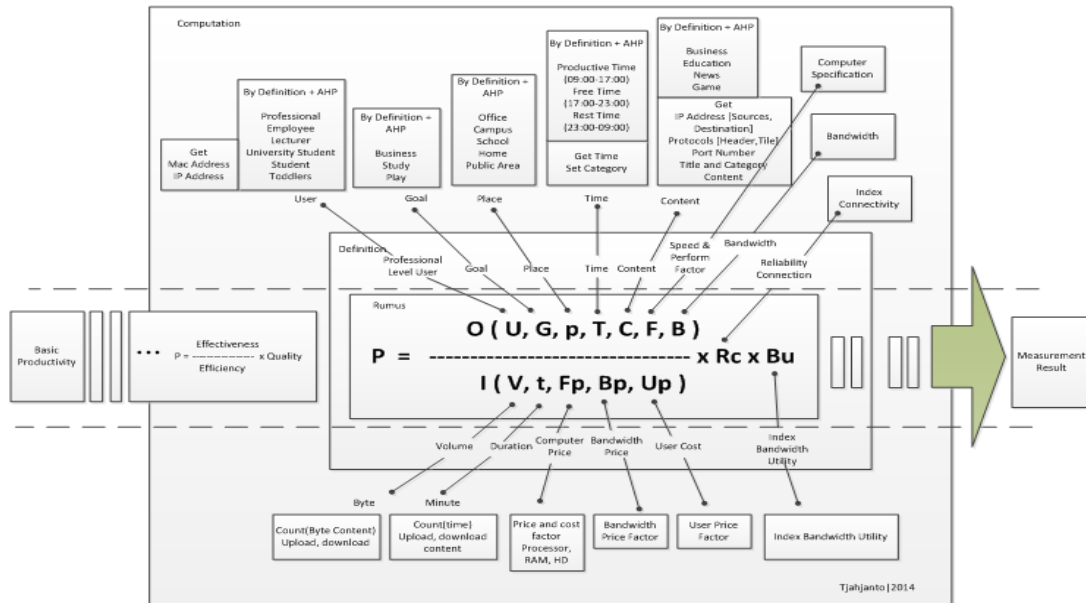


Figure 1. Measurement Framework

2.2. Variable Measurement Algorithms

Variable measurement algorithm is a method or technique to get the number of measurements, either automatically from the computer system, as well as from the data table that has been previously configured, the appropriate provisions of the measurement [6]. Figure 2 is a block diagram illustrates how to get the value of a variable measure its magnitude.

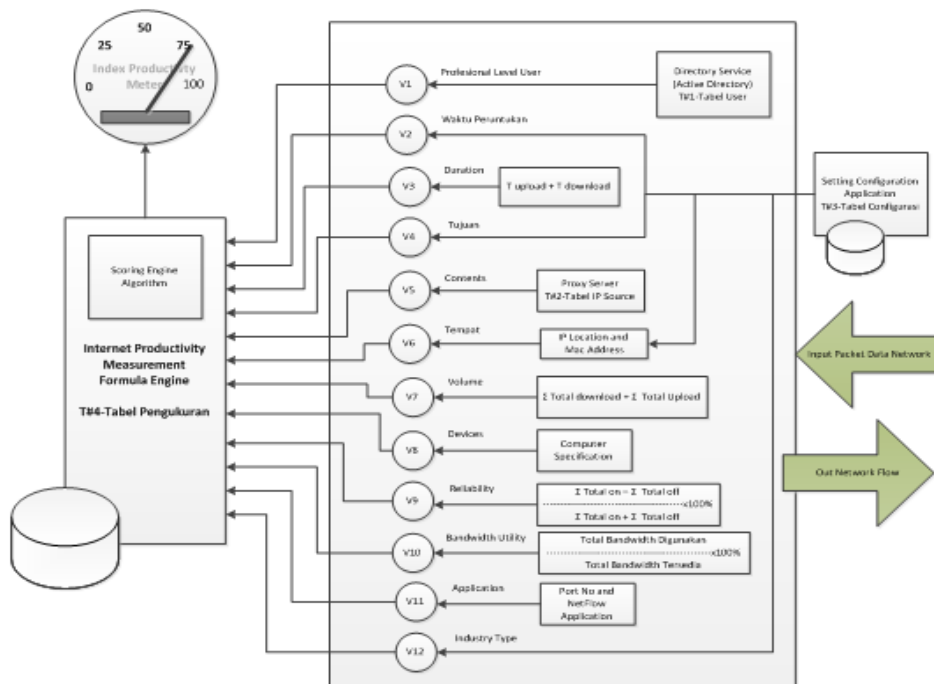


Figure 2. Input Variables Measurements

To find the number of measurement variables automatically, from the measured object, the necessary technical measures, in accordance with Figure 2 also having regard to the system model in Figure 3 is the basis for measurement of the following steps:

1. Start the measurement
2. Preparation of configuration settings
  - a) Input Table Type of Industry
  - b) Input Table User Profile
  - c) Table Input Device Profile
  - d) Input Table Category Contents
  - e) Input System Configuration Data (Measurement Scale)
3. Determine the measurement duration  $t_1-t_n$
4. Read data from proxy
5. Collect data and IP User Content
6. Filter the data according to the content category
7. Put the measuring table
8. Save the configuration settings
9. Calculations corresponding measurement formula
10. Display the value of the measurement
11. Save the measurement data
12. End of measurement

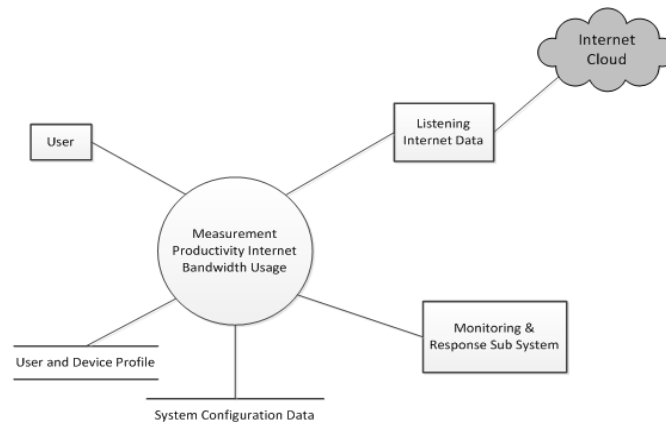


Figure 3. Function Based Matric

### 3. Measurement Application Architecture

Figure 4 illustrates the location or position measurement applications on a computer network, a server can be in one box, or can also be in two server box, and placed between the firewall and the hub switch. Also, that can create a computer-based appliance that is installed inside measurement applications productivity internet bandwidth usage, which has its own IP number [6].

### 4. Measurement Application Architecture

#### 4.1. Variable Qualitative Level with AHP

Measurement of all variables, there are 6 types of qualitative variables that need to be quantitative conversion by using the AHP method (Analytical Hierarchy Process), this method used in Measuring Information Security Awareness of Indonesian Smartphone Users [9]. The following Table 2 describes the results degree of levelling.

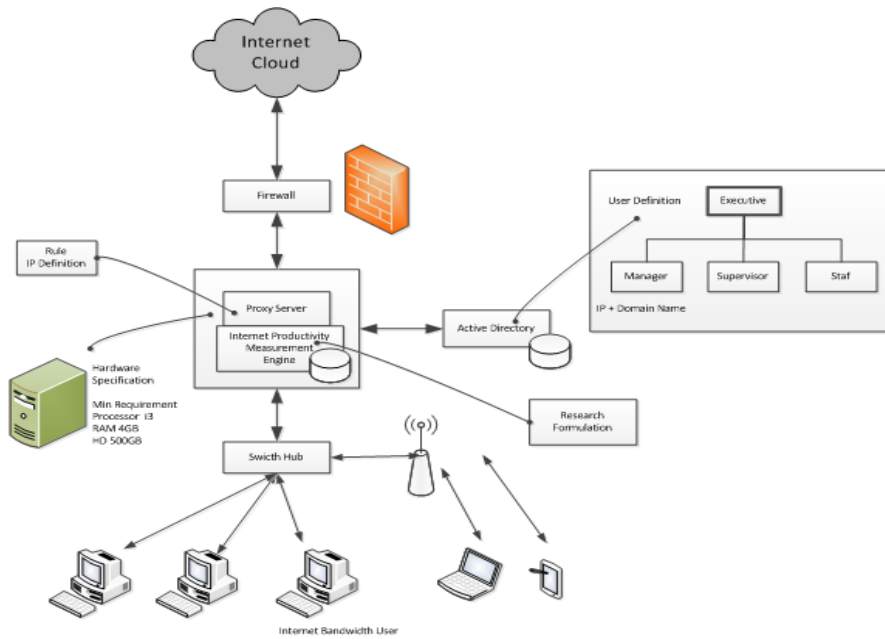


Figure 4. Application Measurement in the Network

Table 2. Level Variable with AHP

Variable 1	Type Variable 2	Symbol 3	Variable Name 4	5	6	7	8	9
V1	Qualitative	U	User Level	Professional 9	Lecturer 7	Student 5	Student 3	Toddler 1
		0.3600		0.3600	0.2800	0.2000	0.1200	0.0400
V2	Qualitative	T	Time Slot	Productive 9	Rest 7	Free 5	3	1
		0.2800		0.4286	0.3333	0.2381		
V4	Qualitative	G	Goal	Business 9	Work 7	Study 5	Game 3	1
		0.2000		0.3750	0.2917	0.2083	0.1250	
V5	Qualitative	C	Content	Business 9	n 7	News 5	Game 3	1
		0.1200		0.3750	0.2917	0.2083	0.1250	
V6	Qualitative	P	Place	Office 9	Campus 7	School 5	Home 3	1
		0.0400		0.3750	0.2917	0.2083	0.1250	
V11	Qualitative	A	Application	Browser 9	Email 7	Chatting 5	FTP 3	P2P 1
				-	-	-	-	-
V12	Qualitative	Ti	Industry	Office 9	Educational 7	Factory 5	Foundation 3	1
				-	-	-	-	-

Application variable (V11, A) do not levelling process, these variables are ignored because all internet applications can be run through a web browser, while a variable of type Industry (V12, Ti) levelling process is not done well, as industry type variable will only be selected one course, namely when selecting measurement universe.

In Table 2 column three, AHP calculation results showed that the variables U: User has the highest value of 0.3600 compared to the other variables are successively variable T: Time

Allotment = 0.2800, G: Destination = 0.200, C: Content = 0.1200, and P: Points = 0.0400, which means that the influence of the variable U: User greatest compared to other variables.

In Table 2 Line V1 is User Level, of the results of AHP calculation shows Professionals have level value = 0.3600 compared Teachers value = 0.2800, Student = 0.2000, Student = 0.1200 and Toddlers = 0.0400, which means that professionals are more productive when compared with students. Levelling Also is happen for the value of the next line V2, V3, V4, V5, and V6 in Table 2. That's Shows in the content of the variable.

#### 4.2. Effective Factor (Output Factor)

As concluded in the previous study [1], that productivity is the effectiveness of the task divided by the efficiency of resource use and multiplied by the quality of the process, which can be abbreviated effectiveness divided efficiency multiplied by the quality factor. Here are the results of the simulation effectiveness consisting of variable U: User, G: Goals, P: Place, T: Time, C: Content, F: Specification, B: Bandwidth and A: Application, in the table below.

Table 3. Effective Factor (Output Factor)

Col No	1	2	3	4	5	6	7	8	9
Unit Desc.	Level User	Level Goal	Level Place	Slot Time	Content	GHz Spec.	MBPS Bandwidth	Level Application	
Var.	U	G	P	T	C	F	B	A	Output
	Xo1	Xo2	Xo3	Xo4	Xo5	Xo6	Xo7	Xo8	Yo
	X1	X2	X3	X4	X5	X6	X7	X8	Y
Max	9	9	9	9	9	4	8	1	1889568
	7	7	7	7	7	3	4	1	201684
	5	5	5	5	5	2.4	2	1	15000
	3	3	3	3	3	2	1	1	486
	2	2	2	2	2	1.2	0.5	1	19.2
Min	1	1	1	1	1	0.8	0.25	1	0.2
	$\Sigma U$	$\Sigma G$	$\Sigma p$	$\Sigma T$	$\Sigma C$	$\Sigma F$	$\Sigma B$	$\Sigma A$	$\Sigma O$
	27.00	27.00	27.00	27.00	27.00	13.40	15.75	6.00	2106757.40

The figure in Table 3 above shows the maximum and minimum values of the output of all variable factors that influence it. While the numbers in column 8 Application variables are all = 1, because the variable A: Application is negligible, since almost all Internet applications can be run on the browser application.

#### 4.3. Efficiency Factor (Input Factor)

Efficiency factor or input consists of a variable V: Volume, D: Duration, Fp: Specification Cost, Up: User Cost, and Ap: Application Cost.

The table below is the result of simulation Efficiency Factor of productivity, of the maximum value to the minimum value that will happen, except column 15 Application Cost, all value = 1 for Application Cost ignored by the same reason as that of the output factor.

Table 4. Efficiency Factor (Input Factor)

Col No	10	11	12	13	14	15	16
Unit Desc.	10MB Volume	Hour Duration	Factor Spec. Cost	Factor Bandwidth Cost	Factor User Cost	Factor Application Cost	
Var.	V	t (t0-tn)	Fp	Bp	Up	Ap	Input
	Xi1	Xi2	Xi3	Xi4	Xi5	Xi6	Yi
	X1	X2	X3	X4	X5	X6	Y
Max	10	4	10	10	5	1	20000
	7.5	3	8	8	4	1	5760
	5.0	2	6.5	4	3	1	780
	2.5	1	4.5	2	2	1	45
	1.5	0.5	3.5	1	1	1	2.625
Min	0.5	0.25	3	0.5	0.5	1	0.09375
	$\Sigma V$	$\Sigma t0-tn$	$\Sigma Fp$	$\Sigma Bp$	$\Sigma Up$	$\Sigma Ap$	$\Sigma I$
	270.00	10.75	37.50	27.50	15.50	6.00	26587.72

#### 4.4. Quality Factor

The quality factor productivity measurement consists of variables that factor Connection Reliability index availability of connections and bandwidth Utility is the index of bandwidth usage 5. The following table describes the simulation of all the possibilities that will be obtained in the measurement.

Table 5. Quality Factor

Colom Number	17	18	19
Unit	Index	Index	Index
Description	Reliability Connection	Bandwidth Utility	
<b>Variable</b>	<b>Rc</b>	<b>Bu</b>	<b>Quality</b>
	<b>Xq1</b>	<b>Xq2</b>	<b>Yq</b>
	<b>X1</b>	<b>X2</b>	<b>Y</b>
Max	1	1	1
	0.9	0.9	0.81
	0.8	0.8	0.64
	0.7	0.7	0.49
	0.6	0.6	0.36
Min	0.5	0.5	0.25
	$\Sigma Rc$	$\Sigma bu$	$\Sigma Q$
	4.50	4.50	3.55

The Table 5 above also explains that the quality of productivity is determined by factors Reliability and Bandwidth Connection Utility, visible when both factors are declining, drive quality also decreased. That change in the quality factor occurs in a linear fashion.

#### 4.5. Maximal and Minimal Productivity Score

The following table described the maximum and minimum measurement of productivity measurement results of the internet bandwidth usage.

Table 6. Productivity

Colom Number	20	21	22
Unit	%		
	Index	PxQ	P
<b>Variable</b>	<b>P</b>	<b>P1</b>	<b>P2</b>
	<b>Y%</b>	<b>Y1</b>	<b>Y2</b>
Max	100.00	94.48	94.48
	30.02	28.36	35.01
	13.03	12.31	19.23
	5.60	5.29	10.80
	2.79	2.63	7.31
Min	0.56	0.53	2.13
	$\Sigma P$	$\Sigma P1$	$\Sigma P2$
	152.00	143.61	168.97

## 5. Analysis of Measurement

### 5.1. Input Analysis on Productivity

The graph in Figure 5 does not include the variable formed by the A: Application, because any application can be executed by the browser and the scale of the highest value of all variables is 10. P = Productivity Actual value may decline and rising to the highest level, is influenced by variables input. This shows the change of the input variables affecting productivity.

Figure 5 also explains that the productivity will decrease significantly when there is little change in the entire variable input (especially variable U, G, P, T, C). Variable F: Specification does not have to increase to get maximum productivity value.

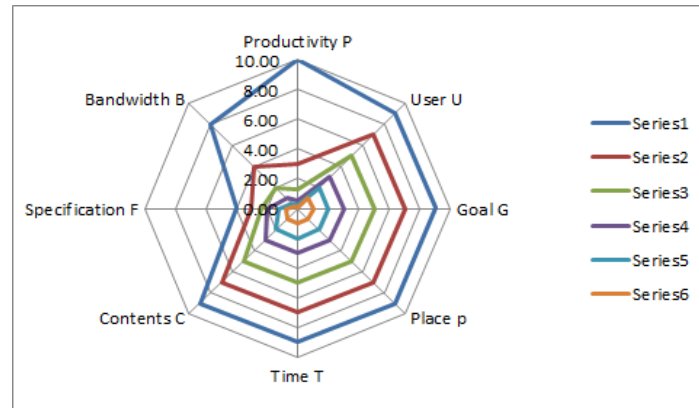


Figure 5. Input Graph Analysis on Productivity

### 5.2. Output Analysis on Productivity

Figure 6 portray the graph changes in the value of productivity depends on the output variable. Graph formed without variable Ap: Application Cost, because using only a browser application, all applications can be run internet. Graphic scaled to scale the highest value of all variables is 10.

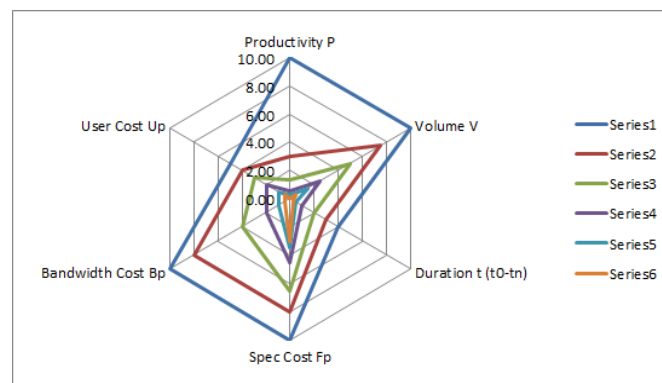


Figure 6. Output Graph Analysis on Productivity

In the Figure 6 shows the output changes affect productivity. if observed, that the value of productivity will decrease significantly when there is little change in the output variables, especially the variables V, FP and BP, while the variable D: Duration and Up: User Cost Factor, does not need to be high to get maximum productivity value.

### 5.3. Factor Analysis Output and Input Factors on Productivity

Figure 7 portray changes in the value of P: Productivity varies from minimum to maximum in line with changes in the variables that influence. From the graphic below productivity value change is not linear with changes in variables that affect it.

This can be seen in Figure 7 that are not required variable F: Specification, D: Duration, and Up: User Cost Factor to obtain maximum productivity value. Even variable B: Bandwidth is also no need to be at the maximum value to obtain high productivity values. It is said that only the maximum bandwidth does not guarantee the value of the productivity of the use of the internet will be a maximum.



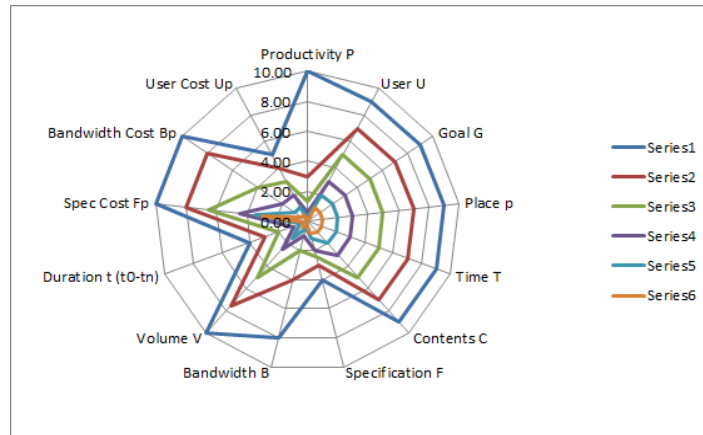


Figure 7. Output Graph Analysis on Productivity

**5.4. Value Analysis Productivity**

From Figure 8 graph, the more it appears that the value of P = productivity will decrease with the decrease of the value of other variables (U, G, p, T, C, F, B, V, D, Fp, Bp, Up), so also on the contrary, the value of P = Productivity will rise in line with the increase in the variables that influence it.

However impairment P = Productivity is not as linear variables other (U, G, p, T, C, F, B, V, D, Fp, Bp, Up), tend to go straight down when the other variables are just starting down. This shows that the productivity of Internet bandwidth usage is influenced by almost all supporting variables, not by a certain variable, as described in the chart star image analysis above is Figure 5, Figure 6 and Figure 7.

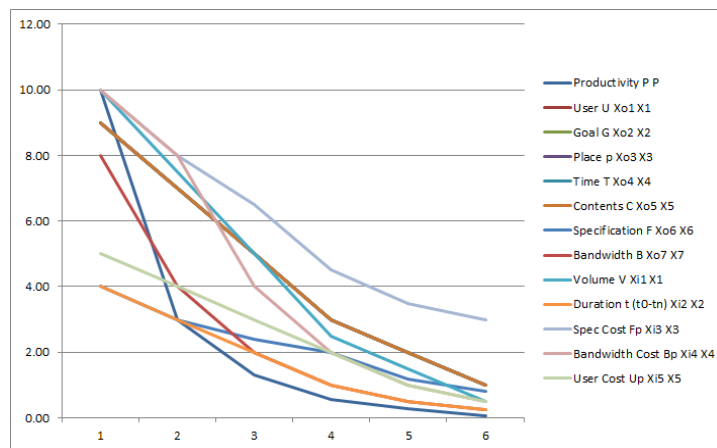


Figure 8. Graph Analysis Process of Productivity Decline

**6. Conclusion**

**6.1. Conclusion**

From the simulation results with the measurement object universal measuring general (regardless of the type of industry to be measured), the following conclusions were obtained:

1. Measuring the productivity of Internet bandwidth usage can be done, in which qualitative variables scaled by AHP, and can be combined with quantitative variables, so that the measuring results obtained for all possible composition measuring value, which will be the basis of the actual measurement, shown in Tables 2-6.

2. The maximum input factors do not guarantee that the maximum value of productivity would be anyway, so the maximum output factor does not guarantee will get maximum productivity values, shown in Figure 7. The analysis of input and output factors.

3. To obtain maximum productivity required output and input conditions are optimal, consider Figure 7. The analysis of input-output factor.

4. That the value of the bandwidth is not the main factor for productivity productive Internet bandwidth usage.

## 6.2. Follow-up Implementation and Simulation

From the above conclusion, that the implementation and simulation have described the possibilities of measuring values obtained. And the results of this simulation will be the basis of further research, namely:

1. The further research will perform direct measurements on one or more organizations, can the company or the campus academic organizations, in accordance with the target universe to be measured.

2. The further research will perform a comparative analysis between the results of measuring the simulation with real measurement results, so it is expected that the analysis results can be used to improve the quality factor productivity measurement Internet bandwidth usage.

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