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ENGINEERING RESEARCH THROUGHPUT, RESEARCH FINDINGS AND PATENTABILITY IN NIGERIAN UNIVERSITIES

Nwobodo L. O*[1], Inyiama H. C[2]

1 Department of Computer Engineering, Enugu State University of Science & Technology, (ESUT)

2 Department of Electronic & Computer Engineering, Nnamdi Azikiwe University, Awka

Abstract - The importance of high-quality research projects has been emphasized. This was studied using Faculty of Engineering in Nigeria University as a case study. n the Faculty of Engineering, a quality project can be patented and sold for money or the patent can become part of a production line operated in partnership with others or even use in a production line owned by the faculty alone. The higher the number of good quality projects completed annually within the faculty of Engineering, the higher the proportion of them that would be patentable and the higher the money accruable to the faculty from research works. This was further illustrated using multiple regression analysis. It is highly recommended that the faculty of Engineering in any university should insist on high quality (Patentable) timely research output because it greatly enhances their earning capacity. It is the view of the authors that a research finding is not fully exploited until it becomes part of a production line owned by the faculty alone or in partnership with others in industry.

Key Words: Engineering, Research, Throughput, Research Findings, Patentability, Nigerian, Universities.

1 Introduction

Intellectual property (IP) rights are the legally recognized exclusive rights to a creation of the mind, Richard P, (2008). Under intellectual property law, owners are granted certain exclusive rights to a variety of intangible assets such as musical, literary and artistic works, discoveries and inventions; and words, phrases, symbols and designs, Helen.E. N (2014). Intellectual property rights may comprise of any of the following: Patents, copyright, industrial design, trademarks, trade secret etc. WIPO (2008), IPO (2011) documented that a patent grants an inventor the right to exclude others from making, using, selling, offering to sell and importing an invention for a limited period, in exchange for the public disclosure of the invention. This right is, like any other right, given by law to protect the invention. The holder of such right could be the inventor himself or someone who has bought the invention from the inventor or someone who has been given the right by the inventor. The invention is, basically, a product or a process for making the product that is new, useful and industrially exploitable. One may end up with an invention in a bid to provide a potent solution to a technological problem. In a university, where there is high research output, the finished projects can be patented and sold or committed to a production line in a partnership or set up and owned by the faculty alone. There is need for high quality research completed without much delay within the faculty of Engineering in Nigeria Universities because the higher the number of projects completed in the faculty within a year, the greater the proportion of them that are patentable and the higher the potential earnings accruable to the faculty from the completed research work. A patent for an invention not only increases its monetary value, but it also helps you generate more revenue through its commercialization. This is also a useful means of managing intellectual property that will move the faculty forward especially in these days of recession and the faculties can

fend for themselves through this process. The Engineering Faculty should set up a policy that a research project is not really completed until it is featured as part of a production line somewhere in the industry. Adopting such a strategy, catalyses the rapid emergence of viable, well-run indigenous companies and should lead to an increase in the pace of industrialization in Nigeria.

2 Aim and Objective

This paper discusses Engineering Research Throughput, Research Findings, Patentability and Profitability in Nigerian Universities. There is a gross underutilization of the research throughput of Engineering Faculties in Nigerian Universities. This paper aims at highlighting the reasons for these and advises on ways to make Engineering research throughput more effective and profitable.

3 Review of Related Literature

Stathis Kodak (2012) developed a specific Intellectual Property (IP) tool to support its IP generation process, the so-called invention tracker for managing information processing between different departments, it does patent findings and patent decisions, it uses commercial database (Micro patent) that enables R&D staff to gather information about external patents, but it has misguided patent procedure and gave patent for free. Smith and Hansen (2002) split the strategic management of IP in the activities of IP generation, protection and valuation and argue that firms must ensure that these activities are aligned with business strategy, they also mentioned that patent protection should be given out free. Helmbold D. et.al (2000) worked on a distributed, event driven database for IP management in big corporations. The system builds potential preference IP models by refining the local information database within the enterprise. Hazam K.D (2001) also emphasized that the system demonstrated effectiveness in managing patent, copyright and trademark data, including accurately tracking of IP right division, especially expiry. The inability of the system to interpret risk evolution model, decision support framework that aligns with the uncertainty within the IP landscape is held by domain expert as shortening. Stewart K.E and Wright .M (2007) Proposed a model for an IP management system that enables managers to evaluate the value of created IP, measure and manage IP portfolios (e g patent) from a value-based perspective. The model as basis uses quantitative KPIs (Key Performance Indices) to carry out this evolution. Key Performance indices (KPI) may be quantitative or qualitative, when purely quantitative, quality may be compromised, leading to wrong decisions. It is posited that this proposal does not take consideration of the dynamic environment of the organization.

4 University Patentable Research Output

100 (hundred) randomly selected projects of the faculty of Engineering of a certain University in Nigeria taken from library holdings. In statistics, it is best to work with a pure random sample, however this is not always possible for practical reasons, for example, in opinion polls involving a population of say 100 million people, it is not practical to represent all 100 million names and then begin to take a random sample of them. What is typically done is to divide the population into clusters and then take a random sample to represent each cluster. This was the path taken in this research. Cluster sampling was used in this research. The faculty was divided into departments and some small departments were lumped into bigger department of similar orientation to form the clusters, then random samples were taken from each cluster according to table 1a.

Table 1a: Random Sampling of each cluster

	Departments	Number in Random Sample
1	Chemical Engineering	17
2	Mechanical Engineering and Industrial/Production Engineering	17
3	Material & Metrological Engineering and Polymer & Textile Engineering	16
4	Civil Engineering	16
5	Electrical Engineering	17
6	Electronics &Computer Engineering	17

The 100 randomly selected projects were evaluated for patentability using the services of expert valuers. They considered the following:

a. Novelty of the project
b. Contribution to knowledge
c. Potential application areas, the results are as follows in Table 1b.

Table 1b: University Patentable Research Output

S/N	Projects	Awards	Patentable (P)	Improved Practice (IP)
1	10	Distinction	4	10
2	20	Excellent	3	20
3	30	Very Good	2	30
4	30	Good	1	20
5	10	Fair	0	2
Total	100		10%	82%

The outcome of the University research work evaluated is categorized into five (5). This is to identify the patentable and novel projects. Only 4 out of 10 distinction projects can go for patents, 3 out of the 20 excellent, 2 out of 30 very good, 1 out of 30 good projects are patentable, the rest are not. (Table 1b). Thus about 10% of all Research outputs are patentable based on this random sampling.

4.1 Factors that determine Patentability of Intellectual Property (IP) & Usage

The following are the factors that determine if an IP could have a patent:

1. Novel Research Output
2. Cost of Patenting
3. Cost of Litigation, this is multiplied by the probability of litigation (Low Probability of litigation is preferred)
4. Valuation of Patent, (Based on current prices) with attributes, High, Average, Low with the following assumptions:
   ≥ ₦10milliom = High
   <₦10million and ≥ ₦ 5million = Average
   < ₦ 5million = Low
5. Technological limitations when harnessing the Patent. This could be High, Average or Low, using fuzzy linguistic variables.

Total cost of Patenting = Cost of paperwork and legal representation + Possible Cost of litigation + Cost of making up for Technological limitations.

CP = CPLR + PCL + CTL

Where, CP = Cost of Patenting

CPLR = Cost of paperwork and legal representation

PCL = Possible cost of Litigation

CTL = Cost of technological limitations

These can be represented as in Table 2 for a Risk Averse Company

Table 2: Patent Evaluation Table for a Risk Averse Company.

Value of Patent \ Total Cost	High	Average	Low
High	IP	P + IP	P + IP
Average	IP	IP	P + IP
Low	IP	IP	IP

IP = Intellectual Property Improvement

P + IP = Patentable + IP Improvement

This table is used to determine when an Intellectual property is worth Patenting. It should have a patent only on three conditions:

1. When the value of patent is high, and the cost of patenting is Average.
2. If the value of Patent is High and total cost of patenting is Low
3. If the Value of Patent is Average and Total cost of patenting is low.

Table 2 can be represented using the 9(nine) Fuzzy logic Statements below:

if Value of Patent is High and Total cost is high then IP
if Value of Patent is High and Total cost is Average then P + IP
if Value of Patent is High and Total cost is Low then P + IP

if Value of Patent is Average and Total cost is high then IP
if Value of Patent is Average and Total cost is Average then IP
if Value of Patent is Average and Total cost is Low then P + IP

if Value of Patent is Low and Total cost is high then IP
if Value of Patent is Low and Total cost is Average then IP
if Value of Patent is Low and Total cost is Low then IP

Key: IP means enhanced Intellectual Property only

P + IP means enhanced Intellectual Property and Patent the research finding.

4.2 Research Throughput and Patentability

1. Only about 10% of Faculty of Engineering Projects are currently Patentable (What if the quality of engineering projects improves such that 20%, 30%, 40%, 50%, or 60% are patentable (Table 3)).
2. Also about 50 projects are done in a session currently (What if the situation improves and up to 60, 70, 80, 90, 100 projects are completed per session (Table 3)). Based on these points, a MATLAB software was written to generate Table 4, 5 and 6.

Table 3: Research Throughput

% p \ No P/ yr.	50	60	70	80	90	100
10	5	6	7	8	9	10
20	10	12	14	16	18	20
30	15	18	21	24	27	30
40	20	24	28	32	36	40
50	25	30	35	40	45	50
60	30	36	42	48	54	60

No p/yr. is the No of Projects per year
% p is the percentage patentable

Table 3 is a research throughput representing the number of Faculty of Engineering projects completed per year against the percentage of the projects that are patentable. For example, 10% of 50 projects is 5 patentable projects for that year, if 60 projects were completed, then 10% patentable is 6 and so. The higher the number of projects, the higher the number of patentable ones. Also, the higher the percentage of the projects that are patentable (i.e., quality) the higher the number of patentable projects (Table 3). The bar chart of Table 3 is shown in Fig 1.

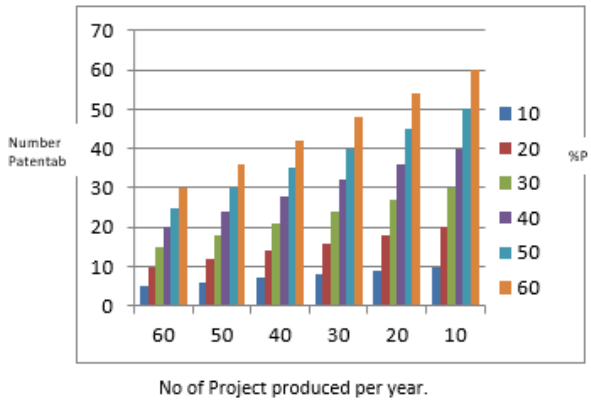

Fig 1: Bar Chart for Research Throughput

Fig 1 is a pictorial representation of research throughput. It is a bar chart representing the numbers of projects produced per year, the number patentable and the percentage patentable. It plots the number patentable versus number of projects produced per year. The more the number of projects produced per year, the more the patentability and the more the percentage patentable. For example, where the number of projects is 50, the number patentable is 30 at 60% patentability, and when the project increased to 100, it produces 60 at 60% patentable.

With the expert advice from experienced valuers, it is envisaged that.

Current value of a Patent is 10million naira if sold.

Value of a Patent is 15million naira if exploited in a partnership.

And the value of a Patent is 20million naira if exploited alone, (i.e., if the Faculty of Engineering decides to float a company to produce the product in the patent)

Table 4: Patent Value at 10million per patent

%p \ No P/ yr.	50	760	70	80	90	100
10	50m	60m	70m	80m	90m	100 m
20	100 m	120 m	140 m	160 m	180 m	200 m
30	150 m	180 m	210 m	240 m	270 m	300 m
40	200 m	240 m	280 m	320 m	360 m	400 m
50	250 m	300 m	350 m	400 m	450 m	500 m
60	300 m	360 m	420 m	480 m	540 m	600 m

Table 4 shows the value of Patents in Table 3 if sold for 10 million each. Multiplying percentage that are patentable with the value of patent sold at 10million gives total value of money for the number of projects that year.

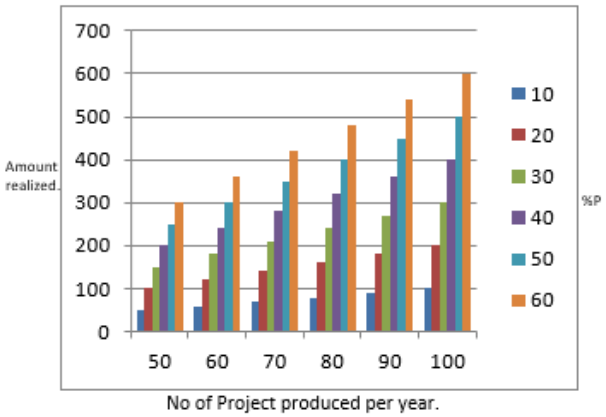

Fig 2: Bar Chart for Patent Value at 10million per Patent

Fig 2 denotes that the more the number of projects per year, the more the money earned. For example, when number of projects done per year is 50 at 50% patentability, the Faculty will realize 250million. If the number of projects increases to 100 per year at 50% patentability, the Faculty would realize ₦500 million. As the project increases, the amount realized increases also. The Faculty will do well by increasing the number of quality projects.

Table 5: Patent Values at 15million per partnership

No P/yr.						
%tag Patentable	50	60	70	80	90	100
10	75m	90m	105m	120m	135m	150m
20	150m	180m	210	240m	270m	300m
30	225m	270m	315m	360m	405m	450m
40	300m	360m	420m	480m	540m	600m
50	375m	450m	525m	600m	675m	750m
60	450m	540m	630m	720m	810	900m

Table 5 shows what happens when the faculty goes into partnership venture with a suitable partner. The value of Patent if exploited in a Partnership is 15 million. Multiplying the proportion patentable in Table 3 with 15 million, gives a value for the number of projects done for that year. For example, from the first row of Table 3.

10% of 50 =5

5* ₦ 15m = ₦ 75m

Also 10% of 60 = 6

6 * ₦15m = ₦ 90m; and so on

These values are recorded in Table 1.5.

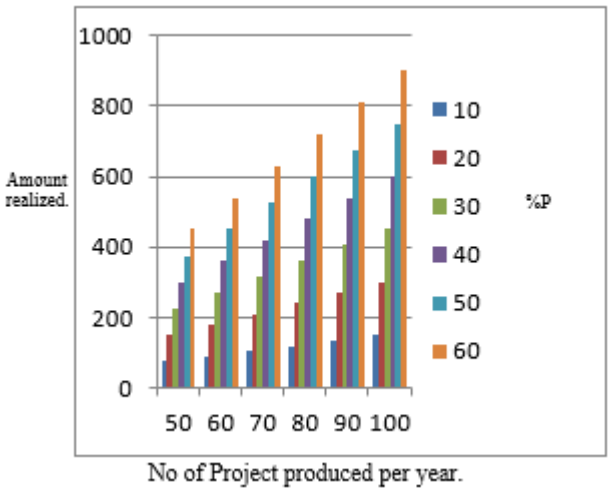

Fig 3: Bar Chart for Patent Value at 15million per Patent

This is the same as Fig 1, the difference is that each patent is worth 15million each when they go into partnership venture with a suitable partner

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Table 6: Patent Values at 20million Sole Proprietary

No P/yr. %tag Patentable	50	60	70	80	90	100
10	100m	120m	140m	160m	180m	200m
20	200m	240m	280m	320m	360m	400m
30	300m	360m	420m	480m	540m	600m
40	400m	480m	560m	640m	720m	800m
50	500m	600m	700m	800m	900m	1,000m
60	600m	720m	840m	960m	1,080m	1,200m

Table 6 shows the scenario where the Faculty may choose to add value to the Patent by going into production using the IP content in the Patent. Here, the value of each Patent is ₦20m.

10% of 50 = 5

5 * ₦20m = ₦100m (See the first row in Table 6)

If the percentage patentable were to be 60% and 100 projects were completed that year, then 60% * 100 = 60, 60 * ₦20 m = ₦1200m. The higher the number of Patentable works, the bigger the potential earning of the Faculty (Table 6)

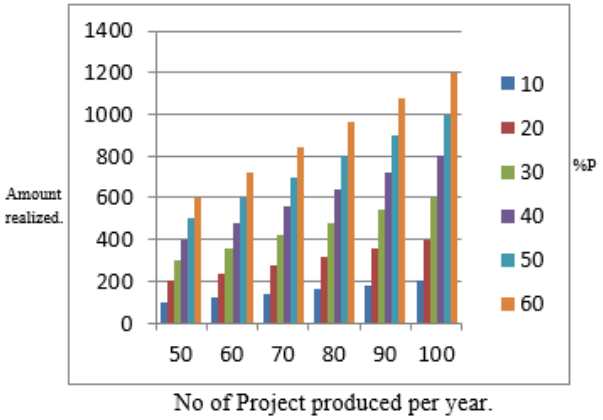

Fig 4: Bar Chart for Patent Value at 20million Sole Proprietary

Fig 4 is a chart that explains the amount the faculty will make if it goes into production alone. Each patent is worth 20million. As the number of projects increases, the money realized by the faculty increases.

5 Multiple Regression Analysis

The number of research output per year and the percentage of it that is patentable shown in Table 3 is subjected to multiple regression analysis of the type:

$$Y = ß_o + ß_1X_1 + ß_2X_2 + \varepsilon \qquad \textbf{(1)}$$

Where Y = the dependent variable and X_1, X_2 are independent variables representing the number of projects completed per year (X_1) and the percentage of it that is patentable (X_2). And ßo, $ß_1$, $ß_2$ are coefficient while ε represent the error.

From the multiple regression done using the Matlab software in Table 7, it was found that,

$$\beta = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{pmatrix} \text{ and}$$

Y	X1	X2
5	50	10
10	100	10
12	60	20
18	90	20
21	70	30
24	80	30
28	70	40
30	60	50
32	80	40
36	50	60
45	90	50
60	100	60

Y is dependent on two variables, X_1 and X_2. The values were fitted into the Matlab software of Table 7 to obtain the values of $ß_o$, $ß_1$, and $ß_2$.

$ß_o$ = -26.25

$ß_1$ = 0.35

$ß_2$ = 0.75

Therefore, Substituting the values of $ß_o$, $ß_1$, and $ß_2$ into equation 1, it becomes Y = -26.25 + $0.35X_1$ + $0.75X_2$.

The F* test of utility was applied to the Multiple regression results.

Ho (null hypothesis) says ßo, ß1 and ß2 has nothing to do with the filled curve of y in terms of X_1 and X_2. H_1 (alternative hypothesis) is taken if H_O is rejected. To perform test for utility of the regression.

F* was calculated as

$$\frac{MSR}{MSR}$$

And so F* = $\frac{MSR}{MSR}$ = 61.0396 *using MATLAB Software* (*Table* 7)

This is much higher than the cut off value for H_o to be true. Therefore, Ho is rejected and H1 is taken. The regression shows a correct relationship between y, X_1 and X_2. Table 1.7 shows the MATLAB software used to do the test for utility of the multiple regression.

Table 7: Multiple Regression Analysis

```
% Y=B0+B1X1+B2X2+E multiple Regression
Y=[5;10;12;18;21;24;28;30;32;30;45;60];
X=[1 50 10;1 100 10;1 60 20;1 90 20;1 70 30;1 80 30;1 70 40;1 60 50;1 80 40;1 50 60;1 90 50;1 100 60];
n=12;
k=2;
B=inv(X'*X)*X'*Y
% calculate Standard Error for the Regression SSE
SSE=(Y'*Y)-(B'*X'*Y);
G=n-(k+1);
zeta=sqrt(SSE/G);
zy=0;
zy2=0;
for r=1:n
   zy=zy+Y(r);
   zy2=Y(r)^2+zy2;
end
SSY=zy2-(zy)^2/12
%calculate mean square for regression MSR
MSR=(SSY-SSE)/k
SSR=SSY-SSE
%calculate mean square for error (MSE)
MSE=zeta^2
Ftest=MSR/MSE
%This is the ratio mean square for regression (MSR) to the mean Square for %error
```

6 Conclusion

The importance of high-quality research projects has been emphasized. This aspect was studied using Faculty of Engineering in Nigerian University. The study looked at the number of projects completed in an academic year in the faculty, the proportion of the finished projects that are patentable and the likely rewards that could accrue to the faculty of Engineering if the patents were sold or committed to a production line in partnership with others or committed to a production line set up and owned by the faculty alone. The research underlined the importance of high quality (patentable) research projects completed without much delay within the faculty of Engineering. The higher the number of projects completed in the faculty within a year and the greater the proportion of them that are patentable, the higher the potential earnings accruable to the Faculty from completed research work.

7 Recommendation

It is strongly recommended that the faculty of Engineering in Nigeria Universities, should insist on high quality (Patentable) timely research output because this enhances their earning capacity in terms of patentable outputs and patronage. The faculty should not be shy about floating companies to produce in line with research findings. It is the view of the researcher that a research project is not really completed until it is featured as part of a production line somewhere in industry. Adopting such a system catalyses the rapid emergence of viable, well-

run indigenous companies and should lead to an increased space of industrialization in Nigeria.

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