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Design and simulation of the dynamic expert system for intellectual property management in corporate bodies

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Abstract
The design of a dynamic Expert System (DES) for Intellectual Property (IP) Management in Corporate bodies has been illustrated using Electronic Development Institute (ELDI) Awka as case study. A dynamic expert system (DES) is dynamically kept up to date as more knowledge is gained. This is a useful means of managing the Intellectual Property that drives an organization forward so that the Knowledge repository can be enhanced with new industry best practices as more knowledge is gained and edited to remove obsolete knowledge. The DES was subjected to Monte Carlo Simulation to see how it would fare for the next five (5) years (20 quarters). A quarterly elicitation process is done in a continuous in-house search for new IPs. The new IP claims are validated through peer review and successful ones are used to update the DES knowledge repository. This makes the operational IP of the corporate body grow dynamically with industry best practices. A successful new IP is rated grade 1 or grade 2 or grade 3 according to its quality and the grade is assigned during peer review. The grade of the new IP determines the remuneration to be paid to the contributor for the effort. A remuneration scheme is worked out in this research such that the worth of a new IP to the corporate body is much higher than the remuneration paid to the contributors of new IP. There is therefore a reduced cost of new IP acquisition in the corporate body due to this cost effective approach used. Thus the net worth of a new IP is the worth of the new IP to the corporate body less remuneration paid to the operation staff.

Keywords: design, simulation, dynamic, expert, system, intellectual, property, management, corporate, bodies

1. Introduction
IP is at the core of most corporate strategy. Its effective management is very vital to building corporate value. A Dynamic Expert System as the name implies, is dynamically kept up-to-date as more knowledge is gained Gia S. (2009) [3]. This is a useful means of managing the intellectual property that drives an organization forward so that it can be enhanced as knowledge increases and edited to eliminate obsolete knowledge or techniques. The dynamic expert system is thus able to keep track of best practices at any point in time and grows like a living organism to enhance organizational performance as it grows richer with best practices. A dynamic expert system results when there is an initial expert system in a given domain and the domain experts are continuously monitored for improvements in their domain of expertise that could be used to upgrade the already developed expert system. When this is done continuously, the expert system performs better and better and behaves more like a living organism whose knowledge is dynamically upgraded. In the context of a company, one is concerned with Intellectual Property (IP) vested in the individuals that work for the company, Cornelius T. (2001) [2]. An initial expert system in this regard would be made up of best practices at every level of the organization for performing the operations of the firm. If through collaboration and knowledge sharing within the company, new best practices are evolved and used to replace the older but now obsolete best practices, then the intellectual property of such a company will be dynamically upgraded and the company can keep pace with changing technology. These dynamic growths in the company's intellectual property means that the company is now able to mature with time in capability in terms of IP content even far beyond the levels represented in the initial expert systems. Such a growth is measurable and closely linked to the competitiveness of the firm within its industry. It is expected that this research will develop a suitable metrics for IP growth evaluation among other things.

2. Significance
1. IP Management enhances a firm's own potential for income and enables them exploit further research opportunities.
2. Good IP management is important not only because of the financial returns that it can help generate for a firm, but because it can also contribute to their corporate aim and objectives.
3. Effective IP management system is a vehicle for firms to organize profit-enhancing collaborations with competitors & suppliers etc.

3. Review of Related Literature
Hazam *et-al* (2001) [4] proposed an IP management system whose decision support algorithm sets on online convex optimization. This technique aims to optimize coordination cost, it uses economic model in estimating the value of IP in other to evaluate management decision events. Helmbold D. et.al (2000) [5] 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) [4] 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. Helmbold D. *et al* (2000) [5] also worked on system that handles planning, communication, publication, evaluation depreciation, evaluation depredation of intellectual property. The model used for decision support evaluation is a hybrid of statistical and support vector machine. According to Chen J, (2009) [1], the system is mainly viewed as only effective for IP management workflow. It is said to optimize distribution of tasks to IP professionals within an organization. Its limitation is that its structure does not allow it to provide data that enables performance evaluation of strategic IP management decision. Stewart K.E and Wright M (2007) [7] 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 Indicators) to carry out this evolution. The problem with using pure quantitative KPIs is that aspects of quality are often neglected and wrong decision is reported. It is posited that this proposal does not take consideration of the dynamic environment of the organization. Robert *et al*, (2003) [6] developed what is referred to as an enterprise IP management system. This system made collaboration and communication on organizational IP issues effective. Furthermore its reporting and automated publication capabilities were reasoned to be excellent (Robert *et al*, (2003) [6]. However it is alleged to be weak in adaptation evaluation for supporting dynamic IP management decision, since its analytic computation is based on deterministic mathematical procedures. This makes it not able to account adequately for difficult constraints, such as accounting for legal aspects of intangible assets development, protection and transfer IP litigation risk evaluation.

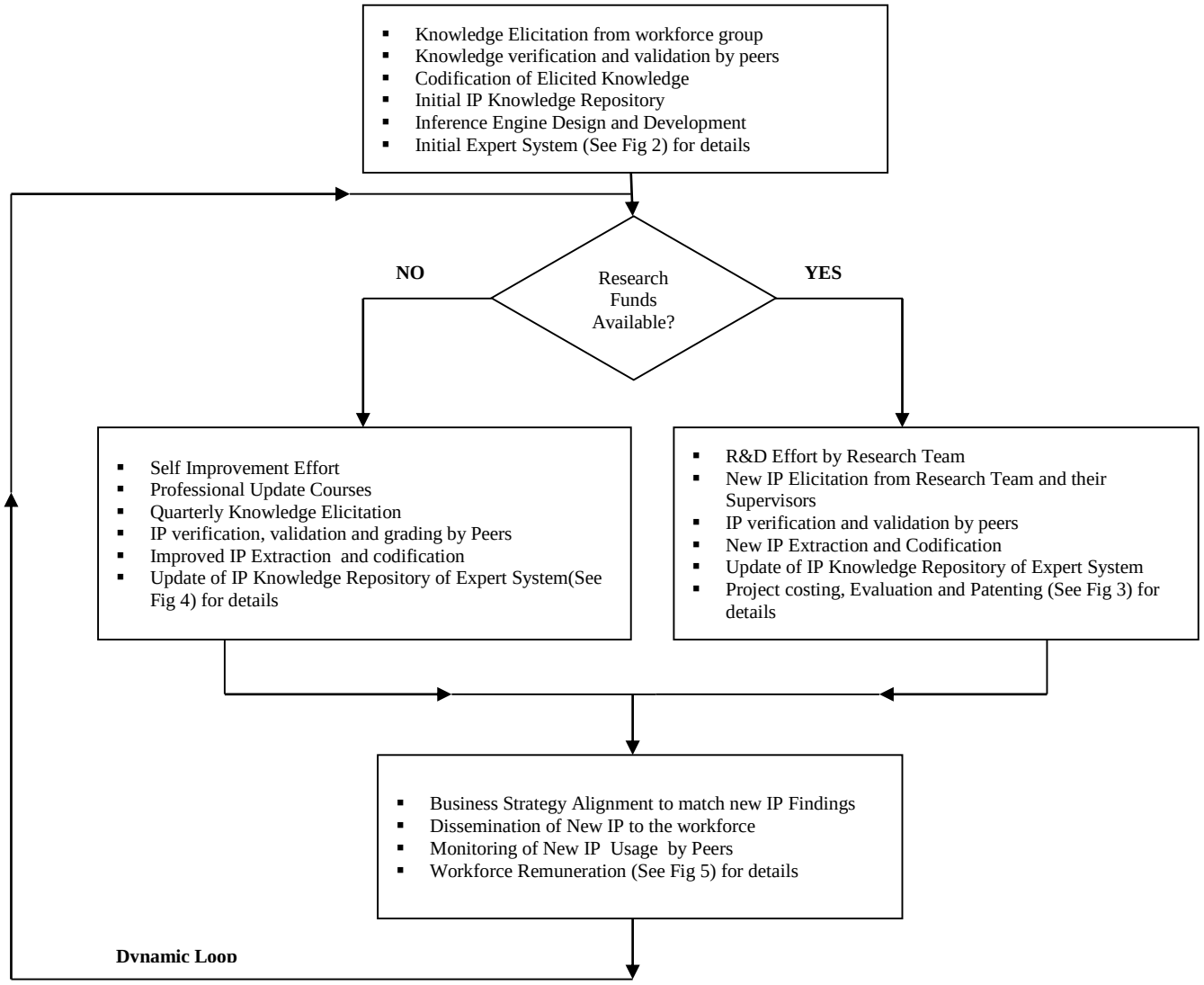

Fig 1: The Model of a Dynamic Expert System for IP Management in Corporate Bodies

4. Model Design

Fig 1 is a dynamic expert system model. There is an initial static expert system which is enhanced as more knowledge is gained and the newer knowledge used to replace the older ones. Knowledge can be obtained through a self-improvement exercise or R&D effort by the team of researchers, after which they are interviewed to elicit their new IP. This is used to update the knowledge repository. The elicited new IP is also made available to the entire workforce.

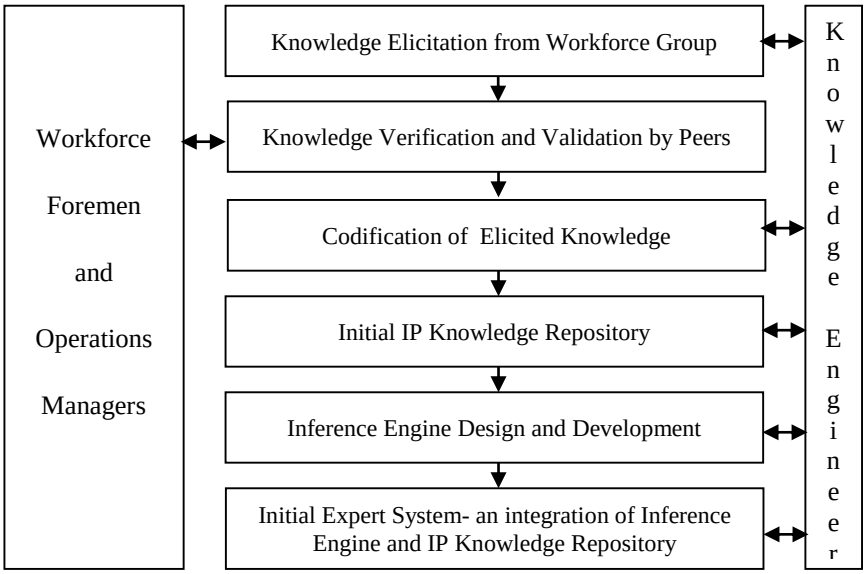

Fig 2: Steps in the development of the initial Expert System Using Elicited Knowledge of the Workforce

Fig 2 denotes the steps in the development of the initial expert system using elicited knowledge of the workforce.
The outcome of the knowledge elicitation process is to capture the best work practices used in the company at all levels. This now constitute the primary intellectual property or knowledge repository which will begin to grow as knowledge elicitation process is repeated in subsequent quarters of the year. The foremen together with the operations manager of each workgroup verify and validate the knowledge elicited from members of the workgroup. The knowledge engineer codifies the successful elicited knowledge and stores them in the knowledge repository. An inference engine is made to sift through the repository in search of expert like solutions to a problem. An integration of inference engine and intellectual property knowledge repository forms the initial expert system.

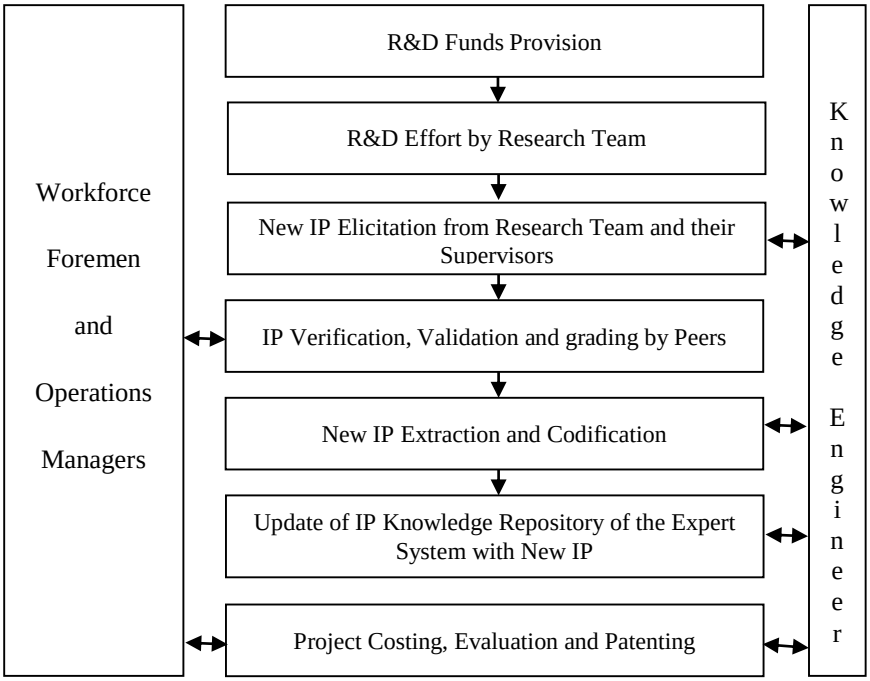

Fig 3: Development of new business IP through Research

Fig 3 indicates the development of new business IP through research when R&D funds are provided, the research team makes R&D effort, and the outcome of such research would no doubt make a new set of best practices and intellectual property available to the company. These are captured by the knowledge engineer, evaluated, ratified and graded by peers (workforce foremen and operations manager). The new extracted IP are codified by the knowledge engineer which is used to update the expert system. Project costing, evaluation and patenting are done by the knowledge engineer and the Peers.

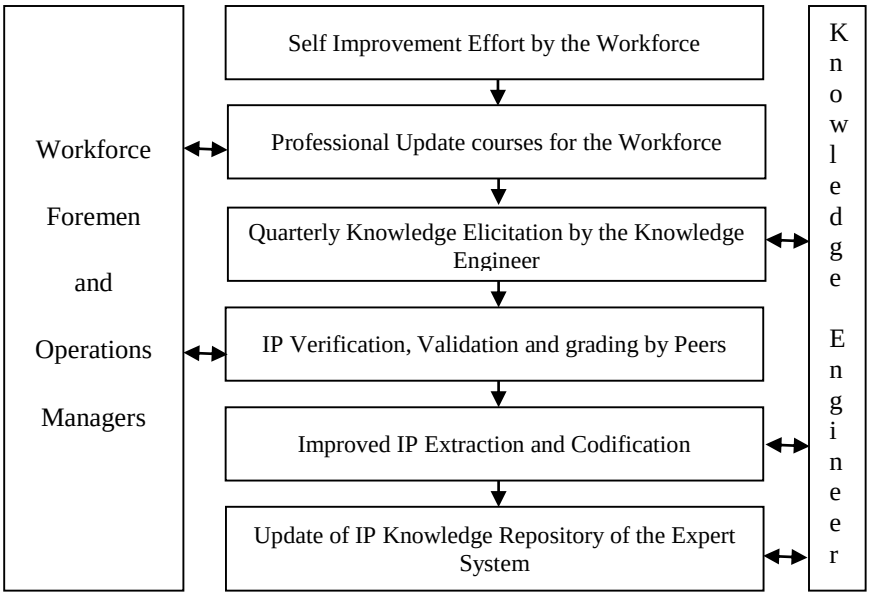

Fig 4: Quarterly Knowledge Elicitation and Knowledge Repository

Fig 4 explains the quarterly knowledge elicitation and knowledge repository update. In fig 1, when there is no research available, the researchers go for self- improvement effort, training in order to improve on intellectual their property. The best practices for all identifiable job functions of each category of workers are elicited by the knowledge engineer, verified, validated and graded by the Peers (Workforce foremen and operations managers). The extracted IP are codified and used to update the knowledge repository. A new best practice may be found which leads to the deletion of the old practice and inclusion of the new best practice in the knowledge repository. Continuous quarterly elicitation of intellectual property or new best practices from the workforce makes the system dynamic.

Example, if KR_{size} = N records (1)
Where KR = Knowledge Repository

When a knowledge is removed for enhancement, it becomes

$$KR_{del} = KR_{size} - 1 = N - 1 \quad (2)$$

In Eqn (2), an absolete knowledge is removed, therefore the knowledge base size becomes N – 1. If the removed IP is replaced by a better one, at that point, the knowledge base becomes N. So the overall number of IP in the knowledge base remains the same.

$$KB_{add} = (KB_{size} - 1) + 1 = KB_{size} = N \quad (3)$$

The enhancement of IP does not change the size of knowledge base. It removes what was there and adds a new IP.
After each research effort, a knowledge elicitation is done to search if new IPs have been found; the addition of new IP found for existing work processes followed the equations shown in equation 1 - 3. However if a new process is started then new IPs are developed to match the demands of the new process. Unlike the IPs used to replace the obsolete ones leaving the number of IPs in the knowledge repository the same, new IPs arising from a new process increase the number of IPs in the knowledge base, thus knowledge base grows in terms of number of new IPs added to it, This is shown in equation 4. If the number of entries in the knowledge base N and M is the new IP meant to support a new process developed by the research team, then the size of knowledge base becomes;

$$\text{New Process IP}_{(size)} = M_{new}$$
$$KB_{(size)} = N + M_{new} \quad (4)$$

There is a constant monitoring of new Intellectual Property. The staff are motivated to contribute by remunerating those who contributed their knowledge and also those that used the newly found best practices (Fig 3).

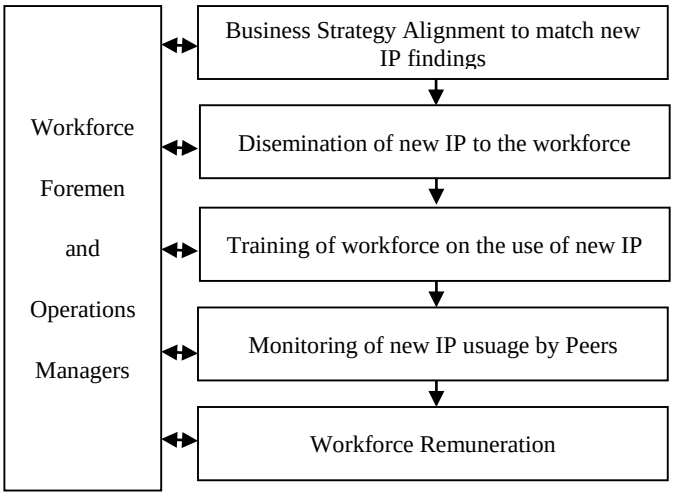

Fig 5: Business Strategy Alignment and Complaint Workforce Remuneration

The new IPs from fig 3 and 4 were used to update the knowledge repository. Business strategies are aligned to match the new IP findings of fig 3 and fig 4 and made available to the entire workforce. The workforce are trained on the ise of new IP. The foremen make sure that each worker under him makes use of the best practices in all his/her job functions in the company else he/she will not be qualified for normal increment. The worker found to possess IP best practice used to replace the existing IP which would be to the advantage of the company are duly remunerated.

5. Model Simulation

A simulation of the Dynamic Expert System (DES) flowchart of fig 1 was done to serve as a look ahead facility to see what the outcome of DES would be in the next 5 years. New IP discovery is captured every quarter, which is 4 times per year. The 5 years simulation therefore covered 20 quarters. On the average, each section of ELDI can add between 1 and 6 new IPs per quarter. Using Monte Carlo simulation, made it possible to work out numbers of new IPs per section per quarter via random number generation. From the records in ELDI, it is found that each workforce section develops between 1 and 6 new IPs per quarter. To simulate this, a random number N is generated for a section per quarter. N modulo 7 gives a remainder which has between 1 and 6 and serves as the number of new IPs for the section for that quarter. This is indicated in the 3rd column of Table 1. Also each new IP is rated as either grade 1 or grade 2 or grade 3. Again a random number M is generated and M modulo 7 (i.e. a number which lies between 1 and 6 inclusive) is found. If the M modulo 7 is 1 or 2, grade 1 new IP is assumed. If M modulo 7 is 3 or 4, grade 2 new IP is assumed and if M modulo 7 is 5 or 6 grade 3 new IP is assumed. This is the treatment given in the simulation to each new IP found and is informed by the current happenings in the company. It is envisaged by the expert valuers that each new IP could add as much as 9 times the step size in salary of the staff that discovered it if it is rated grade 1. Grade 2 new IPs are deemed to be worth 6 times the step size in salary of the staff that discovered it while grade 3 new IPs add 3 times the step size in salary of the staff that found it. However, staff remuneration for each grade 1 new IP is only 1 step size in salary of the staff involved; grade 2 new IP attracts 0.5 step size in salary to the discoverer while grade 3 new IP attracts 0.25 step size in salary to the discoverer. This ensures that the worth of the IP to the Company is far ahead of the cost of remuneration demanded from the Company. Table1 is the simulation result of the production section of ELDI. A simulation results of the remaining sections of ELDI is done using the techniques developed for the production section.

Table 1: Remuneration and Worth of IP for Production Section

s/n	Qtr	New IP	Section ID	GL	STEP	INC ₦	Quality of IP (Grade)			Remuneration ₦	Worth ₦
							1 (1&2)	2 (3&4)	3 (5&6)		
1	1	3	Prd-001	8	4	1,900	-	0.5	-	950	11,400
2	1		Prd-001	9	7	2,300	1	-	-	2,300	20,700
3	1		Prd-001	15	8	8,100	1	-	-	8,100	72,900
4	2	4	Prd-001	17	5	14,508	-	0.5	-	7,254	87,048
5	2		Prd-001	11	2	2,700	-	-	0.25	675	600
6	2		Prd-001	4	6	718	-	-	0.25	179.5	4,308
7	2		Prd-001	1	8	360	-	0.5	-	180	2,160
8	3	2	Prd-001	12	6	7,000	-	0.5	-	3,500	42,000
9	3		Prd-001	13	4	7,690	1	-	-	7,690	69,210
10	4	1	Prd-001	10	1	2,600	1	-	-	2,600	23,400
11	5	5	Prd-001	14	6	7,990	1	-	-	7,990	71,910
12	5		Prd-001	2	8	500	-	-	0.25	125	1,500
13	5		Prd-001	3	14	644	-	-	0.25	161	1,932
14	5		Prd-001	16	3	12,900	-	0.5	-	6,450	77,400
15	5		Prd-001	10	3	2,600	1	-	-	2,600	23,400
16	6	3	Prd-001	8	13	1,900	-	-	0.25	475	5,700
17	6		Prd-001	3	11	644	-	0.5	-	322	3,864
18	6		Prd-001	7	15	1,600	1	-	-	1,600	14,400
19	7	1	Prd-001	9	2	2,300	-	0.5	-	1,150	13,800
20	8	6	Prd-001	3	13	644	-	0.5	-	322	3,864
21	8		Prd-001	8	11	1,900	1	-	-	1,900	17,100
22	8		Prd-001	7	2	1,600	1	-	-	1,600	14,400
23	8		Prd-001	5	5	870	1	-	-	870	7,830
24	8		Prd-001	4	7	718	-	0.5	-	359	4,308
25	8		Prd-001	2	9	500	-	-	0.25	125	1.500
26	9	2	Prd-001	1	15	360	1	-	-	360	3,240
27	9		Prd-001	11	1	2,700	-	0.5	-	1,350	16,200
28	10	4	Prd-001	8	8	1,900	-	-	0.25	475	5,700
29	10		Prd-001	4	9	718	-	-	0.25	179.50	4,308
30	10		Prd-001	1	13	360	-	0.5	-	180	2,160
31	10		Prd-001	6	4	930	-	-	0.25	232.50	2,790
32	11	2	Prd-001	9	9	2,300	-	0.5	-	1,150	13,800
33	11		Prd-001	2	4	500	1	-	-	500	4,500
34	12	2	Prd-001	4	3	718	-	-	0.25	179.50	2,154
35	12		Prd-001	7	14	1,600	1	-	-	1,600	14,400
36	13	2	Prd-001	9	5	2,300	-	0.5	-	1,150	13,800
37	13		Prd-001	11	11	2,700	1	-	-	2,700	2,430
38	14	6	Prd-001	13	3	7,990	-	-	0.25	1,997.50	23,970
39	14		Prd-001	17	4	14,502	1	-	-	14,502	130,518
40	14		Prd-001	3	8	644	-	0.5	-	322	3,864

41	14		Prd-001	6	9	930	-	-	0.25	232.50	2,790
42	14		Prd-001	12	3	7,000	-	-	0.25	1,750	21,000
43	14		Prd-001	16	7	12,900	-	0.5	-	6,450	77,400
44	15	1	Prd-001	9	4	2,300	-	0.5	-	1,150	13,800
45	16	2	Prd-001	4	9	718	1	-	-	718	6,462
46	16		Prd-001	2	1	500	1	-	-	500	4,500
47	17	6	Prd-001	7	3	1,600	-	-	0.25	800	4,800
48	17		Prd-001	11	11	2,700	-	-	0.25	1,350	8,100
49	17		Prd-001	17	5	14,502	1	-	-	14,502	130,518
50	17		Prd-001	13	8	7,690	-	0.5	-	3,845	46,140
51	17		Prd-001	8	5	1,900	-	0.5	-	950	11,400
52	17		Prd-001	4	8	718	1	-	-	718	6,462
53	18	3	Prd-001	2	1	500	-	-	0.25	125	3,000
54	18		Prd-001	3	6	644	-	-	0.25	161	1,932
55	18		Prd-001	7	10	1,600	1	-	-	1,600	14,400
56	19	2	Prd-001	16	6	12,900		0.5	-	6,450	137,400
57	19		Prd-001	14	3	7,990	-	0.5	-	3,995	47,940
58	20	5	Prd-001	14	5	7,990	-	0.5	-	3,995	47,940
59	20		Prd-001	9	8	2,300	1	-	-	2,300	20,700
60	20		Prd-001	15	5	8,100	1	-	-	8,100	72,900
61	20		Prd-001	5	9	870	-	0.5	-	435	5,220
62	20		Prd-001	1	4	718	-	0.5	-	359	4,308
						Subtotal:		**146,841**		**1,431,848**	

Table 1 is Remuneration and Worth Table (RWT), generated using Monte-Carlos Simulation for the production sections. A similar RWT was also generated for Research, Quality Control, Marketing and Agricultural sections of ELDI workforce. Intellectual Property growth was simulated for (5) years. New IP's, grade level and step size were generated through random number generation from their probability functions. From the first quarter, three (3) new IP's were generated and four (4) in the second quarter of the Production section etc. From table 2, the actual grade and step size values of the inventors are retrieved.

Remuneration is calculated as:

- Quality of IP * Step value = Cost of IP
- Grade 1* step value = 1 * step value = cost of IP
- Grade 2 * step value = 0.5 * step value = cost of IP
- Grade 3 * step value = 0.25 * step value = cost of IP

Worth of IP is the value the IP earns for the company.

- Grade 1 worth 9 times the inventor's step size = 9 * Step Value
- Grade 2 worth 6 times the inventor's step size = 6* Step Value
- Grade 3 worth 3 times the inventor's step size = 3 * Step Value

Table 2: The Grade and Step Size of ELDI Staff

s/n	Grade	Step Size (N)
1	01	360
2	02	500
3	03	644
4	04	718
5	05	870
6	06	930
7	07	1,600
8	08	1,900
9	09	2,300
10	10	2,600
11	11	2,700
12	12	7,000
13	13	7,690
14	14	7,990
15	15	8,100
16	16	12,900
17	17	14,502

Table 2 is the Grade and Step Size of ELDI Staff. Each Staff has different grade level and grade size attached to them. Grade Level 12-14 terminates at Step 11. Grade level 15-17 terminates at Step 9. Grade level 01-11 terminates at step 15.

The new IP gained by all sections of ELDI workforce during the period covered by simulation (20 quarters or 5years) is summarized in Table 3.

Table 3: New IP Gain for 5years (20 Quarters)

s/n	Section code	Section name	Total no of IP	Cost of IP	Worth of IP	Gain
1	Prd-001	Production	62	146,841	1,431,848	1,285,007
2	Res-002	Research	63	130,162.50	1,333,738	1,203,575.50
3	QC-003	Quality Control	67	271,059	2,201,988	1,930,929
4	Mkg-004	Marketing	46	114,233	1,208,892	1,094,659
5	Agc-005	Agriculture	44	145,814	1,503,834	1,358,020
		Total:	**282**	**808,109.50**	**7,680,300**	**6,872,190**

Table 3 shows the Gain the company gets after remunerating its staff that contributed the IP. The total number of IP for 20 quarters is 282. The company uses less than the Worth of IP to Remunerate Staff and also make their own gain. It is calculated as:

Gain = Worth of IP – Cost of IP (Remuneration)

i.e. Worth of IP in a section per 20 quarters – Cost of IP in a section per 20 quarters.

6. Evaluations of Dynamic Expert System (DES)

Table 4 is a Summary outcome of the Dynamic Expert System Simulation for 5 years (20 quarters). It shows that the total number of new IPs over the period of simulation is 282, while the cost to the company in terms of the remuneration paid to staff for the new IP contributed is N 808,109.50. But the worth to the company of the new IPs introduced is N 7,680,300. That means that this DES provides a cheap means of achieving a vital growth in IP at minimum cost. The gain to ELDI in this simulation is N 7,680,300 – N 808,109.50 = N 6,872,190.50. This is important to the company's bottom line. Also DES ensures that the company is operated along best practices only and should therefore be very efficient and effective.

6.1 Evaluation of New IP Gained

Again DES can be evaluated in terms of the new IP gained during the five (5) years simulation period.

Table 4: Details of Yearly, Categorized IP.

Year	New Grade 1 IP (NGD1)	New Grade 2 IP (NGD2)	New Grade 3 IP (NGD3)	Total New IP for the Year (TNIP)
Year 1 Qtr 1 – Qtr 4	NGD1 = 19	NGD2 = 18	NGD3 = 21	TN IP YR 1 =58
Year 2 Qtr 5 – Qtr 8	NGD1 = 18	NGD2 = 23	NGD3 = 14	TN IP YR 2 = 55
Year 3 Qtr 9 – Qtr 12	NGD1 = 17	NGD2 = 16	NGD3 = 12	TN IP YR 3 = 45
Year 4 Qtr 13 – Qtr 16	NGD1 = 23	NGD2 = 19	NGD3 = 15	TN IP YR 4 = 57
Year 5 Qtr 17 – Qtr 20	NGD1 = 31	NGD2 =19	NGD3 = 17	TN IP YR 5 = 67
Totals	TGD1 = 108	TGD2 = 98	TGD3 = 78	Sum of IP for 5Yrs = 282

Table 4 shows the details of the new IP gained each year for the five (5) years simulation period, categorized according to grade of IP.

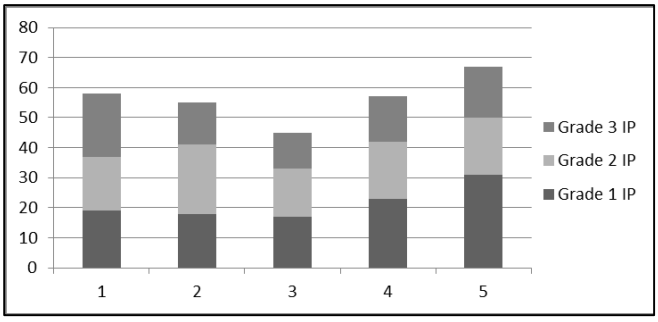

Fig 6: Stacked Column chart for yearly new IP findings

The bar chart of Fig 6 shows the yearly new IP findings, with each year segmented according to the quality of the IP namely, grade 1, grade 2 and grade 3. The bar chart shows a gradual fall in the number of new IP acquisition from year 1 to year 2 and then to year 3, which is the lowest. The new IP began to rise again in year 4 and was highest in year 5. In real life, this phenomenon can be explained as follows: When a new process is started, there often is considerable room for improvement, that is, new IP can easily be found hence the high value of new IP in year 1 of 58. As time goes on, the number of new IP added dwindles first to 55 and then to an all time low of 45 in the 3rd year. That shows that it is getting harder and harder to improve on the process with the technology in use. The number of new IP began to rise from year four, first from 57 to 67 in year five. In real life, this suggests that a new technology might have been found with new promise so that there is considerable room for new IP to be acquired. The all time high of 67 in year 5, suggests that the number of new IP has peaked for current technology in use and may be falling in subsequent years.

Table 5: Details of Yearly, Categorized IP with Quality Factor.

Year	New Grade 1 IP Quality factor = 3	New Grade 2 IP Quality factor = 2	New Grade 3 IP Quality factor = 1	Total New IP for the Year
Year 1 Qtr 1 – Qtr 4	NGD1 * QF = 57	NGD2 * QF = 36	NGD3 * QF =21	TN IP *QF =114
Year 2 Qtr 5 – Qtr 8	NGD1 * QF = 54	NGD2 * QF = 46	NGD3 * QF =14	TN IP *QF = 114
Year 3 Qtr 9 – Qtr 12	NGD1 * QF = 51	NGD2 * QF = 32	NGD3 * QF =12	TN IP *QF = 95
Year 4 Qtr 13 – Qtr 16	NGD1 * QF = 69	NGD2 * QF = 38	NGD3 * QF =15	TN IP *QF = 122
Year 5 Qtr 17 – Qtr 20	NGD1 * QF = 93	NGD2 * QF = 38	NGD3 * QF =17	TN IP *QF = 148
Totals * Quality Factor	TGD1 *QF = 324	TGD2 *QF = 190	TGD3 *QF = 79	Sum of QF = 593

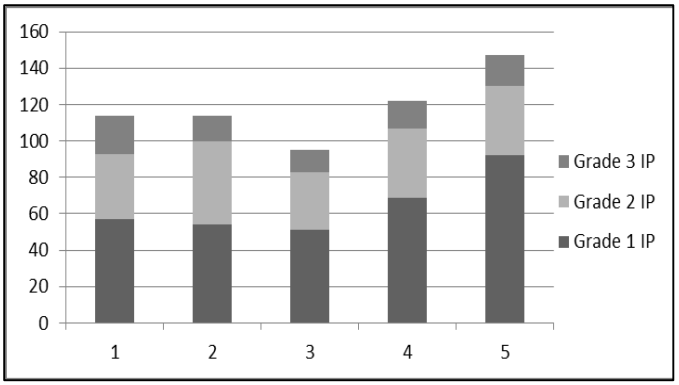

Fig 7: Stacked column chart for Yearly IP with Quality Factor.

To take the quality factor into account properly, each grade 1 new IP is rated 3 units, a grade 2 new IP is rated 2 units and a grade 3 new IP is rated 1 unit. The three segments of IP grade 1, grade 2 and grade 3 are thus modified as in Table 5 with quality factor used as explained above. This was used to plot the stacked column chart of Fig 7. Unlike Fig 6, where the quality factor was not used, Fig 7 shows that the performance in year 2 is actually equal to that of year 1 when the quality factor is taken into account.

Table 6: New IP Gained in 5 Years

Year (X)	1	2	3	4	5
New IP	58	55	45	57	67
Cumulative New IP (V)	58	113	158	215	282

Table 7: Cumulative New IP with Quality Factor

Year (X_2)	1	2	3	4	5
New IP	114	114	95	122	148
Cumulative New IP(V_2)	114	288	323	445	593

Table 7 shows the cumulative new IP with Quality Factor taken into account. Thus, each new IP is qualified either as grade 1, grade 2 or grade 3 and is therefore multiplied by a quality factor (QF). A new IP of grade 1 has a QF of 3; a new IP of grade 2 has a quality factor of 2 while a new IP of grade 3 has a quality factor of 1. Utilizing the quality factor allows one to have a true measure of the real growth attained, because the new IP grows incrementally from year to year. What is really important in terms of growth is the yearly cumulative of the new IP multiplied with the quality factor. (Table 7). The same cumulative for the number of new IPs but without the quality factor was also shown in Table 6. The Matlab software of Table 8 was used to generate the graphs of fig and fig.

Table 8: Graph plotting software for new IP gain over 5 years of simulation

```
% MATLAB script for plotting polyfit of new IP
% Linear Regression and Polyfit of the cummulative new IP of Table 6
v=[58 113 158 215 282];
x=[1 2 3 4 5];
y=polyfit(x,v,1); % Generate the coeefficients of m and c in the equation V=mx + c
p=polyval(y,x); % predicting the values of y using x
m=polyfit(x,v,2);% Generate the coefficient of a,b and c in the equation V=ax^2+bx+c
g=polyval(m,x);% predicting the values of M using x
% c=polyfit(x,v,3);
% b=polyval(c,x);
%a=polyfit(x,v,4);
% k=polyval(a,x);
figure
plot(x,v,'-or')
hold on
plot(x,p,'b')
hold on
plot(x,g,'-+k')
legend('main','linear','quadratic')
xlabel('years')
ylabel('Cummulative New IP')
% applying quality factor QF to the cummulative New IP
% NEw IP multiplied by Quality Factor is a measure of the actual
% intellectual property achieved
v2=[114 288 323 445 593];
x2=[1 2 3 4 5];
y2=polyfit(x2,v2,1)% Generate the coeefficients of m and c in the equation V2=mx2 + c
p2=polyval(y2,x2) % predicting the values of y2 using x2
m2=polyfit(x2,v2,2);% Generate the coefficient of a,b and c in the equation V2=ax^2+bx+c
g2=polyval(m2,x2);% predicting the values of M using x
figure(2)
plot(x2,v2,'--*r')
hold on
plot(x2,p2,'-ob')
hold on
plot(x2,g2,'-+k')
legend('main','linear','quadratic')
xlabel('years')
ylabel('Cummulative New IP with QF')
f1=poly2str(y,x);
f2=poly2str(y2,x2);
u=polyval(y2,10)
```

Table 8 is a Matlab software used to generate the graph showing cumulative new IP gained over the years of simulation and graph showing cumulative new IP gained over the years of simulation multiplied with the quality factor.

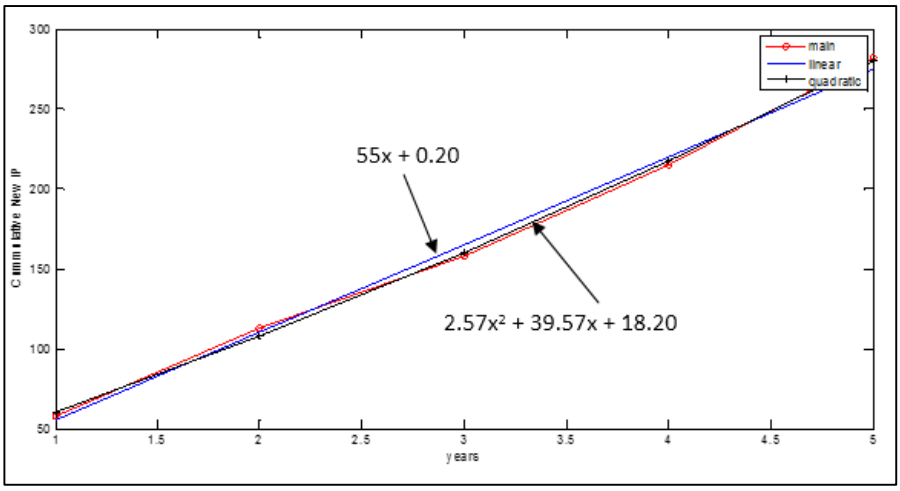

Fig 8: Graph showing cumulative new IP gained over the years of simulation**.**

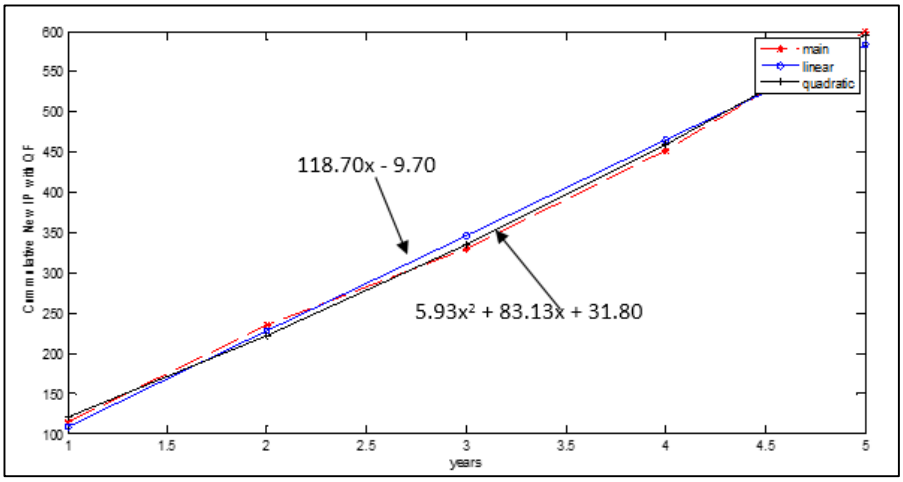

Fig 9: Graph showing cumulative new IP gained over the years of simulation multiplied with the quality factor.

Fig 8 shows the values of new IP without the quality factor fitted to a straight line of best fit and then to a quadratic curve to show which fits better. The idea is to find out whether the outliers of the straight line graph suggest a quadratic fit. Indeed, this appears to be the case in fig 8. Again, Fig 9 shows the values of new IP qualified with quality factor as in Table 7 fitted to a straight line and at the same time to a curve of quadratic nature. The quadratic curve seem to be a better fit for the values in table 6 and also the values in table 7.

7. Conclusion

The design and simulation of dynamic expert system for Intellectual Property management in corporate bodies has been implemented using ELDI Awka, Nigeria as a case study. A model is developed to capture the existing best practices and IP existing in the company through knowledge elicitation by the knowledge engineer. These are evaluated and ratified by the foremen and operations manager of the different workgroups of ELDI Company. The successful IP are codified and stored in the knowledge repository. This is made accessible to the entire workforce. The knowledge repository is enhanced every quarter so that the company's workforce is continuously up to date with best practices. The company grows as old practices are abandoned and new ones follows in line with current trends. The quarterly enhancement of the company's intellectual practice knowledge repository makes the expert system dynamic. A simulation of the dynamic expert system is done to serve as a look ahead facility to see the outcome of DES in the next five years. A Scheme of remuneration to staff in a corporate body for evolving new IP that keeps the inventors happy even though the new IP is worth several times the remuneration paid out to them was worked out in this research. The simulation shows that using a dynamic expert system would reduce the cost of IP acquisition, enhance IP growth of the company's workforce, lead to greater customer satisfaction and improve earnings to the corporate body. The dynamic expert system is clearly an innovative way to manage intellectual property in a corporate body.

8. References

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