مجلة الجامعة

University Journal

Issued Twice a Year By Gharian University.

مجلة الجامعة

University Journal

Issued Twice a Year By Gharian University.

All correspondence should be addressed to the following address

Editor in chief
University journal
Gharian University
General Administration Building
Gharian City Libya

Tel : 00218913248894

Fax: 0242634833

Email :majlt aljamea @ yahoo.com .

June (2018)

التحقق من الجرعة الإشعاعية الممتصة المحسوبة بواسطة جهاز تخطيط العلاج الإشعاعي.

عبدالرؤوف محمد عقيلة[1]، فرج أحمد المصروب[2]، فاضل عزالدين الشريف[1]، رويدة أبوجبهة[1].

[1] قسم الفيزياء، كلية العلوم، جامعة الجبل الغربي. [2] قسم الفيزياء الإشعاعية الطبية، مركز طرابلس الطبي.

الملخص :

يعتبر جهاز تخطيط العلاج الإشعاعي من أهم أدوات تخطيط العلاج لمرضي الأورام السرطانية. عليه، فإن التحقق من تخطيط وحسابات الجرعة الإشعاعية التي يتم إيصالها إلي الورم السرطاني داخل المريض والمتحصل عليها بواسطة جهاز تخطيط العلاج الإشعاعي كان الهدف من هذه الدراسة. ومن أجل هذه الغاية استخدم جهاز تخطيط علاج إشعاعي نوع PLATO-RTS في بعدين لحساب الجرعة الإشعاعية عند نقاط محددة داخل مماثل بشري (Alderson Rando phantom). الجرعة الإشعاعية الممتصة داخل المماثل البشري استخدم لقياسها كواشف التألق الحراري المصنوعة من الليثيوم فلورايد. حيث قورنت نتائج حسابات الجرعة الإشعاعية الممتصة المسحوبة بواسطة جهاز تخطيط العلاج الإشعاعي بنتائج الجرعة المقاسة بواسطة كواشف التألق الحراري. كان أكبر اختلاف بين الجرعة المحسوبة الجرعة المقاسة 12.5 cGy وأن متوسط الخطاء كان يتراوح بين 2.53% و 8.82% حيث تعتبر هذه النسبة مقبولة عند إجراء القياسات بواسطة كواشف التألق الحراري.

Verification of radiation absorbed dose calculated by treatment planning system

A. M. Aghila[1], F. A. Elmasrub[2], F. E. Shrif[3], R. Abujabha[4]
[1,3,4] Physics Department, Faculty of Science, Al-Jabel Al-Gharbi University, Gharain, Libya.
[2] Medical Radiation Physics Department, Tripoli Medical Center, Tripoli, Libya.

Abstract:

A computerized Treatment Planning System (TPS) is an important tool for designing a treatment plan of cancer patients. Testing the accuracy of planned and calculated radiation dose obtained by TPS delivered to the tumor inside the cancer patients was the purpose of this study. For this purpose, a 2D PLATO-RTS Treatment planning system was used to calculate the dose at specific points inside an Alderson Rando phantom. The absorbed radiation dose inside the phantom was measured using the thermoluminescent dosimeter TLD-100s Lithium Flouride (LiF:Mg;Ti). The results of absorbed radiation dose obtained by TPS were compared with the results obtained by TLD. The largest difference between planned and measured radiation dose was found 12.5 cGy, and the mean percentage error was found 8.82% and 2.53% which is considered to be acceptable with TLD 100 (LiF: Mg, Ti).

1. Introduction:

Due to the fact that radiation has biological effects on living cells, it is used to treat cancer patients. Radiation dose delivered to tumor cells must be accurate in both quality and quantity **[1]**. The International Commission on Radiation Units and measurements (**ICRU**) recommended in its report numbered 62 released in 1999 and other publications that the delivered prescribed tumor dose must be accurate within

5% to ensure adequate tumor control **[2-6]**. Therefore, in order that radiation treatment to be effective and efficient, a quality assurance program should be applied carefully during each step of treatment process. Treatment planning is one of main parts of radiation treatment which provide a radiation dose distribution in patient using a Treatment Planning System (TPS). The quality assurance program of TPS is indispensable part of appropriate treatment. Many International organizations and agencies are recommended and provided guidelines for TPS quality assurance, for instance, International Atomic Energy Agency **(IAEA)** in its technical report series 1540 **[7]**, and American Association of Physicists in Medicine **(AAPM)** in its task groups 53 and 55 **[8, 9]**. The aim of this paper is to verify the radiation absorbed dose distribution at specific points calculated by TPS inside anthropomorphic phantom (Alderson Rando phantom) as a patient with measured value obtained by using thermoluminescent dosimeter **TLD**.

2. Material and methods:

This study was undertaken in Tripoli Medical Center **(TMC)**, Radiotherapy Department, Tripoli, Libya. The machine used is Theratronics 780C Cobalt-60 Unit to provide an external radiation beam. The treatment head of the machine unit consists of a cubic Cobalt-60 radioactive isotope of side 2cm, two jaws to define the field size of treatment area from 5×5 cm^2 to 35×35 cm^2, and gantry which is capable to rotate around the machine central axis 360^o**[10]**. An Alderson Rando radiation therapy anthropomorphic phantom **(ART)** was used for creating treatment plans and then for investigation of delivered dose to specific points in the phantom. The ART Phantom has designed following the ICRU report 44 and 48 **[11, 12]** and made of materials that equivalent to a natural human organics. The materials, for example, which simulate a soft tissue, lung and skeleton have densities of 0.997 g/cm^3, 0.32

g/cm^3 and 1.61 g/cm^3, respectively **[13, 14]**. The ART phantom is transected horizontally into 34 slices. Each slice with 2.5 cm thickness and has holes where thermoluminescent rods dosimeter can be inserted **[15]**. The region of the phantom which the TLD rods placed was abdomen. The external body contour of the phantom in the interest region, and the internal organics were delineated manually.

The TPS used to calculate radiation dose distribution inside the phantom was a 2D PLATO-RTS Treatment planning system manufactured by Nucletron B.V. in The Netherland. Beam data entered into the TPS were measured using WELLHOFER WP 700, computerized 3D-radiation field analyzer dosimetry system.

The measurements of radiation dose at specific points inside the phantom were carried out using a TLD 100 (LiF: Mg, Ti), in the shape of rods, measuring 1mm in diameter and 6 mm in length, and the TLD reader was Harshaw TLD model 5500 with control software Teledyne system 310 manufactured by Thermo Fischer Scientific Inc. A group of 27 TLD rods were calibrated using 100 cGy gamma radiation of Co-60 at the first, and then used to perform measurements. From this group, 7 rods were chosen to be used for reader calibration, remains were divided into two groups (each group contains 10 rods), the first group labeled from R1 to R10 while, the second group labeled from D1 to D10. These two groups were used for dosimetry measurements. The response of TLDs to 100 cGy is shown in table 1 and 2.

Two plans were created to deliver radiation dose to the target area inside the phantom. The first plan was three fields of size 10×10 cm^2 and a SSD (Source to surface distance) of 80 cm to deliver a radiation dose of 100 cGy to the target area. The three fields were anterior, right lateral and left lateral with gantry angle at 0^O, 90^O and 270^O respectively. The second plan was four open fields with SSD of 80 cm

to deliver a radiation dose of 200 cGy to the target area. The four fields were anterior, posterior, right lateral and left lateral with gantry angle at 0^O, 180^O, 90^O and 270^O respectively. The radiation fields were of size 9.5×10 cm^2 for anterior and posterior fields while the radiation fields were of size 6.5×10 cm^2 for right and left lateral fields. The dose distribution of two plans is shown in figure 1 and 2. The measurements of the second treatment plan were repeated twice with the same previous conditions.

3. Results and discussions:

The results of the first group of the TLDs, which has labeled from R1 to R10, are shown in Table (1) which presents the response of the TLDs to 100 cGy radiation absorbed dose. It is found that the mean percentage errors in calculations are typically 3.34%, while that for the second group labeled from D1 to D10 are 4.69% as shown in Table (2).

Table (1): Shows the response of the TLDs to 100 cGy radiation absorbed dose, and the percentage error between them, for the first group of TLDs.

Dedicator No	Given dose (cGy)	Measured dose (cGy)	% error
R1	100.00	96.80	3.20
R2	100.00	98.60	1.40
R3	100.00	96.92	3.08
R4	100.00	95.24	4.76
R5	100.00	95.78	4.22
R6	100.00	98.52	1.48
R7	100.00	96.04	3.96
R8	100.00	96.63	3.37
R9	100.00	95.46	4.54
R10	100.00	97.79	2.40

Table (2): Shows the response of TLDs to 100 cGy radiation absorbed dose, and the percentage error between them, for the second group of TLDs.

Dedicator No	Given dose (cGy)	Measured dose (cGy)	% error
D1	100.00	102.60	2.60
D2	100.00	103.70	3.70
D3	100.00	107.30	7.30
D4	100.00	105.50	5.50
D5	100.00	103.70	3.70
D6	100.00	106.20	6.20
D7	100.00	105.00	5.00
D8	100.00	105.50	5.50
D9	100.00	104.70	4.70
D10	100.00	102.70	2.70

By comparing the mean percentage error of two groups, the second group was excluded.

Figures (1) and (2) show schematic of the first and the second treatment plans obtained by the TPS respectively. The colored lines represent isodose curves normalized to 100% at maximum dose, and the black stars represent the points were TLDs can be inserted inside the ART phantom. Figures (3) and (4) show the places of the TLDs and their planed dose according to the first and second plan respectively.

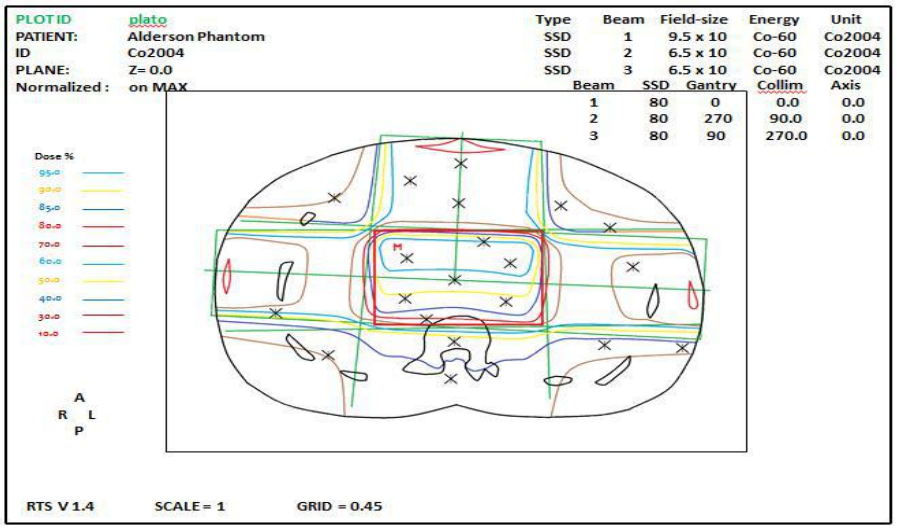


Fig. 1: shows the first treatment plan with three open beams.

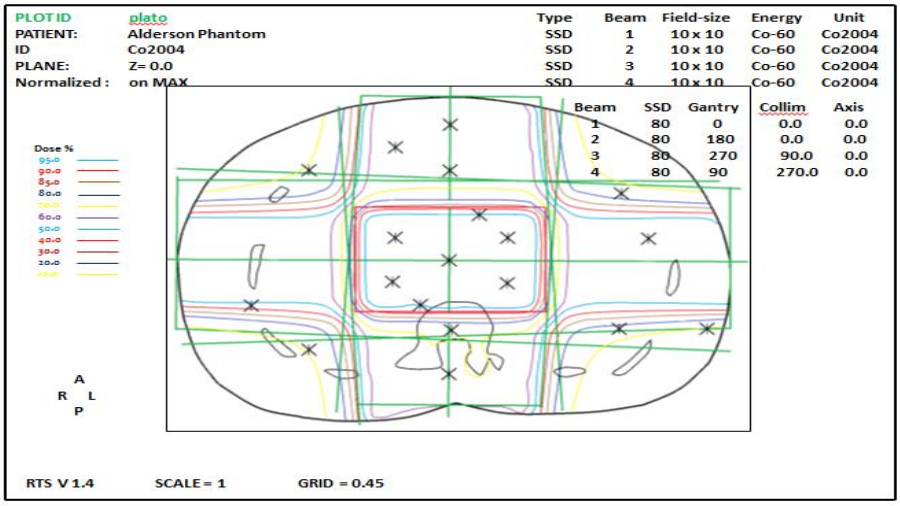


Fig. 2: shows the second plan with four open beams.

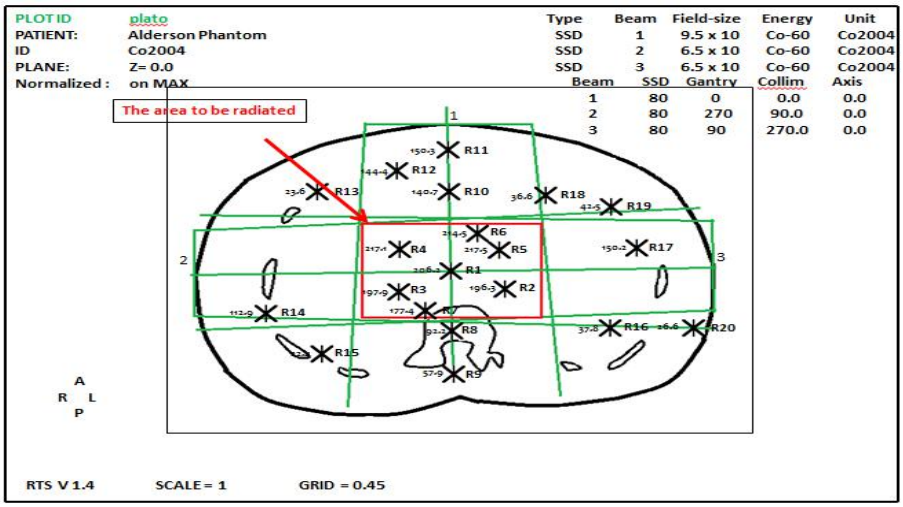


Fig. 3: shows the radiation absorbed dose at specific points inside the phantom using four open beams.

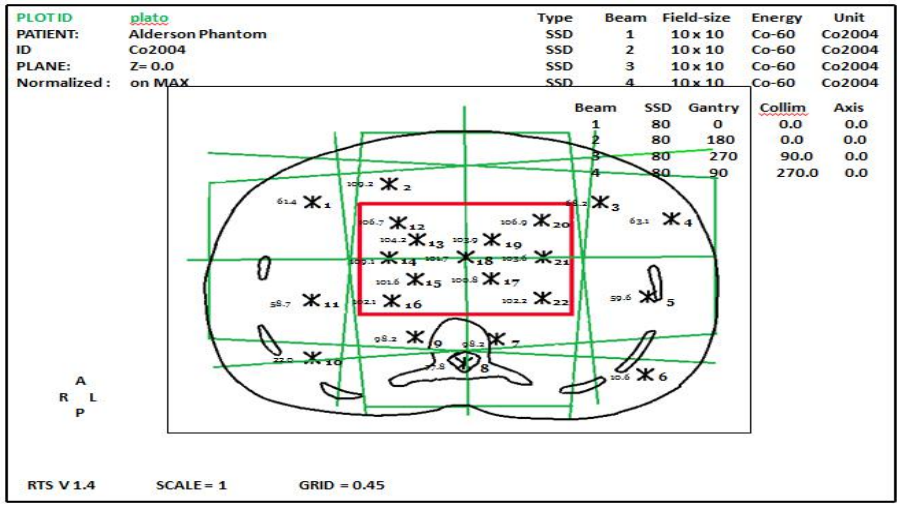


Fig. 4: shows the radiation absorbed dose at specific points inside the phantom using three open beams.

For the first plan, the isodose curve line of 90% was selected as treatment isodose line to deliver 100 cGy to the target volume. For the second plan, the isodose

curve line of 85% was selected as treatment isodose line to deliver 200 cGy to the target volume.

The comparison of measured radiation absorbed dose by TLDs and planned radiation dose calculated by TPS at specific points inside the ART phantom are shown in Tables 3 and 4.

Table (3) : Shows the comparison between standard dose values and measurement dose values, and the percentage error between them, for the third group of TLD.

Dedicator No	Planned dose	Measured dose	Percentage error
R1	61.4	67.78	9.4
R2	63.1	69.81	9.6
R3	59.6	64.83	8.1
R4	77.8	85.38	8.9
R5	22.0	20.37	8.0
R6	58.7	64.21	8.6
R7	109.1	113.3	3.7
R8	102.1	113.7	10.2
R9	101.6	114.1	11.0
R10	98.2	110.0	10.7

Table (4) : Shows the comparison between Planned dose values by TPS, and measured dose values by TLD, in the first and second experiments, and also the percentage errors of average measured dose.

Detector No	Planned dose	Measured dose (1)	Measured dose (2)	Average measured dose	% error
R1	217.5	209.7	210.9	210.3	3.42
R2	196.3	200.7	205.1	202.9	3.25
R3	217.1	221.3	222.5	221.9	2.16
R4	177.4	170.6	169.1	169.85	4.45
R5	92.2	92.51	91.00	91.76	0.48

R6	57.9	58.58	60.28	59.43	2.57
R7	144.4	150.0	149.7	149.85	3.64
R8	23.6	24.57	24.13	24.35	3.08
R9	112.9	114.0	113.8	113.9	0.88
R10	42.5	42.03	41.81	41.92	1.38

In table 3, the largest difference between the planned dose and measured dose of 12.5 cGy for R9 TLD. This difference is due to the calibration error and the position of the TLD. Also, the next big difference is with R8 and R10 of approximately 12 cGy. However, the mean percentage error for all TLDs is typically 8.82%.

In table 4, the largest difference between planned and measured dose of -7.55 cGy for R4 TLD which is located at point 4 inside the irradiated area. The next big difference is with R1, R2 and R7 of -7.7, 6.6 and 5.45 cGy, respectively. The mean error for all TLDs is 2.53%.

In both plans, the percentage mean error values are in the range of the allowed values, which is 10% when using the TLD-100s of such measurements.

4. Conclusion:

An investigation of radiation absorbed dose calculated by TPS was the propose of this study. The results showed that the TPS provides adequate accuracy of absorbed radiation dose calculation, and are in reasonably good agreement with the recommended values. However, the results can be improved by considering all organics of the anthropomorphic phantom.

5. References:

1. Sameer S. A. ,*A comparative study of measured percentage depth doses for two medical linear accelerators,* Umm al-Qura Univ. J. Sci. Med. Eng. Vol. 19, No. 2, pp. 145-151, 2007.

2. ICRU. ICRU Report 62. Bethesda. MD. 1999. International commission on Radiation Units and Measurements.*Prescribing, recording, and reporting photon beam therapy*,

3. Brahme A., *Dosimetric precision requirements in radiation therapy.* ActaRadiol.Oncol., 23: 397-91, 1984.

4. Dutreix A. :*When and how can we improve precision in radiotherapy?* Radiother.Oncol, 2: 275-92, 1984.

5. ICRU, ICRU Report 24. Bethesda. MD. 1976. International Commission on Radiation Units and Measurements. : *Determination of absorbed dose in a patient irradiate by beams of X or gamma rays in radiotherapy procedures*.

6. Mijhgeer B. J., Batterman J. J. and Wambersie A. :*What degree of accuracy is required and can be achieved in photon and neutron therapy?*Radiother.Oncol., 8: 237-52, 1987.

7. IAEA: *Specification and acceptance testing of radiotherapy treatment planning systems.* IAEA-TECDOC-1540, 2007.

8. B. Fraass, K. Doppke, M. Hunt, G, Kutcher, G. Starkschall, R, Stem and J. Dyke "Quality assurance for clinical radiotherapy treatment planning: Report of the AAPMRadiation Therapy Committee Task Group No. 53," 1998.

9. A. Niroomand-Rad, C. Blackwell, B. Coursey, K. Gall, J. Galvin, W. McLaughlin, A. Meigooni, R. Nath, J. Rodgers and C. Soares " Radiochromic film dosimetry:

Reommendations of AAPM Radiation Therapy Committee Task Group No. 55" 1998

10. Theratron 780C Operator's manual edition 4B. Kanata, Ontario.

11.ICRU, ICRU Report 44. Bethesda: 1989. International Commission on Radiation Units and Measurements.*Tissue substitutes in radiation dosimetry and measurement.*

12. ICRU, ICRU Report 48. Bethesda: 1992.International Commission on Radiation Units and Measurements.*Phantoms and computational models in therapy, diagnosis and protection.*

13. Abella V., Miro R., Juste B, and Verdu G., *Comparison of MCNP5 Dose Calculations inside the RANDO Phantom Irradiated with a MLC Linacphton beam against treatment planning system PLUNC, Progress in nuclear science and technology, 2011*

14. Leonardo S. Boia, Maximiano C. Martins, Helio A. Junior, Ademir X. Silva, Alessandro F. Soares, *Preparing a voxel-simulator of Alderson Rando physical phantom, International nuclear atlantic conference, Belo Horizonte, MG, Brazil, 2011.*

15. The Alderson Radiation Therapy Phantoms. Radiology support Devices, Inc. http://www.rsdpantoms.com/rt_art.htm.

الزمرة لمجموعة الأشكال لثلاث مولادات لـ

$^3S =< a\ ,\ b,\ c\ :\ a = b,\ b = c,\ c = a\ >$

✍ د. كلثوم محمد الأسود

قسم الرياضيات، كلية العلوم، جامعة الجبل الغربي.

الملخص :

لأي شبه زمرة $^3S =< a\ ,\ b,\ c\ :\ a = b,\ b = c,\ c = a\ >$ يمكن أن نحصل علي الزمرة الهندسية.

هذه الورقة البحثية تسلط الضوء على تقنية إنشاء زمر جزئية ناظمية أو الاعتيادية ذات مولد واحد ومولدين مع اختلاف الرتب وتناقش كيفية تغطية $N^3K_{H_i},\ i \in$ عن طريق اختيار مجموعة من الأشكال الهندسية التي تم الحصول عليها سابقا من $^3S =< a\ ,\ b,\ c\ :\ a = b,\ b = c,\ c = a\ >$.

ذلك توضح هذه الورقة الطرق لإيجاد المولدات والعلاقات للزمرة الأساسية $\pi_1(^3K_{H_i}),\ i \in N$.

Groups of Diagram Group of Three Generators of Semigroup Presentation.

K. M. Alaswad
Mathematical Department, Faculty of Science, Al-Jabel Al-Ghrbi University, Gharian, Libya.

ABSTRACT

For any given semigroup presentation we may obtain the fundamental group.This paperhighlights the issue of determining the covering space ${}^3K_{H_i}$ for all connected 2-complex graphs ${}^3K_i,\ i \in N$ by selecting groups of one and two generators with various orders from a diagram group that was already obtained from semigroup presentation ${}^3\mathrm{S} =< a\ ,\ b,\ c\ :a = b,\ b = c,\ c = a\ >$. The paperalso discusses the mechanism to compute the generators and the relations for the fundamental group $\pi_1({}^3K_{H_i}),\ i \in N$

KEYWORDS: Fundamental group, semigroup presentation, generators, relations, maximal tree.

1. INTRODUCTION

In our previous research,we obtained the covering 2-complex in graphs of diagram group over semigroup presentation ${}^3\mathrm{S} =< a\ ,\ b,\ c\ :a = b,\ b = c,\ c = a\ >$(refer to [6]). This research discusses how to cover the connected 2-complex graphs ${}^3K_i,\ i \in N$by selection group from the diagram group that was previously obtained from this semigroup presentation.

Let$S =< \mathrm{X}: r >$ be a semigroup presentation, then we may obtain the diagram group $D(S,W)$which W is a word onX defined by Guba and Sapir (please see [4]).The 2-complex, associated with presentation *S*is denoted by *K*(*S*). As the

complex we have fundamental group and we denoted by $\pi_1\,(K(S),W)$. Kilibarda has shown that the fundamental group is isomorphic to diagram group $D(S,W)$ (refer to [5]).We will consider the fundamental group $\pi_1\,(K(S),W)$ constructed from semigroup presentation ${}^3\mathrm{S} =< a\,,\ b,\ c\ : a = b,\ b = c,\ c = a\ >$. For our presentation, the 2-complex consists of infinitely connected${}^3K_i, i \in N$. Note that all vertices in ${}^3K_i$ are words of length i. Thus iflength (u) = length (v) then $\pi_1\,(K(S),u)\ =\ \pi_1(K(S),v)$ (see [1]).

As a group, it is sufficient to determine its generators and relations. Thegenerators of this group can be determined from the 2-complex $K(S)$ by identifyingthe maximal tree T. Fix a vertex $v\ \in\ K(S)$ and the edge $\notin T$. Then $\gamma_{i(e)}e{\gamma^{-1}}_{\tau(e)}$ isthe generator, where $\gamma_{i(e)},\gamma_{\tau(e)}$ are paths in T from $\in K(S)$, to the initial andterminal of e respectively.

Let H be a subgroup of $\pi_1({}^3K_{H_i}), i \in N$, fix a vertex v in the connected 2-complex graph ${}^3K_{H_i} =< \Gamma: \Re >$. Now, the covering space ${}^3K_{H_i}$ will be constructed and then to obtain the covering map ψ_H: ${}^3K_{H_{i+1}} \rightarrow {}^3K_{H_i}$in a similar way. Let v be a vertex of ${}^3K_i$and consider the collection of paths

$$P_v = \{[\alpha]: i(\alpha) = O, \tau(\alpha) = v\}.$$

Now, how to associate a subgroup H of a diagram group with a covering graph ${}^3K_{H_i}, i \in N$? How to determine the generators for covering space ${}^3K_{H_i}, i \in N$ and what are the properties of${}^3K_{H_i}, i \in N$in a diagram group?

Definition 1.1: A 2-complex graph K_H contains the followings:

i. Vertices: The set of right cosets $H[\alpha]$ of H, where $[\alpha] \in P_v, v \in V$.
ii. Edges: All ordered pairs $(H[\alpha],\ x^{\varepsilon})$ where x is an edge in K and $\varepsilon = \pm 1$.
iii. Functions:

a. $i(H[\alpha],\ x^{\varepsilon}) = H[\alpha]$.

b. $\tau(H[\alpha],\ x^{\varepsilon}) = H[\alpha\ x^{\varepsilon}]$.

c. $(H[\alpha],\ x^{\varepsilon})^{-1} = (H[\alpha x^{\varepsilon}], x^{-\varepsilon})$.

Theorem 1.2 [2], [3]:The component ${}^{3}K_{H}$ is a connected 2-complex graph.

Theorem 1.3 [2], [3]: The mapping $\psi_H : {}^{3}K_{H} \to {}^{3}K$, $\psi_H(H[\alpha]) = v$ and $\psi_H(H[\alpha],\ x^{\varepsilon}) = x^{\varepsilon}$ is a mapping of 2-complex graphs.

Theorem 1.4 [2], [3]:The mapping $\psi_H : {}^{3}K_{H} \to {}^{3}K$, $\psi_H(H[\alpha]) = v$ and $\psi_H(H[\alpha],\ x^{\varepsilon}) = x^{\varepsilon}$ is a locally bijective.

Theorem 1.5[2], [3]**:** The mapping$\psi^{*}: \pi_1(K', v') \to \pi_1\big(K, \psi(v')\big)$ is an injective if ψ is a locally bijective.

2. COMPUTING GENERATORS FOR FUNDAMENTAL GROUP

This section presents the generators for all fundamental groups $\pi_1({}^{3}K_{H_i}, v), i \in N$ are calculated and what methods are used for this purpose.

i. Case one when the length of W is equal to one $(L(W) = 1)$

Let W be a positive word on ${}^{3}S$, let $L(W) = 1$, then we have 3^1 possibilities vertices in the connected 2-complex graph ${}^{3}K_1$ namely a, b, c as is shown in Figure 1.

Theorem 2.4: Consider the following connected 2-complex graph ${}^{3}K_1$ as shown in Figure 1, such that $G = \pi_1({}^{3}K_1, a)$ contains δ_1, where $\delta_1 =< e_{a,b}e_{b,c}e_{a,c} >$. If H_{1_2} is the smallest normal subgroup of G containing $< \delta_1^2 >$, then the covering complex${}^{3}K_{H_{1_2}}$ for${}^{3}K_1$ is a hexagonal shape.

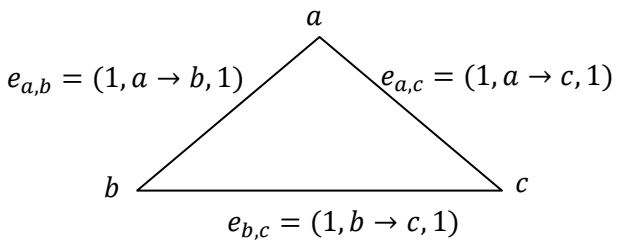


Figure 1: Connected 2-complex graph ${}^3K_1$

Proof: Similarly, as proved in the previous theorems in [6], the same applied procedure is used to determine the covering space ${}^3K_{H_{2_1}}$ for the connected 2-complex graph ${}^3K_2$. Table 1 and Tale 2 summarize the results of all possible vertices and edges, respectively, in ${}^3K_{H_{1_2}}$ that map to the vertices and the edges in ${}^3K_1$.

Table 1 Vertices in ${}^3K_1$ and ${}^3K_{H_{1_2}}$

Vertex in ${}^3K_1$	**Vertex in ${}^3K_{H_{1_2}}$**
a	$H[1]$
b	$H[e_{a,b}]$
c	$H[e_{a,b}e_{b,c}]$
a	$H[e_{a,b}e_{b,c}e_{c,a}]$
b	$H[e_{a,b}e_{b,c}e_{c,a}e_{a,b}]$
c	$H[e_{a,b}e_{b,c}e_{c,a}e_{a,b}e_{b,c}]$

Table 2 Edges in ${}^3K_1$ and ${}^3K_{H_{1_2}}$

Edges in ${}^3K_1$	**Edges in ${}^3K_{H_{1_2}}$**
$e_{a,b}$	$(H[1], e_{a,b})$

$e_{a,b}e_{b,c}$	$\left(H\left[e_{a,b}\right], e_{a,b}e_{b,c}\right)$
$e_{a,b}e_{b,c}e_{c,a}$	$\left(H\left[e_{a,b}e_{b,c}\right], e_{a,b}e_{b,c}e_{c,a}\right)$
$e_{a,b}$	$\left(H\left[e_{a,b}e_{b,c}e_{c,a}\right], e_{a,b}e_{b,c}e_{c,a}e_{a,b}\right)$
$e_{a,b}e_{b,c}$	$\left(H\left[e_{a,b}e_{b,c}e_{c,a}e_{a,b}\right], e_{a,b}e_{b,c}e_{c,a}e_{a,b}e_{b,c}\right)$
$e_{a,b}e_{b,c}e_{c,a}$	$\left(H[1], e_{a,b}e_{b,c}e_{c,a}e_{a,b}e_{b,c}\right)$

Now suppose $\psi_H : {}^3K_{H_{1_2}} \rightarrow {}^3K_1$ defined by $\psi_H(H[1]) = a$, $\psi_H\left(H\left[e_{x,y}\right]\right) = y$, $\psi_H\left(H[\alpha], e_{x,y}\right) = e_{x,y}$. This map can be viewed as locally bijective. For this reason, ${}^3K_{H_{1_2}}$ is the covering graphfor ${}^3K_1$ and it is of hexagonal shape.Therefore, the covering space ${}^3K_{H_{1_2}}$ for ${}^3K_1$ in this case is of hexagonal shape, as shown in Figure 2.

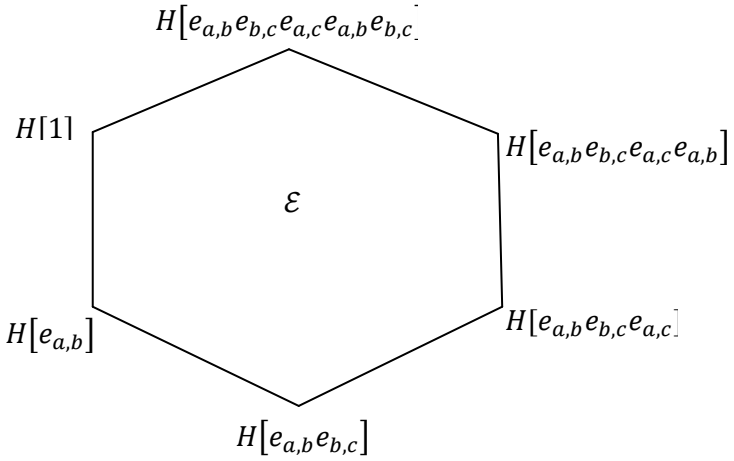


Figure 2 Covering complex ${}^3K_{H_{1_2}}$

Since a is a vertex of the connected 2-complex ${}^{2}K_3$, and $H[1]$ lies overa, then by Theorem 1.5, $\psi_H^*: \pi_1({}^{2}K_{H_{1_2}}, H[1]) \to \pi_1({}^{3}K_1, a)$ is injective. Therefore, $\psi_H^*: \pi_1({}^{3}K_{H_{1_2}}, H[1]) \to Im\,\psi_H^* = H$. As a result, $H = \pi_1({}^{2}K_{H_{1_2}}, H[1])$ can be considered as a subgroup of $G = \pi_1({}^{3}K_1, a)$.

The generators for $\pi_1({}^{3}K_{H_{1_2}}, H[1])$ are computed here using maximal tree methods. Select a maximal treeT$({}^{3}K_{H_{1_2}})$for ${}^{3}K_{H_{1_2}}$(see Figure 3).

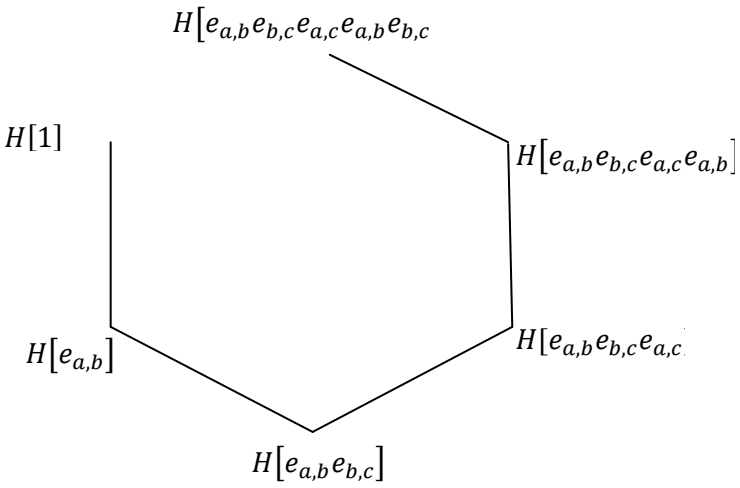


Figure 3 Maximal treeT$({}^{3}K_{H_{1_2}})$

The generator for the fundamental group $\pi_1({}^{3}K_{H_{1_2}}, H[1])$ will be:

$$g({}^{3}K_{H_{1_2}}) = \left(H[1]\,, e_{a,b}\right)\left(H[e_{a,b}]\,, e_{a,b}e_{b,c}\right)\left(H[e_{a,b}e_{b,c}], e_{a,b}e_{b,c}e_{c,a}\right)\left(H[e_{a,b}e_{b,c}e_{c,a}], e_{a,b}e_{b,c}e_{c,a}e_{a,b}\right)$$
$$\left(H[e_{a,b}e_{b,c}e_{c,a}e_{a,b}], e_{a,b}e_{b,c}e_{c,a}e_{a,b}e_{b,c}\right)\left(H[1], e_{a,b}e_{b,c}e_{c,a}e_{a,b}e_{b,c}\right)^{-1}.$$

As a rule, if H_{1_n} is the smallest normal subgroup of G containing$< \delta_1^m >$, then the covering space ${}^{3}K_{H_{1_n}}$ for${}^{3}K_1$ is $3m$ sides geometric shaped, as shown in Figure 4.

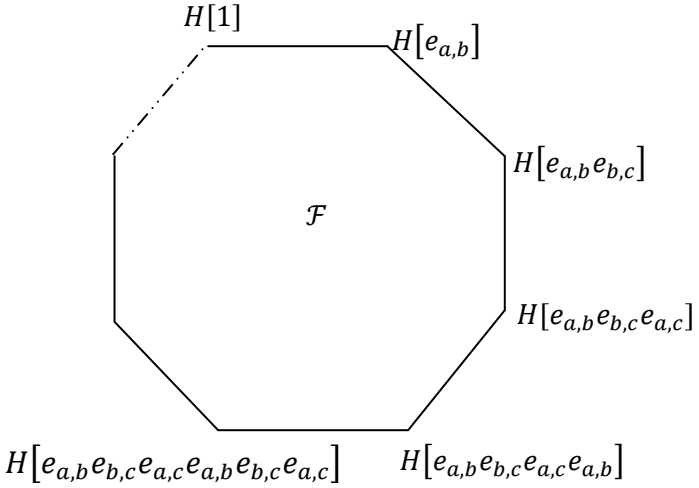


Figure 4 Covering space ${}^3K_{H_{1_n}}$

To determine the generators for $\pi_1({}^3K_{H_{1_2}})$, the same previously applied procedure is used for the covering graph ${}^2K_{H_{3_n}}$. □

ii. Case two when the length of W is equal to two $(L(W) = 2)$

Indeed, in the connected 2-complex graph ${}^3K_2$,there are nine possible vertices namely a^2 , ab , ac , ba, b^2 , bc, ca, cb, c^2. Hence, the connected 2-complex graph ${}^3K_2$ will have the general shape shown in Figure 5.

Theorem 2.5: Consider the connected graph ${}^3K_2$ as given in Figure 5, such that $G = \pi_1({}^3K_2, a^2)$contains γ_1, where $\gamma_1 =< e_{a^2,ab}e_{ab,ac}e_{ac,a^2} >$. If H_{2_1} is the smallest normal subgroup of G containing $< \gamma_1^2 >$, then the covering graph ${}^3K_{H_{2_1}}$ for ${}^3K_2$ is a hexagonal shape plus four triangles.

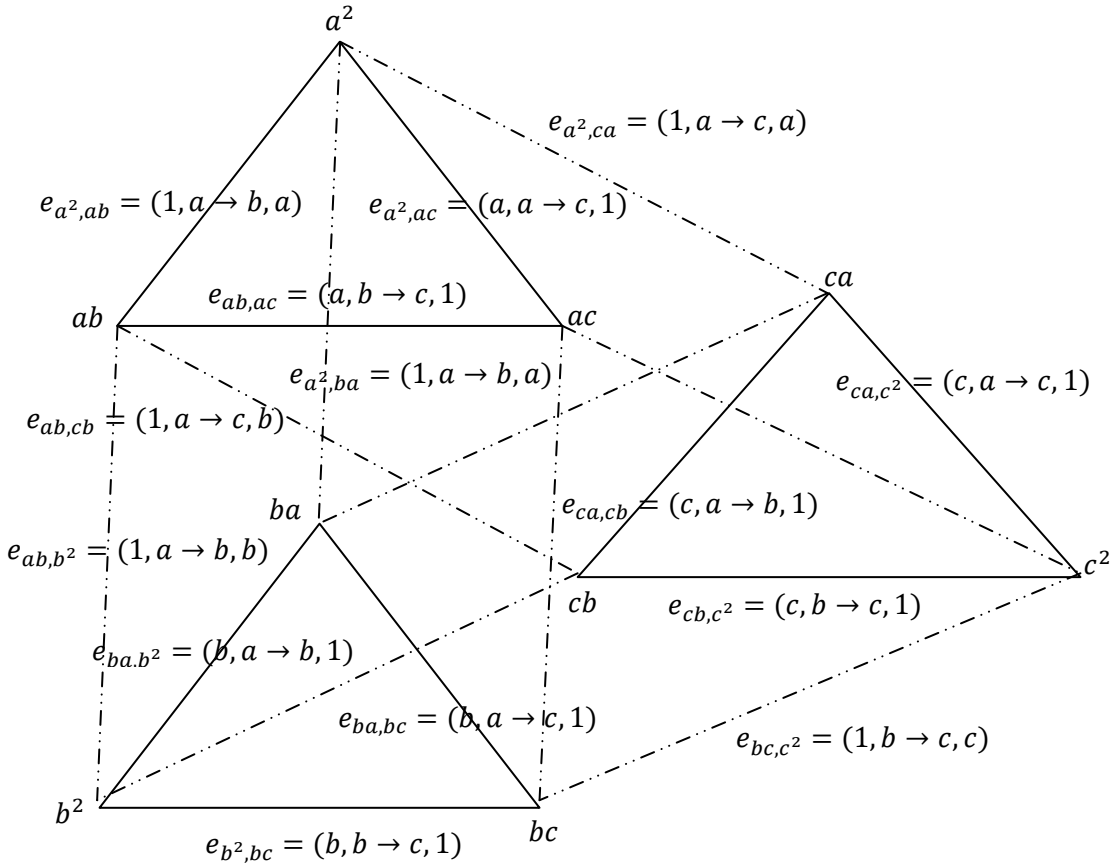


Figure 5 Connected 2-complex graph ${}^3K_2$

Proof: Using a similar way, the covering space can be concluded as the procedure applied in previous theorem. Table 3 and table 4 summarize the possible vertices and edges in ${}^3K_{H_{2_1}}$, respectively, that map to the vertices and edges in ${}^3K_2$.

Table 3: Vertices in ${}^3K_2$ and ${}^3K_{H_{2_1}}$

Vertex in ${}^3K_2$	**Vertex in ${}^3K_{H_{2_1}}$**
a^2	$H[1]$
ab	$H\left[e_{a^2,ab}\right]$
ac	$H\left[e_{a^2,ab}e_{ab,ac}\right]$
a^2	$H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}]$
ab	$H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}\right]$
ac	$H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}\right]$
ba	$H\left[e_{a^2,ba}\right]$
b^2	$H\left[e_{a^2,ab}e_{ab,b^2}\right]$
bc	$H\left[e_{a^2,ab}e_{ab,ac}e_{ac,bc}\right]$
ca	$H\left[e_{a^2,ca}\right]$
cb	$H\left[e_{a^2,ab}e_{ab,cb}\right]$
c^2	$H\left[e_{a^2,ab}e_{ab,ac}e_{ac,c^2}\right]$
ba	$H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ba}]$
b^2	$H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,b^2}\right]$
bc	$H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}e_{ac,bc}\right]$
ca	$H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ca}\ ]$
cb	$H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,cb}\right]$
c^2	$H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}e_{ac,c^2}\right]$

Table 4: Edges in ${}^3K_2$ and ${}^3K_{H_{2_1}}$

Edge	Edges in ${}^{3}K_{H_{1_2}}$
$e_{a^2,ab}$	$(H[1], e_{a^2,ab})$
$e_{ab,ac}$	$(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})$
$e_{a^2,ac}$	$(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$
$e_{a^2,ab}$	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})$
$e_{ab,ac}$	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac})$
$e_{a^2,ac}$	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$
$e_{a^2,ba}$	$(H[1], e_{a^2,ba})$
e_{ab,b^2}	$(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,b^2})$
$e_{ac,bc}$	$(H[e_{a^2,ab}e_{ab,cb}], e_{a^2,ab}e_{ab,ac}e_{ac,bc})$
e_{ba,b^2}	$(H[e_{a^2,ba}], e_{a^2,ab}e_{ab,b^2})$
$e_{b^2,bc}$	$(H[e_{a^2,ab}e_{ab,b^2}], e_{a^2,ab}e_{ab,ac}e_{ac,bc})$
$e_{ba,bc}$	$(H[e_{a^2,ba}], e_{a^2,ab}e_{ab,ac}e_{ac,bc})$
$e_{ba,ca}$	$(H[e_{a^2,ba}], e_{a^2,ca})$
e_{bc,c^2}	$H[e_{a^2,ab}e_{ab,ac}e_{ac,bc}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})$
$e_{a^2,ca}$	$(H[1], e_{a^2,ca})$
$e_{ab,cb}$	$(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,cb})$
e_{ac,c^2}	$(H[e_{a^2,ab}e_{ab,cb}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})$
$e_{ca,cb}$	$(H[e_{a^2,ca}], e_{a^2,ab}e_{ab,cb})$
e_{ca,c^2}	$(H[e_{a^2,ca}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})$

e_{cb,c^2}	$(H[e_{a^2,ab}e_{ab,cb}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})$
e_{ca,c^2}	$H[e_{a^2,ca}], e_{a^2,ab}e_{ab,cb}e_{ac,c^2})$
$e_{a^2,ba}$	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}v_1)$
e_{ab,b^2}	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}v_2)$
$e_{ac,bc}$	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}v_3)$
$e_{a^2,ca}$	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}v_4)$
$e_{ab,cb}$	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}v_5)$
e_{ac,c^2}	$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}v_6)$
e_{ab,b^2}	$(H[e_{a^2,ab}v_1], e_{a^2,ab}v_2)$
$e_{b^2,bc}$	$(H[e_{a^2,ab}v_2], e_{a^2,ab}v_3)$
$e_{ab,bc}$	$(H[e_{a^2,ab}v_1], e_{a^2,ab}v_3)$
$e_{ba,ca}$	$(H[e_{a^2,ab}v_1], e_{a^2,ab}v_4)$
$e_{b^2,cb}$	$(H[e_{a^2,ab}v_2], e_{a^2,ab}v_5)$
e_{bc,c^2}	$(H[e_{a^2,ab}v_3], e_{a^2,ab}v_6)$
$e_{ca,cb}$	$(H[e_{a^2,ab}v_4], e_{a^2,ab}v_5)$
e_{cb,c^2}	$(H[e_{a^2,ab}v_5], e_{a^2,ab}v_6)$
e_{ca,c^2}	$(H[e_{a^2,ab}v_4], e_{a^2,ab}v_6)$
$e_{ba,ca}$	$(H[e_{a^2,ba}], e_{a^2,ca})$
$e_{b^2,cb}$	$(H[e_{a^2,ab}e_{ab,b^2}], e_{a^2,ab}e_{ab,cb})$
e_{bc,c^2}	$(H[e_{a^2,ab}e_{ab,ac}e_{ac,bc}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})$

where

$$v_1 = e_{ab,ac}e_{a^2,ac}e_{a^2,ba}$$

$$v_2 = e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,b^2}$$

$$v_3 = e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}e_{ac,bc}$$

$$v_4 = e_{ab,ac}e_{a^2,ac}e_{a^2,ca}$$

$$v_5 = e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,cb}$$

$$v_6 = e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}e_{ac,c^2}.$$

Now let $\psi_H : {}^3K_{H_{2_1}} \to {}^3K_2$ defined by $\psi_H(H[\alpha]) = a^2$, $\psi_H\big(H[e_{x,y}]\big) = y, \psi_H\big(H[\alpha], e_{x,y}\big) = e_{x,y}$. This map can be viewed as locally bijective. Therefore, ${}^3K_{H_{2_1}}$covering space for${}^3K_2$ is of hexagonal shape plus four triangles, as shown in Figure 6.□

Since a^2 is a vertex of the connected 2-complex ${}^3K_2$, and $H[1]$ lies over a^2, then by Theorem 1.5, $\psi_H^*: \pi_1({}^3K_{H_{2_1}}, H[1]) \to \pi_1({}^3K_2, a^2)$ is injective. Therefore, $\psi_H^*: \pi_1({}^3K_{H_{2_1}}, H[1]) \to Im\, \psi_H^* = H$. As a result, $H = \pi_1({}^3K_{H_{2_1}}, H[1])$ can be considered as a subgroup of $G = \pi_1({}^3K_2, a^3)$.

To compute the generators for the fundamental group $\pi_1({}^3K_{H_{2_1}})$, the maximal tree method was used. Select a maximal tree $\mathrm{T}_1({}^3K_{H_{2_1}})$for ${}^3K_{H_{2_1}}$(see Figure 7).

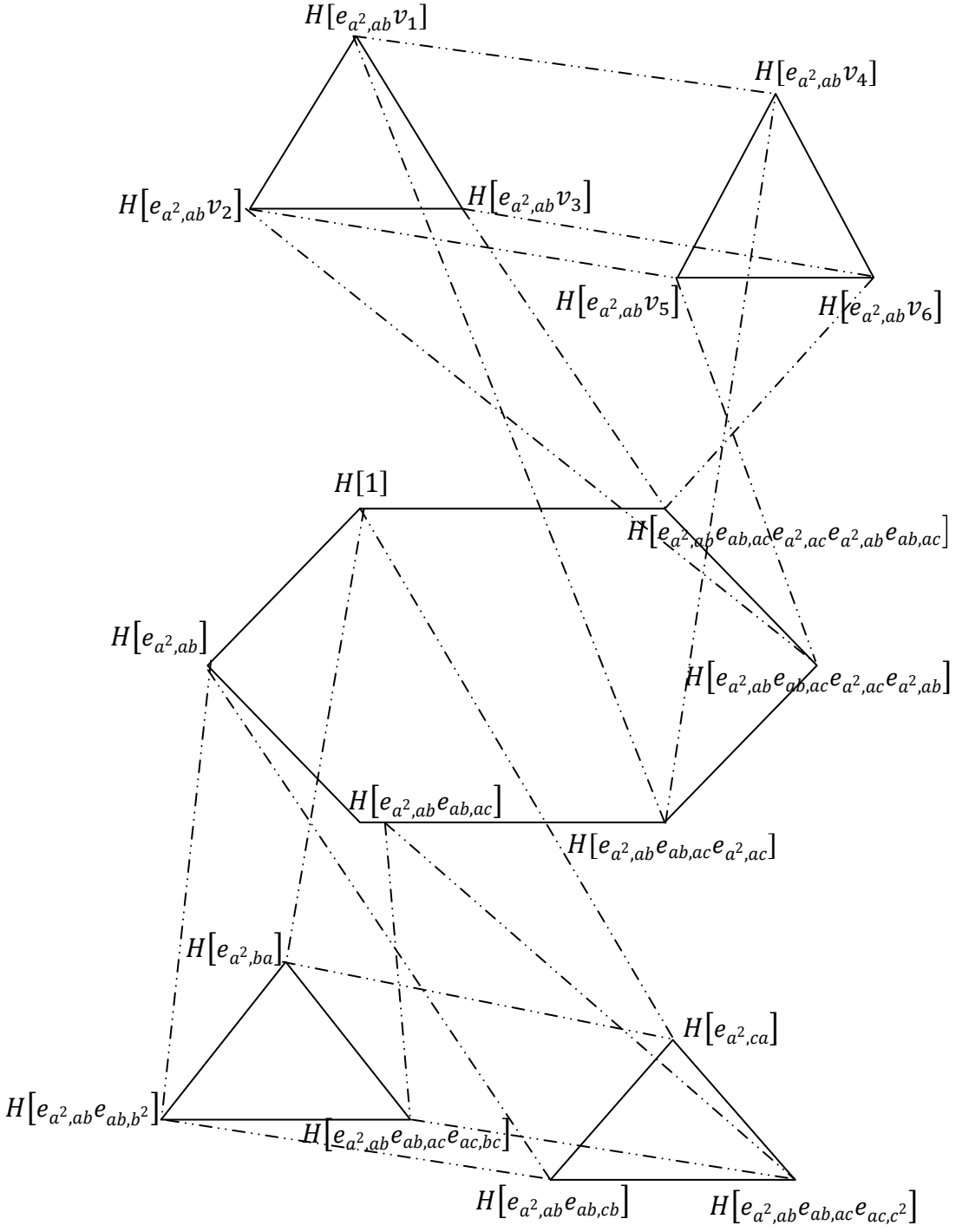


Figure 6 Covering space$^3K_{H_{2_1}}$

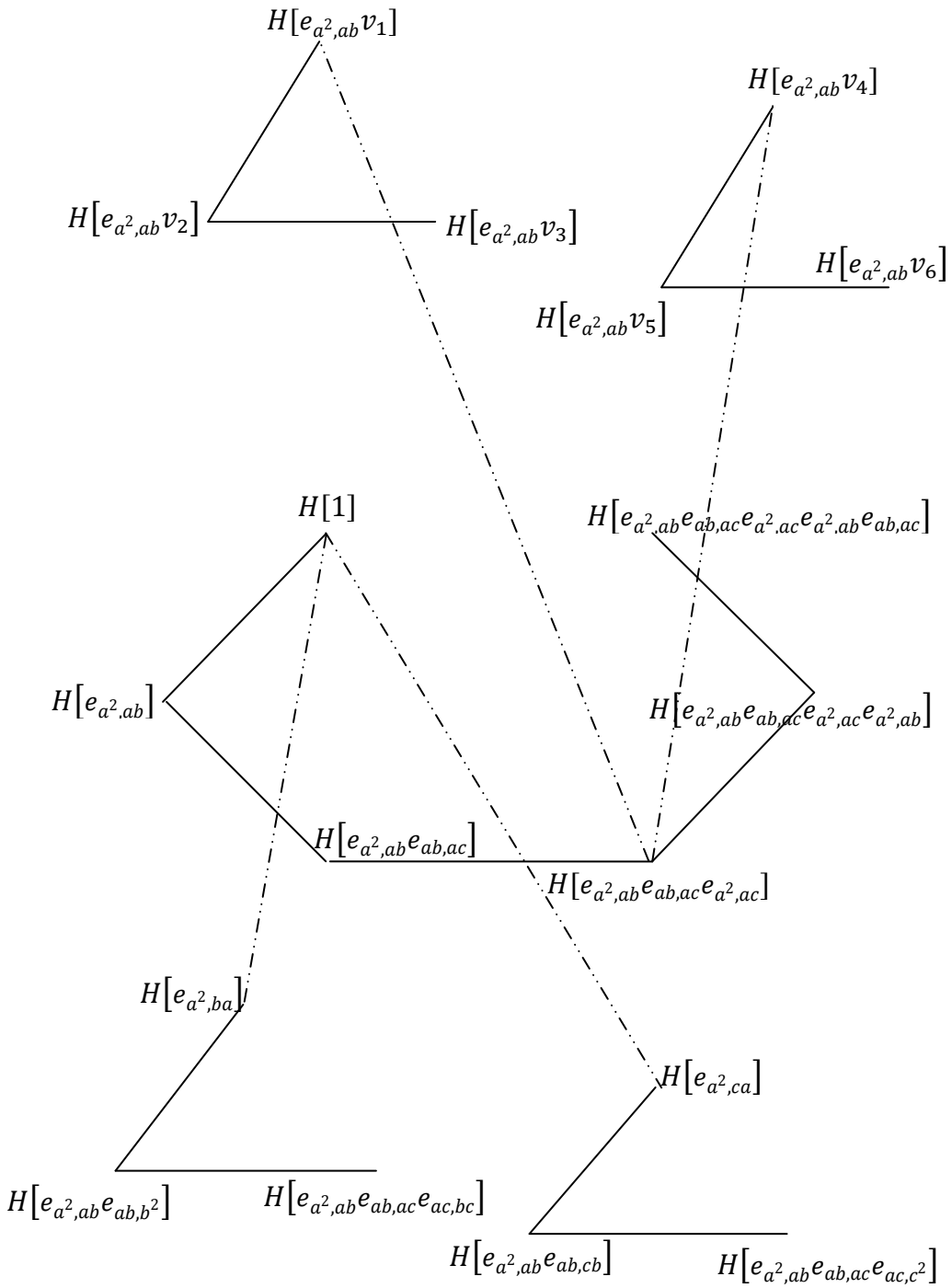


Figure 7Maximal treeT($^3K_{H_{2_1}}$)

The generators for the fundamental group$\pi_1({}^3K_{H_{2_1}})$ are given as the following:

1. $g_1(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ab})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac})^{-1}.$

2. $g_2(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ba})(H[e_{a^2,ba}], e_{a^2,ab}e_{ab,b^2})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,b^2})^{-1}(H[1], e_{a^2,ab})^{-1}.$

3. $g_3(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ca})\ (H[e_{a^2,ca}], e_{a^2,ab}e_{ab,cb})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,cb})^{-1}(H[1], e_{a^2,ab})^{-1}.$

4. $g_4(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ab})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{ac,bc})$

$(H[e_{a^2,ba}], e_{a^2,ab}e_{ab,ac}e_{ac,bc})^{-1}(H[1], e_{a^2,ba})^{-1}.$

5. $g_5(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ab})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})^{-1}$

$H[e_{a^2,ab}e_{ab,ac}e_{ac,bc}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})^{-1}(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,cb})^{-1}(H[1], e_{a^2,ab})^{-1}.$

6. $g_6({}^3K_{H_{2_1}}) =$

$(H[1], e_{a^2,ab})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}v_1)(H[e_{a^2,ab}v_1], e_{a^2,ab}v_2)(H[e_{a^2,ab}v_2], e_{a^2,ab}v_3)$

$e_{a^2,ab}v_3)^{-1}(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_1)^{-1}(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})^{-1}$

$(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})^{-1}(H[1],e_{a^2,ab})^{-1}.$

7. $g_7(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1],e_{a^2,ab})(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_4)$

$(H[e_{a^2,ab}v_4],e_{a^2,ab}v_5)(H[e_{a^2,ab}v_5],e_{a^2,ab}v_6)(H[e_{a^2,ab}v_4],e_{a^2,ab}v_6)^{-1}$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_4)^{-1}(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})^{-1}$

$(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})^{-1}(H[1],e_{a^2,ab})^{-1}.$

8. $g_8(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1],e_{a^2,ab})(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}],e_{a^2,ab}v_2)$

$(H[e_{a^2,ab}v_1],e_{a^2,ab}v_2)^{-1}(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_1)^{-1}$

$(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})^{-1}(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})^{-1}(H[1],e_{a^2,ab})^{-1}.$

9. $g_9(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1],e_{a^2,ab})(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}],e_{a^2,ab}v_5)$

$(H[e_{a^2,ab}v_4],e_{a^2,ab}v_5)^{-1}(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_4)^{-1}$

$(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})^{-1}(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})^{-1}(H[1],e_{a^2,ab})^{-1}.$

10. $g_{10}(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1],e_{a^2,ab})(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$

$$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})$$
$$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac})$$
$$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}v_3)(H[e_{a^2,ab}v_2],e_{a^2,ab}v_3)^{-1}$$
$$(H[e_{a^2,ab}v_1],e_{a^2,ab}v_2)^{-1}(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_1)^{-1}$$
$$(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})^{-1}\big(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac}\big)^{-1}\big(H[1],e_{a^2,ab}\big)^{-1}.$$

11. $g_{11}(\pi_1({}^3K_{H_{2_1}})) =$

$$(H[1],e_{a^2,ab})(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$$
$$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})$$
$$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac})$$
$$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}v_6)(H[e_{a^2,ab}v_5],e_{a^2,ab}v_6)^{-1}$$
$$(H[e_{a^2,ab}v_4],e_{a^2,ab}v_5)^{-1}(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_4)^{-1}$$
$$(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})^{-1}\big(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac}\big)^{-1}\big(H[1],e_{a^2,ab}\big)^{-1}.$$

12. $g_{12}(\pi_1({}^3K_{H_{2_1}})) =$

$$(H[1],e_{a^2,ab})(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$$
$$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_4)(H[e_{a^2,ab}v_4],e_{a^2,ab}v_5)(H[e_{a^2,ab}v_5],e_{a^2,ab}v_6)$$
$$\big(H[e_{a^2,ab}v_4],e_{a^2,ab}v_6\big)^{-1}\big(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],e_{a^2,ab}v_4\big)^{-1}(H[e_{a^2,ab}e_{ab,ac}],e_{a^2,ab}$$
$$e_{ab,ac}e_{a^2,ac})^{-1}\big(H[e_{a^2,ab}],e_{a^2,ab}e_{ab,ac}\big)^{-1}\big(H[1],e_{a^2,ab}\big)^{-1}.$$

13. $g_{13}(\pi_1({}^3K_{H_{2_1}})) =$

$$(H[1],e_{a^2,ba})(H[e_{a^2,ba}],e_{a^2,ab}e_{ab,b^2})(H[e_{a^2,ab}e_{ab,b^2}],e_{a^2,ab}e_{ab,ac}e_{ac,bc})$$
$$(H[e_{a^2,ba}],e_{a^2,ab}e_{ab,ac}e_{ac,bc})^{-1}(H[1],e_{a^2,ba})^{-1}.$$

14. $g_{14}(\pi_1({}^3K_{H_{2_1}})) = (H[1], e_{a^2,ab})(H[e_{a^2,ba}], e_{a^2,ca})(H[1], e_{a^2,ca})^{-1}$.

15. $g_{15}(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ba})(H[e_{a^2,ba}], e_{a^2,ab}e_{ab,b^2})(H[e_{a^2,ab}e_{ab,b^2}], e_{a^2,ab}e_{ab,cb})$

$(H[e_{a^2,ca}], e_{a^2,ab}e_{ab,cb})^{-1}(H[1], e_{a^2,ca})^{-1}.$

16. $g_{16}(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ba})(H[e_{a^2,ba}], e_{a^2,ab}e_{ab,b^2})(H[e_{a^2,ab}e_{ab,b^2}], e_{a^2,ab}e_{ab,ac}e_{ac,bc})$

$(H[e_{a^2,ab}e_{ab,cb}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})^{-1}(H[e_{a^2,ca}], e_{a^2,ab}e_{ab,cb})^{-1}(H[1], e_{a^2,ca})^{-1}.$

17. $g_{17}(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ab})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}v_1)(H[e_{a^2,ab}v_1], e_{a^2,ab}v_4)(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}v_4)^{-1}$

$\left(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}\right)^{-1}(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})^{-1}\left(H[1], e_{a^2,ab}\right)^{-1}.$

18. $g_{18}(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ab})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$

$\left(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}\right)\left(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}v_2\right)$

$(H[e_{a^2,ab}v_2], e_{a^2,ab}v_5)(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}v_5)^{-1}(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}],$

$e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})^{-1}(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})^{-1}$

$(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})^{-1}\left(H[1], e_{a^2,ab}\right)^{-1}.$

19. $g_{19}(\pi_1({}^3K_{H_{2_1}})) =$

$(H[1], e_{a^2,ab})(H[e_{a^2,ab}], e_{a^2,ab}e_{ab,ac})(H[e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac})$

$$\left(H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}\right],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}\right)$$

$$\left(H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}\right],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}\right)$$

$$\left(H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}\right],e_{a^2,ab}v_3\right)\left(H\left[e_{a^2,ab}v_3\right],e_{a^2,ab}v_6\right)$$

$$\left(H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}\right],e_{a^2,ab}v_3\right)^{-1}$$

$$\left(H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}\right],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}\right)^{-1}$$

$$\left(H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}\right],e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}\right)^{-1}\left(H\left[e_{a^2,ab}e_{ab,ac}\right],e_{a^2,ab}e_{ab,ac}e_{ac,c^2}\right)^{-1}$$

$$\left(H\left[e_{a^2,ab}\right],e_{a^2,ab}e_{ab,ac}\right)^{-1}\left(H[1],e_{a^2,ab}\right)^{-1}.$$

The relations for the fundamental group $\pi_1({}^3K_{H_{2_1}})$ are as the following:

1. $r_1((\pi_1{}^3K_{H_{2_1}})) =$

$$(H[1],e_{a^2,ab})(H\left[e_{a^2,ab}\right],e_{a^2,ab}e_{ab,b^2})(H\left[e_{a^2,ab}\right],e_{a^2,ab}e_{ab,b^2})^{-1}$$
$$(H[1],e_{a^2,ba})^{-1}.$$

2. $r_2(\pi_1({}^3K_{H_{2_1}})) =$

$$(H[1],e_{a^2,ab})(H\left[e_{a^2,ab}\right],e_{a^2,ab}e_{ab,cb})(H\left[e_{a^2,ca}\right],e_{a^2,ab}e_{ab,cb})^{-1}$$
$$\left(H[1],e_{a^2,ca}\right)^{-1}.$$

3. $r_3(\pi_1({}^3K_{H_{2_1}})) =$

$$(H\left[e_{a^2,ab}\right],e_{a^2,ab}e_{ab,b^2})(H\left[e_{a^2,ab}e_{ab,b^2}\right],e_{a^2,ab}e_{ab,ac}e_{ac,bc})$$
$$\left(H\left[e_{a^2,ab}e_{ab,ac}\right],e_{a^2,ab}e_{ab,ac}e_{ac,bc}\right)\left(H\left[e_{a^2,ab}\right],e_{a^2,ab}e_{ab,ac}\right)^{-1}.$$

4. $r(\pi_{1_4}({}^3K_{H_{2_1}})) = (H\left[e_{a^2,ab}\right],e_{a^2,ab}e_{ab,ac})(H\left[e_{a^2,ab}e_{ab,ac}\right],e_{a^2,ca})$
$$(H\left[e_{a^2,ab}e_{ab,cb}\right],e_{a^2,ab}e_{ab,ac}e_{ac,c^2})^{-1}(H\left[e_{a^2,ab}\right],e_{a^2,ab}e_{ab,cb})^{-1}.$$

5. $r_5(\pi_1({}^3K_{H_{2_1}})) =$

$(H[e_{a^2,ab}e_{ab,b^2}], e_{a^2,ab}e_{ab,cb})(H[e_{a^2,ab}e_{ab,cb}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})$

$(H[e_{a^2,ab}e_{ab,ac}e_{ac,bc}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})^{-1}(H[e_{a^2,ab}e_{ab,b^2}], e_{a^2,ab}e_{ab,ac}e_{ac,bc})^{-1}$.

6. $r_6(\pi_1({}^3K_{H_{2_1}})) = (H[e_{a^2,ba}], e_{a^2,ca})(H[e_{a^2,ca}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})$

$(H[e_{a^2,ab}e_{ab,ac}e_{ac,bc}], e_{a^2,ab}e_{ab,ac}e_{ac,c^2})^{-1}(H[e_{a^2,ba}], e_{a^2,ab}e_{ab,ac}e_{ac,bc})^{-1}$.

7. $r_7(\pi_1({}^3K_{H_{2_1}})) = (H[e_{a^2,b}], e_{a^2,ab}e_{ab,b^2})(H[e_{a^2,ab}e_{ab,b^2}], e_{a^2,ab}e_{ab,cb})$

$(H[e_{a^2,ca}], e_{a^2,ab}e_{ab,cb})^{-1}(H[e_{a^2,ba}], e_{a^2,ca})^{-1}$.

8. $r_8(\pi_1({}^3K_{H_{2_1}})) = (H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}v_2)(H[e_{a^2,ab}v_1], e_{a^2,ab}v_2)^{-1}$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}v_1)^{-1}$.

9. $r_9(\pi_1({}^3K_{H_{2_1}})) =$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}v_2)(H[e_{a^2,ab}v_2], e_{a^2,ab}v_3)$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}v_3)^{-1}(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}$

$e_{a^2,ab}e_{ab,ac})$.

10. $r_{10}(\pi_1({}^3K_{H_{2_1}})) = (H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}v_4)(H[e_{a^2,ab}v_4], e_{a^2,ab}v_5)$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}v_5)^{-1}(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab})^{-1}$.

11. $r_{11}(\pi_1({}^3K_{H_{2_1}})) =$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}], e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac})$

$(H[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}e_{ab,ac}], e_{a^2,ab}v_6)(H[e_{a^2,ab}v_5], e_{a^2,ab}v_6)^{-1}$

$$(H\left[e_{a^2,ab}e_{ab,ac}e_{a^2,ac}e_{a^2,ab}\right], e_{a^2,ab}v_5)^{-1}.$$

12. $r_{12}(\pi_1({}^3K_{H_{2_1}})) = (H\left[e_{a^2,ab}v_1\right], e_{a^2,ab}v_2)(H\left[e_{a^2,ab}v_2\right], e_{a^2,ab}v_5)$
$(H\left[e_{a^2,ab}v_4\right], e_{a^2,ab}v_5)^{-1}(H\left[e_{a^2,ab}v_1\right], e_{a^2,ab}v_4)^{-1}.$

13. $r_{13}(\pi_1({}^3K_{H_{2_1}})) = (H\left[e_{a^2,ab}v_1\right], e_{a^2,ab}v_3)(H\left[e_{a^2,ab}v_3\right], e_{a^2,ab}v_6)$
$(H\left[e_{a^2,ab}v_4\right], e_{a^2,ab}v_6)^{-1}(H\left[e_{a^2,ab}v_1\right], e_{a^2,ab}v_4)^{-1}.$

14. $r_{14}(\pi_1({}^3K_{H_{2_1}})) = (H\left[e_{a^2,ab}v_2\right], e_{a^2,ab}v_3)(H\left[e_{a^2,ab}v_3\right], e_{a^2,ab}v_6)$
$(H\left[e_{a^2,ab}v_5\right], e_{a^2,ab}v_6)^{-1}(H\left[e_{a^2,ab}v_2\right], e_{a^2,ab}v_5)^{-1}.$

To sum up,if H_{2_n} is the smallest normal subgroup of G containing$< \gamma_1^m >$, then the covering space ${}^3K_{H_{2_n}}$ for${}^3K_2$ is of hexagonal shape plus 2^m triangles.□

To compute the generators for $\pi_1({}^3K_{H_{2_n}})$, the same procedures used for the covering space ${}^3K_{H_{2_1}}$ is repeatedly applied.

Theorem2.6: Consider the connected 2-complex graph ${}^3K_2$ as shown in Figure 5, such that $G = \pi_1({}^3K_2, a^2)$contains α_1, α_2; where $\alpha_1 =< e_{a^2,ab}, e_{ab,ac}, e_{ac,a^2} >$, $\alpha_2 =< e_{a^2,ba}, e_{ba,ca}, e_{ca,a^2} >$. If H_{2_2} is the smallest normal subgroup of G containing $< \alpha_1^2, \alpha_2^3 >$, then the covering graph${}^3K_{H_{2_2}}$ is a covering complex for ${}^3K_2$ and is of hexagonal shape with nine sides shaped plus five triangles.

iii. Case three when the length of W is equal to $k(L(W) = k)$

Let W be a positive word on ^{3}S. When the length of W equals to k, this gives ${}^3K_k$ which is shown in Figure 8.It is noted that the 2-complex graph ${}^3K_k$ obtained from semigroup presentation ${}^3\text{S} =< a, b, c : a = b, b = c, c = a >$ is again a collection of subgraphs. When the length of W equals to k, there are 3^k vertices in the connected 2-complex graph ${}^3K_k$. In fact, ${}^3K_k$ is just three copies of ${}^3K_{k-1}$.The requirement here is to verify the covering space for ${}^3K_k$and what doesthe covering complex for ${}^3K_k$look like, then to compute the generators and the relations for the fundamental group$\pi_1({}^3K_k)$.

The following theorem is used to determine the covering space for the connected 2-complex graph ${}^3K_k$ and to decide on the shape of this covering.

Theorem2.7: Consider the connected graph ${}^3K_k$ as shown in Figure 8, such that $G = \pi_1({}^3K_k, a^k)$ contains β_1; where $\beta_1 =< e_{a^k,a^{k-1}b}e_{a^{k-1}b,a^{k-1}c}\ e_{a^k,a^{k-1}c} >$. If H_{k_1} is the smallest normal subgroup of G containing $< \beta_1^2 >$, then the covering space ${}^3K_{H_{k_1}}$ for${}^3K_k$is of eight sides shaped geometric plus k^2 squares.

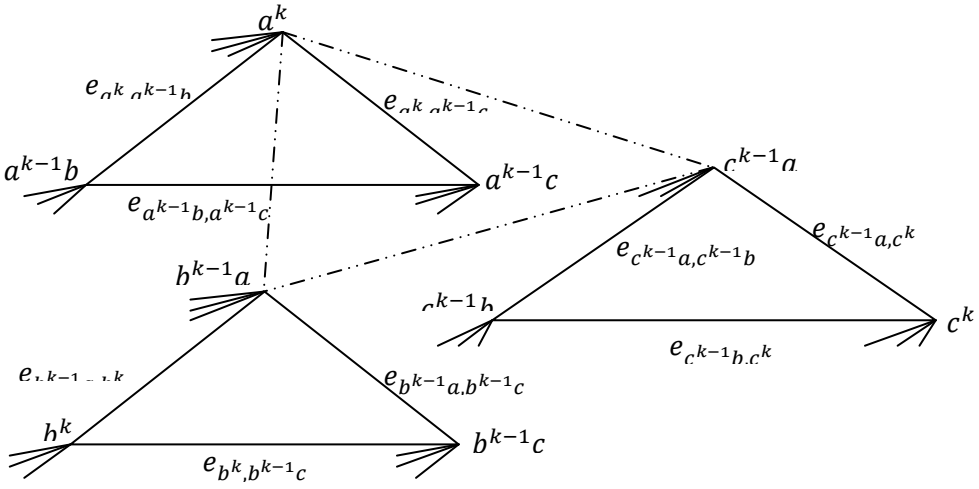


Figure 8 Connected 2-complex graph${}^3K_k$

Proof: Likewise, as it was proved in the previous theorems on connected 2-complex graph ${}^3K_2$, the similar procedure is applied to conclude the covering space ${}^3K_{H_{k_1}}$ for ${}^3K_k$.

References:

[1] A.G.B. Ahmad & A.M. Al-Odhari. The graph of diagram groups constructed from natural numbers semigroup with a repeating generator. Jour. of Inst.Of Math &Com.Sci. (Math.Ser.) 17 (2004), 67-69.

[2] J. Rotman. An Introduction to theory of Groups.2nd edition. New york: Springer – Verlag, 1995.

[3] J. Rotman. Advanced Modern Algebra . New Jerssey:Pearson Education, In. 2002.

[4] V.Guba and M. Sapir. Diagram Groups. Memoirs of the American Mathematical Society, 1997.

[5] V.Kilibarda. On the algebra of semigroup diagrams, Int. J. of Alge. And comput.7(1997), 313-338.

[6] M.A. Kalthom& A.G. Ahmad 2011. Covering space for diagram group from semigroup presentation S $=< a, b, c : a = b, b = c, c = a >$. International Journal of Countemporary Mathematical Sciences, 25-28(6): 1341-1350.

[7] S. p. Pride, Low Dimensional Homotopy Theory ForMonoids, Int. Jour. Of Algebra And Computation, 6, (1995), 631-649.

منهجية مقترحة لتحسين أداء بروتوكول الالتزام بالتنفيذ ثنائي المرحلة.

✍ **Aimen Ahmad, Kamal Ali Albashiri and Hatim Al-Mabrouk**
Department of Data Analysis, Faculty of Accounting, University of Gharyan; Matamatas and Computer Science, Faculty of Applied Science, Cankaya University.

الملخص :

نظم قواعد البيانات الموزعة تحتاج إلى بروتوكولات الالتزام بالتنفيذ وذلك للتأكيد على ضمان تنفيذ العمليات الموزعة (Distributed Transaction) كوحدة واحدة دون تجزئة ولإنجاز هذه المهمة أُقترحت العديد من البروتوكولات الخاصة بتنفيذ العمليات المرتبطة بقواعد البيانات الموزعة حتى الآن. هذه الورقة تُعنى بخوارزميات إدارة العمليات في نظم قواعد البيانات الموزعة وخصوصاً تلك المتعلقة ببروتوكولات الالتزام بالتنفيذ ودرجة تعقيدها (Complexity) من حيث عدد الرسائل المستخدمة للإنجاز مهمة تنفيذ هذه العمليات.

بروتوكول الالتزام بالتنفيذ تنائي المرحلة 2PCP مستخدم بشكل واسع في تشغيل الأنظمة التي تنفذ العمليات الموزعة.

البروتوكول المقترح هو امتداد للبروتوكول للالتزام بالتنفيذ تنائي المرحلة 2PCP وهو يقترح تحسين أداء هذا البروتوكول في المرحلة الثانية من حيث درجة التعقيد.

An approach to improve the performance of Two-Phase Commit Protocol

Aimen Ahmad, Kamal Ali Albashiri and Hatim Al-Mabrouk
Department of Data Analysis, Faculty of Accounting, University of Gharyan; Matamatas and Computer Science, Faculty of Applied Science, Cankaya University.

Abstract:

Distributed database systems use commit protocols to ensure atomicity in case of distributed transactions and a wide variety of commit protocols have been proposed so far. This paper considers efficient algorithms to manage transactions in distributed database systems. The emphasis is on commit protocols and their message complexity. Two-Phase Commit (2PC) protocol is a widely accepted standard protocol for distributed transactions. The new protocol was proposed in this paper which is an extension of 2PC. The proposed protocol means to improve the performance of 2PC protocol.

Keywords: distributed database systems, commit protocols, phase Two-Phase commit (2PC), distributed transactions, messages, and performance.

1. Introduction:

Distributed databases are critical for many modern information processing applications. They possess many properties in order to ensure reliability of transactions. For instance, when data is distributed, its availability and reliability are increased in addition to improvement in access time to the information. A distributed database, in contrast to a centralized database, receives its name based upon having one or more tables divided into partitions or replicated with the storage of these partitions and copies spread across different sites. In being distributed, it is also possible for tables to be fragmented across different sites.

Distributed databases employ many types of protocols such as commitment protocols and replication protocols. The function of these protocols is to manage data and transactions to ensure consistency of data across sites of the distributed database. Aside from consistency, performance is the most important aspect of distributed database systems, which is impacted by several components of the system, one of which is the commitment protocol used to manage transactions amongst sites in the system. The performance of these protocols can vary widely. The Two-Phase Commit (2PC) protocol and its variants, Presumed Commit (2PPC) and Presumed Abort (2PPA), are well-known and practical commit protocols for distributed databases.

Distributed database systems use distributed commit protocols to ensure the atomicity across the sites, when a transaction execute at multiple sites it must either be committed at all the sites or aborted at all the sites instead a transaction committed at one and aborted at another[1].One phase(1PC) protocol was the first one proposed by Jim Gray[2] but due its number of shortcomings, 2PC was proposed which is a widely accepted standard protocol for distributed transactions.2PC protocol is expensive because it requires three broadcasts and acknowledgments to overcome this requirement, New Presumed Commit (NPC) protocol is proposed in this paper which is an extension of 2PC. NPC minimizes the execution overhead in the 2PC protocol in terms of the exchanged messages. The rest of the paper organized as follows: Section 2introduces distributed system transactions, Section 3describes 2PC protocol, Section 4 presents the work motivation of this paper, Section 5 explains the design and evaluation of the new proposed NPC protocol, and Section 6 presents the conclusion.

2. Distributed Database Transaction:

When a transaction fails to complete execution, the transaction will enter an abort state. When transaction completes its execution successfully, the transaction is called committed. Some states of a transaction depend on its execution as the diagram depicts in Figure1. A transitional state appears as a one-line circle, while a two-line circle indicates a terminal state. An idle state occurs when the transaction is not running. The transaction is expressed by the arrow in which the tail appears to leave a state and the tip appears to enter a state. These states are:

Active State: Also called the initial state. While a transaction is running, it is considered to be in an active state and not all changes are performed as depicted in Figure 1.

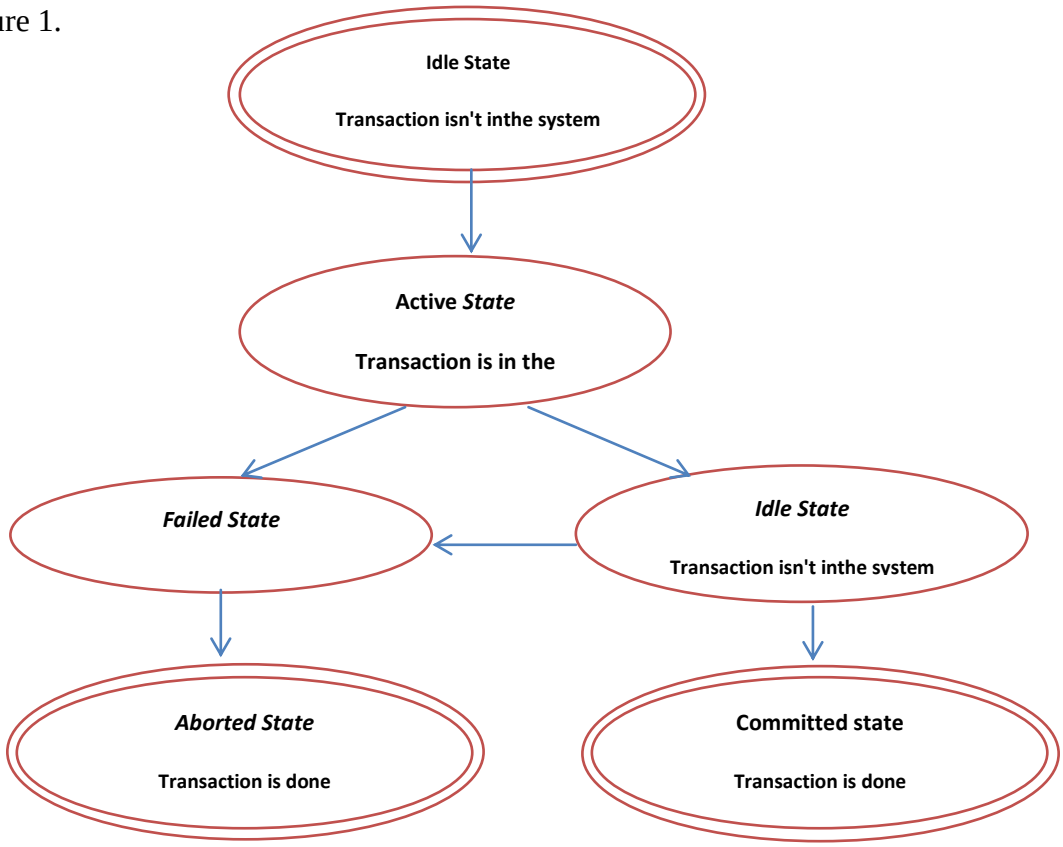


Figure 1: State transition diagram.

Partially Committed: Also known as before committed, the transaction enters in this state immediately after executing its last sentence.

Failed State: For some reason, such as deadlock, the transaction enters this state if it could not process its execution. As a result, it will be forced to enter an aborted state.

Aborted State: A transaction enters an aborted state when it terminates unsuccessfully and will be rolled-back. The database has been returned to the state it was in before the transaction started.

Committed State: When the transaction completes its execution successfully, it will enter the committed state as its final state[3].

3. Two-Phase Commit (2PC) Protocol:

Distributed database systems need commitment protocols to ensure properties of transaction like isolation and data integrity. 2PC protocol extends the 1PC protocol by reducing the number of windows of vulnerability, which are the periods of time when a slave site must wait on a coordinator decision [4].

The windows of vulnerability in 2PC protocol are smaller because, during the first phase, the slave's sites simply vote and do not wait for the coordinator. The coordinator state will change. 2PC protocol proceeds in two-phases: voting and decision. The coordinator in the first phase collects the slaves' votes. In the second phase, the coordinator broadcasts the general decision in which the slaves commit or abort transaction[5].

2PC protocol ensures the atomicity property for distributed transactions. Synchronization is necessary to commit the transaction. Because the scheduler may not be ready to commit one of the transactions that it scheduled, it might be that another transaction in the schedule reads the value thata former transaction updates.

The strict concurrency protocol does not allow reading to read any updated value until the updater of that value commits. It also does not allow the occurrence of deadlock in sub-transactions. A deadlocked site causes the transaction to enter an aborted state. This is called a unilateral abort[6].

The algorithms of the coordinator and slave are illustrated by the diagram of this protocol as depicted in Figure 2. Before using this diagram, it is best to describe the terms of the different states of the coordinator and slave.For the coordinator, the“Preparing state” or “Wait state” means that the coordinator is waiting for the slave sites to send messages. For a slaves site, “Prepared state” or “Ready state” means that the slave site sent a commit message and is waiting for new message from the coordinator[7].If the coordinator makes a decision to execute the transaction, it will enter to first phase of the protocol by sending a prepare message to the slave to commit the transaction.

The first part of executing the transaction is that the coordinator writes a ’begin commit’ record in its log along with “preparing states” while waiting for the slaves’ votes. In the first phase of the protocol, if a slave wants to commit the transaction, it writes a ’Ready’ record in its log file and sends a commit message to the coordinator. After that, the slave site enters the” prepared state”. Otherwise, the slave writes an ’abort’ record in its log file. Then, the slave sends an abort message to the coordinator[8].

The commitment point has been reached when the coordinator receives the done message (ready or not-ready) from all slaves. If the coordinator receives at least one not-ready message from a slave in the first phase, the coordinator broadcasts the global abort message, considered the start of the second phase of the protocol.

The coordinator will globally abort the transaction as soon as it receives acknowledgement messages from all slaves. In this case, if the coordinator receives more than one not-ready message from the slaves, it will ignore them because it

needs just one not-ready message to abort the transaction. Also, the coordinator can make the decision to abort the transaction before it enters the first phase. Then it globally sends the abort message to the slaves and enters the "aborting state" [9].

As soon as the coordinator receives the not-ready message, the coordinator writes an 'abort' record in its log.

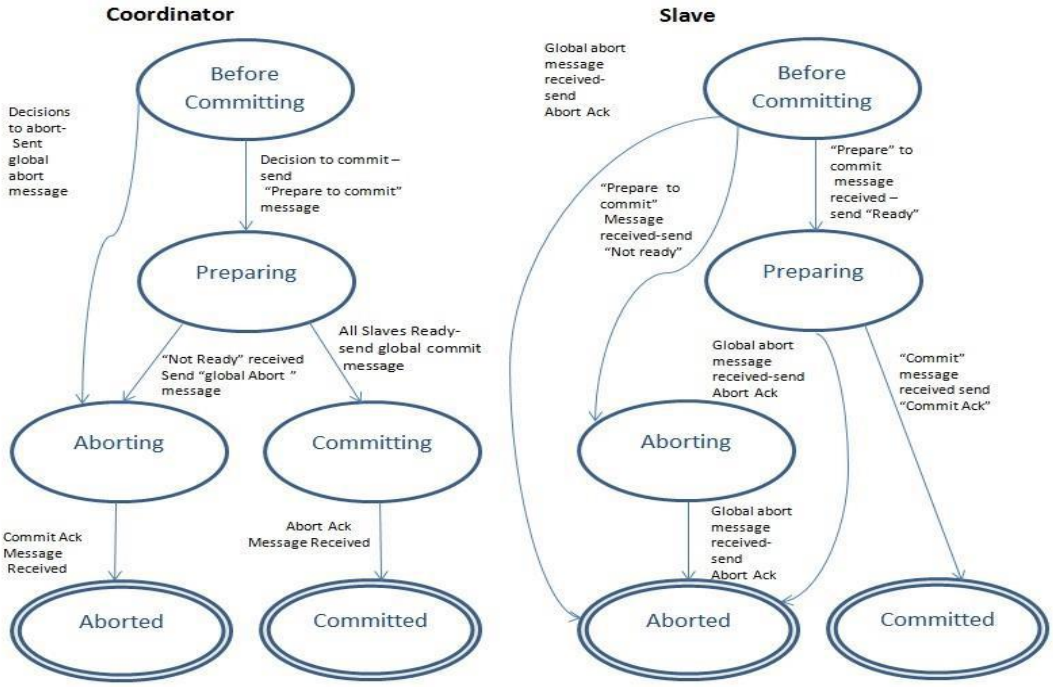


Figure 2: Coordinator Slave Algorithms Diagrams in 2PC Protocol.

If the coordinator in the first phase receives a ready message from all of the slaves, it will write a 'commit' record in its log and enter the second phase of the protocol. As soon as a slave sends a ready message, it enters to" Prepared state."

In the second phase, after the coordinator has received commit messages from all slaves, it will send commit a message to the slaves and enter the "Committing

state". This phase is called the decision phase. The coordinator awaits an acknowledgement message from each slave site. When the coordinator receives all the messages, it writes an 'end transaction' record in its log.

There are two rules for the coordinator to reach a termination decision, known as global commit rules. They are:

1- If even one participant votes to abort the transaction, the coordinator has to reach a global abort decision.

2-If all the slaves vote to commit the transaction, the coordinator has to reach a global commit decision[10].

In the second phase, after all slaves receive a commit message from the coordinator, the slaves apply the actions of the transaction, and acknowledge the coordinator. After a slave enters the second phase and receives a global abort message, it acknowledges the coordinator by an abort message[11]. In addition, the slave sites that sent ready messages in the first phase cannot change their decisions in the second phase. When a slave is in the" Ready state" in the second phase, it could move to abort or commit the transaction based on the received message from the coordinator. In addition, the global transaction decision is taken by the coordinator depending on the global commit rule. Finally, the coordinator and the slaves enter certain states and await a message to change from state to state. Therefore, if the expected message is not received by any site in which it is a coordinator or slave, the timer runs out.

3.1 Centralized Communication in 2PC Protocol:

The structure of the communication paradigm as illustrated in Figure 3 is employed in implementing 2PC protocol. It is called the centralized structure since

the communication is only between the coordinator and slaves. There is no communication amongst the slaves in any phase.

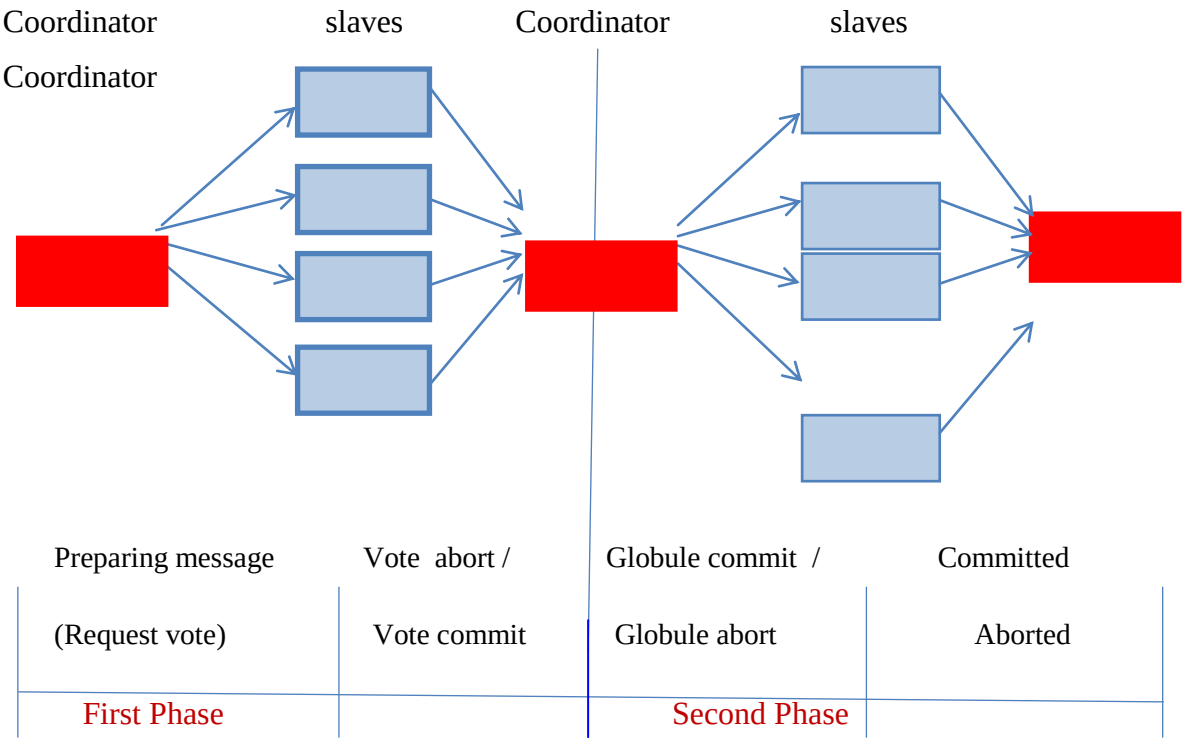


Figure 3: Centralized2PC Protocol Communication Structure

3.2 Failure Handling in 2PC Commit Protocol:

In the first phase of this protocol, if the coordinator fails, the slaves can abort the transaction by sending not-ready or vote-abort messages. In contrast, if the coordinator fails in the second phase, the slaves will be blocked. To deal with the failures, 2PC protocol must be extended to include a termination protocol that guides the sites to deal with these failures.

3.3 Termination in 2PC Protocol:

The function of the termination protocol is terminating transactions when a failure happens. These may be site failures or communication failures. 2PC protocol treats both types in the same manner [8]. When a site fails, the operational sites invoke a termination protocol to terminate the transaction by whether there is commitment of abortion. The purpose of invoking this termination protocol is to release the resources the transaction holds as soon as a failure is detected.

A time-out mechanism detects the failure of a slave by the coordinator or detects the failure of the coordinator by the slaves. The time-out occurs in the destination site when the source site cannot receive a response within the expected period [12].

Understanding the termination protocol entails understanding the details about transaction states of the coordinator or slave. The transition from state to state is performed by any site in the system by writing a record in its log and submitting a message in the message queue. Although it is appropriate to assume that three actions are performed by an atomic action, it is not reasonable to assume that the transitioning of states and the transmitting of messages from the message queue are an atomic action. For example, when the coordinator transitions from the" Preparing state" to the" Committing state," it might fail after sending messages. As a result, some sites may not receive global commit messages. At this time the termination protocol must be invoked to terminate the transaction by commitment or abortion.

3.3.1 Coordinator Termination:

This protocol is activated by the coordinator when it detects the failure of one or more slaves. The coordinator has several cases to process:

Case 1: A slave's failure is detected when the coordinator is in the "Before commit" state. The slave failed during the transaction execution. In this case, the coordinator writes an 'Aborting' record in its log and sends a global abort message to all slaves.

Case 2: A slave's failure is detected when the coordinator is in the" Preparing state." The salve could have been in the "Before commit", "Aborting", or "Prepared" states. If the slave is in "Before commit," it never received any messages from the coordinator. If the slave is in the "Abort" state, it received the prepare message and voted not-ready. If the slave is in the "prepared" state, the slave failed to send a ready message to the coordinator. The coordinator assumes that the slave does not want to commit the transaction. Therefore, the coordinator must proceed to abort the transaction.

Case 3: A slave's failure is detected when the coordinator is in the "Committing" state. This signifies the fact that the coordinator did not receive an acknowledgment message from the slave. There are two possibilities for this. The slave failed in either the "Prepared state" before it received the global commit message or after receiving the commit message from the coordinator and before sending a Commit acknowledgment message to the coordinator. In both cases, the coordinator must continue polling the slaves for acknowledgment messages before ending the transaction globally.

Case 4: A slave's failure is detected when the coordinator is in the" Aborting" state. This signifies that the coordinator did not receive an acknowledgment abort message from a salve and the slave may be in the "Before commit", "Prepared", "Aborting", or "Aborted" state. Regardless of the slave's state, the coordinator must poll the slaves for acknowledgment messages to abort the transaction globally.

3.3.2 Slave Termination:

This protocol is activated by any slave that detects that the coordinator has failed in order to terminate the transaction. Each slave that detects the coordinator's failure takes a few steps:

Case 1: The slave detects the coordinator's failure when it is in the "Before commit" state. In this case, the coordinator failed when it was in the "Before commit", "Preparing", or "Aborting" state. The slaves must elect a new coordinator to abort the transaction globally.

Case 2: The coordinator's failure is detected when the slave is in the "Aborting" or "Before commit" state. In this case, the slaves elect a new coordinator to abort the transaction globally.

Case 3: The coordinator's failure is detected when the slave is in the "Prepared" state. The coordinator may have failed in the "Preparing", "Aborting", or "Committing" state. The coordinator failing in the "Aborting" or "Committing" state will be handled in the same way. Therefore, there are two cases to be handled. In the first case, the coordinator failed in the "Preparing" state before it sent the global abort message or global commit message to the slaves. The slaves will be blocked while they are holding resources such as some rows or columns. For this reason, 2PC protocol is called a blocked protocol.

What happens to the coordinator in this case is that the coordinator decides to abort or commit the transaction and transfers to the "Committing" or" Aborting" state. Then the coordinator fails before the messages leaves the messages queue at the coordinator's site.

The coordinator's decision has been applied only at the coordinator's site and the slaves do not know anything about the coordinator's decision. In the second case, the coordinator fails when it is in the "Committing" or" Aborting" state. The coordinator fails before it sends a global commit message or global abort message or

after receiving global messages by some of the slaves. In the last possibility, the failure is detected by the slaves, necessitating their election of a new coordinator that discovers the coordinator's state at the time of its failure.

The new coordinator sends a message to all the slaves asking them to reply based upon the last message that they received from the failed coordinator. When the slaves reply to the new coordinator, they will have one of the following possibilities:

First Possibility: No slave has received a global abort message or global commit message, so the slaves will be blocked until the coordinator has been re-paired.

Second Possibility: Some slaves received an abort message and the other slaves are still in the "Prepared state." This means that the coordinator made a decision to abort the transaction and failed before it completed sending abort messages to all slaves. The transaction must be aborted by the new coordinator.

Third Possibility: The coordinator sends a global commit message, but once it completed sending this message to all slaves, it failed. In this case, the rest of the slaves are still in the "Preparing" state. When the new coordinator is elected, the transaction will be committed.

Forth Possibility: When all the slaves received a global abort message from the coordinator, the coordinator failed. The slaves elect a new coordinator that will abort the transaction.

Last Possibility: When all the slaves received a global commit message from the coordinator, the coordinator failed. The slaves elect a new coordinator that will commit the transaction. There is no way for some slaves to receive a global abort message and others to receive a global commit message.

3.3.3 Evaluation of 2PC Protocol:

2PC protocol is expensive because it requires three broadcasts and acknowledgments as illustrated in Figure 4. The cost of this protocol depends upon

the number of sent messages and the number of log records on stable storage that are needed in the two phases of the protocol. In addition, the protocol requires additional messages if a failure occurs.

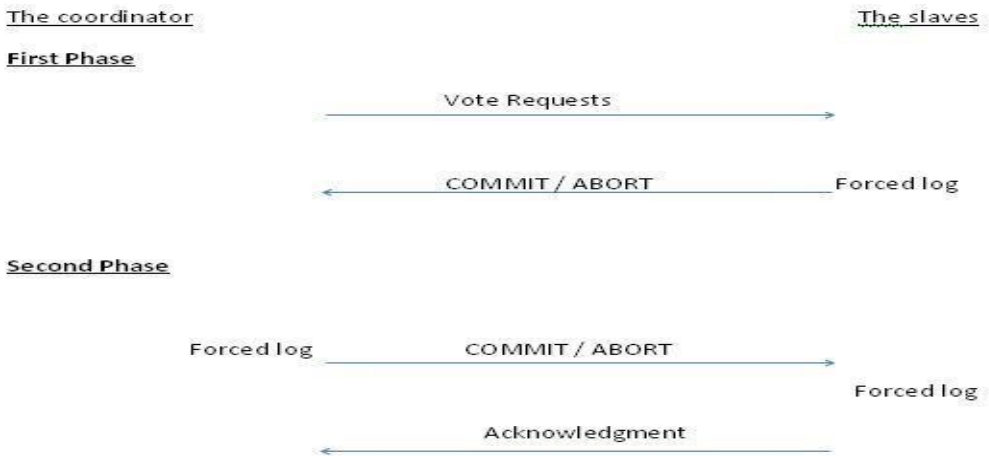


Figure 4: Two-Phase Commit Protocol

4. Work Motivation:

Decreasing consumed time by the transaction processing needs to emphasis the protocol which commits the distributed transaction to make high protocol's performance.

These protocols have worked by messages to make connection amongst the sites. Increasing the number of messages means increasing message overhead and the possibility of communications failures. As a result, the transactions need more messages to deal with failures occurrence. Also, the commit protocol, which produces many massages, consumes more time. Consequently, the protocol is expensive in term of the cost of distributed transactions processing. For these

reasons, there is a need to design commit protocol that it has ability to process the distributed transactions with less messages.

Furthermore, the protocol has to achieve the properties of processing the distributed transactions, which are atomicity, isolation, durability and consistency.

5. New Presumed Commit (NPC) Protocol:

The new proposed protocol is called New Presumed Commit (NPC) Protocol. The new protocol minimizes the execution overhead in the 2PC protocol in terms of the exchanged messages. The coordinator aims to release the held resources as soon as possible by taking decision by at least one abort, or abort acknowledgment messages. The new protocol reduces the communication failures because it reduces the number of messages.

5.1 Protocol Design:

The design of NPC protocol is similar to the design of 2PC protocol with some exceptions. The new protocol contains two phases to execute the distributed transactions with committed assumption, and that is why the proposed protocol name has included the term Presumed. The first phase of NPC protocol is called voting phase that includes one broadcast of messages from the coordinator to the slaves.

The first broadcast means that the coordinator wants to poll the slaves whether they are ready or not ready to commit the submitted transaction. Subsequently, if a slave site ready to commit the transaction, that means the assumption of the protocol true. The coordinator has the same committed assumption. Then, the slave site writes commit record to his log file. If the sites are ready, that means there is no problem in the schedule of transaction such as deadlock

problem. If all sites are ready to commit the transaction, the coordinator precedes to the second phase which all the slave's sites have the record in their logs files. In other words, all slaves are ready.

On the other hand, if a site in the first phase is not ready to commit the transaction, it sends abort message to the coordinator. Because the site does not agree with the committed assumptions of the protocol in the first phase, the slave site has to send abort message to the coordinator. In addition, this site also has to write abort record to its log before sends aborted message to the coordinator. If some sites are not ready in the first phase, the coordinator needs just one abort message to make decision to abort the transaction. When a slave site is ready to commit the transaction, it holds the resources which needs(table, fragment, rows or columns) to apply the transaction in the second phase.

In distributed transaction processing, the resources are distributed amongst a lot of transactions which need the same data. As a result, holding the resources for long time by a transaction takes the chance from another transaction, and it makes delay which it is undesired in distributed database systems. When the coordinator delays to make an action, that causes the slaves sites hold the recourse which is undesired. For this reason, in the proposed protocol, the coordinator has to make decision as fast as possible. For instance, if a site is not ready in two cases, the coordinator makes decision as soon as it receives the first abort message from slave site in the second phase of the new protocol. Releasing the recourse by the sites as fast as possible is one of the goals of NPC protocol.

In the second phase, when the coordinator sends the commit decision to the slaves, the slaves imply the transaction depend on the received commit decision. Before the slave's sites take action to imply the commit decision, the slaves' sites have to take an action in NPC protocol. The action entails that all slaves have to check its logs files to check if there is no commit record at the logs files of the

salve's. If a slave site detects abort commit record in its log, immediately it sends abort message to the coordinator.

The coordinator aborts the transaction as soon as it receives abort messages from a slave site. All sites release the resources which holds after they acknowledge the coordinator by abort acknowledgment messages. For the last action in NPCprotocol, the coordinator ensure that all slaves sites have acknowledged the coordinator by the same kind of acknowledgment messages.

To ensure the isolation property, NPC protocol uses 2PC Lock protocol as concurrency scheme to preserve the serializability amongst all sub transactions. As a result, there is no overlap between two transactions at the same time.

This protocol, as illustrated in Figure 5 makes the transaction cheaper by reducing the number of sent messages in the first phase. The protocol includes Two-Phases, but in first phase the sites only reply to the coordinator when they abort the transaction. Therefore, when a site commits a local transaction, it does not send a message back to the coordinator. On the other hand, if some sites abort the transaction, the coordinator needs just one abort message to make a decision to abort the whole transaction in the second phase.

In the second phase, if the coordinator does not receive any messages, it assumes that all slaves chose to commit the transaction.

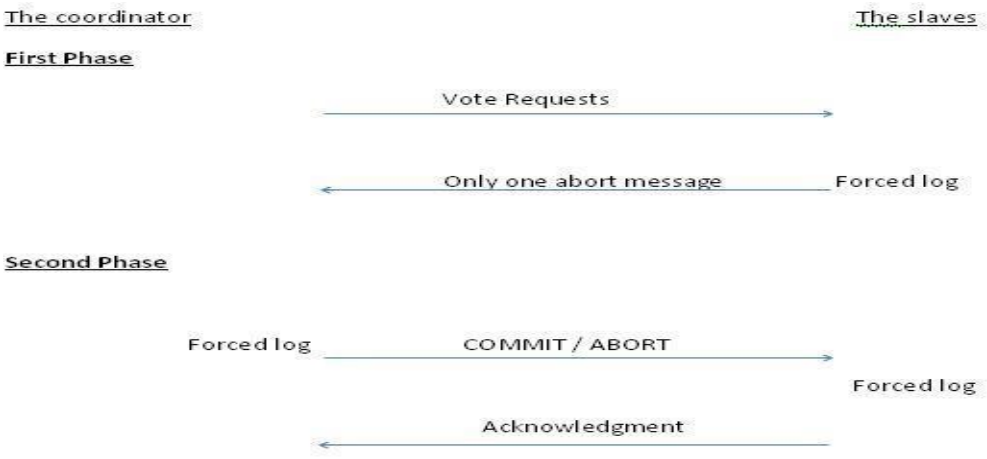


Figure 5: New Presumed Two Commit Protocol

As a result, the coordinator broadcasts a general commit decision to all slaves. The slaves then apply the transaction and acknowledge the coordinator by a commit acknowledgement message.

5.2 Protocol Composition and Correctness:

Quality benchmark of a commit protocol is achieving the transactions properties which are the consistency, isolation, atomicity and durability. Therefore, the new protocol entails recording any action in a log file before it is achieved by a site. This technique gives the new protocol the ability to deal with any failure in such a way that it could ensure the properties of the distributed transaction. The new protocol ensures isolation property for any distributed transaction. The new protocol uses concurrency-control component which is Two-Phase Lock Protocol. The new protocol can ensure that all sub transactions run serially in the first phase of the proposed protocol. In the write action, there is no two transactions use the same data at the same time.

Durability property is ensured by the new protocol. When the coordinator commits the transaction successfully, some soft failure can happen. By checking the logs files, it could refresh all the transaction's updates. Although a failure happens, the new protocol ensures that any committed transaction is effective. The consistency property requires rules like integrity constraints. If a designer satisfies these rules when he designs distributed database, the protocol can achieve the consistency property. If the database is consistent before an action of distributed transaction, it has to be in the same case after the update. Because the new protocol ensures the isolation execution of distributed transaction, it can preserve that the database is in consistent after the execution of transaction.

The new protocol can achieve the atomicity property because it can detect the soft failure at any site. In other words, the new protocol saves all the updates at the log file before it takes an action. Therefore, when the coordinator detects the soft failure, some updates are lost. The recovery operation recovers the failed sites by using undo or redo operations to rewrite all the updates which are done the failed. The recovery operations are one of the components of the new protocol. As a result, all the updates are effective in the same time or not.

Distributed transactions use commit protocols to ensure that all slaves commit the transaction or not. Therefore, when a slave fails, it must be detected by the commit protocol. NPC protocol aborts the transaction in the following cases:

Case 1: In the first phase, if a slave votes to abort the transaction, it sends an abort message to the coordinator. In turn, the coordinator aborts the transaction by making a general decision in the second phase. As a result, the atomicity property is achieved in such a way that there is no any update happens.

Case 2: If the abort messages are lost before being received by the coordinator, the coordinator starts the second phase of executing the transaction. Although the coordinator sends commit messages to all slaves, there may be one aborted slave in

the transaction. The slave that aborted the transaction checks its log to look for a commit record. If it does not find this record, it sends an abort acknowledgment message. If the coordinator receives at least one an abort message from some slave, the coordinator aborts the transaction. The coordinator achieves the atomicity property of the transaction in such a way that there is no any update happens.

Case 3: If all slaves vote to commit the transaction and a slave failed after voting, the coordinator starts the second phase of executing the transaction and sends commit messages to all slaves. The failed slave is detected when the coordinator does not receive an acknowledgment message from the failed slave. As a result, if the coordinator receives at least one an abort message from some slave, the coordinator aborts the transaction. The coordinator achieves the atomicity property of the transaction in such a way that there is not any update happens.

Case 4: If some site does not send acknowledgment message whether it is commit message or abort message, the coordinator can detect that some site is failed by a failure. In this case, the coordinator aborts the transaction. As a result, the coordinator achieves the atomicity property of the transaction in such a way that there is not any update happens.

Case 5: When the committed assumption is achieved by all sites in the transaction, and there is no any kind of a failure, in this case, the coordinator makes all the update which are done by all sites of the transaction effective. In each case, the coordinator aborts the transaction because there does not exist a consensus amongst slaves.

5.2 Performance Evaluation:

2PC protocol consumes (4*P) messages in committed and aborted transactions. The normal case of the proposed protocol when all slaves agree to commit the transaction. In this case, there are three broadcast actions, which are the

messages from the coordinator, so the total number of messages is (3*P) messages, which is less than (4*P).

If a slave aborts the transaction in the first phase, the aborted transaction produces (3*P+1) messages. The coordinator needs just one abort message to make a decision, so as soon as it receive one message, it ignores additional abort messages.

If a slave aborts the transaction in the second phase, the aborted transaction produces (3*P+1) messages.

6. Conclusion:

Designing an efficient commit protocol is very important for distributed database systems as commit protocols are required to ensure the atomicity of a distributed transaction. 2PCprotocol is commonly used commit protocol in distributed database system transactions but 2PC suffers due to blocking of participants sites in case of failure of coordinator site. 2PC protocol used to eliminate the blocking but has its own problems like more communication overhead due to an extra phase. In this paper, we evaluated 2PC protocol. The protocol was evaluated in terms of its performance with concentration on improving it, resulting in the proposal of a New Presumed Two-Phase commit (NPC) protocol. NPC produces fewer messages in the first phase of transaction-execution in both the committed and aborted transaction cases. The advantages of the proposed protocol are not just in reduction of the cost of performance, but also in decreasing the possibility of communication failures in the first phase by decreasing the number of messages sent.

In future these commit protocols can be evaluated in managing transaction in real time distributed database systems.

7. References:

[1] Muzammil Hasan "Transaction Commit Protocol in Mobile Environment: A Survey "*IJETAE Vol.5 Issue* 1,2015.

[2] Jim Gray, Notes on Data Base Operating Systems, Lecture Notes in Computer Science (60): 393-481 Springer-Verlag 1978.

[3] A. Silberschatz, H. F. Korth and S. Sudarshan, *Database System Concepts*, 6th ed. NewYork: McGraw-Hill, 2010.

[4] Manoj Kumar "Commit Protocol in Distributed Database Systems," *International Journal for Innovative Research in Science and Technology, Vol.2 Issue* 12, May. 2016, pp. 227-281.

[5] B. S. Boutros and B. C. Desai, "A two-phase commit protocol and its performance," *in Proc. Seventh International Workshop on. Database and Expert Systems Applications,* Sep. 1996, pp. 100-105.

[6] Y. J Al-houmaily and G. Samaras, "A two-phase commit," *Research Gate*, Apr. 2015, pp. 3204-3209.

[7] S. Gupta, and M. Sadoghi, "Easy Commit: ANon-Blocking Two-Phase Commit, "*in Proc.21stInternational Conference on Extending Database Technology*, Mar. 2018.

[8] M. L. Liu, D. Agrawal and A. Elabbadi, "The Performance of Two-Phase Commit Prorocols in the Persence of site Failures," *Distributed and Parallel Databases,* vol. 6, no. 2, Apr. 1998, pp. 157-182.

[9] M. T. O¨zsu and P. Valduriez, *Principles of Distributed Database Systems*, 3rd ed. New York: Springer, 2011.

[10] T. K. Abuya, R. M. Rimiru and W. K. Cheruiyot, "The Clustering Algorithm in Two-Phase Commit Protocol for Optimizing distributed Transaction Failure,"

International Journal of Computer Science and Mobile Computing", *vol. 4,Issue*no. *3*, Mar. 2015, pp. 97-106.

[11] T. Kraska, M. J. Franklin, G. Pqang, S. Madden and A. Fekte, "MDCC: Multi-Data Center Consistency," *Eurosys'13*"*ACM,*Apr. 2013.

[12] C. Papanastasiou, "In Algorithm for The Distributed Two-Phase Commit Protocol," *International Journal of Computer Science and Information Technology Research* ", *vol. 4,Issue*no. *3*, Sep. 2016, pp. 233-244.

القدرة علي ترجمة الكلمات التعويضية للتعابير المحذوفة وأثرها علي القراءة لذي طلبة الجامعات الليبية الدارسين للغة الإنجليزية كلغة أجنبية.

✍ د. عبدالسلام عمارالناجح

كلية العلوم الصحية، غريان

ملخص البحث :

تفحص هذه الدراسة قدرة طلبة الجامعات الليبية الدارسين للغة الإنجليزية كلغة أجنبية عاي تعويض التعابير المحذوفة من النص المكتوب و المستبدلة بكلمات مثل : ***not, do, so, one, ones*** وما إذا كان ذلك يؤثر إيجابا على القراءة . وتعتبر الكلمات التعويضية المذكورة آنفا بديلا عن تكرار بعض مكونات اللغة كالجملة و شبه الجملة.

تفترض الدراسة أن الطلبة الليبيون الدارسين للغة الإنجليزية كلغة أجنبية يواجهون مشاكل في ترجمة الكلمات التعويضية مما يترتب عليه الفشل في الوصول إلى فهم النصوص المكتوبة. ولتأكيد الفرضية أو نفيها أجريت شبه تجربة شارك فيها (100) مئة طالب جامعي قاموا بتعويض كلمات محذوفة من نصوص معدلة قدمت لهم وتم اختبار مدى فهمهم للنصوص بعد تعويض الكلمات المحذوفة.

أظهرت نتائج البحث أن غالبية الطلاب المشاركين في الدراسة تحصلوا على درجات أقل من درجة النجاح و كان متوسط الدرجة المتحصلين عليها (45) درجة. وهذا ما يترتب عليه إجراءات تربوية تشمل المنهج وطرق التدريس.

The Ability to Correctly Interpret The Substitutes Found in Written Texts and its Impact on The Reading Comprehension of Libyan University Students Learning EFL.

Dr. Abdussalam A. Annajih

Gharyan University, Libya.

Abstract:

This study investigates whether Libyan university students studying English as a foreign language are able to correctly interpret substituted items found in written texts such as ***one***, ***ones***, ***do,***, ***so*** and ***not*** and whether this positively impact their reading comprehension. As a cohesive relation between language items such as clauses or independent sentences, substitution is a sort of counter which is used in place of the repetition of a particular item. It is hypothesized that Libyan students learning EFL encounter problems in correctly interpreting these substitutes and consequently fail to have satisfactory understanding of their reading materials. A quasi-experiment was organized to test the ability of a hundred Libyan university students to interpret a number of substitutes mentioned in modified statements and consequently comprehend the message of these statements. The results revealed that the majority of the study participants failed to get the passing mark which is 50 over a hundred and the average mark they got was 45. This result may have many pedagogical implications which concern the syllabus and the teaching methods.

Key words: *reading materials, substitute, quasi-experiment, syllabus*

I. Introduction:

This study will cover topics such as reading comprehension, cohesion, substitution and finally the relation between reading comprehension and substitution. All of these will be discussed in relation to Libyan university students learning English as a foreign language. The definition of reading as an important language skill will be highlighted and reading for comprehension will be the focus. Substitution as a relation within a text and its contribution to text cohesion and whether foreign language students can correctly interpret the substitutes found in written texts will be discussed.

Among the four language skills reading is considered by many linguists as the most important skill that a person needs in order to develop other language skills and to progress in his/her life. In a civilized world where media and internet have the leading role of spreading information learning reading is of a paramount importance.

This study investigates whether Libyan university students studying English as a foreign language are able to correctly interpret substituted items found in written texts such as *one, do,* and *so* and whether this positively impact their reading comprehension. Libyan university students studying English as a foreign language will participate in this study**.** The practical investigation will try to answer the following questions:

Can Libyan University students studying EFL correctly interpret the substitutes available in any written text? If they do, Does that positively affect their reading comprehension?

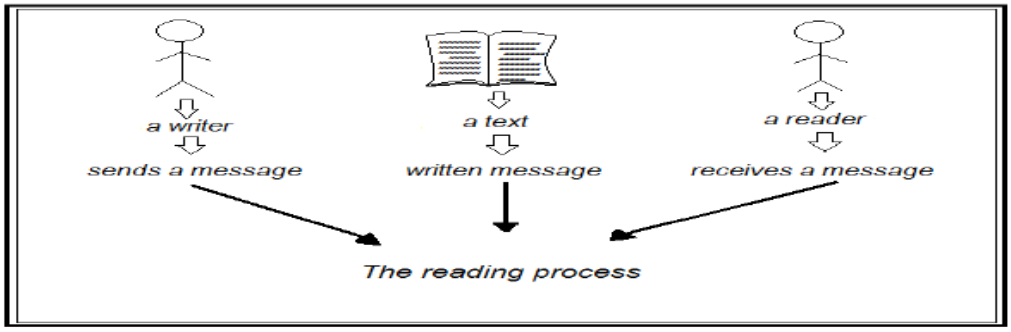
Finally, the conclusion and the recommendations which are based on the results of the experiment will be highlighted for university educational management to consider.

II. Literature review:

To review the literature related to this study topic it is crucial to cover topics such as the meaning of reading and the definitions suggested to this term by linguists and educational researchers. According to Smith (1985, p.101) a good definition of the concept 'reading' should include illustration, description, and analysis. Because of these characteristics, definitions such as "reading is the identification of written words" or "reading is the comprehension of the author's thoughts" are not comprehensive enough to include the characteristics mentioned above. Even if we limit our reading to books for academic purposes, still there are books such as telephone directory which we just scan or skim searching for specific information. Beside this, the word 'reading' has been used metaphorically in situations such as reading palms and reading faces. Again, defining reading as the decoding of written words does not cover the metaphorical use of reading.

Nuttall (1996) indicates that the operations of reading comprehension are affected by many factors. Some of them are the reader's knowledge of the world (i.e. schemata), purpose of reading, reader's motivation, reader's interest, and reader's knowledge of the language or text type. She describes reading as the transference of a message from the writer's mind to the reader's mind, as Figure 1 below illustrates.

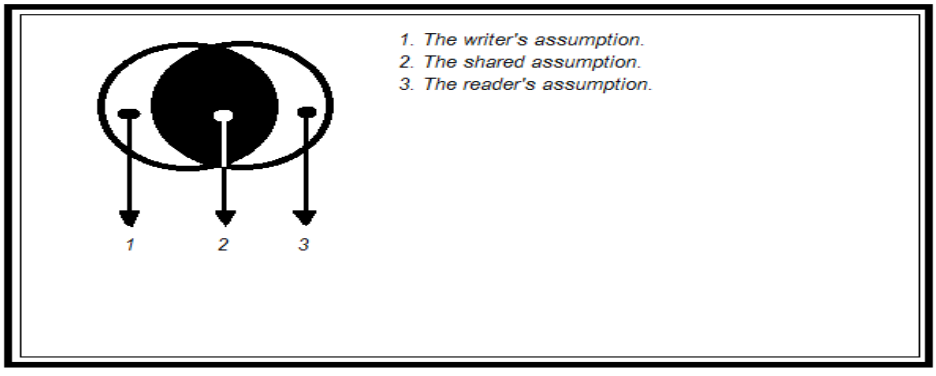
Figure 1. Transfer of information from the writer's mind to the reader's mind



Schemata which mentioned by Nuttall (1996) above has been described by Widdowson (1983, p.34) as "cognitive constructs which allow for the organization of information in long-term memory". Cook (1989, p.69) defines schemata as "the mind, stimulated by key words or phrases in the context, activates a knowledge schema."

Another factor to be considered, which includes the fillings and the believes that the reader and the writer have in common about the topic being treated, i.e. the shared assumption between the both. *The more sharing assumption is there the more the reader success in reading comprehension.*

Figure 2. The shared area between the writer and the reader



Harris (1979) emphasizes that reading is the outcome of the interaction between the reader and the writer by using textual features such as cohesive ties as a medium to make the meaning explicit.

Thus, as Innajih (2007) concludes, reading is an interactive process between the reader and the text with prior question(s) in mind in order to extract meaning from a written text and achieve satisfactory comprehension. The ability to integrate the information related to knowledge of the world (i.e. schemata) and the correct interpretation of the textual features such as cohesive ties which include reference, ellipsis, substitution, conjunctions, and lexical cohesion speed the achievement of comprehending the message writers want to convey.

II.1. The nature of cohesion:

Cohesion is one of the important characteristics of text, and can be realized by a strong version through grammatical features such as reference, ellipsis and substitution, or it can have a weak form version through lexical cohesion. These terms were used by Ruqaiya Hasan in her doctoral thesis (1964) as (cited in Gutwinski 1976) to distinguish between the grammatical and lexical cohesive features in a text. Hasan (1968) explains that a text has external and internal linguistic features, however cohesion is exclusive only to the internal features. As in Halliday and Hasan, Hasan confines the use of the term (cohesion) to include only inter-sentence relations.

Moe (1978) argues that a text with little explicit cohesive relationship is more difficult to understand. If a text lacks explicit cohesive items, the reader needs extra effort to infer the semantic relations which makes the load on the cognitive process heavier.

II.1.1. Types of cohesive relations:

Halliday and Hasan divide cohesive relations into a small number of distinct category, grammatical and lexical. Grammatical, such as reference, substitution and ellipsis, others, such as reiteration and collocation, are lexical. Conjunctions, however, are partly grammatical and partly semantic. The following is brief information about each cohesive device.

II.1.1.1. Reference:

Reference is a common cohesive device that consists of words which don't have a complete meaning in their own right, Salkie, (1995, p. 64). Halliday and Hasan (1976, p.308) define reference as "the relationship between an element of the text and something else by reference to which it's interpreted in the given instance." Reference can be categorized into three subtypes. First, *personal reference* is achieved through the use of personal pronouns such as *he, she,* and *it;* possessive pronouns such as *his, her* and *its*, and possessive adjectives such as *my, your*, and *their*. These pronouns refer to individuals and objects that are mentioned in some other parts of a text.

II.1.1.2. Ellipsis:

As Halliday and Hasan (1976) put it, ellipsis is substitution by zero. It refers to the omission of an item that is already understood from the antecedent context. An elliptical item "leaves specific structural slots to be filled from elsewhere" (Halliday and Hasan, (1976, p.143).

Ellipsis plays an important part in sentence connection. If we come across a structure that seems to be an elliptical construction, we are usually forced to look

back to what was said previously in order to interpret the sentence. We interpret the sentence by reference to what has been ellipted and we can only know what has been ellipted on the basis of what is present in the preceding context.

Quirk et al. (1985, p.707) state that ellipsis is an abbreviating device for reducing redundancy and therefore its major use is to avoid repetition in a text. Also, it is always possible to 'reconstitute' the elliptical item so that it becomes fully explicit.

II.1.1.3. Lexical Cohesion:

Lexical cohesion involves the repetition of a noun phrase, or the use of another noun phrase which bears a relation to the antecedent noun phrase. Halliday and Hasan (1976) divide lexical cohesion into reiteration (which is subdivided into the repetition of a lexical item, the use of a general word to refer back to a lexical item, and the use of a synonym, or super ordinate terms) and collocation. Lexical cohesion is a cohesive relation whose cohesive effect is achieved by the selection of vocabulary. The following statements exemplify the types of lexical cohesion:

(1) There's a *flower* in the vase. The *flower* was bought from a market.

(The word *flower* is repeated in the second sentence.)

(2) The *computer* should be replaced. That old *thing* works erratically.

(The word *thing* is the general word referring to *computer*.)

II.1.1.4. Connective ties or conjunction:

Conjunction is the type of cohesive device that involves the use of ties that perform the main function of connecting sentences. Conjunctive items usually link

two ideas in a text or discourse together semantically. With the use of conjunction, the understanding of the first idea accommodates the interpretation of the second idea. In English, conjunctive relations are usually established through the use of conjunctive ties, which may be a coordinating conjunction (like *and, but, or*), an adverb (like *in addition, however, thus*), or a prepositional phrase (like *besides that, despite the fact that*).

II.1.1.5. Substitution as a cohesive relation:

Substitution as a grammatical relation within text is a process involves the replacement of one item by another, i.e. it is a kind of counter which is used in place of repetition of a particular item. It is a relation in the wording rather than in the meaning. In other words, it is a relation between linguistic items such as words or phrases. It occurs when one linguistic item is replaced by another that contributes new information in a text. This new information differs from the information previously provided by the antecedent linguistic item. So for example,

(3) I have a second hand car which needs regular maintenance. When I have enough money I will buy a new one. Here *one* substitutes for *car*. Both *car* and *one* have the same structural function since both of them are Head of the nominal groups (*second hand car* and *new one*). So instead of repeating the word *car* in the second statement we replace it with the word *one* to avoid repetition.

a. Types of substitution

Substitution as a linguistic relation between words and clauses will be reviewed in relation to grammar which concerned with nouns, verbs and clauses.

Hence we have nominal substitution, verbal substitution and clausal substitution. Luckily, the list of the substitute items is very small. It includes:

- Nominal: one, ones, same
- Verbal: do
- Clausal: so, not

a.1. Nominal substitution

The substitute items *one/ones* occupy the head of the nominal group. For example:

(4) I wrote the titles of my research paper with the black pen. Because if I used the blue one my supervisor will not like it.

The common noun *pen* in the first statement is the head of the nominal group *black pen* and *one* is the head of the nominal group *blue one*. *One/ones* usually fill the head slot which has to get its full meaning from the preceding statement or text. In certain instances the substitutes *one/ones* may be associated with defining modifiers such as *this* which refers anaphorically to a preceding modifier mentioned somewhere before as in the following example:.

(5) I thought I'd found all the lost books. I didn't know about this one. *This* here is acting as a defining modifier. So what is carried over with the substitute may be the whole of what there was, or it may be only a part of it.

Nominal substitute *Same*

The item *same* occurs as a cohesive element which categorized into two types of cohesive ties "The first one, The same" can be used as a pronominal reference item. The second type is used as a one of common item in nominal substitution. In

nominal substitute *same* preceded by the definite article "The". The same presupposes an entire nominal phrase it doesn't necessarily require modification of the head noun and sometimes the position of the same at the end. For example:

(6) A: I ate seven dates and a glass of milk on my breakfast every day.

B: I ate the same.

Here, *the same* substitutes the noun phrase the *seven dates and a glass of milk*, and don't need pre modifier, also it comes at the end.

The function of *the same* as the accented form of the substitute in all types of substitution that occur in clausal and verbal as well as nominal as in Table 1 below:

Table 1. Function of the *same*

Nominal	Non-accented	Accented form (same salient)
Clausal "reported"	So	(so) the same
Verbal	Do	Do the same
Attribute	So	Be the same

II. Verbal substitution:

The verb *do* is the major substitute in English language. This substitute item operates as the head of the verbal group. The lexical verb *"do"* occupies the position of the verbal group from the right side, as in the following example:

(7) A: You shouldn't *go* to the college today.

B: But I want to *do* it. (*do* replaces *go*).

"Do" can also substitute for a verb plus certain other elements in the same sentence. Example:

(8) I don't *understand* the Chinese calendar, and I don't think you *do* either.

The verbal substitution regularly extends across sentence boundaries, as in:

(9) He never really *succeeded in his ambition*. He might have *done*, one felt, had it not been for the restlessness of his nature.

Here *done* substitutes for *succeeded in his ambitions*, and so serves to link the two sentences by anaphora, exactly in the same way as the nominal substitution *one*.

Conditions of the use of the verbal substitution:

There is a great variation in the use of the substitute *do* in Modern English. It is somewhat similar to the nominal substitute *one* in range of uses. Halliday and Hasan (1976, p.117) argue that it is so because ellipsis is almost always an acceptable alternative. They add that, in Shakespearean English, the verbal substitute *do* was much less clearly distinct from the finite verbal operator *do*, because of the more general use of the latter in a positive declarative verbal group, *e.g. as I do live* (in Modern English *as I live).* The form of the verbal substitute in Shakespearean English is *do so*. Verbal substitute is more commonly used in speech than in writing. In spoken English people do not always speak in full sentences; they rather use incomplete sentences and sometimes they just use utterances, for instance:

(10) 'Is Sam going to be late?'_ 'May do'.

III. Clausal substitution:

Clausal substitution is the replacement of a clause by a clause substitute *'so'* and *'not'* which presupposes an entire clause. The clausal substitution is classified into three types in terms of the context it occurs: report, condition and modality in each of these types may occur in two cases to express positive use of *'so*', to express negative use *not*. *So* is almost always anaphoric. For instance:

(11) a. Do you think my project will be perfect?

b. Yes, I think so. / No, I think not.

So substitutes the whole clause *my project will be perfect*, is a positive express. *Not* substitutes the whole clause *my project will be perfect,* is a negative express.

III. Substitution and reading comprehension:

Substitution is a replacement of an item by another within a text. As a formal and grammatical language feature substitution is one of the cohesive devices which ties the flow of meaning in the text. It is usually used by writers to avoid repetition and exclude boredom which may occur while reading. However, most of the linguists and educational researchers have found out that interpreting the substitutes used in texts is not easy for students studying English as a foreign language. For example, Shokouhi et al. (?) stated that students who process a cohesive text found that substitution and ellipsis were more difficult for students to process than other cohesive devices such as reference and lexical cohesion.

In line with that Al-Jarf (2001) asked 59 college students to identify four types of cohesive ties in reading text. The results of her study revealed that substitution was the most difficult to process, and Monson (1982) found that

substitution-ellipsis structures were the most difficult cohesive devices for all age students to process.

This study is trying to shed some light on this topic by having the following practical quasi-experiment which will be organized in the Department of English, Faculty of Arts- Gharian.

IV. Research methodology:

This study investigates whether Libyan university students studying English as a foreign language are able to correctly interpret substituted items found in written texts such as *one*, *ones does*, *so* and *not* and whether this positively impact their reading comprehension. Libyan university students studying English as a foreign language participated in this study**.** Their reading comprehension was tested by using statements modified to have some omitted substitutes and their task was to get the substituted items**.** Data were collected and analysed by using SPSS computer software as it will follow.

IV.1. The study problem:

There is a great number of students of Libyan universities who join English departments in various provinces in the country every year. They study different English language skills which qualify them to understand, speak and write good English. However, in practice most of the graduates do not have enough confidence to read and write when they are faced with contexts that need their qualification. Who is to blame? Teachers, syllabus, educational management or the students themselves. Reading for comprehension, for example, is one of the victims in this process. Most of the graduates cannot read with at least satisfactory

understanding. To join the "literacy club" as Smith (?) calls it a person should have enough vocabulary and knowledge of the language plus the proper techniques which help readers to tackle difficult texts.

Our research focused on one of the problems that face Libyan university students studying English as a foreign language. When reading in English readers are required to use all the means available in the text to extract the correct meaning the writers want to convey. Cohesive ties as Halliday and Hasan (1976) call them are one of the devices which can help readers to get the correct meaning if they know how to use them. This study investigates substitution as one of the cohesive ties which our university students find difficulty in recognising, understanding and using them. To recognize, understand and use substitution, Libyan university students need to be good in grammar as well as have enough assets of vocabulary. This study will shed some light on this topic and try to understand the reasons behind students' failure to interpret the correct substitutes and consequently fail to have the appropriate messages the writers want to convey.

IV.2. The research questions:

The data collected in this study tried to answer the following questions:

1-Can Libyan University students studying EFL correctly interpret the substitutes available in any written text?

2-If they do, does that positively affect their reading comprehension?

IV.3. The research participants:

A hundred Libyan university students from Al-Jabal Al-Gharbi University, Faculty of Arts-Gharian, English Department in academic year 2012/2013

participated in this study. They were in their third year of study and their English skills background was approximately similar since they have successfully passed all the required English courses to be in the third year. Just 5 per cent of them were males and the others were female students, their average age is between 19 to 22 years old. The following tables 2, 3 and figure 3 illustrate the above information.

Table 2. Age of the study participants

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	100	19.00	22.00	20.2400	.74019
Valid N (listwise)	100				

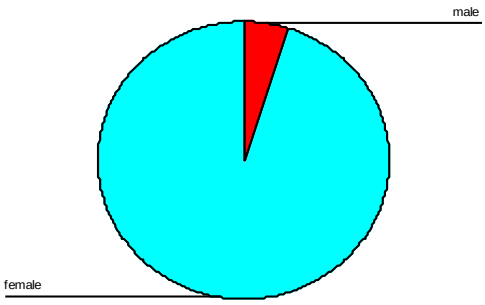


Figure 3. Gender of the participants

IV. 4. Instrument:

About twenty statements modified to include related independent either sentences or questions with their answers were used as the instrument of the reading comprehension test. These statements are tied to each other by a number of substitutes such as *one, ones, do, so,* and *not*. Most of the statements were adopted from the examples mentioned by Halliday and Hasan (1976) in their book (Cohesion

in English). The participants were asked to recognise the nominal or the verbal clauses the substitutes *one, ones, so, do* and *not* replace in the second statement to avoid repetition. The second task was to complete the second statement or the answer of the mentioned questions with the suitable substitute. By supplying the correct substitute (i.e. *one, ones, do, so, not*) or recognizing the nominal, verbal or clausal structures the substitutes replace, it is assumed that the participants comprehend the related statements and get the message the writer wants to convey. The test was organized at 9'oclock in the morning away from noise and interruption. Most of the participants finished the test within the time limit which was 90 minutes.

IV.5. Data analysis:

Test papers were collected, corrected and given marks. The mean and frequency of the test marks were calculated by using the SPSS software programme. The average mark the study participants managed to achieve was 45 which was below the passing mark. The results revealed that:

- ✓ 62 respondents (62%) of the total number have got marks below 50.
- ✓ Only 4 respondents (4%) had got marks of 80 and over 80.
- ✓ Just one respondent (1%) was able to correctly interpret all the substituted forms that were given in the exam.

The findings suggested that the majority of the study respondents failed to get the passing mark which is 50 out of a hundred. Only few cases managed to get high marks which impacts the mean of the total marks and makes it looks closer to the passing mark. Actually a very small number (about five per cent) managed to correctly interpret the substitutes mentioned in the given statements. .

Table 3. Mean and standard deviation of the test marks

	N	Minimum	Maximum	Mean	Std. Deviation
Test Marks	**100**	**5.00**	**90.00**	**45.00**	**20.31**
Valid No.(likewise)	**100**				

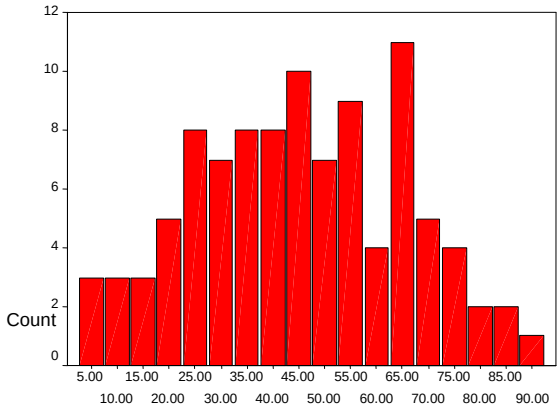


Figure 4. Frequency of test marks

V. Discussion:

This study examined the ability of a sample of Libyan university students to correctly interpret the substitutes mentioned in written texts and its impact on their reading comprehension. The results of the quasi-experiment organized in the research revealed that the majority of the study participants failed to get the passing mark which is 50 out of a hundred. This result suggested that the participants did not manage to correctly interpret the substitutes (i.e. *one, ones, do, so,* and *not*) mentioned in the statements given to them. This could be attributed to the following reasons:

1. Cohesive substitution is grammatical in nature which means that students who are weak in English grammar are not able to recognise and interpret the substitutes mentioned in any written text correctly. Libyan university students are taught traditional grammar rules with no reference to their semantic functions. The best students can narrate grammar rules, answer English grammar questions and get high marks but this knowledge of grammar is not reflected in their reading comprehension tests. For instance, semantic terms such as patient and agent are something new to many students.

2. Also cohesive devices as Halliday and Hasan (1976) term and classify them are something new to most of the Libyan students learning EFL. These items should be explicitly taught to Libyan university students in their writing and reading comprehension courses. Giving simple examples in the form of statements is not enough for comprehending how to recognise these ties and how to benefit from their existence in normal authentic texts. In practice it is usually difficult to differentiate ,for example, between ellipsis and substitution. In the linguists' view, *substitution* requires an explicit linguistic form such as *do* and *one* to refer to the presupposed item, whereas in *ellipsis*, no linguistic item is used to refer to the presupposed item.

3. When readers or listeners encounter an elliptical or substitute clause, they need to supply the missing words, which provide a cohesive relationship with what has been stated before. As cohesive ties conjunctives, reference, ellipsis, substitution and lexical cohesion are used by skilled writers to signal and guide readers to get the correct meaning they want to convey. Students can only benefit from their existence if they recognise these relationships and how they operate within a text which is difficult for many foreign language students.

4. As stated above, most of linguists and educational researchers have found out that interpreting the substitutes used in texts is not easy for students studying English as a foreign language. For example, in an experimental study Shokouhi et al. (?) found that students who process a cohesive text found that substitution and ellipsis were more difficult for students to process than other cohesive devices such as reference and lexical cohesion.

VI. Conclusion and recommendation:

This research work investigated the ability to correctly interpret the substitutes found in written texts and its impact on the reading comprehension of Libyan university students learning EFL. A hundred students from Al-jabal Al-gharbi university, Faculty of Arts-Gharian, English Department participated in this study. Their reading comprehension with the focus on substitution as one of the cohesive ties was tested. The results suggested that the majority of the study participants failed to recognise and benefit from the substitute items found in the test statements and consequently failed to understand the messages the writer wanted to convey.

This may have many pedagogical implications. Cohesion and cohesive ties are very important tools used by most of the writers to help readers understand any

authentic written text, whether it is long or short. This means that these devices need more attention from teachers of writing and reading comprehension courses. Actually, every individual tie should be explicitly taught with enough exercises by using long authentic texts. Modified artificial statements prepared for teaching the cohesive ties are not enough for Libyan students studying English as a foreign language.

Curriculum designers are recommended to have enough exercises in the materials they publish. Integrating grammar in text comprehension is vital technique to benefit from the grammar rules students used to learn by heart. Reading is an interactive process which includes the integration of all the grammatical and structural information available in the text together with the knowledge of the world to guarantee the correct interpretation of the message the writer wants to convey.

At last, the study recommends to using various activities and encouraging students to improve their reading comprehension performance. Teachers are recommended to select the suitable materials for their students with the appropriate language level and interesting topics to encourage them.

Finally, we hope that teachers, students and curriculum designers can benefit from this work and have better readers who can read with confidence and satisfactory understanding.

References:

Al-Jarf, R., S. (2001). Processing of Cohesive Ties by EFL Arab College Students. *Foreign Language Annals*. Vol. 34, No.2.

Cook, G. (1989). *Discourse.* Oxford: Oxford University Press.

Gutwinski, W., (1976). *Cohesion in literary texts*: *A study of some grammatical and lexical features of English discourse*. The Hague: Mouton.

Halliday, M. A. K. and Hasan, R., (1976). *Cohesion in English*. London: Longman.

Hasan, R., (1964). *A linguistic study of contrasting features in the style of two contemporary English prose writers*. Thesis (PhD). University of Edinburgh.

Hasan, R., (1968). *Grammatical cohesion in spoken and written English: Part one*. London: University College, Longmans Green and Co Ltd.

Harris, A. J. (1979). *How to teach reading: A competency based program*. New York: Longman.

Innajih, A. A., (2007). *The Impact of Textual Cohesive Conjunctives on The Reading Comprehension of 4th Year English Major Students in Libyan Universities.* Thesis (PhD). University of Newcastle. UK.

Louwerse, M. M., (2000). *From cohesion in text to coherence in comprehension*. Thesis (PhD). University of Edinburgh, UK.

Martin, J. R., 1992. *English Text: System and Structure*. John Benjamin's Publishing Company, Philadelphia.

Moe, A. J., (1978). Cohesion as a factor in the comprehensibility of written discourse. *The annual meeting of the national reading conference*. Florida: St. Petersburg.

Monson, D. (1982). *Effect of Type and Direction on Comprehension of anaphoric Relationships*. ERIC No. ED 298003.

Nunan, D., (1999). *Second language teaching and learning*. Canada: Heinle and Heinle Publishers.

Nuttall, C., (1996). *Teaching reading skills in a foreign language*. 2nd ed. Oxford: Heinemann English language Teaching.

Quirk, R., Greenbaum S. Leech G. and Jan S., (1985). *A comprehensive grammar of the English language.* London: New York: Longman.

Salkie, R. (1995). *Text and Discourse Analysis*. London: Routledge.

Smith, F., (1985). *Reading*. UK: Cambridge University Press.

Widdowson, H. G. (1983). *An Applied Linguistics Approach to Discourse Analysis. PhD Thesis*. University of Edinburgh.