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Language Acquisition

Part 3 of 3 *Language Universals – Lexical Contextures* *Sociocultural Heritage*

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ABSTRACT

In the third and last part of this work, we will develop two aspects that seem central when explaining how it was possible for us to acquire a natural language (NL) that allows communicating the vicissitudes posed by our universal language (UL). We refer concretely to linguistic universals and lexical categories, which will be known here as lexical contextures, but not observed from the grammar, but from a way of seeing reality. Applying everything learned so far, through the transcurssive logic (TL), we will try to give a coherent answer to questions that undoubtedly represent the key to understanding the place that occupies, in our subjective reality, the NL, and its relationship with the acquisition of conventional code, without the need to resort to any of the ontogenetic theories outlined in the first part of this work. Finally, after pointing out the importance of universals, lexical contextures and social inheritance in the acquisition of language, we will outline the general conclusions of the whole work.

Keyword: Natural language, language acquisition, Psycholinguistics, Transcurssive Logic.

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1.0 INTRODUCTION

In living beings, the phenotype depends on the activation of genes according to a pattern of hidden colors, as we saw in the second part (Salatino, 2018). In a linguistic simile, the structuring of the

expressions of the different natural languages could follow a pattern of hidden colors that would make it possible to arrange each expressive element in its proper place. Thus, constituting the true language in which a language (Universal Mother Tongue - UMT) is written, which has nothing to do with the language that communicates on the surface or Natural Mother Tongue (NMT). Therefore, two languages, however different they may seem, could have a similar hidden arrangement and, then, the superficial difference should be, to 1) an alteration, not of the code, but of its interpretation and 2) an alteration of the elements that grant their identity. That is a different production of hidden colors.

What we want to express is that the relationship between the UMT and the NMT is similar to the one we can find between the genotype and biological phenotype.

The preceding is closely linked to the much-promoted opposition between universals and linguistic typology. In total agreement with what was sustained by Comrie (1989, p.35), we can say that these aspects, more than antagonistic, are complementary. Moreover, in reality they observe among themselves a triple relationship: opposition, complementarity, and concurrence, that is, what we already know as a complex relationship.

The language, both universal and natural, as we have already shown, obeys a common logical pattern with all subjective reality. This pattern (PAU), as we have already seen, is structured as an opposition: subject/object, mediated by another opposition: similarities/differences. Universals and typology, precisely, also show this last opposition, that is, to proclaim the existence of universals is to accept that among all known languages there are concrete and irreducible similarities. On the other hand, the attempt to typologically characterize the known languages is equivalent to the acceptance of obvious differences between them.

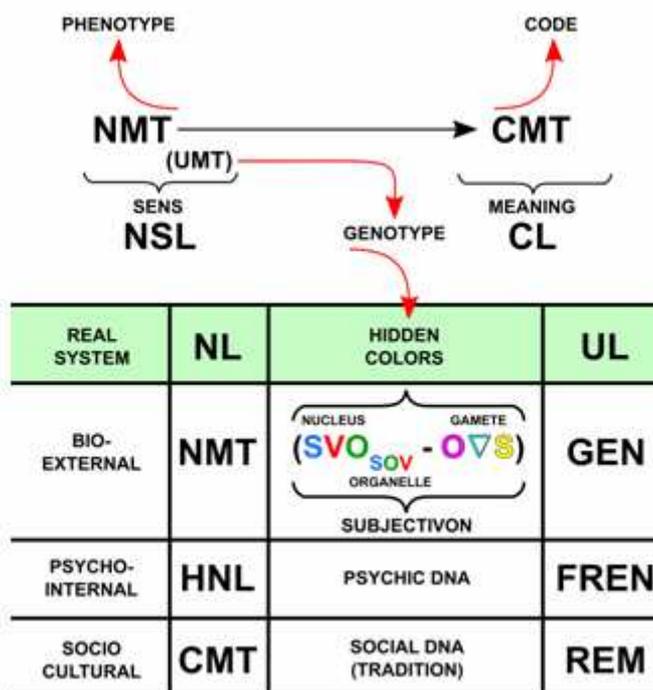
The transcurssive logic (TL) allows the study of these important aspects to understand our language a little better and does so from a genetic proposal. The genetic here differs substantially from the method proposed by Greenberg (1957) who addressed both the universals and the typology from a widely criticized 'comparative genetics.' However, I want to rescue the enormous and brilliant work of this linguist because, beyond being one of the primary sources of inspiration for the fundamental structure of the TL, he proposed solutions to substantial issues that, according to my estimation, are not so wrong.

The concrete proposal presented here is based on considering universals and typology as genotypic and phenotypic manifestations, respectively, of a specific language. That is, the implicit similarities and explicit differences that approximate and move away one language from another.

The universal has in this work, two different meanings that derive directly from the issues addressed. Both the 'order of words' and some lexical categories are considered universal. In the first case, the six possible logical combinations between the three constituents of a clause (S, O and V), proposed by Greenberg, that is: SVO, OSV, VOS, OVS, VSO and SOV, force us to divide the languages in two large groups: those in which some order of these becomes manifest and those that show a free order, since all languages belong to one of these patterns, of course not taken in the grammatical sense but transcurssive, that is, as subjectivons. What happens is that in those languages that appear to have no prevailing order, in reality, it is implicit, or what is the same, is part of its "genetic structure" that does not become manifest, but always is; they are "inactivated genes."

In the case of the lexical categories, as will be seen later, only the noun is justified as universal, and the treatment of the temporal axis that each language makes is added, based on superficial and deep aspects that the TL can characterize from the subjective, as the most essential functional facet of natural language. Figure 1 shows a comprehensive view from our perspective. There one can observe the relationships that link the different languages described in this work and also provide details that help to understand how its acquisition is possible.

Figure 1. Linguistic genetics



References: NMT: natural Mother tongue – CMT: conventional mother tongue. UMT: universal mother tongue – NSL: natural symbolic language – CL: conventional language – HNL: human natural language – NL: natural language. UL: universal language – CL: conventional (everyday) language. GEN/FREN/REM: structural units of real systems

In the previous figure, we can see the relationships that link the different languages described in this work and also provides details that help us understand how your acquisition is possible.

First, the relationship between NMT (phenotypic) and UMT (genotypic) is highlighted. This relationship is what serves to communicate the meaning of a fact, through the NSL. From here the CMT (the code) is derived, which carries a meaning that expresses through the CL.

The genotype is sustained, for its expression, in a series of hidden colors that determine the genetic behavior of a specific NMT. These "colors" are hidden in the subjectivon or in the "cell" in which the domain of a UMT is structured. There are its noble elements, that is, its nucleus, its gamete and its organelle (s), which define how an NMT will be and evolve, thus establishing a simile with the biological DNA.

From the NMT derives the HNL, of symbolic nature, which is acquired according to what is structured in the psychic DNA, as we will see in detail in this third part. For now, we will say that this acquisition is based on universal aspects that we will later develop. Finally, a CMT is acquired based on a logic that is reflected in the constant and automatic use of its categories, until it creates perceptive habits that divide the evident reality in a different way among the different populations, something that is later expressed in the grammar of its CLs. As defined by Chomsky (1992, p.278), a grammar is a system of rules that generate an infinite class of "potential percepts", each with its phonetic, semantic and syntactic aspects, the class of structures that constitute the everyday language in question, and we would add, facilitated by the social DNA, that is, the tradition that substance the social heritage.

All previous development is governed by a single UL, which is made manifest in the respective structural units (GEN, FREN, and REM) (See Appendix A), according to the real system from which the considered language derives.

2.0 ABOUT THE LINGUISTIC UNIVERSALS

The subject of universals, so discussed among philosophers in the first place and then among linguists and philosophers, has reached, according to what Mairal and Gil (2006, p.vii) see, regarding the linguistic approach, a moment of adequate explanations, by offering satisfactory answers to the why of the differences between the different languages. These answers are based, from the cognitive sciences, on the supposed demonstration that the differences are only superficial, since, there are also supposed and undeniable regularities that underlie their deep structures.

The previous assessment that carries the indelible Chomskian stamp, in fact, never constituted an adequate response to not being able to demonstrate concretely, that pretended double structure of the simple code, the one that sheltered in the tautological 'generative grammar,' that aspired to be a reflection of innate patterns controlled by the brain.

The problem of universals is neither philosophical, nor linguistic, but psycho-bio-sociocultural and is not even a problem, quite the contrary; it is a subjective solution to the real question: to survive.

However, we are going to approach the issue from the linguistic point of view because it is the closest approach, in appearance, to the subjective since it involves our preferred means of communication. However, we will not fall into the cognitive temptation to consider the distinction between internal (or theoretical or Chomskian) universals and external universal (or empirical or functionalist, semanticist or cognitive pragmatists: of Langacker, Dik Van Valin, Bybee, among others). We will only do a sterile analysis, by hybrid, for two reasons: first, to avoid the reproduction of preconceptions and prejudices; and, second, to invoke the order of words in a very superficial way, because it resembles in the terms, although not in the meaning, to our nomenclature and because in some way, it has syntactic connotations, just like our UL. The second reason forces us to also consider, the proposal of Greenberg.

Among the various proposed linguistic universals are those referred to the syntax and specifically, in what refers to the order of the words.

According to this criterion, languages are divided into configurational or those that are rigidly adjusted to a specific structure and those that are not configurational or that do not follow any predetermined scheme (Greenberg, 1963, pp. 73-113). Among the first ones, the Greenberg typology refers, among other aspects, to the position occupied by the Subject, the Object, and the Verb. Examples are Spanish (SVO) or Basque (SOV). Among the latter, we have, for example, Russian, with sequences: SVO, OVS, and VSO, which are used according to the context. The initial proposal of Greenberg included three types of languages, which he identified as I, II and III and represented the languages known today as VSO, SVO, and SOV, respectively. Over time and in the face of practical evidence, this initial amount was extended to cover all the combinatorial possibilities between the three essential elements, that is, they were added: VOS, OVS, and OSV.

Lehmann (1978, p.3) reduced the six previous types to only two: OV and VO, arguing that what was important was the order that the verb (V) kept concerning the object (O) and that the position of the subject (S), it was not important.

According to Lehmann, the VO languages would include the sequences: SVO, VSO, and VOS of Greenberg; whereas the OV would consist of the sequences: SOV, OSV, and OVS.

Currently, of the many proposals that emerged over time about universals, these two are considered to be those that remain in force: Greenberg's functional, of inductive nature and Lehmann's formal, of deductive nature. We will not consider the contributions of Vennemann and Dik for being of restricted management.

2.1 Greenberg's functional proposal

Many of the universals proposed by this author, out of a total of 43, formulate them regarding an implication, that is: if a language X has a property a, then it also has property b. Generalizing we can say: if x then y, and from here we get to:

Table 1. Functional proposal of Greenberg

x and y	11
x and not-y	10
not-x and y	01
not-x and not-y	00

In the previous table, extracted from Comrie (1989, p.17), x = absolute and y = unconditional. The binary digits are the correspondence with the transcurssive logic. Dik (1997, p.27) shows the following table, where, with some modifications, there are four types of universals that are distinguished from the work of Greenberg (1963):

Table 2. Greenberg's universals

	IMPLICATIONAL (0)	UNCONDITIONAL (1)
RELATIVE (0)	TYPE D (00)	TYPE (01)
ABSOLUTE (1)	TYPE C (10)	TYPE (11)

TYPE A (11): Absolute and unconditional: all languages have the property x. For us it is the property that arises from the obvious, that is, superficial change.

TYPE B (01): Relative and unconditional: almost all languages have the property x.

TYPE C (10): Absolute and implicative: if a language has x, then it also has y. These are, in our case, universal tendencies or linguistic generalizations, rather than true universals.

TYPE D (00): Relative and implicative: if a language has an x, it will probably have a y. For our proposal, here are the true universals, those that remain hidden or that are not evident to the naked eye, that is, our primitive substantive and the temporal axis, which is in the +7000 languages known today in the world.

Comrie (1989, p.18) says that the following rule is fulfilled: there are always three of these four universals, in any language. That is, one is still hidden.

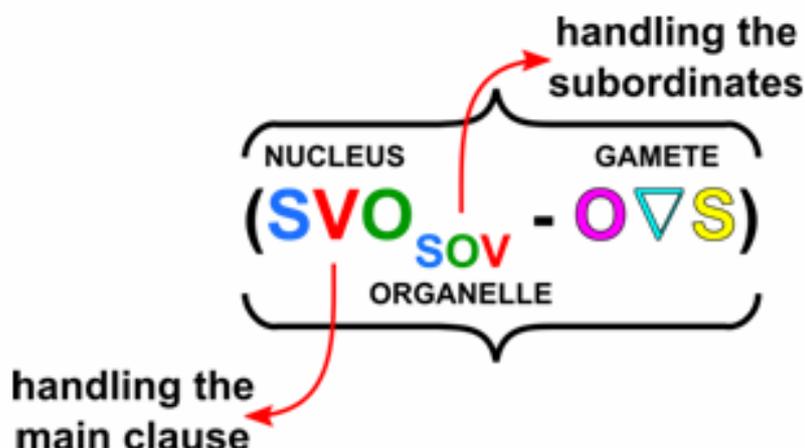
According to our proposal, types A, B, and C are phenotypic (superficial and evident), while D is genotypic (hidden and profound) and genuinely universal. This coincides entirely with the ABC model of the hidden colors and the Goethe proposal that we will see later, and thus Comrie's rule would be explained, three of the four types are fulfilled. One is always hidden, and that is, in my view, the true universal, because it is what conditions all others, that is, makes them manifest either alone or combined and can even come to hide them completely.

The conception of universals as a list constituted by the superficial variations of a large number of languages, including all of them, is likely to lead us to commit errors when assigning them to a particular type.

In German, for example, the controversy over the basic order of words could not be resolved until the underlying SOV order was noticed (German is SVO, like other germanic, English, pe). Through the syntactic operations that characterize the phenomenon of the verb in 2nd position (SVO), all the apparent orders of this language could be explained without problems, without the need to suppose that the main clauses, which are SVO, followed a different basic order subordinate or adverbial (among others), which are SOV.

The above, Givón (2001, p.247) explains it this way: when the main verb is grammaticalized, of the conservation of the position to the left of the complement [levo-rotated], it automatically becomes, the order of the words of the main clause, that is, SVO, that is, subordinate, adverbial, etc. They are more conservative (they persist in the OV format), while the main clause is more innovative, adopting the VO format. In our scheme, the German would behave as if we were facing a language 'inside another' or a second language had been acquired, that is, the scheme would be (Figure 2):

Fig. 2. German genetics



Is this why the German is so similar to English (which is SVO) (both are Germanic languages) and not Spanish (Romance language) which is also predominantly SVO? Answering this question would be important because it is being said that there are superficial elements that link the different languages of the different families (the right and left variants). But also, that there are deep elements that do so and explain why there are languages like Russian, for example, that has a surface order free, although it shows a slight levorotatory tendency in some of the variants.

2.2 Lehmann's proposal

This reduction approach divides the languages into VO and OV, which allows integrating other correlations, in addition to those suggested by Greenberg, and include within this simple scheme, more languages. The following table summarizes the most important guidelines of this approach.

Table 3. Lehmann's proposal

VO	OV
SVO	SOV
VSO	OSV
VOS	OVS
COMPLEMENT TO THE RIGHT	COMPLEMENT TO THE LEFT

In the previous table, the Greenberg patterns are grouped in the two types of languages, and also the concomitance factor is highlighted, that is, in the OV languages the concomitant element of O is V, to the right, therefore, the rest of the modifiers of O will go to the left (complement to the left). The same, but in the opposite direction, happens with the VO languages.

The above does not coincide with the disposition of the universal patterns proposed in this work, which is:

Table 4. Transcurssive proposal

D _x	L _v
SVO	VSO
VOS	SOV

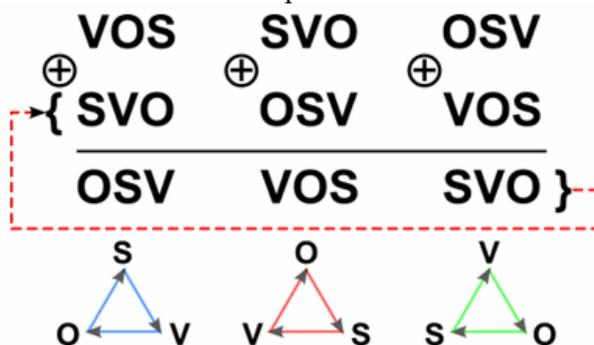
As clearly seen in the table, there are two "crossed exceptions" (*) to the Lehmannian rule. The most frequent patterns are SOV and SVO (in that order), as established by Greenberg. Each of them is the paradigmatic pattern of the divisions suggested by Lehmann, that is, OV and VO, respectively. Our proposal characterizes the paradigm of the OV languages as levorotatory (L_v) and

that of the OV as dextrorotatory (D_X). Our difference concerning Lehmann derives from where we group the rest of the ordering possibilities.

In favor of Lehmann's proposal is that associations OV / VS and VO / SV are more frequent than OV / VS and VO / SV. In favor of our proposal is that SVO is an intermediate form between forms with initial V and final V (Dryer, 1991), which gives rise to our right-handed variant: SVO → OSV → VOS, thus nucleating three of the six defined domains by Greenberg.

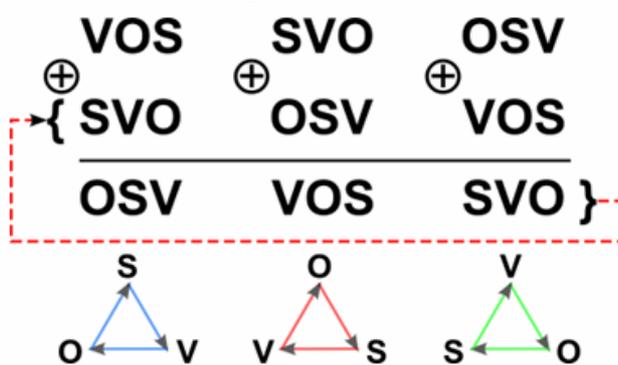
The above is a true variant of languages grouped in this way, and on the other hand, would agree with those who do not accept VSO as a possibility VO, by interposing the S. This sequence also responds to the calculations made previously, as shown in Figure 3.

Fig. 3. Circle to the right in the dextro-rotated superficial variants



The levorotatory variant could be constructed in the same way and respond to the same calculations. That is SOV → VSO → OVS, according to Figure 4.

Fig. 4. Circle to the left in the levo-rotated superficial variants



In the previous case, the intermediate form (OVS) would be the mirror image of SVO. Everything of the levorotatory variant is not proven, or, better said, it is not investigated, it is only a synthesizing induction.

There are some 'linguistic' details, not minor, that could support our proposal. For example, the investment of the SVO order in the order VSO, which is one of the exceptions, present in different constructions that denote emphasis. Thus, in English poetics (English is SVO) we can sometimes find the order VSO. Sentences in Arabic use the order SVO or VSO, depending on whether the important one is the subject or the verb, respectively. The non-VSO languages that use the VSO order in the interrogative form are: English and other German languages; French and Spanish (not always). With all the above it is demonstrated that VSO is less VO than levorotatory.

Something similar happens with the form OSV (the other exception), which, although it is a rare form, is seen in some Brazilian languages (Xavante, Jamamadi, Apurona, Kayabí, and Nabeti) and in spoken Italian. It is not uncommon in Yiddish, where it is used to highlight different

properties of the object. It is occasionally seen in English (future tense) or used with the conjunction "but." Both in English and in German, it appears in the relative clauses where, the relative pronoun, is the object (direct or indirect). It is also used in the American sign language. Other languages that use OSV are Arabic and the passive form of Chinese. Finally, and here is the most important detail, it is one of the two most common orders in Malay, the other is SOV. That is, it is shown that OSV is less OV than dextrorotatory.

If we take the Comrie table based on Greenberg, seen above, and distribute it in the six Greenberg universals (SVO, OSV, VOS, OVS, VSO, SOV) and then we distribute it according to the Lehmann division, with the reservations made previously, the "unification" of the two proposals is achieved. The functionalist (Greenberg's inductive) and the formalist (Lehmann's deductive), in one and universal. The abductive, proposed by the TL and that as we saw, serves as support to the UMTs, which will give rise to all the NMTs, which are acquired to respond to a UL that regulates all the real systems: the bio-external, the psycho-internal and sociocultural.

2.3 Genetics of the order of words

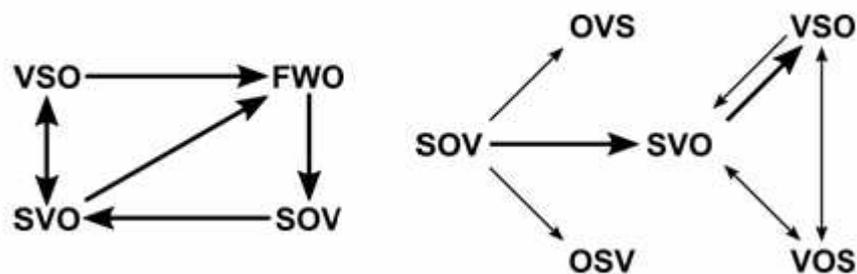
The great contribution of Greenberg's work (1963) was not to inventory the order of words but to recognize the existence of strong correlations between what appeared to be independent syntactic structures. In any case, he pointed out that of the six theoretical orders there were only three: SOV, SVO, and VSO. According to Gell-Mann & Ruhlen (2011), the works carried out in comparative linguistics suggest that all or almost all the languages now recognized, could derive from a previous language. If this is the case, these authors say, almost all the existing languages started from a basic "ordering" of the subject (S), the verb (V) and the object (O). From their comparative work, researchers draw three conclusions. 1) The order of the words in the ancestral language was SOV; 2) The direction of the syntactic change, when it occurs, has been for the most part SOV > SVO, and beyond, SVO > VSO / VOS with an occasional reversion to SVO; and 3) The two extremely rare word orders (OVS and OSV) derive directly from SOV.

Vennemann (1973) represented a possible order in the changes that the possible combinatorial patterns suffered. Figure 5 (left) shows that an SOV language can change only to SVO. SVO language can change to VSO or remain as a language with free word order (FWO) in which S and O can be marked by affixes, as in Russian. A VSO language can, at times, revert to the SVO type or become an FWO language. Finally, FWO language can, gradually, evolve towards the universally preferred type: SOV.

Gell-Mann & Ruhlen (2011), meanwhile, outlined a scheme (Figure 5, right) that illustrates the possible directions of change in word order. Thick lines indicate the most frequent changes, while the other lines indicate other possible changes. The suggested changes agree with what was proposed by Dryer (1991), who proposes that, naturally, the changes occurred from the OV > VO languages.

Fig.5. RD order models

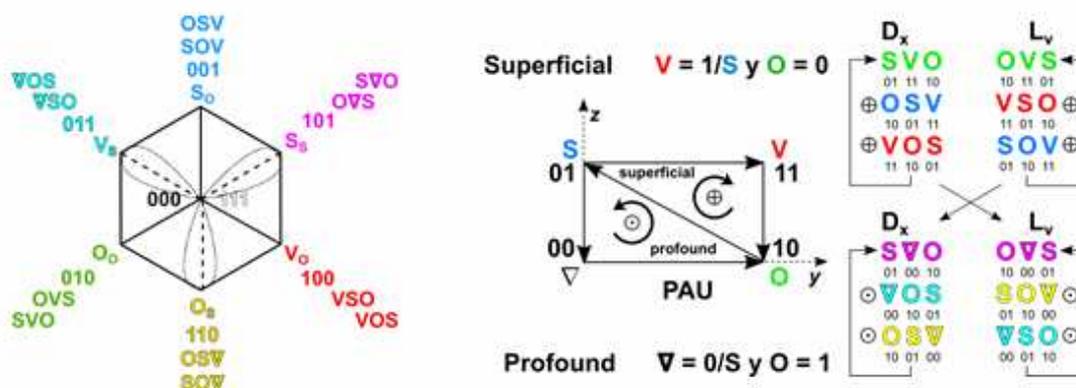
Left: Vennemann – Right: Gell-Mann & Ruhlen



The TL provides a genetic model of the "order of words" based, on the one hand, on the pattern of hidden colors of a REM analyzed in the second part of this work. On the other side, in the structure established for a subjectivon.

Figure 6 shows the disposition of the "continents" that constitute our psyche and that allow us to make sense of a "real fact." Understanding by "real fact" the existing relations between a subject (S) and a generic object (O), using a double transformation (V / ∇), where the S is the source of those changes and the O the transformation (V / ∇), where the S is the source of those changes and the O the destiny of them. These references will be handy later when we approach the mechanism of acquisition of the lexical contextures.

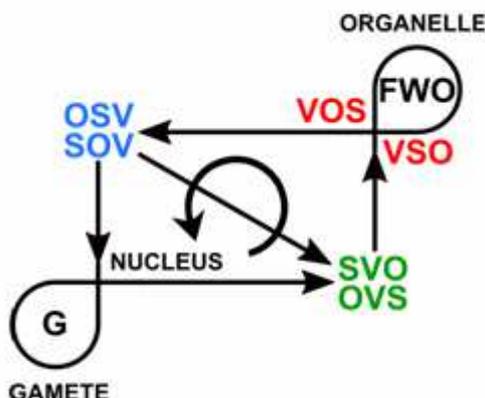
Fig. 6. The continents that structure the psyche and the hidden colors of a REM or real fact



The scheme on the right side of Figure 6 justifies the assignment of the primary and secondary colors to the six universal patterns. Figure 6 (left), using the "genetic scheme" of a subjectivon, distributes the universal patterns and relates them according to the succession of changes proposed by the previously analyzed models.

We must emphasize that the model proposed by the TL (Figure 7), unlike the others, constitutes a dynamic expression of what is supposed to have occurred in the evolutionary history of the origin of our language. Dynamics that we see in this work is a replica of what happens when our psyche is formed, as we will see later.

Fig. 7. Genetics of words order



The previous scheme shows that, according to the proposals already reviewed, the "universal ancestral pattern" is SOV. All others derive from or are associated with it, forming something similar to the "core" of a subjectivon. In the appearance, there are those patterns that represent a change in themselves (they are preceded by an action) and as an "organelle", figure the "free word order" (FWO), which explains the apparent behavior of some languages that do not seem

to have a base pattern. Finally, the rest of the changes are given in a dynamic but hidden (deep) way whose support is in the "gamete" (G) of the subjectivon. When the system iterates several times at the apparent or superficial level and no significant change occurs, the way to generate "genetic variability" is to appeal to the "gamete", so that once the "order of words" is reorganized, all start again.

3.0 LEXICAL CONTEXTURES

Lexical contextures, taken as "word classes" (see Appendix B), and used as a frame of reference for language acquisition, present two significant limitations: 1) not all known languages show all lexical contextures, nor do they use in the same order and 2) do not coincide, in all languages, with the same conventional semantic categories.

The above considerations give grounds for suspecting that not only there are no structures, but also neither is there universal functions. If the apparent characteristics are not constant, nothing prevents us from seeking the constant in what underlies that changing mantle.

Given the biological connotations that we have given to natural language, it, like any living being it is subject to two aspects that determine its appearance. That is, if two different languages are subjected to the same changes, they will show different states and do so in total consonance with their nature. This mutability of form, but not of function, would explain why different languages "respond" meticulously to particular causes, in a certain way and not of another (Theory of transference, Tesnière, 1965). The question is to unravel the laws that govern the mutability of form through the establishment of a function, to explain, the evolutionary adaptation and its 'intention' to survive, as we would do in the subject that makes natural language possible.

The germ of these presumed laws may be in accepting that the complex evolves from something simple. This means, neither more nor less, that natural language arose from an archetypal language, that is, from a universal language (UL). There would be no way to be able to state categorically that such or such a manifestation constitutes a language if they did not come from the same model. Although it can be argued that both the UL and the UMTs to which it originates are "theoretical constructs," no one can deny that the different known languages have specific characteristics, which are not fixed but can be given about a vast series of variations of an initial model.

All this suggests that it is as if the subjective reality were based on this archetypal language to elaborate each of the +7000 languages that we know today.

The individual changes exhibited by the different languages are, according to our proposal, the diverse expressions of an archetypal language that has within it the innate capacity to assume multiple forms and assign them different functions. Aspects that will adapt to the context to be able to evolve, once created.

Some details of the archetypal language, as we have already seen, allow us to show that it has autonomy, like any living being. For example, create different manifestations from itself and that these depend on a complex interrelation between its constituent elements, that is, they formed a true system, open and closed at the same time, which is affected by a continuous evolution or passing. The emergence of different languages is possible, insofar as each form/function that characterizes them is constituted according to a primary form/function. The latter is like saying that each aspect governed by a specific language is constructed according to the same formative type, that is, as if 'the whole language' were contained in each of its parts, and that, under appropriate conditions, each evident aspect can be created from any of them.

In this paper, it is postulated that the noun (See Appendix B) is the true universal of all existing languages. In fact, as a lexical structure, it is the only one that, on the surface, practically it is never absent. As we will see later, on this fundamental stone and guided by the model that represents the original language, the architecture of each known language will be designed, and the bases will be established to understand the phenomenon of natural language acquisition, which would be possible because each language would behave as a harmonious whole composed of other

languages. As conceived here, a language is only a noun as a "totipotential" seed (See Appendix B). Something similar to the "leaf" as the origin of all the organs of the flowers, according to the proposal of Goethe, that we will see next.

This allows us to affirm that each language evolves from contexture to contexture. Each one of these lexical contextures (here the name "lexical" is appropriate because, on the surface of the conventional language code, it will end up being expressed by one or more words) is identical to the others. Although different in its appearance (form) and fulfills a certain function according to the "place" it occupies in this interrelation, which gives it a particular identity. What produces that apparent difference of the lexical contextures, which, according to an internal principle, are identical? How is it possible that the laws that govern the evolutionary process of a language according to a single principle, can create once a noun and another a verb?

In principle, the answer to these questions is not in what can be evidenced by analyzing the apparent form of these manifestations, as has been done over time, for typological purposes, but as we already anticipated, the answer lies in what lies beneath.

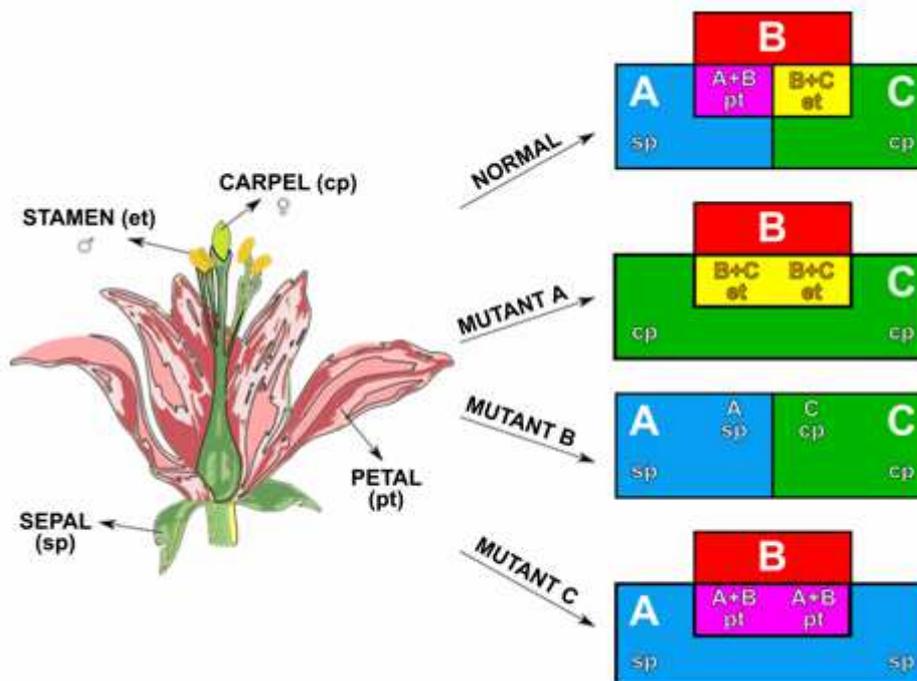
To reaffirm our proposal, we will take as reference two models, one that emerged from biology and presented by Coen and Meyerowitz in 1991, called ABC model, which is based on the remarkable predictions made by Johann Wolfgang Von Goethe 200 years before, and the other from linguistics, created by Hengeveld in 1992, oriented towards typology.

Goethe, the immortal genius of the literary world, in 1790, reflected in his small and delightful work: "The metamorphosis of plants" the hypothesis that the organs of the flowers had as a common origin the leaf, understood as a universal structure: "Even in regular and constant formations, nature has many ways of revealing the wealth hidden in a leaf." (Goethe, 2009, p.67).

Coen and Meyerowitz based on the principle elaborated an explanatory, simple and elegant model of the formation of the organs of the flowers. (1991, pp. 31-37).

Three genes called A, B, and C (hence the name of the model) will be responsible for the formation of *sepals* (sp: flower calyx), when gene A is expressed; of the *petals* (pt), by the simultaneous expression of genes A and B; of *stamens* (et: male floral organs), by the joint expression of genes B and C, and of *carpels* (cp: female floral organs), by the expression of gene C (Figure 8).

Fig. 8. ABC model and hidden colors model



Genes A, B, and C are not true genes, but functions that fulfill a group of genes that can vary, within narrow limits, from one flower to another.

In 1999 Enrico Coen presented the model, assigning each gene an arbitrary color. We, in the previous figure, have chosen to assign the primary colors of light (blue, red and green), then according to the detail given above, the different organs will assume a color that, in some cases, will be the result of the combination (in pairs) of these three basic colors. That is to say: the **sp** will be blue, the **pt** will be magenta, the **et** will be yellow, and the **cp** will be green. In this way, as we can see in the figure, using the colors we can identify the genetic composition of the different organs in the normal flower, but also and here lies the usefulness of the metaphor of the colors, in the flowers that they show anomalies caused by genetic mutations. In this model, a mutation is represented by the absence of a particular gene (Coen, 2000, p.54).

A mutant flower A (Figure 8 - scheme without gene A) will have a genetic structure: **c, bc, bc, c** (colors: green, yellow, yellow, green) and will show the organs: *carpel, stamen, stamen* and *carpel*, that is, it will lack *sepals* and *petals*, it will only have reproductive organs. A mutant flower B (Figure 8 - scheme without gene B) will have a genetic structure: **a, a, c, c** (colors: blue, blue, green, green) and on the surface will show the organs: *sepal, sepal, carpel* and *carpel*, that is, the *petals* and *male organs* will be missing. Finally, a mutant flower C (schema without gene C, in Figure 8) will have as its genetic structure: **a, ab, ab, a** (colors: blue, magenta, magenta, blue) and show as organs: *sepals, petals, petals*, and *sepals*, that is, will lack sexual organs. Therefore, it will be a sterile flower. This last case represents the so-called "double flowers," the most beautiful, which far from being a "super flower," constitutes a serious genetic anomaly that sacrificed the sexual organs by petals, changing the offspring (profound) by beauty (superficial).

The description of the effects of hidden colors has been done in the negative sense, that is, showing what happens when one of them is removed and represents the inverse way in which one learns about the language of DNA through mutations, where it is observed what happens when a particular gene is defective. Using a positive analysis, from the hidden colors, we can say that there exists in the plant a specific set of genes, which we will call "genes of the identity" of organs, dedicated to producing the set of colors **a, b** and **c**. The positive meaning of these genes is that they ensure that a certain color will be produced. Mutations, where one of these genes is defective, will result in the loss of color and, therefore, change the identity of the organ to be developed.

Importantly, neither the genes nor the colors represent the instructions on how to build a certain organ. They simply tell us about the "region" where a specific organ should be located, linguistically, it's just a syntactic problem.

This model that we have just described was also applied to the rest of the living beings, as we saw earlier in the case of the *Drosophila Melanogaster* (Salatino, 2018) fulfilling itself completely, the predictions that Goethe made.

The linguistic model we have chosen is the one elaborated by Hengeveld in 1992, and in which the author proposes a differentiation of the kinds of words that can be used, among others, for typological purposes. This differentiation is based on the syntactic function that each lexical item fulfills so that the order of the words of a language can be partially determined, by the system of parts of the sentence of that language. This model in spite of the adverse criticisms (e.g., Croft, 2000), has enormous practical value because it allows a general view of the theoretical and real possibilities of organizing, according to well-established functional criteria, the kinds of words. The following table shows the elements considered for the model.

Table 5. Hengeveld's model

	NUCLEUS	MODIFIER
PREDICATIVE PHRASE	VERB	MODE'S ADVERB
NOMIAL PHRASE	SUBSTANTIVE	ADJECTIVE

As can be seen in the table, only the mode's adverb is included as a modifier of the verb, because the other classes of adverbs, rather than modifying the core of the predicate, modify the sentence in its entirety.

From the analysis carried out on 40 languages of very different origin, the author concludes that these languages can be divided into three large groups: 1) the *differentiated or specialized*, where each morphology takes its place (same morphology, same place); 2) the *flexible* ones, where the same morphology occupies different place; and 3) the *rigid* ones, where different morphology occupies the same place

Another parameter that establishes the model is the hierarchy of word classes. Some regularity is detected regarding the question of what functions a specific type of word is lacking and what functions can be combined in a single word class. (Hengeveld, 1992, p.68). The established hierarchy is:

VERB > SUBSTANTIVE > ADJECTIVE > ADVERB

This hierarchy says that a category of predicates is more likely to occur as a separate word class, further to the left of the hierarchy. From the combination of the two aspects analyzed, there is a classification of the word class systems in seven main types, according to Table VI (Hengeveld, 1992, p.69).

Table 6. Word class system

Flexible	1	1	V/S/Adv		
	2	V	S/A/Adv		
	3	V	S	A/Adv	
Specialized	4	V	S	A	Adv
Rigid	5	V	S	A	-
	6	V	S	-	-
	7	V	-	-	-

References: V: verb – S: substantive – A: adjective – Adv: adverb

As we can see, the degree of flexibility/rigidity varies from one language to another, which is not random but is adjusted to a specific hierarchy.

We will develop the content of the previous table succinctly, saying that languages such as Spanish or English that have separate word classes for each function have a differentiated word class system. Other languages, on the other hand, do not have separate word classes for each syntactic function.

In languages such as *Warao* (see Appendix B), for example, both adjectives and nouns can be used as the nucleus or modifier of a noun phrase. This type of language is characterized as an adjective-nominal.

In other languages such as the *Garo* (see Appendix B), adjectives and verbs are used, either as the nucleus of predicative sentences or as modifiers of a nominal phrase, so they are known as adjective-verbal languages.

The *Warao* and the *Garo* also differ in other aspects. For example, in the *Warao*, both the nucleus and the modifier of the nominal phrase can occupy two different syntactic positions, but in the *Garo*, this does not happen. To use lexemes that are defined as modifiers within a nominal phrase, they must be relativized, which shows that the position of the modifier is not occupied by a lexical unit (morphological), but syntactic (functional), so the construction is transformed into a relative clause. Within this clause, the core of the predicate (the verb) functions as in the main clause.

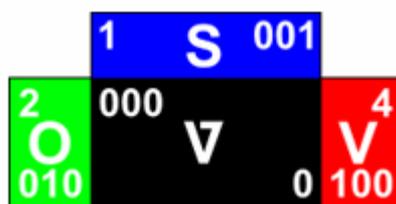
From all of the above, it is concluded that the *Warao*, because it has a type of lexeme that can occupy the position of the nucleus or the modifier within a nominal phrase, has a flexible word

class system. While the *Garo*, lacking a class of lexical elements that can occupy the position of the modifier of a nominal phrase (i.e., that morphologically lack adjectives, not so, functionally), made a non-lexical alternative (not morphological) and has, therefore, a system of rigid word classes.

To demonstrate the relationship of lexical contextures with language acquisition, we start with two basic assumptions. 1) natural language is not acquired suddenly, or as a whole, but starting from a basic structure/function (universal), it develops, and it evolves; and 2) this evolution is governed by the same logic that governs all subjective reality, that is, the differences and similarities that link in an operative unit, the complex relationships that are evident between the subject (S) and object (O).

Our demonstration will take elements of the two models analyzed previously, although with the appropriate adaptations. In the ABC model and the hidden colors, on the one hand, we will add a level of analysis, that is, it will be in any case ABCD. In fact, at a biological level, over time, the model has been extended, and today it is already considered ABCDE models, with which we are not forcing the comparison, and on the other hand, we will adapt to the handling of colors and nomenclature. Let's see all this in detail. Figure 9 shows the proposed new model.

Fig. 9. SVO ∇ Model



References: SVO: structural aspects (phenotypic) - ∇ : functional aspects (genotypic)

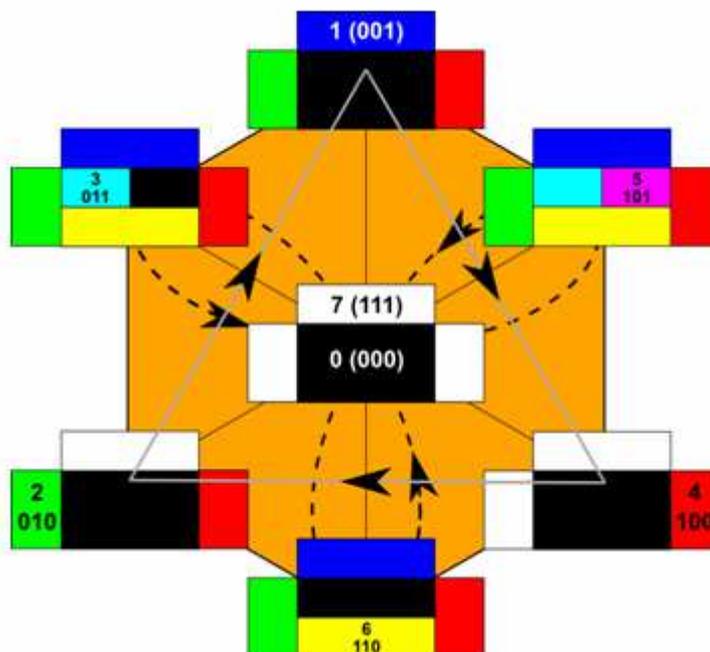
We notice in the previous figure an essential modification in the assignment of colors, which in this case are not arbitrary, but respond to the code assigned in this work, to the different contextures.

As we have said before, the colors used are those that correspond to the theory of the color of light, something that is reflected in the binary codes (and decimals) that each color shows. If the codes of the superficial aspects (phenotypic) are added, give 7 (111) which is precisely the one corresponding to the white (additive synthesis of the primary colors: red, green and blue). On the other hand, the deep (genotypic) aspects, the true hidden colors, have a 0 (subtractive synthesis of the secondary colors). Assuming that the model described characterizes any language, the method using colors is a simple way to represent the different levels considered here, as mandatory constituents of any language. This is important because we are not going to analyze the acquisition of a particular language, but natural language in general. With this we want to emphasize; first, the universal principle of the archetypal language and, secondly, that all language derives from a *subjectivon*, that is, there is no language that is not included in any of the six patterns proposed by Greenberg. That some do not show it, it is only appearance, since, at the genotypic level, the one governed by the hidden colors is present.

In the SVO ∇ model, colors do not represent genes, but contextures. However, their structure is genetic, since as we have seen, it is organized as a eukaryotic cell, with its nucleus, its gamete, and its organelle (s). The above explanation is relevant because, in this model, you cannot see the different variants (or mutants) by removing a gene, but by building them genetically. In any case, we do not consider a typological objective for the moment, but simply to show two fundamental mechanisms: a) how the natural mother tongue (NMT) is acquired through the archetypal language, and b) how natural human language is acquired (HNL), from which will derive the conventional mother tongue (CMT) and everyday language (CL).

The NMT, as well as the NHL, is not acquired all at once; instead, as we established in our basic assumptions, it is done gradually. There are fundamental differences between both mechanisms, Figure 10 will help us to understand better.

Fig. 10. Sequences in the acquisition of the natural maternal tongue (NMT) and the human natural language (HNL)



References: \triangle : dextro-rotated \cong HNL acquisition – levo-rotated \cong NMT

The first thing that must be understood is that the HNL is a consequence of a structural process, while the NMT is a consequence of a functional process. By this, we mean that, although both begin at the same time and develop in parallel (heterarchical), do not start with the same aspect, or occupy the same level. That is, the NHL is a superficial process that begins with an apparent change or transformation and is structured in the same way as the psyche does, projecting itself phenotypically into the structural syntactic (word order) of the CMT. On the other hand, the NMT is a hidden process that begins in a profound change and acquiring its operation from the universal mother tongue (UMT), it is projected genotypically in the functional syntactic (types of words) of the CMT. The previous approach from the model of Hengeveld and reducing it extremely, suggests that in the NHL what is acquired first is the verb, while in the NMT the first to be acquired is the noun. This detail, which *a priori* seems irrelevant and even whimsical, becomes transcendental when trying to characterize some pathologies that cause alterations of the word; theme of a future work.

In the preceding figure, the two heterarchical processes outlined have been expressly distinguished. His *heterarchy* (See Appendix B) becomes evident in the central area of the scheme where we have represented the two levels in which we are going to handle: the superficial one with the white color that summarizes the structural and the deep with the black color that integrates the functional.

The dextrorotatory gray triangle, which is in the foreground, tries to show the relations between the primary colors (those that additively form the white one by direct summation gives 7 (4 + 2 + 1)) which are each in the place of the obligatory components of the superficial level, as we saw in the second part of this work when we spoke of the origin of the natural human language, where the details can be refreshed (Salatino, 2018). Here it suffices to say that, adjusting in part to the hierarchy proposed in the Hengeveld model (verb > noun [noun and adjective]), the first thing

that is acquired to initiate the "order of words" is the verb or that which fulfills with its function (according to the language). Then the object and ultimately the subject, thus ensuring the symbolic character that this language that is being acquired will have. Once all elements have been acquired (closed the triangle), the pattern will be "accommodated" to the one that governs the NMT, which in turn derives from the respective subjectivon. This fit is achieved when each of the elements acquired begins to have a functionalized structure.

The black levorotatory Trifolium, which in the figure is in the background, shows the relations between the secondary colors (those that by subtractive synthesis give black. The algebraic sum gives 0 $[(4-2) + (2-1) + (1 -4)]$), and which constitute our hidden colors: yellow, cyan and magenta. Here, represented by the secondary colors, each types of words that are acquired is shown. This process begins with the noun, to follow by the verb, the adjective and finally, by the adverb, as shown in Figure 11, in which this dynamic has been superimposed on the basic elements that make up the Hengeveld model.

Fig. 11. Dynamics of the acquisition of word types

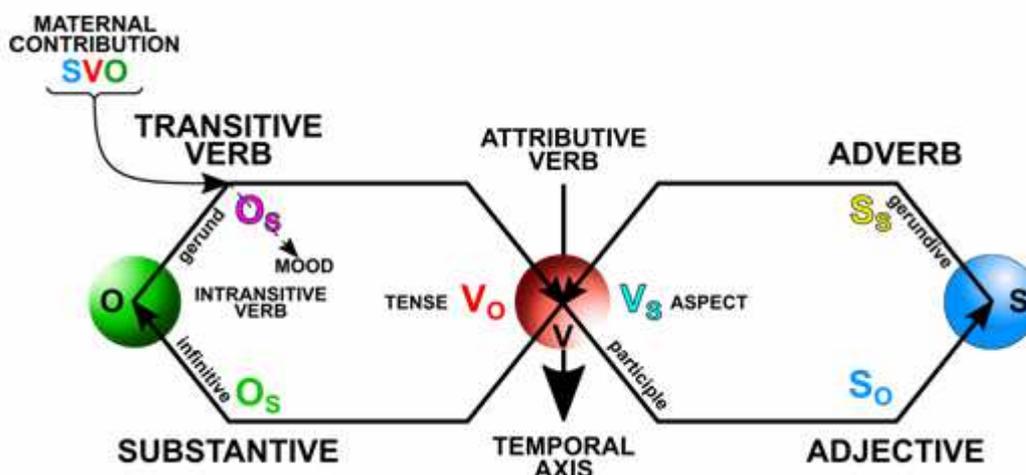
	NUCLEUS	MODIFIER
PREDICATIVE PHRASE	VERB Dx	MODE'S ADVERB Lv
NOMINAL PHRASE	SUBSTANTIVE	ADJECTIVE

References: Dx: dextro-rotated – Lv: levo-rotated

To better understand the above, we will propose a minimal theoretical example of a hypothetical language of the Hengeveld differentiated type, and that responds to the pattern (subjectivon): SVO. So that it shows us the management of the hidden colors in the assignment of the different functions, that is, in the identification of the different "types of words" and their successive acquisition.

Speaking of the CMT and the CL, the lexical categories noun, verb, adjective, and adverb morphosyntactically mark a specific language. Although not all of them are evident in any language, as Hengeveld showed, there is usually one that almost never lacks: the noun and not the verb as this author suggests. What we intend to show here is that all these categories have their contextual correlation, and its origin could well be where it seems to be universal: the name, and through those that, *a posteriori* will be transformed into the noun forms of the verb: infinitive, gerund, participle, and gerundive, would have evolved towards the other lexical contextures. Figure 12 shows all this mechanism, in which two well-differentiated stages can be recognized: a) the identification of the object and b) the identification of the subject, linked by the change.

Fig. 12. Evolution in the acquisition of lexical contextures



References: O: object – V: change – S: subject – SVO: maternal subjectivon
O_O: objective object – O_S: subjective object – S_O: objective subject
S_S: subjective subject – V_O: objective change (external) – V_S: subjective change (internal)

The child's psychic life begins with a perceived change that responds to a vital need manifested as dissatisfaction. If there is no external help to help solve this urgent need, death can only happen. If it exists and depending on the quality of such assistance (*Reverie* - see Appendix B), it causes an external change that provides the biologically necessary to achieve satisfaction. Simultaneously there is an internal change in the baby's psyche, which transforms into pleasure and allows it to emerge from it, an apparent change (external) that binds the previous changes and that becomes manifest when the sucking reflex is fired, the crying as a claim for satisfaction or other even more complex acts.

The identity of the object, as a psychic process, is something that is triggered after the perception of an authentic object (for example, the maternal breast), that which is destined to alleviate the vital need. Satisfied this and after its reappearance together with the simultaneous and transient absence of the authentic object, an apparent object is generated, which not only attenuates without eliminating the dissatisfaction, but replacing the now subject (object) in need, which is he, gives origin to the objective object (O_O), that is, what is perceived.

The genesis of the "primitive substantive" is in the apprehension, on the part of the child, of the evident and continuous change as a process that takes place in its environment, and it acquires it for the first time when it must characterize this dynamic process, that is, when it is used to identify entities that satisfy it. What does not satisfy him or is harmful to him, he discards it directly. The child has no choice but to "nominalize," that is, to transform an action, that someone who knows how to speak normally expresses using a verb, in a noun and in this way to leave fixed a situation that could not otherwise be capitalized. In other words, it is like "naming" something that for now cannot relate to your experience, the O_O, which is foreign to him and over which you have no control. Although this "naming" does not imply speaking, but only leave a record.

When the child can relate this first change to his own experience, there is a kind of *metabasis* (See Appendix B). That rudimentary noun is "verbalized." This verbalization represents a displacement, a projection, from the contexture of the objects, where he as an object has been rejected. The first thing that emerges in this complex process of verbalization is a kind of *infinitive*, like the noun form of the verb, but in the modality without its own subject, since, for now, it is he who will fulfill the function of the object that change.

The previous situation generates something similar to the first *intransitive verb*. The one that denotes a single participant, but that impels, on the one hand, the search for a true subject that helps him to solve the urgency for the object, different from him, that satisfies his need, and on the other, where he, as object and provider of virtual objects, ceases to have relevance.

It is important to explain why in an area where the subject prevails, that is, where no object is allowed (since as in all monocontexture the simultaneous presence of object and subject is not accepted), it is possible to operate with objects without suffering rejection or any sanction. This "condescension" is born because the "protective subject" (Here represented by the mother or her human substitute) who lawfully inhabits her world, generates at the expense of her subjectivity, a virtual space hidden from the prevailing binary norm. Where objects are admitted that they do not necessarily have to comply with the laws that govern the O_O, allowing the needy subject to 'play' with the coexistence of the authentic object and the apparent object, that is, learn to be tolerant of this antinomy (Winnicott, 2003, p.27). This is the first feature of the subjectivity of the 'needy subject,' which allows him to designate an object without disappearing.

In the virtual space (Winnicott transitional phenomena, 1975, p.240), the fictitious co-presence of the authentic object and the apparent object does not avoid the growing dissatisfaction that has not yet been alleviated since it derives from an unresolved contradiction. This makes it

possible to change the search by projection, that is, one learns to identify through the projection of dissatisfaction, an object that can be both a provider of satisfactory and unsatisfactory experiences at the same time. This alternative represents a synthesis that overcomes the previous contradictory event, the one that occurred between the satisfying object and the progressive dissatisfaction.

The continent thus configured, which tolerates fictitious objects and opposing sensations is erected in the first outline of *contexture* where the link with an external subject that acts as a virtual continent of objects begins. The mother or substitute with this act of attention, allows the child to generate a place where, from here, he can "house" the objects that are not himself. We will call this place: *subjective object* (O_S), representative of our first "hidden color" (see Figure 12).

The emergence of O_S gives rise to two transcendent facts in the acquisition of natural language. In the first place, the mother to "give up" the O_S , makes it "wrapped" in its own subjectivity, that is, it dyes it of the psycho-bio-socio-cultural aspects that characterize it as a subject. Among the things that are inherited by the baby, is the *maternal subjectivon*, that pattern on which his universal mother tongue was built, that was given to him, in turn, by his grandmother to his mother and that represents the "way of seeing" the subjective reality that his biological mother has.

Secondly, by capitalizing on relationships with what is different from one's own being, in the hand of something similar to the *gerund*, since we are dealing with an action that has been characterized regardless of time or any other element, it ends up in something like a *transitive verb*. That which allows an action to be defined as what passes or is projected from a particular actor to an object. The particularity of the *gerund* of being able to typify simultaneity of two actions or the way in which that action occurs and still, its possible cause or origin, makes it appear as an element to be considered for a characterization of the evident action. We must also point out that the emergence of the O_S now gives the possibility of defining the load of reality that action has on the objects perceived. This last will lead, in conventional language, in the *mood*, or what it tells us about the reality or unreality of the action characterized.

As a result of the completion of the first stage in the acquisition of natural language, we have: 1) the identification of the object through a kind of *noun*; 2) the characterization of the evident change through an action that is implicit in something similar to a *transitive verb*; and 3) the acquisition of the universal mother tongue (UMT), as an indelible pattern from where, now and always, the child will observe reality.

The second stage in the acquisition of natural language begins when what has been achieved in the previous stage is sufficient to tolerate the ambiguity of the sensations, but not to admit that same ambiguity between the objects.

It has already been learned that there is an external object (O_O) that is related to an external subject, but nothing is known about that relationship. Knowing implies a higher level of integration, basically because learning has to do with facing the changes proposed by reality but knowing involves finding differences. The first difference that must be sought is what is between observed object and observer object.

The generation of the first continent, that of the objects, in the psyche of the child, thanks to the link established with an external subject (the mother or its human substitute), allows that observer object represented by the child to become an objective subject (S_O); thus, differentiating itself from the perceived object. This transformation allows the baby to inhabit, in its own right, the "monocontexture of the subjects," like his mother, but with the marked limitation that entails only detecting signals, that is, changes. If we had to qualify this primitive newly acquired language, we could call it *taxic language*, since it works in total dependence on displacements or projections of the child's psyche, as a response to the perception of changes that occur both in him and in his environment.

Through something similar to a *participle*, that is, something that allows an object to be qualified without losing its verbal nature (participating in both natures implicit in the achieved

object), perhaps has reached something like an *adjective*, or something that could qualify a noun or object distinguishing it from others, modifying it. This modified object is the S_0 (see Figure 12).

What has happened up to now is very important because a rudimentary management of the apparent or superficial reality has just been validated, that is, of the real aspects that relate two objects: the O_0 and the S_0 , through an apparent change. In this way, we move on to a kind of natural language that we could call *signic language* or that which allows us to put an object in the place of another, but without confusing them.

The process that we have just described contains the germ, the rudiment of the first psychic structure, the one that will have the mission of integrating the whole psyche. What will give sustenance to its definitive structure and that will be the representative of the external time in the psychic depth. Something, the latter, which does not mean anything other than the *structural memory* or the place where the ideas will be emplaced to sustain the history or the becoming of the subject. After a certain chronological time and because the perennial search for satisfaction of the primary need never stops, the process begins again. When this happens, the first structural psychic unit is confirmed, that is, the first *idea*, that which promotes the emergence of a sign as a fundamental element of natural language. The successful completion of the previous process leaves as a result, in addition to the first psychic structure, an active mechanism of integration between the sensations transformed into perception and ideas. This mechanism is in turn, which makes it possible to combine a second type of memory, the *operational memory*, where the motor actions elaborated in response to what is perceived will be "recorded" (These FAPs (fixed action patterns) will be responsible for receiving in the future development of the child, the necessary motor operations to be able to emit the word).

The passive stability achieved is not enough to cover for a long time the primary need to survive. Although having completed the cycle that allows fairly adequate management of what happens in the environment, making the system output a new input and correcting a deviation (negative feedback that corrects deviations following a linear causality), allows the system to be 'alive' and maybe stay. This will not happen permanently given the inability of the system to adapt and evolve in an environment that cannot be modified and where to stay alive depends exclusively on its passive modifications. Which is not exempt of inability errors that will lead, when accumulating, to the disappearance of the objects, unless there is a structural change that allows reversing the situation.

The previous situation begins to revert when you capitalize on learning about changes and what is known about differences to lay the foundations of a rudimentary act of understanding, to be able to individualize the primitive mechanism that leads to the superficial organization and thus highlight its manifest inefficiency.

Everything that has been learned before the imminent destruction of the treasured internal object is discarded. This generates a high degree of dissatisfaction, but that differs from that felt in the first instance where what was at stake was his own life, in which now what is threatened is the object achieved and in which this threat does not come from the outside, but from himself. Then arises the urgent need to reorganize this object that is assumed destroyed, disorganized by own action and associated with his mother.

To adequately elaborate the above, the child must be able to identify himself momentarily with that his only internal object (his mother), thereby mitigating the fear or dissatisfaction that arises from having destroyed the internal object in the past; in his short experience, or that there is some possibility of doing it again in the future, something that depends exclusively on what has already been lived. This reorganization of the internal object is the mechanism that the child uses to successfully complete the psychic structure, by achieving a stable relationship with that object. This reorganization is never complete, and its insufficiency is felt every time a new object is internalized, or in its adult life, each time it goes through a traumatic situation at the psychic level, which will force it to reconstruct each time, its inside world. The non-existence of psychic modifications that

could have relevance in the acquisition of natural language will depend on the good preparation of the first reorganizing process.

The identification process that occurs at a deep or not apparent level, consists not only in tolerating differences as in a first moment, but in "understanding" that the similarities that exist between the child and his mother, are those that separate him from her, with which emerges a subjective subject (S_s), which differs in addition to the S_o , that explicit observer already known. The first rudiment of a category is thus configured, on a psychic level. In Figure 12, the SS represents the creation of the second continent, that of the subjects, and of the second hidden color, which completes the process of identification of the subject.

Something similar to the *gerundive*, that is to say, that relative to leave a record of what must be carried out, such as the fact that a subject is the source of a change or of an action that will fall on an object, which can be responsible for the emergence of an *adverb* simile, that is, a qualifier of the action exercised by a subject and even a representative of that action (Tesnière, 2015, p.479). The figure of the *adverb* is adequate to characterize this instance basically in its superficial and apparent invariability, since in the deep it operates assuming modifications on the three instances previously described, that is, the *noun* (O_o), the *verb* (O_s) and the *adjective* (S_o) and even on itself (S_s). The action that is being characterized does not respond to obvious or superficial transformations, but to profound or hidden changes. With the identification of subjective change (VS) or deep, represented by our third hidden color, which completes this second stage in the acquisition of natural language, which now has all the characteristics of natural human language. That is, it is a *symbolic language* or where a subject and an object are related through a change, thus emerging the symbol as a sign understood, that is, as a carrier of a certain meaning.

The dynamics of the whole system described would operate on two levels: the superficial one that links the *noun*, the *verb* and the *adjective*, and the profound level that would be reserved for the *adverb*. This distribution in a dynamic assembly has time as its axis.

The temporal aspect, which is considered by us, next to the name, as the only universals within the natural language, is controlled in the aspectual by the profound change (V_s) and in its temporality, by the superficial change (V_o). (See Figure 12). This *time axis* covers two different issues. On the one hand, it defines the necessary nexus that must exist in the given relations between subject and object, in their temporal regimes, with the purpose of synchronization. In other words, in the *now* the *before* and *after* of the *superficial time* must be synchronized with the *past*, the *present* and the *future* of the deep or *internal time*. On the other hand, it leaves evidence of whether an action is permanent or transitory and this is done by varying the location of the *now*. That is, placing it in the present or in the past. The above perfectly could be equated with the so-called *attributive* or *copulative verbs*, which, without reference to an action, indicate its modality or aspect or that at some point that action became evident.

In summary, according to our proposal, natural language is acquired as a consequence of a process that could be equated to a *denominalization* (see Appendix B) that operates at the level of the form through a *metabasis*, gives origin to the other lexical contextures and through a mutation at the level of the function. It has the possibility of locating each contexture in the place of another, that is, operating at the level of the hidden colors, so that, as happens in the biological, each language that is acquired according to genetic patterns that govern which lexical contextures will be operative, when they will do it, how they will do it, and why.

We must clarify that everything described above is a process that is supposed to be unconscious, that is, where the child's consciousness does not participate at all, and that has nothing to do with the process of acquiring conventional language, which is done to through the child's conscious imitation of what his relatives are trying to teach him.

The preceding would explain why the human being begins to handle his language in a fast, efficient and almost as if by magic. In the time that elapses between his birth and the moment he learns his first words (at least about 18 months), the child acquires his natural language. When he begins to speak, he already knows its structure and functioning perfectly; he only has to 'fill in' this

scheme with the conventional words that in the place where he was born, are used to name things and their relationships, as products of a sociocultural inheritance.

What we have just proposed is against what is affirmed by psycholinguistics and in general, by all cognitive sciences. That is, the cognitive (whatever that means) is not the product of an innate construction supported in formal or conventional language and then 'filled in' by some supposedly psychic aspects, as Chomsky claimed and all the current sciences that he helped create, if not and as we have established, it is the exact opposite.

4.0 SOCIOCULTURAL INHERITANCE

In "Deconstructing Darwin," Sampedro tells us (2002, p.194): "what is learned becomes instinct" by referring directly to the evolutionary theory known as the *Baldwin effect* in honor of the proposal made in 1896 by American psychologist James Mark Baldwin, who suggested a mechanism for the selection of learning skills. The selected offspring would acquire a greater capacity to learn new skills that would allow them to overcome the barrier imposed by genetically codified and relatively fixed skills. Emphasizing the fact that sustained behavior can model the evolution of species.

Referred to human natural language we could say, that at the beginning it was the universal language, originated from "the change made action" (taxic language) and thanks to the *Baldwin effect* that action "became flesh", certifying the biological roots which show the signic language, and from there emerged through the psychic structuring, the human symbolic natural language. Therefore, and as Sampedro (2002, p.95) points out to us, language is not an accessory device that we can plug into the brain of a monkey to make it speak like us.

Each living being has its natural language, and this tells us what the world is like for that particular being. This rule, which of course involves humans, states that languages are not interchangeable between species, such as the HOX genes are seen in the second part (Salatino, 2018), but can only be integrated from a primary level to man same that transforms for this reason, in a "compiler of footprints" of all of them.

Starting from the basis that we consider the individual as a social subject, that is, as the result of society and not its unit, since the social unit is the "real fact" or REM, we could try a definition of social inheritance saying that: "it would be the set of acquisitions resulting in each generation, from the progressive integration and reabsorption by the individual, of all the transmitted culture". This would give a continuous incardination of elements of subjective nature (language, institutions, customs, etc.) that would be transmitted hereditarily through a process that is commonly known as *tradition*.

The word *tradition* (Coromines, 2009, p.548) appeared in Spanish in the mid-seventeenth century and derives from the Latin: *tradere* (de *tra*: "to the other side," "beyond," and *dere*: "to give"). That is to say: "to give beyond," thus enclosing the notion of transmitting or delivering, that is, communicating. *Tra* derives from successive transformations of *trans*, which happened to *tran*, then to *tras* and finally to *tra* (Monlau, 1856, p.144) and which does not mean only, as is commonly believed: "to the other side" or "through," But: "from one side to another." This is how it gives the idea of a space covered, pass from part to part, transmit, transform; although not only highlighting the fact of the transfer or passage from one situation to another but leaving a record of the existence of a place or situation of origin and another of destination.

In a more general sense, the term *tradition* has been related to the term *ultra* saying that *tra* or *trans* denotes beyond in a sense or only one direction and *ultra* denotes beyond in every way. However, it is considered, it was chosen to integrate the transcursive denomination that characterizes the logic used in this study because it summarizes in a single particle the spirit of our psycho-bio-sociocultural approach.

In an article that Baldwin published (1896a, pp. 441-451) under the title of "A New Factor in Evolution" is conceptually raised what later became known as the *Baldwin effect*. An important work because it proposes to us, not only what transcended in time, but a series of concepts that will

help us to perceive more clearly the enormous influence of the biological and evolutionary in the social, and even, how the author sees it the social heritage, which defines.

Baldwin tells us that organic development can be approached from three different aspects:

- a. Ontogenic
- b. Phylogenic
- c. Hereditary

a. Ontogenic (organic selection): there are two types of facts that can be distinguished from the point of view of the functions that an organism carries out in the historical course of its life. *i*) the development of its hereditary impulse together with the congenital variations that characterize it or phylogenetic variations that are constitutional and *ii*) a series of functions, acts, etc., which learns in its life course, especially the modifications that an organism suffers during its ontogeny, which as a whole, are known as "acquired characters" and which the author calls "ontogenetic variations".

It is assumed that these acquired characteristics arise by the law of "use and disuse." Now, how can an organism be modified during its history? The answer to the question can be found in three different types of ontogenetic media that produce modifications, adaptations or variations. These are *i*) the physical environment and the influences of the environment that act on the organism producing modifications of its forms and functions. All chemical, physical agents, contacts, obstacles to growth, etc. are included here. All the changes produced by the previous agents are considered as fortuitous or accidental, and the author calls them physical-genetic; *ii*) there is a kind of modifications that arise from the spontaneous activities of the organism itself while carrying out its functions. These variations that are evident in every living being are considered as selective properties. In animals, it is characterized as neuro-genetic; and *iii*) a large number of adaptations of the conscious medium that involve intelligence, such as imitation, gregarious influences, material instruction, lessons of experience, reasoning from the means to the ends, etc.

Adapting the above to our purposes, which the author characterizes as "organic selection," we could say that the ontogenetic modifications are of three types: psycho-genetic, bio-genetic and socio-genetic, so the inheritance affects them all by likewise through the *frenes*, *genes*, and *remes*, respectively. Which would represent the acquisition, by organisms, of new modes or modifications of the adaptive function that influence its structure and that result in the possibility of survival.

b. Phylogenic (physical inheritance): or determined variation that neo-Lamarckism tries to explain using its principle of inheritance of "acquired characters" but that the author does through instinct as a survival strategy. It proposes certain results obtained on phylogeny, and that originate from organic selection, such as *i*) ensuring the survival of certain lines of phylogenetic variation in the direction of certain ontogenetic adaptations of the first generations. As this happens, there is time for other skills to emerge that will then be transmitted and *ii*) the phylogenetic modifications achieved are again used ontogenetically. The two previous considerations distance Baldwin's proposal from the idea of Lamarck (See Appendix B) on the inheritance of acquired characters. To the influence of organic selection, the author calls it the "new factor." The ontogenetic adaptations are new and not preformed, and they effectively reproduce in the successive generations, but not through the biological inheritance but, through the social inheritance, as is the case of the transmission of the *maternal subjectivon* that we saw in the previous point.

c. Hereditary (social inheritance): as Baldwin proposes what can be learned innate through the instinct that becomes a habit. It looks like Lamarck's idea, but it differs from it in that it operates through purely Darwinian mechanisms. It is based on the basic similarity that supposedly exists between innate brain architecture, formed by reinforced synaptic connections, and learning that, in itself, supposedly consists of creating and reinforcing certain synaptic connections. In our case, without affirming exactly the above, we propose that there is a homology between the psychic, the

biological and the social and that the fundamental motor of this homology, as proposed by Lamarck, is the need to survive and not natural selection. According to our point of view, at a cerebral level, the survival instinct allows the experience to generate habits and socially, favorable stimuli for the appearance of certain behaviors and their effects, allowing the diffusion of such behaviors in resonance with a genetic predisposition (social) in certain individuals or social subjects, facilitate their execution. Thus, these individuals will be benefited with social survival. The paradigmatic case of these behaviors, at a psychic level, is natural language and at the social level, through the use of projection in conventional language, the courtesy.

The *Baldwin effect* is also known as "genetic assimilation" and is a perfect substitute for the inheritance of acquired characters. Baldwin, in the case of man, above all, emphasizes imitation as the fundamental element of learning.

4.1 Why REMES and not MEMES?

In "Hereditry and Instinct" (I) (1896b, pp. 438-441), Baldwin tells us that there are two great hereditary influences (we have proposed three: biological, psychic and social). a) the natural inheritance using which they have congenitally transmitted the variations with their original foundations and b) the social inheritance by which socially acquired functions are transmitted imitatively, and that cover all the conscious acquisitions that arise from the interrelation between animals. The first is phylogenetic, while the second is ontogenetic. These two hereditary lines influence each other. The congenital variations, on the one hand, keep the animal alive and make it effective for the conscious use of its intelligence and imitative adaptation in its individual life. On the other hand, intelligent and imitative adaptation is made congenital by further progress and refinement of the variation in the same line of function acquired by the individual, and it is not necessary, to assume the acquired factor of Lamarck.

Richard Dawkins in his as renowned as controversial book "The Selfish Gene," in Chapter XI (1976, p.189) entitled "MEMES: The New Replicators," states that most of the features that are unusual or extraordinary in man can be summarized, in a word: "culture." That cultural transmission is analogous to genetic transmission in that, despite being conservative, it can show a certain evolution. According to the author, in this evolution, language is an example among many others, including fashion, eating habits, ceremonies, and customs, art, and architecture, engineering, and technology. Everything would evolve in historical time in a way that seems like a highly accelerated genetic evolution, but which, in reality, has nothing to do with it. Dawkins, while accepting that kin selection and selection in favor of reciprocal altruism could act on human genes to produce much of our tendencies and our basic psychological attributes, believes that these ideas are not enough to explain the culture and its evolution. Then, just as he proposed a replicating machine (the gene) as the one responsible for biological inheritance, he proposes another type of replicator: the MEME (A neologism that derives from a whimsical apocope of mimesis), with the idea that it represents a unit of cultural transmission or a unit of imitation that, resembling a gene, allows cultural evolution.

As we can see, imitation is the axis of the proposal, and there are good reasons to suppose that Baldwin was the inspirer of such a proposition.

In whom was Baldwin inspired?

Gabriel Tarde, a French sociologist, criminologist and social psychologist who conceived sociology as based on small psychological interactions between individuals (much like chemistry), the fundamental forces being imitation and innovation, published in 1890 (1895), perhaps his most well-known work: "The laws of imitation." There he told us that everything social is only invention and imitation and that with the novelty provided by all kinds of social phenomena (language, religion, politics, industry, art), whether large or small, nothing changes on the surface. Baldwin mentions Tarde in his work and is inspired by it to invoke imitation as the fundamental motor of learning.

Tarde himself, in the prologue to the second edition of his theory of imitation (1895, p.10), apologizes for the confusion he has caused with the use of the word "imitation", which he uses

without morphological changes, so as not to use a neologism, but with an absolutely different meaning to the one that appears in the dictionary. It clarifies that the 'crime' of the abusive use of the term has not been committed since it clarifies duly, and, on several occasions, what is the sense in which he uses it. That is, to record a remote action of one spirit over another and an action that consists of an almost photographic reproduction of a cerebral "cliché" of another brain. He understands by imitation any impression provoked by an "inter-spiritual photography," whether intentional or not, passive or active. Wherever a social relationship is established, there is imitation in this sense. In this same writing, what Tarde does consider abusive is the elastic meaning given by many naturalistic sociologists to the word "inheritance" that they use to express confusingly as a transmission of the vital characters, the transmission of ideas, of customs, of social things that are usually transmitted by ancestral tradition, by domestic education or by imitation-custom.

It is evident that Baldwin did not read this prologue and Dawkins did not either. By this, we mean that the imitation-custom as the absolute engine of learning is not appropriate since not even the origin of its proposal has solid foundations.

What has been said allows us to offer the REM option as a social unit instead of the MEME. Where imitation is not considered, but rather its operationality is based on a structural functionality that, as a "social protein", allows adapting and promoting the evolution of a psychic structure that absorbs the traditional precepts acquired by social inheritance and can transmit them by psychic inheritance and communicate them through a symbolic natural language. In other words, it allows the generating of a culture that can be transmitted from generation to generation. The imitation will be transcendent when once acquired the natural language; it becomes necessary to project it to the conventional language.

5.0 CONCLUSION

As a partial conclusion, we can say that viewed from the TL, both the universals of language, lexical contextures, and even social inheritance, represent fundamental elements in the arduous task that constitutes the analysis of the acquisition of natural language.

The importance of the universals is that they represent a subjective solution found in the assembly of the psycho-bio-socio-cultural aspects that define the human being; defining aspects also of its survival. Using the syntactic metaphor of the "order of words" we have managed to base a solid "linguistic genetics" that helps us to better understand the close relationship between a "universal language" and our natural language. This relationship comes together in the formation of subjectivity that all humans have inherited from their mother. Beyond the patterns, we also suggest that structurally, there would be only two universals: the primitive noun and the temporal axis, something that became evident in the analysis of lexical contextures.

The lexical contextures allowed to unravel one of the mysteries of our natural language, when we could make evident the "constant" that underlies the changing mantle of structures and functions that characterize, in appearance, all the languages that are spoken today in the world. On the other hand, it was feasible, following the metaphor of the "word classes," to determine a possible evolutionary chain that intertwines the different basic contextures and complete the formation of the "continents" that structure our psyche. This last detail is fundamental when elaborating a theory that explains with some degree of coherence the acquisition of our language.

The social heritage, based on the premise that each living being has its natural language and that this tells us what the world is like for that particular being, made us understand, in the case of man, the importance of *tradition*. Through the "ontogenetic variations," Baldwin showed us the enormous influence of the biological and evolutionary in the social, and even, what are the determinants of "social inheritance." As we showed in this part of the work, the "ontogenetic modifications," from TL, could be classified into psycho-genetic, bio-genetic and socio-genetic. Thus, the "triple inheritance" (biological, psychic and social) affects everyone equally. Through the *genes*, *frenes*, and *remes* (the operative units of the real systems that make up the subjective reality) the acquisition, on the part of the organisms, of new modes or modifications of the adaptive

function and its structure can be evidenced. Natural language, as one of the specific elements that promote survival, does not escape the above considerations.

As a general conclusion of this work, there is evidence of the marked contrast that results from focusing on the acquisition of natural language from the genetic point of view. The transcurssive logic provided the elements that allowed probing the very roots of human subjectivity that empower the emergence of a symbolic language.

The *universal language* as a germ, the *subjectivon* as a way of seeing the reality that our mother bequeathed to us, and the "hidden colors" that justify the typology of a language, allowed us to approach one of the subjective aspects by antonomasia. The acquisition of our language is the hallmark that distinguishes us from the rest of living beings, with whom we share almost everything. But, also, it teaches us which one could be a way among many, that the human being was favored with a psychic apparatus, that something very similar to a language, helped to build.

Possessing a symbolic language is a unique fact in the biosphere, but its acquisition, as we have shown throughout the three parts in which this work has been divided, follows its same genetic guidelines. A discovery that allows us to dismiss all the speculations elaborated over our supposed superiority.

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APPENDIX A

- SUBJECTIVE REALITY: We have already defined the frame of reference where the subject develops. This is one of the real systems that define the TL: the sociocultural, which as we saw is a composition of what is present, that is, of the facts as they are shaped by representing interrelations between subject and object, the two only components of subjective reality. It is considered as the 'motor' that drives the gestation and regulation of the dynamics of other real systems. Its structural unit is the REM or real fact.

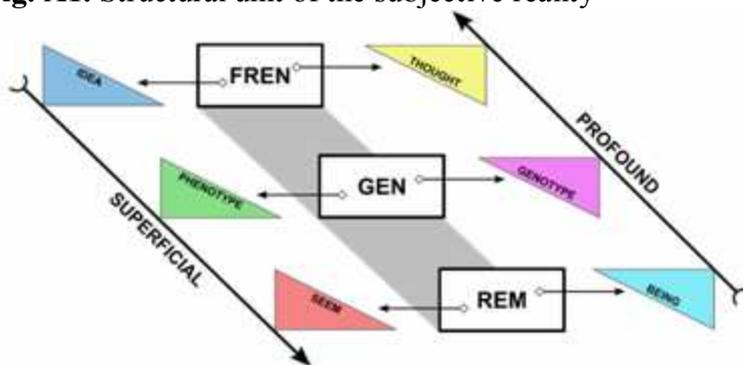
Another of the real systems is the bio-external: characterization from the logical point of view of the three major biological levels that record the physical aspects of life. These levels of life that can be qualified by TL are: a) unicellular or multicellular without central nervous system (CNS), which comprises simple animals and plants; b) multicellular with CNS, which include the animals themselves; and c) the animal that, through understanding, can use the sense it gives to its environment to adapt and evolve, the man. Its structural unit is the GEN.

Finally, the psycho-internal system: all living beings are autonomous and this autonomy becomes evident when they are observed as different from their surroundings. Little life can have a structure that ignores that it is different from what surrounds it. Setting a boundary between the 'inner' and the 'external' is a privilege of the living being. To the real system capable of sustaining this 'knowledge' and relating it to the environment, we will call it psycho-internal and it is the one that takes care of the concrete subjective aspects, both volitional and cognitive. Its structural unit is the FREN.

All units reviewed, show the same structure, that is, they are arranged on two levels, one superficial or evident and one profound or hidden, which arise from the interrelationship of the subject and the object (or their equivalents) through two transformations or changes. These two levels form a group and maintain a complex relationship with each other; that is, a triple relation of opposition, complementarity and concurrence or simultaneity, and with a common logical denominator: the PAU or universal autonomous pattern.

The two levels that the units display is: in the REM, the superficial: they seem and the profound: the being; In the GEN, the superficial: the phenotype and the profound: the genotype. While in FREN, the superficial: the idea and the profound: thought. (Figure A1).

Fig. A1. Structural unit of the subjective reality



APPENDIX B

Class of the word: in this work, this expression should not be taken in its morphosyntactic meaning, but in its transcursive connotation, that is, as a contexture that is related to others to specify its profound function, an element that, in its superficial emergence, it gives a certain shape or appearance. The term "word" should not be taken in the phonological sense, neither formal or morphological, nor functional, nor semantic, but psychic (Salatino, 2014).

Denominalization: is the evolutionary transformation of the contexture that houses the noun in the other lexical contextures.

Garó: language belonging to the basic group of the Tibetan-Burmese branch, spoken in the Indian state of Meghalaya and surrounding states (Author's Note).

Heterarchy: it is when two different processes are carried out simultaneously.

Lamarck, JB: in his "Zoological Philosophy" (from 1809 - year of the birth of Darwin) he presented his theory of evolution (chapter VII - Lamarck, 1986, p.165) according to which organs are acquired or lost as a result of the use or disuse and the characters acquired by a living being are inherited by their descendants. For Lamarck, the principle that governs evolution is necessity or desire, which he called *Besoin* (necessity) and which Darwin then changed by natural selection. This theory is also known as the "inheritance of acquired characters." Baldwin's proposal, instead, revolves around a behavioral version of Darwin's theory of evolution, suggesting that cultural innovations and learning could broaden and predispose the course of natural selection.

Metabasis: in this work, this term is taken as a process of identity transformation.

Reverie: a maternal psychological source that meets the child's needs for love and understanding (Bion, 1987, p. 58). In the case of the so-called wild children, in which, because of their condition of extreme isolation, they are provided with what is necessary to remain alive, but not of what is necessary for the development of their psychic life, appear in them irreparable psychic alterations, for example, they never learn to talk.

Substantive: here noun is taken, not as the lexical category we know, but as a contexture, that is, the continent of a certain function given by the relationship it maintains with the other contextures.

Totipotential: from Latin - *totus* (all) and *potens* (power or ability). A term used in biology to refer to cells that can originate any other type of cells, tissues, organs, and even embryos. A current example is the "stem cells" (Author's Note).

Warao: isolated Amerindian language is spoken by an ethnic group that inhabits the Orinoco delta and includes part of Venezuela, Guyana, and Suriname (Author's Note).

Financial Development and Economic Nexus in Nigeria: The Role of the Stock Market

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ABSTRACT

The stock market has been touted as catalyst for economic growth as a result of its capacity to provide access to long term capital for industrialization and other projects requiring long term capital, especially in developing countries as Nigeria. In order to establish the pattern of the finance-growth nexus in Nigeria by adopting a time series technique and applying regression model estimation, this study sought to evaluate how the stock market has impacted economic growth in Nigeria following the recent liberalization and the subsequent market integration resulting from globalization. The study found long run relationship between the Gross Domestic Product per Capital Growth Rate (GDPGR) and the explanatory variables (stock market capitalization ratio; total value of shares traded, stock turnover ratio and financial liberalization). The Granger Causality Test results showed that there is a bi-directional relationship that runs from turnover ratio (TNVR) to stock market capitalization (SMCR) and vice versa within 5% and 10% level of significance. Also, the results also showed that gross domestic product per capital growth rate (GDPGR), stock market capitalization ratio (SMCR), total value of shares traded (STR), and financial liberalization (FINLIB) jointly have causal effects on stock turnover ratio (TNVR). The study concluded that economic growth and development has not been found invariant to dis-equilibrium in the stock market in Nigeria. It was, therefore, recommended that a policy rethink should be fashioned out to strengthen the stock market so as to enable it to play its pivotal role in the economic growth and development of Nigeria.

Keywords: Economic Growth, Financial Development, Stock Market, Stock Market Dis-equilibrium

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1.0 INTRODUCTION

In pursuing the agenda for economic growth and development, many emerging countries recognize that a major distinguishing factor between them and developed countries is essentially the level of development of their financial sectors, embark on financial markets' reform. According to Akinsola and Odhiambo (2017), most international organizations such as the World Bank and International Monetary Fund (IMF), have advocated the introduction of financial liberalization policies to augment higher savings, investment and rapid economic growth in developing countries. They added that the 1980s and 1990s witnessed the birth of economic reform programs in most African countries after catastrophic economic crises. This position had been canvassed by Singh (1997), who stated that during the 1980s and 1990s, many developing countries (DCs) have been engaged in far-reaching reforms of their financial systems, liberalizing them and making them more market-oriented. In carrying out the reform agenda, the importance of the financial sector had been highlighted and decomposed by many developing countries in order to provide a clear understanding of the content of their reform agenda.

Levine (2000) captured the importance of understanding the role of the financial structure to be able to design a reform program suitable for each developing country (DC) when he asked: Are bank-based or market-based financial systems better for promoting long-run economic growth? The answer to this question may not be far to seek if the relationship between economic performance and financial structure is well explored and put in proper perspective. The argument of Khyareh and Oskou (2015) was that for many years, the role of stock markets have been under looked as important components that enhance economic growth, instead bank-based financial institutions were considered more instrumental in accelerating economic growth. Relatedly, Levine (1997) explained that economic development creates demands for particular types of financial arrangements and the financial system responds automatically to these demands.

Most reforms programs embarked upon by the less developed countries contain one cardinal feature of financial markets liberalization. For example, Nyasha and Odhiambo (2018) elucidated the significance of economic reform programs by stating that the controversy surrounding the finance-growth nexus comes at a time when almost all countries in Africa, and globally, are battling to improve their economic growth rates, or at least to maintain them, in order to improve the living standards of their citizens, to curb public deficits, and to steer the debt/GDP ratio onto a steadily declining path. Regarding stock market liberalization, Kinuthia and Etyang, (2014) and Henry (2000) argued that the stock market liberalization is a decision by a country's government to allow foreigners to purchase shares in that country's stock market.

The list of studies on the role of the capital market in the economic growth and development of Nigeria in the recent past is handful. Their findings and conclusions are divergent, hence, the controversy rages and require further contribution towards resolving it. While Josiah, Adediran and Akpeti (2012); Lawal and Okunola (2012); Ogunmuyiwa (2010), and Okoye and Nwisiennyi (2013) found that the capital market and its liquidity contributed to the economic growth of Nigeria. Adigwe, Nwanna and Amala (2015) and Nurudeen (2009) provided a contrary outcome. Moreover, no recent study covered the period of policy reform which had a significant impact on Nigeria's economic development and growth following financial market liberalization, hence, this study is different and covered the gestation period: 1998 - 2016. The period of policy reform was effective from 1998 which coincides with the first country American Depository Receipts (Bekaert, Harvey and Lundblad (2003). Although the reform program was announced in 1986, following the adoption of the structural adjustment program (SAP); reforms' announcement dates are not always the commencement of reforms effectively. This line of reasoning was also buttressed by Karolyi (2004) who asserted that financial liberalization dates may be difficult to identify with precision and that their economic impact may be delayed or reversed over time. In addition, the author examined other studies which suggest that economic effects of liberalization substantially lag the official dates of reform. Similarly, Henry (2000) highlighted methods used in identifying liberalization which

include official policy decree dates and issuance of American Global Depository Receipts among others.

The objective of this paper is to establish the pattern of the finance-growth nexus in Nigeria by adopting a time series methods and applying regression model estimation which is of great importance as a result of the recent liberalization and globalization experience that has created an impression of improvement in the domestic financial systems as catalyst for the observed growth and development of Nigeria.

The paper is organized as follows: Section 2.0 reviews the relevant literature, Section 3.0 covers Methodology and Data; Section 4.0 deals with Analysis while Section 5.0 Contains Summary and Conclusion.

2.0 LITERATURE REVIEW

2.1 Conceptual Review

2.1.1 Gross Domestic Product (GDP)

The study used GDP per capita growth rate. GDP is measured as yearly percentage growth of real GDP per capita. Njemcevic (2017) justifies the use of per capita GDP because of the effects of labor on growth. The author argued that labor is a significant factor and is expected to have important effect on growth. Other studies which adopted this variable in similar fashion include Azmeh, et al (2017) and Kinuthia and Etyang (2014). Iheanacho (2016) defined growth as the real gross domestic (GDP) growth per capita (growth rate). In order to determine the variation in the growth rate which explains whether the variation is positive (a case of growth) or negative (a case of decline), there should be ways of capturing these measures of growth and development. Iheanacho (2016) identified four widely used measures of financial sector intermediary development as follows: the domestic bank credit to the private sector divided by GDP, liquid liabilities to GDP and Deposit money banks' assets to GDP and bank deposits to GDP. Madichie and Maduka (2014) argued that theoretically, the linkage between finance and economic growth may take different forms while Udude (2014) explained that financial development involves the establishment and expansion of institutions, instruments and markets which support investment and growth process. The significant role of the stock market to economic growth, argued, Gajdka and Pietraszewski (2016) is widely acclaimed and positively correlated. Characteristically, they acknowledge some disagreements on which indicators are best suited in measuring economic growth of a country; they, however, identified the rate of growth of national income, hence investors should prefer those where the rate of GDP growth is high in the long-run.

2.1.2 Stock Market Capitalization Ratio (SMCR)

Stock market capitalization ratio is obtained by dividing total market capitalization by GDP as a measure of the size of the stock market. Khyareh and Oskou (2015) is a recent study which adopted this measure. Levine and Zervos (1998) on their part argued that the market capitalization ratio equals the value of listed shares divided by GDP and was used by them as a measure of market liquidity. Kinuthia and Etyang (2014), SMCR is the product of outstanding shares and market price of equities on a stock exchange and reflects the size of a stock market. Expatiating on the relevance of this variable, Njemcevic (2017) posited that the market capitalization ratio is used as a measure of the size of the market; but pointed out that this measure in economies in transition is volatile since it is majorly influenced by the stock price index, as such markets lack depth and adequate liquidity.

2.1.3 Stock Turnover Ratio (STR):

Stock turnover ratio is a percentage of total market capitalization and is a measure of stock market liquidity. Mohtadi and Agarwal (2004) point out that the turnover ratio is not a direct measure of theoretical definitions of liquidity, they explain that high turnover is often used as an indicator of

low transaction costs. Levine and Zervos (1998) point out that turnover measures trading relative to the size of the stock market; thus, a small liquid market will have a high turnover but small value traded. The adoption of this variable here is modeled after the studies by Levine and Zervos (1998) and Mohtadi and Agarwal (2004). Kinuthia and Etyang (2014) argued that stock markets may also influence risk diversification to avoid liquidity risk. Their assertion was that liquid equity markets positively influence long-term investment since such markets allow securities' holders the opportunity to trade their securities. According to them, stock market liquidity is the extent to which a financial asset can be bought and sold easily without causing a major price dis-equilibrium and loss of value of such an asset. To them, turnover ratio is one of the yardsticks for measuring liquidity and equals the value of stock transactions divided by market capitalization. The argument of Njemcevic (2017) is in tandem with those of Kinuthia and Etyang (2014) as turnover ratio is used to indicate the level of market liquidity.

2.1.4 Total Value of stock traded (TNVR):

Total value of stocks traded ratio is used as a percentage of gross domestic product. Levine and Zervos (1998) state that value traded captures trading relative to the size of the economy. Mohtadi and Agarwal (2004) point out the significance of the value traded ratio by stating that it measures the organized trading of firms' equities as a share of national output and therefore should positively reflect liquidity on an economy-wide basis. They also state that the total value traded ratio complements the market capitalization ratio, because, to them, a market may be large, there may be little trading. The adoption of this variable here is also modeled after the studies by Levine and Zervos (1998) and Mohtadi and Agarwal (2004). Njemcevic (2017) highlighted the well-known fact that value of shares traded is an indicator of stock market liquidity like stock turnover ratio except that the denominator of this indicator is market capitalization while the denominator of stock turnover ratio is the gross domestic product (GDP). Ovat (2012) wrote that the value of shares traded ratio measures the organized trading of firms' equity as a share of national output which positively captures liquidity on an economy wide basis.

2.1.5 Financial Liberalization (FINLIB):

Stock market liberalization is taken as a percentage of foreign ownership of listed equities on the local bourse and this measure is generally believed to enhance risk sharing between foreign and domestic investors. Auzairy, Ahmad and Ho (2011) argued that if liberalization has a positive relationship with market performance, then it complies with the Standard International Asset Pricing Model but if otherwise, then there is no reason for the authorities to implement such policies since it initiates a downfall of market returns.

2.1.6 Overview of the Stock Market in Nigeria

The Nigerian Stock Exchange (NSE) was established in 1960 (NSE, 2007). The Stock Exchange provides the platform for trading in the secondary market after such shares would have been listed on the Trading Floors of the Exchange in Lagos being the headquarters of the NSE. However, such listed stocks can be traded upon simultaneously in all the Floors of the Exchange where it has Branch Offices across major cities in the country. The market has a network of stockbrokerage firms, issuing houses, practicing corporate law firms, and firms of auditors and reporting accountants. The Exchange started operations in Lagos in 1961 with 19 securities listed for trading. Integrity is the watchword of the Stock Exchange. Market operators subscribe to the code "Our word is our bond". The Nigerian Stock Exchange has been operating an Automated Trading System (ATS) since April 27, 1999, with dealers trading through a network of computers connected to a central server and as a result, enables on-line trading and surveillance. The market has been deregulated since 1993 but the Exchange maintains an All-Share Index formulated in January 1984 (January 3, 1984 = 100). However, only common stocks (ordinary shares) are included in the computation of the index. The index is value-weighted and is computed daily while clearing,

settlement and delivery of transactions on the Exchange are done electronically by the Central Securities Clearing System (CSCS) Ltd, a subsidiary of the Stock Exchange.

The market capitalization of the exchange in 1995 was \$2.00billion (Usman, 1998), when the Naira exchanged at ₦67.66 to the US dollar. The turnover of the Nigerian Stock Exchange and the total market capitalization as at 31st December, 2004 was put at ₦120.7 billion and ₦2.112 trillion respectively (Okereke-Onyiuke, 2005). The most capitalized stock on the Exchange in the early 2000s was Nigerian Breweries and its capitalization was put at ₦323.67 billion in 2004. In dollar terms, this was about \$2.42billion when the Naira was exchanging at 134 to the US dollar. The number of Nigerians who own shares is dismal. This clearly indicates that the market is small but the equity culture can be said to be growing as the market is still evolving, although, recent developments in the market casts doubt on the potential of this market. For example, more firms are voluntarily delisting or delisted by regulators than new ones in recent years.

2.2 Empirical Review

The empirical literature is replete with mixed results following reform agenda of many developing countries. For example, Azmeh, Samman and Mouselli (2017) provided evidence that financial liberalization which they measured by the number and size of foreign banks, was not a good policy to increase economic growth in in their sample of 33 developing countries with a GDP per capita of less than 3,595. The study by Tai (2017) provided mixed evidence regarding the impact of financial markets development on the capital structure of firms listed on Ho Chi Minh Stock Exchange, Vietnam. The results showed that market capitalization of firms listed in that stock exchange has a positive effect on their capital structure while volume of shares traded has a negative effect. This means that the effects of financial liberalization on the stock market studied were mixed. One major finding of Akinsola and Odhiambo (2017) was that the financial development coefficient shows a significant and positive relationship between the ratio of domestic credit to the private sector as a share of GDP and economic growth in the Sub-Saharan African countries studied between 1980 - 2015 but based on other results in the same study, they dropped a caveat: financial liberalization policies should be implemented with caution, taking into cognizance the sequencing and timing of the policies to avoid endangering financial stability. Ngongang (2015) studied the relationship between financial development and economic growth using a sample of 21 Sub-Saharan African countries for the period 2000 – 2014 and found that financial development did not have any effect on economic growth. The findings by Ananwude and Osakwe (2017) on the relationship between stock market development and economic growth between 1981 and 2015 showed that there was a positive but insignificant relationship between stock market development and economic growth in Nigeria and South Africa. Orji, Ogbuabor and Anthony-Orji (2015) established that the financial liberalization exercise in Nigeria has impacted significantly on the Nigerian economy. The study by Kinuthia and Etyang (2014) provided evidence of a one-way causality running from market capitalization (stock market development) to GDP per capita.

Concerns regarding the structuring of the financial system in order to enable it play a catalytic role in promoting the economic growth and development of countries is well documented. Policy makers and global financial institutions have addressed this concern through liberalization. While substantiating the financial development-economic growth assertion; Nyasha and Odhiambo (2018) argued that given the rapid and dynamic rate of globalization, there is tremendous pressure on a number of developing countries to modernize their financial sectors in line with global trends, standards and best practices, so as to foster their economic growth and development. Levine (1997) explained that specifically, countries with larger banks and more active stock markets grow faster over subsequent decades even after controlling for many other factors underlying economic growth. Banks and stock markets being the major institutions that play intermediation roles in any economy have been found to be crucial in this regard. Levine (2002) argued that countries with greater degrees of financial development – as measured by aggregate measures of bank development and market development – enjoy substantially greater economic growth rates.

Like banks, the stock market is a channel of savings mobilization from surplus economic units to deficit economic units towards providing the much needed funds in the capital formation process for investment purposes. Olweny and Kimani (2011) wrote that the stock market plays a major role as an economic institution which enhances the efficiency in capital formation and allocation. Regarding the importance of the stock market in the financial systems of many developing countries, Singh (1997) suggested that in addition to financial de-repression, there has been a major new element in the development of developing countries' (DCs) financial systems in recent years – the establishment and fast expansion of stock markets; stressing further that these markets have played a key role in the internal as well as external financial liberalization processes in leading DCs. Ahmad, Khan and Tariq (2012) explained that the stock exchange of a country is the financial institution that deals with financial instruments. There is a consensus in the financial economics literature that stock markets enhance growth and development especially when a once segmented market is linked to the global capital markets; hence, capital mobility is facilitated.

2.3 Theoretical Consideration and Hypothesis Development

The finance led growth theory can be found in the pioneering works of Schumpeter (1911) which posited that a particular model of innovation can lead to economic growth in a less developed country. This model of growth theory, on which this study is premised, was followed by the postulation of Mckinnon (1973) and Shaw (1973) that economic growth in less developed countries can be achieved through trade liberalization and increased efficiency of the financial sector. Arcand, Berkes and Panizza (2012), however, pointed out the damaging outcome of recent crisis and raised concerns that some countries may have financial systems which are “too large” compared to the size of the domestic economy. The implication of this is that there could be a threshold above which financial development hits negative social returns. For instance, Asekome and Agbonkhese (2015) chronicled the benefits of market opening, apparently as part of financial markets reform, to include increased opportunity for diversification, risk reduction as well as lower cost of capital; such expected benefits have not been consistent in several emerging economies. This study made use of the following testable hypothesis: Ho: Stock market development does not have a significant impact on the growth and economic development of Nigeria.

3.0 METHODOLOGY

This study adopted the Generalized Least Squares (multiple linear regression analysis) model to evaluate the relation between stock market development and economic growth and development in Nigeria during the period: 1998 – 2016. Laopodis (2003) is a study which provides support for the adoption of the regression models used in this study. The study analyzed the effect of stock markets development on the real economic growth of Nigeria and the representative samples from the Nigeria Stock Exchange (indicators) were employed.

The dependent variable employed was the real gross domestic product per capita growth rate and four independent variables: market capitalization ratio, stock turnover ratio, total value of stocks traded and financial liberalization.

This paper presents a general model relating Real GDP Per Capita Growth Rate to the independent variables employed in order to assess the effects of stock market development on the economic growth and development of Nigeria, viz:

$$GDPGR = f(SMCR, STR, TNVR, FINLIB) \quad (1)$$

The explicit form of Equation (1) is represented econometrically as follows:

$$GDPGR = \beta_0 + \beta_1 SMCR_i + \beta_2 STR_i + \beta_3 TNVR_i + \beta_4 FINLIB_i + \varepsilon_i \quad (2)$$

where GDP = Gross Domestic Product Per Capita Growth Rate, SMCR = Stock Market Capitalization ratio, STR = Total Value of Shares traded, TNVR = Stock Turnover ratio, FINLIB = Financial Liberalization; ε = Stochastic disturbance term and i = the i th observation since the data is time serial.

To test the existence of a significant relationship among the variables expressed in Equation (2), the hypothesis is re-stated as follows: $H_0: \beta_1 = \beta_2 = 0$. Stock market development does not have a significant impact on the growth and economic development of Nigeria.

4.0 DATA ANALYSIS AND INTERPRETATION

Data used for this study were obtained from CBN Statistical Bulletin, National Bureau of Statistics, 2017 and World (Bank) Development Indicator database, 2017. The variables considered were gross domestic product per capital growth rate (GDPGR), stock market capitalization ratio (SMCR), total value of shares traded (STR), stock turnover ratio (TNVR) and financial liberalization (FINLIB). This section is divided into two main parts, these are: descriptive and empirical analyses.

4.1 Descriptive Analysis

The gross domestic product per capital growth rate (GDPGR) has an average value of 3.24% with a standard deviation of 7.10. This shows that the growth rate within the period varies noticeably. Stock market capitalization ratio (SMCR) has an average value of 15.86% with a standard deviation of 8.13 which implies that market capitalization was about 15.86% of the country's gross domestic product during the period. Total value of shares traded (STR) on the average was N671.89b and standard deviation of 635.38. This means that during the period of this study the Nigerian Stock Exchange recoded a turnover of N671.89 billion on average with a deviation of 635.38 which is significant. The average and standard deviation values of stock turnover ratio (TNVR) were 8.13% and 3.02 respectively. Financial liberalization (FINLIB) has a mean value of 1538.72% and a standard deviation of 2472.79.

Table 1. Summary Statistics

Obn	Mean	Max	Min	Std. Dev.
GDPGR				
20	3.24	30.36	-5.48	7.1
SMCR				
20	15.86	39.95	5.65	8.13
STR				
20	671.89	2350.88	13.57	635.38
TNVR				
20	8.13	17.56	4.69	3.02
FINLIB				
20	1538.72	10858.1	104.9	2472.79

Source: Authors' Computation (2018).

4.2 Empirical Analysis

4.2.1 Stationarity Tests

This section tests for the order of integration, the study employed Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979) and Phillip Peron (PP) test (Phillip and Peron, 1988). Details of these results are contained in Table 2. ADF and PP are the most commonly used unit root tests approaches. The results show that all the series were not significant at all the levels except for GDPGR and FINLAB under Phillips-Perron (PP). However, on the basis of ADF test; it was clearly established that all the series were integrated of order one $I(1)$. This indicates that the study can proceed to check if a long-run relationship exists among the variables using a co-integration test.

Table 2. Unit Root Test

Variables	@LEVEL	@1 ST Diff.	Order
	Augmented Dickey-Fuller (ADF)		
Log(GDPGR)	-2.699	6.477***	I(1)
LOG(SMCR)	-1.731	-4.320**	I(1)
LOG(STR)	-1.452	-4.429**	I(1)
LOG(TNVR)	-2.705	-4.215**	I(1)
LOG(FINLIB)	-3.093	-6.115***	I(1)
	Phillips-Perron (PP)		
Log(GDPGR)	-3.495*	-17.112***	I(0)
LOG(SMCR)	-1.643	-7.247***	I(1)
LOG(STR)	-1.245	-6.279***	I(1)
LOG(TNVR)	-3.034	-15.922***	I(1)
LOG(FINLIB)	-5.602***	-12.133***	I(0)

Source: Researchers' study (2018). *** represents $p < 0.01$, represents ** $p < 0.05$ and represents * $p < 0.1$

4.2.2 Co-integration Test

Co-integration test tests for long run relationships between non-stationary series. In this study, we test for co-integration by means of Johansen approach under both trace statistic and the maximum eigenvalue criteria. As reported in Table 3, the Johansen co-integration test results provide sufficient evidence against the null hypothesis of no co-integration; hence, establishing the presence of a long-run relationship among the variables.

Table 3. Johansson Co-integration Test

Hypothesized No. of CE(s)	0.05				Max-Eigen Statistic	0.05	
	Eigenvalue	Trace Statistic	Critical Value	Prob.**		Critical Value	Prob.**
None *	0.992	161.372	76.973	0.000	86.395	34.806	0.000
At most 1 *	0.898	74.977	54.079	0.000	41.027	28.588	0.001
At most 2	0.685	33.950	35.193	0.068	20.772	22.300	0.081
At most 3	0.378	13.178	20.262	0.350	8.540	15.892	0.485
At most 4	0.227	4.638	9.165	0.326	4.638	9.165	0.326

Source: Authors' Computation (2018). Note: Trace test and Max-eigenvalue indicates 2 co-integrating equation(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values.

4.2.3 Diagnostics check inverse roots of the AR

The test on stability condition for the model indicates that no root lies outside the unit circle. The graphical output of the stability condition is displayed in Figure 1 below. It shows that all the inverse roots of the AR characteristics polynomials lie within the unit circle, thus, we conclude that the VECM models satisfy the stability condition. For inverse Roots of AR Characteristics Polynomial, see appendix.

4.2.4 Granger Causality Test Result:

Following the results from the co-integration tests, the study proceeded by examining the direction of causality among the series. The study utilizes Granger causality within the Vector Auto-regression (VAR) framework. The main goal of this was to examine the effects of stock market development on the economic growth and development of Nigeria. The study utilized time series data for 1998 to 2017. As can be seen from Table 4, the extracted results showed that there is a bi-directional relationship that runs from turnover ratio (TNVR) to stock market capitalization ratio

(SMCR) and vice versa within 5% and 10% level of significance. Also, the result showed that gross domestic product per capital growth rate (GDPGR), stock market capitalization ratio (SMCR), total value of shares traded (STR), and financial liberalization (FINLIB) jointly have causal effects on stock turnover ratio (TNVR). It can be observed that stock market development indicator does not have causal effect on economic growth and development of Nigeria during the period covered by this study.

Table 4. VAR Granger Causality Test Result

VARIABLE	GDPGR	SMCr	STr	TNVR	FINLIB
GDPGR		0.002 (0.966)	0.141 (0.707)	0.061 (0.805)	0.087 (0.768)
SMCr	0.073 (0.787)		0.013 (0.910)	5.708** (0.017)	0.890 (0.345)
STr	0.014 (0.907)	1.642 (0.200)		0.756 (0.385)	0.359 (0.549)
TNVR	0.044 (0.833)	2.817* (0.093)	2.188 (0.139)		2.298 (0.130)
FINLIB	0.040 (0.842)	0.026 (0.871)	0.001 (0.971)	0.612 (0.434)	
All	0.391 (0.983)	3.417 (0.491)	6.801 (0.147)	12.660** (0.013)	5.571 (0.234)

Source: Authors' Computation (2018) *** represents $p < 0.01$, represents ** $p < 0.05$ and represents * $p < 0.1$

5.0 CONCLUSION AND RECOMMENDATIONS

The study examined the effects of stock market development on the economic growth and development of Nigeria. The study utilized time series data that covers the period from 1998 to 2017. The major empirical tools that were used in this study were unit root tests, co-integration test, and VAR based granger causality test. The unit root tests' results showed that all the series were integrated of order 1(1); the Johansen co-integration test revealed that long-run relationship exists among the selected series. However, we found evidence of a bi-directional relationship that runs from turnover ratio (TNVR) to stock market capitalization ratio (SMCR) and vice versa. The study also found that gross domestic product per capital growth rate (GDPGR), stock market capitalization ratio (SMCR), total value of shares traded (STR) and financial liberalization (FINLIB) jointly have causal effects on stock turnover ratio (TNVR). We conclude that economic growth and development has not been found invariant to dis-equilibrium in the stock market in Nigeria during the period covered by this study. We recommend that there should be a policy rethink on how to make the stock market play its pivotal role as espoused by the finance and growth theory. There should be ways to promote the equity culture among Nigerians. The capital market regulators should also encourage medium-and-small scale enterprises (MSMEs) to list in the second-tier of the Nigerian Stock Exchange (NSE). Ways to achieve this include relaxing the listing requirements so as to make the market to be more competitive. Finally, efforts should be made to facilitate aggressive macro-economic growth of the country which in turn can impact the stock market more positively.

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APPENDIX

A1. Hypothesis testing

Null Hypothesis: GDPGR has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Fixed)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.699248	0.2478
Test critical values: 1% level	-4.571559	
5% level	-3.690814	
10% level	-3.286909	

Null Hypothesis: D(GDPGR) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=4)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.477273	0.0003
Test critical values: 1% level	-4.571559	
5% level	-3.690814	
10% level	-3.286909	

*MacKinnon (1996) one-sided p-values.

Warning: Probabilities and critical values calculated for 20 observations

and may not be accurate for a sample size of 18

A2. SMCR

Null Hypothesis: LOG(SMCR) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag = 4)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.731144	0.6969
Test critical values: 1% level	-4.532598	
5% level	-3.673616	
10% level	-3.277364	

Null Hypothesis: D(LOG(SMCR)) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag = 4)

	t-Statistic	Prob.*
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Augmented Dickey-Fuller test statistic	-4.320028	0.0160
Test critical values: 1% level	-4.571559	
5% level	-3.690814	
10% level	-3.286909	

A3. STR

Null Hypothesis: LOG(STR) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag = 4)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.451710	0.8101
Test critical values: 1% level	-4.532598	
5% level	-3.673616	
10% level	-3.277364	

Null Hypothesis: D(LOG(STR)) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag = 4)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.428757	0.0131
Test critical values: 1% level	-4.571559	
5% level	-3.690814	
10% level	-3.286909	

A4. TNVR

Null Hypothesis: LOG(TNVR) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 0 (Automatic - based on SIC, maxlag = 4)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.705265	0.2452
Test critical values: 1% level	-4.532598	
5% level	-3.673616	
10% level	-3.277364	

Null Hypothesis: D(LOG(TNVR)) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 3 (Automatic - based on SIC, maxlag = 4)

	t-Statistic	Prob.*
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Augmented Dickey-Fuller test statistic	-4.215483	0.0235
Test critical values: 1% level	-4.728363	
5% level	-3.759743	
10% level	-3.324976	

A5. FINLIB

Null Hypothesis: LOG(FINLIB) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 3 (Automatic - based on SIC, maxlag = 4)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.092901	0.1406
Test critical values: 1% level	-4.667883	
5% level	-3.733200	
10% level	-3.310349	

Null Hypothesis: D(LOG(FINLIB)) has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 1 (Automatic - based on SIC, maxlag = 4)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.114971	0.0007
Test critical values: 1% level	-4.616209	
5% level	-3.710482	
10% level	-3.297799	

A6. GDPGR

Null Hypothesis: GDPGR has a unit root
 Exogenous: Constant, Linear Trend
 Lag length: 1 (Fixed Spectral OLS AR)

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-3.495531	0.0687
Test critical values: 1% level	-4.532598	
5% level	-3.673616	
10% level	-3.277364	

Null Hypothesis: D(GDPGR) has a unit root
 Exogenous: Constant, Linear Trend
 Bandwidth: 17 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-17.11187	0.0001

Test critical values: 1% level	-4.571559
5% level	-3.690814
10% level	-3.286909

A7. SMCR

Null Hypothesis: LOG(SMCR) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-1.642568	0.7363
Test critical values: 1% level	-4.532598	
5% level	-3.673616	
10% level	-3.277364	

Null Hypothesis: D(LOG(SMCR)) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 13 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-7.246738	0.0001
Test critical values: 1% level	-4.571559	
5% level	-3.690814	
10% level	-3.286909	

A8. STR

Null Hypothesis: LOG(STR) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-1.245475	0.8703
Test critical values: 1% level	-4.532598	
5% level	-3.673616	
10% level	-3.277364	

Null Hypothesis: D(LOG(STR)) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-6.278942	0.0004
Test critical values: 1% level	-4.571559	

5% level	-3.690814
10% level	-3.286909

A9. TNVR

Null Hypothesis: TNVR has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-3.033735	0.1492
Test critical values: 1% level	-4.532598	
5% level	-3.673616	
10% level	-3.277364	

Null Hypothesis: D(TNVR) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 17 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-15.92238	0.0001
Test critical values: 1% level	-4.571559	
5% level	-3.690814	
10% level	-3.286909	

A10. FINLIB

Null Hypothesis: FINLIB has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-5.601656	0.0013
Test critical values: 1% level	-4.532598	
5% level	-3.673616	
10% level	-3.277364	

Null Hypothesis: D(FINLIB) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-12.13303	0.0000
Test critical values: 1% level	-4.571559	
5% level	-3.690814	

10% level -3.286909

A11. CO-INTEGRATION TEST

Date: 10/08/18 Time: 15:16

Sample (adjusted): 2000 2017

Included observations: 18 after adjustments

Trend assumption: No deterministic trend (restricted constant)

Series: GDPGR LOG(SMCR) LOG(STR) LOG(TNVR)

LOG(FINLIB)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.991768	161.3716	76.97277	0.0000
At most 1 *	0.897640	74.97666	54.07904	0.0002
At most 2	0.684634	33.94998	35.19275	0.0677
At most 3	0.377766	13.17758	20.26184	0.3498
At most 4	0.227133	4.637666	9.164546	0.3255

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.991768	86.39498	34.80587	0.0000
At most 1 *	0.897640	41.02668	28.58808	0.0008
At most 2	0.684634	20.77241	22.29962	0.0805
At most 3	0.377766	8.539914	15.89210	0.4846
At most 4	0.227133	4.637666	9.164546	0.3255

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

A12. VAR Granger Causality/Block Exogeneity

Wald Tests

Date: 10/08/18 Time: 23:36

Sample: 1998 2017

Included observations: 18

Dependent variable: D(GDPGR)

Excluded	Chi-sq	df	Prob.
D(LOG(SM CR))	0.073258	1	0.7867
D(LOG(STR)	0.013700	1	0.9068
D(LOG(TN VR))	0.044447	1	0.8330
D(LOG(FIN LIB))	0.039587	1	0.8423
All	0.391162	4	0.9832

Dependent variable: D(LOG(SMCR))

Excluded	Chi-sq	df	Prob.
D(GDPGR)	0.001858	1	0.9656
D(LOG(STR)	1.641561	1	0.2001
D(LOG(TN VR))	2.816564	1	0.0933
D(LOG(FIN LIB))	0.026298	1	0.8712
All	3.417357	4	0.4906

Dependent variable: D(LOG(STR))

Excluded	Chi-sq	df	Prob.
D(GDPGR)	0.141368	1	0.7069
D(LOG(SM CR))	0.012814	1	0.9099
D(LOG(TN VR))	2.187916	1	0.1391
D(LOG(FIN LIB))	0.001351	1	0.9707
All	6.800741	4	0.1468

Dependent variable: D(LOG(TNVR))

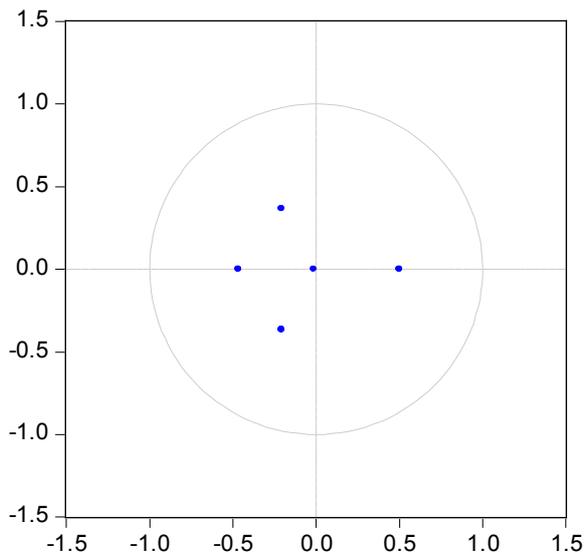
Excluded	Chi-sq	df	Prob.
D(GDPGR)	0.060886	1	0.8051
D(LOG(SM CR))	5.707736	1	0.0169
D(LOG(STR)	0.755662	1	0.3847

D(LOG(FIN LIB))	0.611805	1	0.4341
All	12.65970	4	0.0131

Dependent variable: D(LOG(FINLIB))

Excluded	Chi-sq	df	Prob.
D(GDPGR)	0.086985	1	0.7680
D(LOG(SM CR))	0.890216	1	0.3454
D(LOG(STR)	0.359408	1	0.5488
D(LOG(TN VR))	2.298246	1	0.1295
All	5.571134	4	0.2335

Inverse Roots of AR Characteristic Polynomial



Social Capital and Financial Services: A Study of SMEs in the Manufacturing Sector in Tanzania

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ABSTRACT

This paper examines the relationship between social capital on access to financial services for Small and Medium Enterprises (SMEs) in the manufacturing sector. The study area is Dar es Salaam, Tanzania. A cross-sectional design was used and surveyed semi-structured questionnaire to collect data from respondents using convenience sampling. A total of 81 completed questionnaires were subjected to descriptive statistics and ANOVA analysis. The descriptive results for social capital reveal that majority of respondents regularly talk with other business owners (90.1%), meet frequently with family and friends to talk about business (90.1%), and belong to a religious group (93.8%); while for access to financial services the results show that majority of respondents (82.7%) strongly agree that friends and family provide extra capital when needed. Among the inferential statistics findings on the relationship between social capital and access to financial services indicated that regularly talks with other business owners is statistically significantly to access to grants ($p = 0.003$), regularly talks with other business owners is statistically significantly to friends and family provide extra capital when needed ($p = 0.035$), meeting frequently with family and friends to talk about business is statistically significantly to access to grants ($p = 0.012$), having strong ties with people or entities in business with is statistically significantly to access to grants ($p = 0.008$), and having strong ties with fellow SMEs is statistically significantly to access to grants ($p = 0.012$), fellow SMEs have strong ties with one another is statistically significantly to access grants ($p = 0.025$), belonging to a football club is statistically significantly to access to grants ($p = 0.000$), belonging to a Golf Club is statistically significantly to friends and family provide extra capital when needed ($p = 0.001$), and belonging to a community social group is statistically significantly to friends and family provide extra capital when needed ($p = 0.004$). This paper adds knowledge to the issue of the relationship of social capital and access to financial services for SMEs in the manufacturing sector in Tanzania. Future studies can explore financial cultures by SMEs and access to financial services in the manufacturing sector.

Keyword: social capital, financial services, SMEs, Manufacturing Sector

JEL Code: G29, L26, L66

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1.0 INTRODUCTION

The manufacturing sector, as a driver of industrialization in the global context, is growing as evidenced by the increased output of 4.7% in 2017 (United Nations Industrial Development Organization, 2017). The United Nations Industrial Development Organization (UNIDO) noted that developing and emerging industrial economies like Asia had a higher growth of manufacturing output (6.5%) compared to industrialized economies like Europe (4.9%) in 2017 due to increased output of products such as computers, electronics, machinery, basic pharmaceuticals and food. The report by UNIDO added that Africa's output increased by 2%. UNIDO report also noted that factors such as improved business conditions, rising consumer spending and investments have contributed to the positive development in global manufacturing.

The connection between manufacturing sector growth and bank lending has been established by various authors (Hoxha, 2013; Lin, Sun and Wu, 2015). In Africa, Muchingani, Monametsi and Paradza (2017) found that in Zimbabwe there was a positive relationship between bank's commercial lending and growth of the manufacturing sector. This indicates that financial services facilitate domestic and international transactions for Small and Medium Enterprises (United Nations Conference on Trade and Development, 2014).

Financial services have grown faster than Gross Domestic Products (GDP). For example, in countries that are members of the Organization for Economic Cooperation and Development (OECD) recorded growth average annual rate of 6.3% between 2001 to 2012 (United Nations Conference on Trade and Development, 2014). Although there is growth in the financial services, earlier scholars such as Richard and Mori (2012) cited deficiencies in the provision of financial services to SMEs due to lack of knowledge in financial management by SMEs. Similarly, Alemu (2017) argued that SMEs face challenges in establishing new venture due to poor vertical communication and access to finance and credit services. A study by Shankar (2013) found that SMEs failure to access financial services was attributed to their inability to attend group meetings especially from the microfinance institutions. However, the term financial services in this study is focused on ease of access as documented by other researchers such as Per and Benson (2003).

The finding by Shankar (2013) showed that the aspect of social capital which deals with individuals and group networks from a social capital theory perspective, among SMEs, is a challenge. More studies are needed to understand the phenomenon of social capital and financial services, especially in developing countries perspective. This paper examines social capital and financial services with a specific objective of examining the relationship between social capital and access to financial services for SMEs in the manufacturing sector in the context of Tanzania.

2.0 LITERATURE REVIEW

2.1 Definition of Concepts

2.1.1 Social Capital

The concept of social capital appears in various articles (Coleman, 1988; Portes, 1998, Lin, 1999; Buskens and Van de Rijt, 2008; Sato, 2013). Coleman (1988) defines social capital at the community and societal levels. Further literature provides the definition of social capital as the resources embedded in social networks accessed and used by actors for action (Lin, 1999). Sato (2013) noted that social capital has been defined at the individual, the meso and the societal level. In this paper, social capital refers to SMEs social networks from the perspectives of the business, friends and family, as well as the community.

2.1.2 Financial Services

Financial services provide services such as domestic and international transactions and credits to primary, industrial and tertiary sectors as well as to individuals (United Nations Conference on Trade and Development, 2014). Financial services mean firms in retail banking, commercial lending, insurance, credit cards, mortgage banking, investment advisory, and asset management (Hatzakis, Nair and Pinedo, 2010). Further understanding of financial services as a concept is

connected to mobile devices as mobile financial services and this is noted in recent articles such as Kim, Zoo, Lee and Kang (2018). In this paper, financial services are referred to as ease of access in terms of finance sources such as access to grants as well as extra capital from friends and family as defined by Per and Benson (2003).

2.1.3 Small and Medium Enterprises

Small and Medium Enterprises (SMEs) are defined as non-subsidary, independent firms which employ fewer than a given number of employees, for example, the European Union the upper limit for SMEs is 250 employees while the USA is 500 employees (OECD, 2005). According to OECD, SMEs are not only defined by number of employees but also by financial assets. The definition of SMEs is based on a fixed quantitative measure, for example, number of workers, number of capital, total assets and sales turnover (Hashim and Abdullah, 2000; Omar *et al.*, 2009). Other countries such as Mexico define SMEs as employing 1 to 250 employees; Japan, Norway, Switzerland and Turkey from 1 to 249 employees; and United States from 1 to 499 employees (OECD, 2010; Berisha and Pula, 2015). The definition of SMEs in this paper is adopted from the Tanzania SME Development Policy 2003 by the Ministry of Industry and Trade indicated in UNIDO (2013) which states that Small and Medium Enterprises (SMEs) include micro enterprises.

2.2 Theoretical Framework

This paper adopts the social capital theory developed by Bourdieu and Wacquant (1992). In developing the social capital theory, Bourdieu and Wacquant assumed that social capital is resources by individuals or groups which accrue due to having durable networks that have either more institutionalized or less institutionalized relationships of mutual acquaintance and recognition. Social capital is commonly defined as social networks (Sato, 2013). Sato defines social capital in terms of four aspects which are goals and utility, levels of definition, coverage of social capital and types of social capital. Gudmundsson and Mikiewicz (2012) noted that social capital in relation to education means the degree of social engagement of residents. In this paper, social capital is referred to as the usage of one's network in gathering information to enable the business owner to excel his/her business.

Hang and Hsu (2016) are among the scholars who have used the social capital theory. Hang and Hsu applied the social capital theory to determine users' subjective well-being in social networking sites. On the other hand, Agyapong *et al.* (2017) did a study in Ghana and used the social capital theory to understand performance of micro and small firms in an emerging economy. In examining the relationship among social capital, innovation and performance, the results revealed positive influences between the relationships of social capital and performance as noted by Agyapong *et al.* This paper applies social capital theory to guide the analysis on the relationship between social capital and access to financial services for SMEs in the manufacturing sector.

2.3 Empirical Literature Review

Financial services documented in India by Shankar (2013) involved financial inclusion which implies expanding access to financial services to those who do not have access to financial services. The study used qualitative approach and the results showed that one of the major barriers on access to financial service is the inability to attend group meetings (Shankar, 2013). The study by Asmundson (2011) described financial services as the process of acquiring the financial good. In this paper, financial services are considered as access to financial services through grants and loans.

Iturrioz, Aragon and Narvaiza (2014) did a case study in Spain to illustrate how to foster shared innovation within SMEs' networks. Findings from existing documents and interviews from informants revealed that the main drivers for developing innovation networks were dependent on intermediaries and social capital systematic dynamics as noted by Iturrioz *et al.* In 2015, a study in Italy examined social capital by looking at evolution of inter-organisational social capital with foreign customers by SMEs (Presutti, Boari and Fratocchi, 2015). The findings indicated that

relational and cognitive social capital has positive effects only for low levels of inter-organizational psychic distance. This study also examines social capital but in relation to financial services as opposed to SMEs performance.

Other scholars such as Mwathi *et al.* (2018) from Africa have investigated financial services and this is in relation to mobile money services. For example, Mwathi *et al.*, examined mobile money transfer services and financial inclusion in Uganda. Mwathi *et al.*, used correlation coefficient and regression analysis as tools of analysis, and the results showed that system quality, intention to use, and user satisfaction were the major factors that predict financial inclusion. Faith (2018) demonstrated further that there is a strong link between companies who invest in information technology and level of innovativeness. Faith recommended that there is a need to identify mechanism that can improve SME and entrepreneurial performance in Uganda. In Ethiopia, Alemu (2017) argued that SMEs face challenges in establishing new venture and this is because the majority of the sampled entrepreneurs who were male (59.7%) had poor vertical communication and access to financial and credit services.

In Tanzania, Marwa (2014) explored the causes of access to external financing by Micro, Small and Medium Enterprises (MSMEs). By using a desk review methodology, the results revealed that credit rationing is due to the mismatch between requirements of formal financial institutions' lending process and structural problems in MSMEs. Gamba (2016) explored the nexus of social capital and development and findings shows social capital can be recognized as a tool for development. This study is interested in social capital in relation to financial services access. Existing literature (Richard and Mori, 2012; Marwa, 2014; Swai *et al.*, 2016; Agolla *et al.*, 2017; Mkwizu *et al.*, 2018; Mwathi *et al.*, 2018) shows extensive research on SMEs and financial services but limited studies on social capital and financial services. This paper examines social capital and financial services by examining the relationship between social capital and financial services with a focus in the manufacturing sector. This paper hypothesizes that there is a significant relationship between social capital and access to financial services for SMEs in the manufacturing sector.

3.0 METHODOLOGY

This study selected food processors in the manufacturing sector by SMEs due to Tanzania's policy shift from agricultural economy towards the industrial economy as indicated in the National Five Year Development Plan 2016/17 -2020/21 by the Ministry of Finance and Planning (2016). The Dar es Salaam region was selected in this study because according to the National Bureau of Statistics SMEs survey of 2012, Dar es Salaam (45%) is the second region after Mbeya (46%) in terms of percentage of SMEs in businesses.

A cross-sectional design was adopted, and the population of 141 SMEs was sourced from the Tanzania Food and Drugs Authority (TFDA) website (<https://www.tfda.go.tz/>) under food products registered SMEs manufacturers in Dar es Salaam region in Tanzania as the study area. Convenience sampling method was used in this study. A search for telephone contacts of the manufacturers were done through their websites and social media search, and questionnaire was administered via telephone calls. A total of 81 completed questionnaires from respondents, representing 57% of the population which the authors thought were sufficient for descriptive statistics analysis and one way ANOVA.

The independent variable, social capital was analysed through an instrument that was adopted and customized from Pishghadam *et al.* (2011), and Per and Benson (2003). The dependent variable being financial services is measured using ease of access. The measurement items on access to financial services are adopted and customized from studies by Per and Benson (2003). Pilot study prior to data collection ensured the validity of the data collection instrument and the reliability using Cronbach's Alpha showed social capital as 0.796 and financial services as 0.905. A Cronbach's alpha value of 0.70 or above is considered as acceptable for reliability test on consistency of responses (Saunders *et al.*, 2012).

4.0 FINDINGS AND DISCUSSION

The demographic information for the sampled respondents is shown in Table 1. Majority of the respondents were aged between 31 to 40 years old (32.1%), male (54.3%), 2-5 years of operating business (48.1%), sole proprietor (46.9%), registered (90.1%) with 1 employee. These findings suggests that most of the SMEs in the manufacturing sector are middle aged males with 2-5 years of operating business as registered sole proprietors and have 1 employee. The findings from Alemu (2017) are similar to those of this study in that majority of the SMEs were male.

Table 1. Demographic information of Respondents

Variable	Frequencies (n)	Percentage (%)	
Age :	21-30	22	27.2
	31-40	26	32.1
	41-50	18	22.2
	51-60	15	18.5
Gender:	Male	44	54.3
	Female	37	45.7
Year of Operating Business:	Less than a year	16	19.8
	1-2 years	15	18.5
	2-5 years	39	48.1
	Above 5 years	11	13.6
Type of Business:	Sole Proprietor	38	46.9
	Partnership	27	33.3
	Limited Liability company	16	19.8
Registration Status:	Registered (Formalized)	73	90.1
	Not Registered (Not Formalized)	8	9.9
Size of Business in numbers of employees:	1 employee	39	48.1
	2-4 employees	20	24.7
	5-10 employees	18	22.3
	11 or more employees	4	4.9

Source: Field Data (2018)

The findings on social capital dimension which was divided into ties with general community (such as football club and social groups), and ties with the business community (such as fellow SMEs, friends and family, and business entities) show that majority of respondents regularly talk with other business owners (90.1%), meet frequently with family and friends to talk about business (90.1%), and belong to a religious social group (93.8%). The results imply that majority of the sampled SMEs in the manufacturing sector talk with other business owners, meet frequently with family and friends to talk about business and belong to a religious social group. The findings of this study are not in line with Shankar (2013) which showed inability to attend group meetings. The variations of the study by Shankar (2013) conducted in India and this study is because of networks abilities in terms of meeting frequently.

Descriptive findings on financial services show that majority of respondents strongly agree that friends and family provide extra capital when needed (82.7%), and friends and family are their first stop when their cash strapped (72.8%). On the other hand, the majority of respondents strongly disagreed that they have not applied for a loan in the past three years (43.2%), have applied for a loan and were denied (39.5%), and have access to grants (38.3%). The results of this study suggest that most of the SMEs in the manufacturing sector rely on friends and family for financing their business and less on formal lending institutions for loans and grants. This is in line with a study

conducted in Ethiopia by Alemu (2017) which showed that entrepreneurs faced challenges in access to financial and credit services. The only difference is that in Tanzania's SMEs, the manufacturing sector rely more on friends and family rather than formal institutions.

One way ANOVA analysis for the relationship between social capital and access to financial services is shown in Appendices 1a, 1b and 1c. The findings in Appendix 1a show that regularly talks with other business owners is statistically significantly to access to grants ($p = 0.003$), regularly talks with other business owners is statistically significantly to friends and family provide extra capital when needed ($p = 0.035$), meeting frequently with family and friends to talk about business is statistically significantly to access to grants ($p = 0.012$), having strong ties with people or entities in business with is statistically significantly to access to grants ($p = 0.008$), and having strong ties with fellow SMEs is statistically significantly to access to grants ($p = 0.012$).

Appendix 1b, shows that fellow SMEs have strong ties with one another is statistically significantly to access grants ($p = 0.025$), belonging to a Football Club is statistically significantly to access to grants ($p = 0.000$), belonging to a Golf Club is statistically significantly to access to grants ($p = 0.002$), belonging to a Golf Club is statistically significantly to friends and family provide extra capital when needed ($p = 0.001$), belonging to a Golf Club is statistically significantly to friends and family the first stop when cash strapped ($p = 0.010$), belonging to a Golf Club is statistically significantly to having not applied for a loan in the past three years ($p = 0.048$).

Further findings in Appendix 1c show that being actively involved in a political party association is statistically significantly to being part of a loan credit saving society ($p = 0.011$), being actively involved in a political party association is statistically significantly to having applied and was successful in obtaining a loan from a financial institution in the past three years ($p = 0.022$), belonging to a community social group is statistically significantly to access to grants ($p = 0.012$), belonging to a community social group is statistically significantly to friends and family provide extra capital when needed ($p = 0.004$), belonging to a community social group is statistically significantly to friends and family are the first stop when cash strapped ($p = 0.029$), belonging to a community social group is statistically significantly to having not applied for a loan in the past three years ($p = 0.002$). From the findings in Appendices 1a, 1b and 1c, this study proved that there is a statically significant relationship between social capital and access to financial services and this supports the social capital theory.

This implies that for SMEs in the manufacturing sector to have access to financial services in the context of Tanzania should possess social capital networks in terms of regularly talking with other business owners, strong ties with business entities and fellow SMEs, and belong to the general community. These findings are not consistent with Alemu (2017) which showed that SMEs in Ethiopia have poorer communication. Further differences in results is noted in a study by Shankar (2013) which indicated that access to financial services in India is hindered by the inability to attend weekly group meetings. In this study, SMEs communicate by regularly talking to other business owners, and meet frequently with friends and family to talk about business hence have ties with the general and business communities which are important aspects for access to financial services.

5.0 CONCLUSION

We conclude that the relationship between social capital and access to financial services is statistically significant and support the social capital theory in terms of strong social capital networks among SMEs with other business entities, fellow SMEs and friends and family.

The outcome has policy implications for industrial decision makers to encourage SMEs to have social capital networks that have strong ties among SMEs by talking and meeting frequently, and belonging to groups such as a community social groups and football club. The practical implications of this study is that in order for SMEs in the manufacturing sector to access financial services, more efforts to instil strong networks with the general community such as belonging to a football club, golf club and social groups. Furthermore, access to financial services can be enhanced

if policy makers provide more business networking opportunities where business owners can meet regularly to discuss business.

Future researchers could analyse social capital and financial service for SMEs in other sectors since this study was limited to SMEs in the manufacturing sector. In addition, a longitudinal study may be adopted in order to capture data over a period of time.

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APPENDIX

Appendix 1a. One way ANOVA findings of Social Capital and Financial Services

I regularly talk with other business owners.		Sum of Squares	Mean Square	F	Sig.
Access to grants	Between Groups	37.884	12.628	5.181	0.003
	Within Groups	187.671	2.437		
	Total	225.556			
Friends & Family provide extra capital when needed	Between Groups	14.897	4.966	3.015	0.035
	Within Groups	126.831	1.647		
	Total	141.728			
I meet frequently with family and friends to talk about business.		Sum of Squares	Mean Square	F	Sig.
Access to grants	Between Groups	24.391	12.196	4.729	0.012
	Within Groups	201.164	2.579		
	Total	225.556			
I feel I have strong ties with people or entities that I do business with.		Sum of Squares	Mean Square	F	Sig.
Access to grants	Between Groups	31.889	10.630	4.226	0.008
	Within Groups	193.667	2.515		
	Total	225.556			
I feel I have strong ties with fellow SMEs.		Sum of Squares	Mean Square	F	Sig.
Access to grants	Between Groups	24.402	12.201	4.731	0.012
	Within Groups	201.154	2.579		
	Total	225.556			

Source: Field Data (2018)

Appendix 1b. One way ANOVA findings of Social Capital and Financial Services

My fellow SMEs have strong ties with one another.		Sum of Squares	Mean Square	F	Sig.
Access to grants	Between Groups	30.469	7.617	2.967	0.025
	Within Groups	195.087	2.567		
	Total	225.556			
I belong to a Football Club.		Sum of Squares	Mean Square	F	Sig.
Access to grants	Between Groups	47.395	15.798	6.828	0.000
	Within Groups	178.160	2.314		
	Total	225.556			
I belong to a Golf Club		Sum of Squares	Mean Square	F	Sig.
Access to grants	Between Groups	44.099	11.025	4.617	0.002
	Within Groups	181.457	2.388		
	Total	225.556			
Friends & Family provide extra capital when needed	Between Groups	29.263	7.316	4.944	0.001
	Within Groups	112.465	1.480		
	Total	141.728			
Friends & Family are my first stop when I am cash strapped	Between Groups	22.139	5.535	3.568	0.010
	Within Groups	117.885	1.551		
	Total	140.025			
I have not applied for a loan in the past three years	Between Groups	27.306	6.827	2.516	0.048
	Within Groups	206.249	2.714		
	Total	233.556			

Source: Field Data (2018)

Appendix 1c. One way ANOVA findings of Social Capital and Financial Services (FS)

I am actively involved in a political party association.		Sum of Squares	Mean Square	F	Sig.
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I am part of a loan credit saving society	Between Groups	28.550	7.138	3.528	0.011
	Within Groups	153.771	2.023		
	Total	182.321			
I have applied and was successful in obtaining a loan from a financial institution in the past three years	Between Groups	19.827	4.957	3.061	0.022
	Within Groups	123.086	1.620		
	Total	142.914			
I belong to a community social group.		Sum of Squares	Mean Square	F	Sig.
Access to grants	Between Groups	29.870	9.957	3.918	0.012
	Within Groups	195.685	2.541		
	Total	225.556			
Friends & Family provide extra capital when needed	Between Groups	22.420	7.473	4.823	0.004
	Within Groups	119.308	1.549		
	Total	141.728			
Friends & Family are my first stop when I am cash strapped	Between Groups	15.441	5.147	3.181	0.029
	Within Groups	124.584	1.618		
	Total	140.025			
I have not applied for a loan in the past three years	Between Groups	24.173	8.058	5.225	0.002
	Within Groups	118.741	1.542		
	Total	142.914			

Source: Field Data (2018)

Neuron as an Electric PAU

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ABSTRACT

The objective of this work is to show that it is possible to describe, in approximate form, the operation of a neuron if it is defined from the electrical point of view. To create the neurons that make up artificial neural networks were used as a resource the *deus ex machina*. That is, an external element was sought to solve the problem, ignoring its internal logic. Llinás (1988) showed that a neuron in mammals is not only that 'ideal cell' that helped to unravel all the researchers before him, but also represents a dynamic element that has a wide range of electrophysiological properties that allow it to handle different ionic conductances, either dependent on a certain voltage level, or on some molecule that activates them. Among the electrophysiological properties of the CNS neurons, Llinás highlights its spontaneous activity, which is closely linked to the voltage-activated ionic conduction, in particular, the one is known as the low threshold of Ca^{++} initially identified in the cells of the inferior olive (IO). Thus, neurons become true unicellular oscillators or resonators. The self-rhythmicity that enables Ca^{++} and other ions make a nerve cell can respond to certain frequencies. According to a theory of neuropsychic functioning (Salatino, 2013) is that they are described and substantiated from the electrical point of view, each of the parts that make up a neuron. That is: 1) Dendrites as an RC circuit that acts as a receiver (or tuner); 2) Soma as an RL circuit that by a phenomenon of self-induction justifies the generation of the "action potential"; 3) Dendrite-soma complex as an RLC circuit that acts as a resonator, generating certain frequencies; and 4) Axon-synapse complex as an RM (resistor-memristor) circuit that allows to "remember" a particular frequency. This allows us to see the neuron as an integrator of the passive electrical elements (that dissipate or store energy) of two terminals, which, according to the classical circuit theory, are three: the capacitor, the resistor, and the inductor. A fourth basic element is included: the memristor, whose operation can only be detected at the nanoscale. The four fundamental variables that define the aforementioned elements are: a) electrical voltage, b) electric current, c) electric charge and d) magnetic flux. With them, different PAUs were created that allowed, through the Transcursive Logic, to simulate the electrical functioning of a neuron. This operation was corroborated by industrial simulators of electrical circuits.

Keyword: neurophysiology, electrical theory, psychic functioning, Transcursive Logic.

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1.0 INTRODUCTION

To create the neurons that make up artificial neural networks were used as a resource the *deus ex machina*. That is, an external element was sought to solve the problem, ignoring its internal logic.

It is possible to describe, in approximate form, the operation of a neuron if it is defined from the electrical point of view.

Since the end of the eighteenth century, the existence of animal current is known, through the experiments of Galvani (1797). In the mid-nineteenth century, Matteucci (1844) describes the “current of injury or muscular.” Helmholtz (1854) calculated the velocity of propagation of the excitatory signal in a neuro-muscular preparation. At the same time, Du Bois-Reymond (1849), discovered the “action potential” of a nerve, through its electrical stimulation, and it was Bernstein (1868) who determined its velocity of propagation and proposed that the living cell was surrounded by a cellular membrane slightly permeable to ions and that the interior was filled with an electrolyte where the ions moved freely.

Began the twentieth century, many were the contributions that pin down the electrical characteristics of both the nerve and the cell membrane. Walther Nernst (1907) proposed that both the nerve cell membrane and the muscle membrane were polarized due to their selective permeability to potassium. Thus, he managed to explain the 'resting potential' as a consequence of a selective permeability between cations and anions.

The intracellular measurements made by Hodgkin and Huxley (1952) led to determine the differential equations that explained the mechanism of ionic conductances producing the action potential and the behavior of the nerve as an electric conductor. For these results, they were deserving of the Nobel Prize in Medicine in 1963.

Llinás (1988) showed that a neuron in mammals is not only that 'ideal cell' that helped to unravel all the previous researchers, but also represents a dynamic element that has a wide range of electrophysiological properties that allow it to handle different ionic conductances, either dependent on a certain voltage level, or on some molecule that activates them.

Among the electrophysiological properties of the CNS neurons, Llinás highlights its spontaneous activity, which is closely linked to the voltage-activated ionic conduction, in particular, the one known as the low threshold of Ca^{++} initially identified in the cells of the inferior olive (IO).

The aforementioned spontaneous activity has a particularity and is that it is inactivated during the resting potential and is reactivated during hyperpolarization of the membrane. The latter is a behavior that seems paradoxical, as it contradicts the 'neurobiological dogma' that states that the depolarization of the membrane from the resting potential increases excitability, while hyperpolarization decreases it. The dogmatic is an oversimplification, since, in the IO, a subthreshold depolarization can produce an action potential superimposed on depolarizations or hyperpolarizations. This phenomenon authorizes, that the CNS neurons to be considered as true unicellular oscillators or resonators.

The conductance of Ca^{++} as that of other ions is organized in such a way as to allow self-rhythmicity to a nerve cell. Also, as the dynamics of these conductances, in some cells, respond to a certain frequency (s), they can be considered as resonators. The best example of this is, again, the cells of the IO, which tend to respond to frequencies that are directly modulated by their intrinsic electrical properties.

2.0 A THEORY OF NEUROPSYCHICAL FUNCTIONING

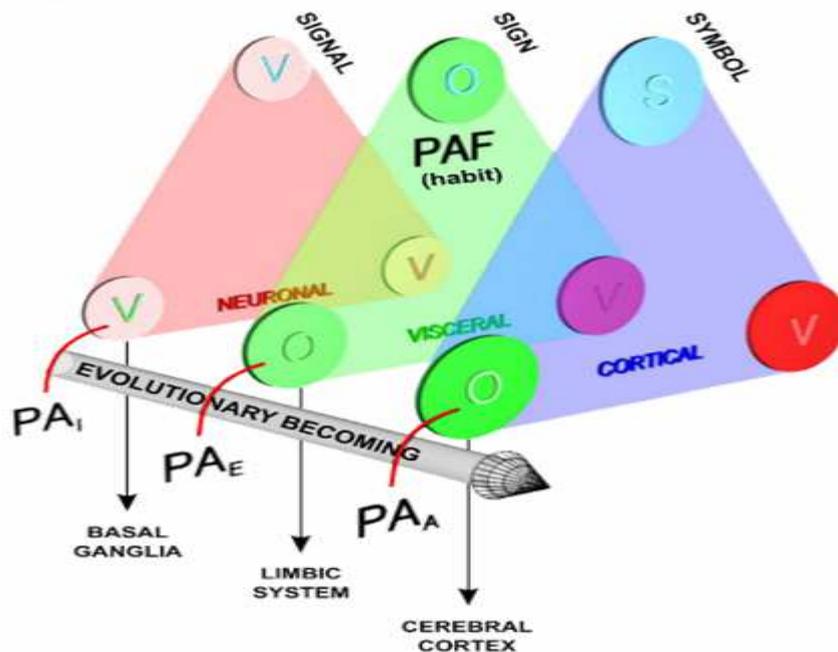
Before describing a neuron from the electrical point of view, we will summarize a theory about psychic structure and function already elaborated (Salatino, 2013), under whose principles this neuron must operate. According to this theory everything that affects from the outside to our brain, as a stimulus, it does in the form of waves that have a certain range of frequencies. Therefore, the central nervous system (CNS) should be able to measure the frequency of the input wave and thus

certify that something has been perceived. But, besides, depending on the frequency, it will tell us to which part of the subjective reality (that of the subject that perceives - Salatino, 2009) belongs. That is, if what you just entered is about biological reality (stimuli from the body). With the psychic reality (stimuli that come from the immediate surroundings of the subject). Or with the sociocultural reality (stimuli originated in the relationship with others).

We must bear in mind that there is a specific sector of the brain, product of the phylogenetic evolution of the CNS, to respond to each of these instances (Salatino, 2012, p.82) (Figure 1).

Figure 1 shows synthetically the evolutionary integration that occurs in the human CNS. In the diagram, we can see the concurrence of three brains. The 'neuronal brain,' the oldest one, that sits in the basal ganglia, where the perceived element is a pure transformation or change through a 'signal.' The 'visceral brain' that lies in the limbic system, where 'objects' are perceived using a 'sign,' that is that indicates the relationship between two objects utilizing a change. Finally, the 'cortical brain,' the newest evolutionarily speaking, that from the cerebral cortex can detect 'subjects' with the help of a 'symbol,' that is, what records the relationship between a subject and an object thanks to a change or transformation.

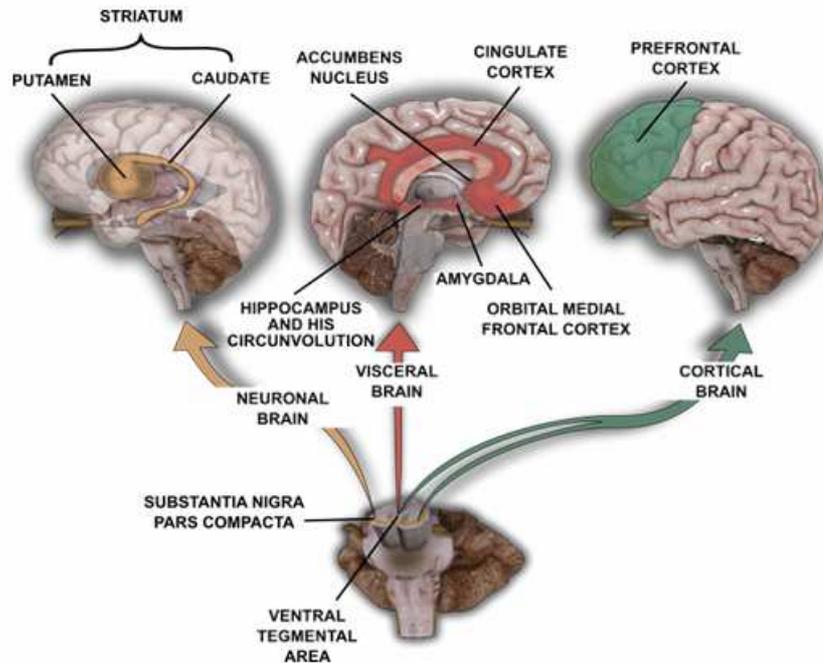
Fig. 1. Filogenetic distribution of the SNC



References: inputs: signal, sign, symbol - outputs: PA_I : innate response; PA_E : modifiable response by experience - PA_A : learned response (Salatino, 2009).

The above scheme also tells us about the outputs (the response) projected by each of these 'brains.' Although, before producing an output, it must be elaborated. The elaboration of the answers, in the same way, is directly related to the frequency. The aforementioned theory tells us that there is a selector mechanism of each of the brains described, to 'take the data' that have entered and so proceed to elaborate a response and 'record it' before projecting it. That mechanism is seen in Figure 2.

Fig. 2. Dopaminergic system

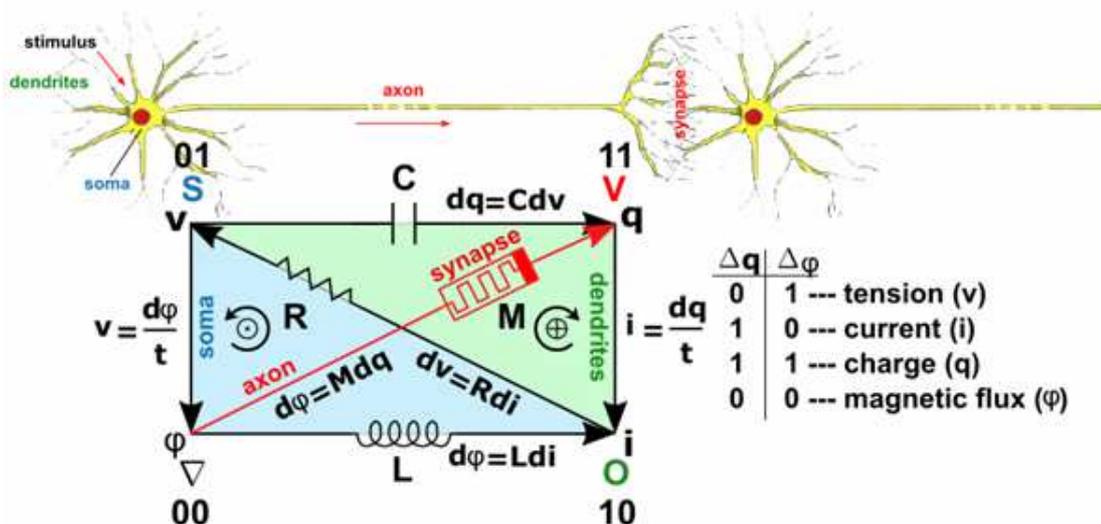


Dopamine is a neurotransmitter that is involved in all CNS responses. From the dopamine-producing areas, at the base of the brain, it is distributed to the nuclei and gray matter areas of the “different brains” to coordinate a specific response, register it and determine to what part of reality it is necessary to project it. These answers, as indicated in Figure 1, can be innate if they are directed to biology, modifiable with experience if the destination is the immediate environment, or directly learned if the objective of the projection is sociocultural ambit.

3.0 THE NEURON FROM THE ELECTRIC POINT OF VIEW

After reviewing the tasks that must be fulfilled by neurons and how they should be done, to emulate these processes succinctly, we present an “electrical model” of a generic neuron, and we do it from the Transcursive Logic (TL) (Salatino, 2017) (Figure 3).

Fig. 3. Neuronal PAU



References: C: capacitance - R: resistance - L: Inductance; M: memristance - Δ : variation - S: subject - O: object; V: apparent transformation - ∇ : hidden transformation \otimes : XOR - \odot : XNOR.

The TL will constitute a practical guide of how to observe the dynamics of this system of transformations. Something similar to a “phase space” of 4 dimensions (4 variables). By locating the four fundamental variables that can dynamically define the system (3 apparent or known and one hidden or unknown), through a PAU (Universal Autonomous Pattern), a new panorama opens up in this portion of the reality that we are analyzing and that until the moment of the analysis was ignored. Like any guide, TL “simplifies” reality to emphasize certain aspects. For example, it is always possible to determine a 'trajectory' in this 'phase space' that is cyclical and borderline, both of the apparent and of what is not visible to the naked eye. In the case at hand, as we shall see, this is what happens with the inclusion of a memristor in a classic circuit. This ensures that the fundamental law is fulfilled so that the principles of the TL can be applied. That is that these four fundamental variables, this PAU form an algebraic structure called a group. This confirms that the 'simplified system' complies with the essential laws of symmetry that demonstrate the conservation and invariance of their relations before any possible variation driven by a transformation, as occurs in objective reality. In short, we make sure that there is a correspondence, fundamentally, between the reality analyzed and the proposed model.

With the previous scheme, it has been tried to represent, like an electrical circuit, the different components of a natural neuron. Thus, the surface level of the PAU (Ibidem, p.87) (green or apparent triangle) represents the point of entry of the electric impulse (dendrites). The deep level of the PAU (blue or hidden triangle) is equivalent to the neuronal body (soma). While the “theoretical connection” between the extremes of both levels, it takes the place of the cylinder axis or axon, which is where the 'action potential' is transmitted to the exit point: the synapse. The synapse represents the point of union between neurons and is where one neuron communicates with the dendrites of another neuron (s).

From the strictly electrical, the neuron can be seen as an integrator of the passive electrical elements (that dissipate or store energy) of two terminals. According to classical circuit theory, there are three basic elements: the capacitor, the resistor, and the inductor. In 1971, Professor L. Chua of the University of Berkeley predicted the existence of a fourth basic element that he called *memristor* (See Appendix). This element was initially defined as a mathematical entity since it usually functions 'hidden' because its unique properties only become apparent at the nanoscale (Vourkas & Sirakoulis, 2016, p. xii).

There are, in turn, four fundamental variables that define the elements mentioned above. These variables are: v (electrical voltage), i (electric current), q (electric charge), and ϕ (magnetic flux). Then, for the elements of two terminals, the relation between v and i defines the resistor as $dv = Rdi$. The relationship between q and v defines the capacitor as $dq = Cdv$. The relation between ϕ and i defines the inductor as $d\phi = Ldi$. Finally, Chua indicated that the relation between q and ϕ defined the memristor as $d\phi = Mdq$ (Radwan & Fouda, 2015, p 153).

As we can see in Figure 3, each variable has been assigned a binary code that responds to the attached table of assignments. This code allows glimpsing the origin of these variables. The voltage (v) arises from a variation of the magnetic flux ($\Delta\phi$), while the current (i) results from a variation of the electric charge (Δq). The charge (q) arises from a “composition” of v and i , while the magnetic flux (ϕ) does not depend on any of the two previous variables.

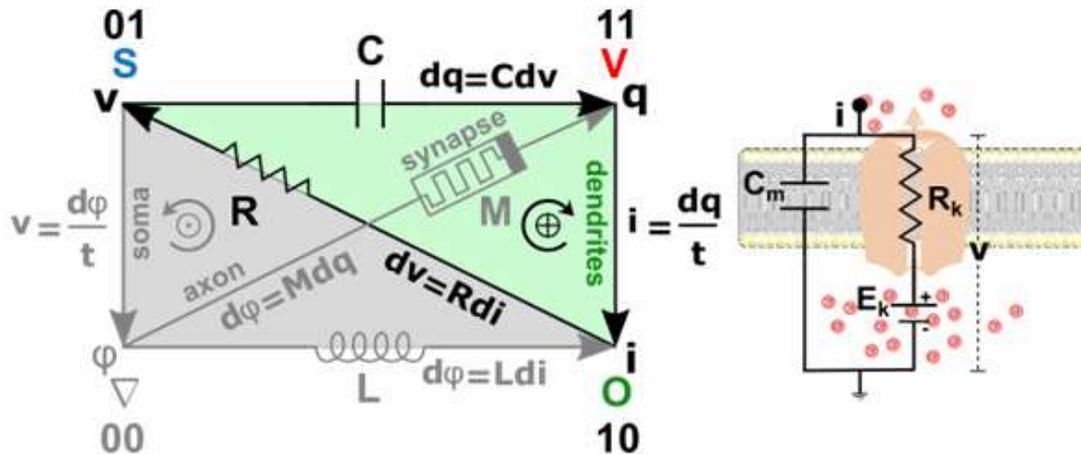
4.0 PROCESSING OF ELECTRICAL ACTIVITY

We will analyze how it is that a neuron, when receiving an external impulse (stimulus), generates an 'action potential' as an answer, although we will do it exclusively, from the electrical and not neurobiological point of view. Only as an analytical exercise, we will decompose this process in different stages according to the natural neuronal component involved, and we will match it with the respective structural or functional aspect of the PAU.

4.1 Dendrite – superficial level

In the natural neuron, dendrites are the favorite place where external stimuli enter, although here, for simplicity, we will consider only one of them.

Fig. 4. Electric circuit of the dendrites



Every neuron has a “resting potential,” generated by the active difference of ionic concentration on both sides of its cell membrane. When an electrical signal is generated in part of a neuron, for example, in response to a synaptic input by a dendrite, the membrane potential changes. The rate of change of this potential and, therefore, the generation of an 'action potential' or electrical impulse that travels along the cell membrane, depends on the passive electrical properties of the neurons. Of these properties, we will highlight two: the *capacitance* and the *resistance* of the membrane.

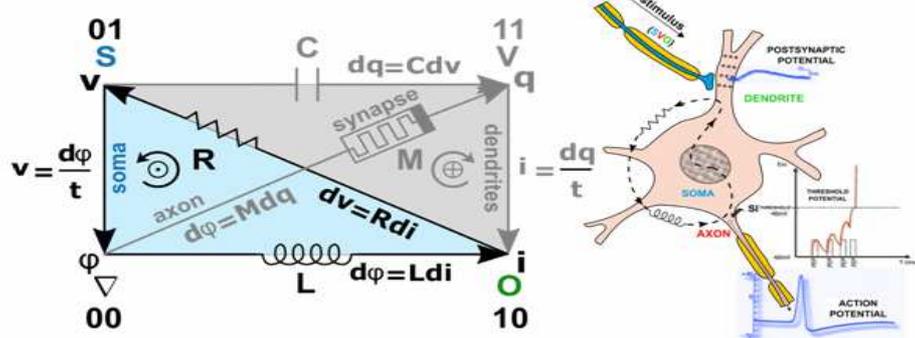
Figure 4 shows an equivalent circuit of the cell membrane consisting of a *resistance* representing a single potassium channel (R_k), a *battery* that indicates by the outward flow of K^+ where the “resting potential” originates (E_k) and a *capacitor* constituted by the lipid bilayer of the membrane (C_m).

According to the above, the best way to represent a membrane with ion channels is an RC circuit (composed by a resistor (R) and a capacitor (C)), like the one shown in the previous figure, occupying the surface level of the PAU. This type of circuit can be used to filter certain frequencies and let others pass. According to the theory presented, this part of the neuron could represent part of the "perceptual apparatus" because it can vary the range of frequencies it can capture.

4.2 Soma – profound level

Computational Neuroscientists consider that a neuron triggers an action potential when a large enough number of excitatory synapses are activated simultaneously. This oversimplification of the conditions in which a neuronal firing occurs (*Deus ex Machina*) has generated a great number of mathematical formalisms, such as those that served McCulloch & Pitts to create the first artificial neuron, with the capacity to operate with a logic of Boole, the foundation of digital electronic circuits. (Kandel, 2013, p.1583) Synaptic potentials and action potentials involve a much more complex dynamic than that described above, either for its production or its inhibition (Figure 5).

Fig. 5. Soma electric circuit

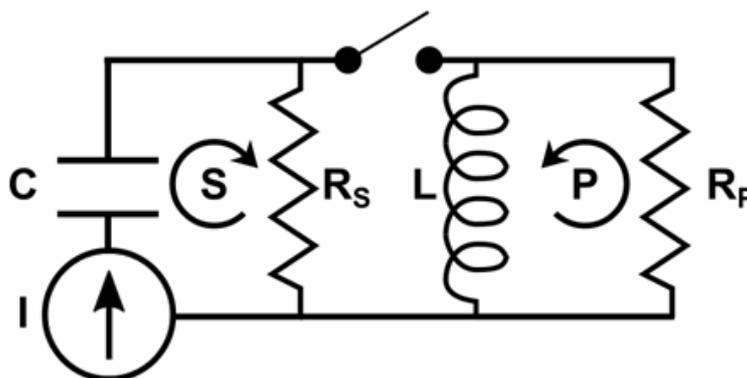


The membrane of the postsynaptic neuron is the source of the synaptic current, which is generated with the arrival of stimuli (SVO) to the dendrites as we saw in the previous point, and which can produce an excitatory or inhibitory action. Figure 5 shows an excitatory synapse.

The release of excitatory neurotransmitters changes the ionic permeability of the postsynaptic membrane and produces a “postsynaptic potential” of long duration, but low voltage, although of an additive nature. Ultimately, for an “action potential” to occur, must reach the initial segment (SI in the figure) of the axon a depolarizing potential that exceeds the "threshold potential." The integration in the postsynaptic neuron, in this case, of signals that depolarize it is called “summation.” That is, the small postsynaptic potentials are accumulated by a “cycling” of the current between the input dendrite (represented by a resistance) and the SI, (represented by an inductor) until the 'threshold potential' is reached, the moment in which an 'action potential' is triggered (Randall et al., 1997, p 215).

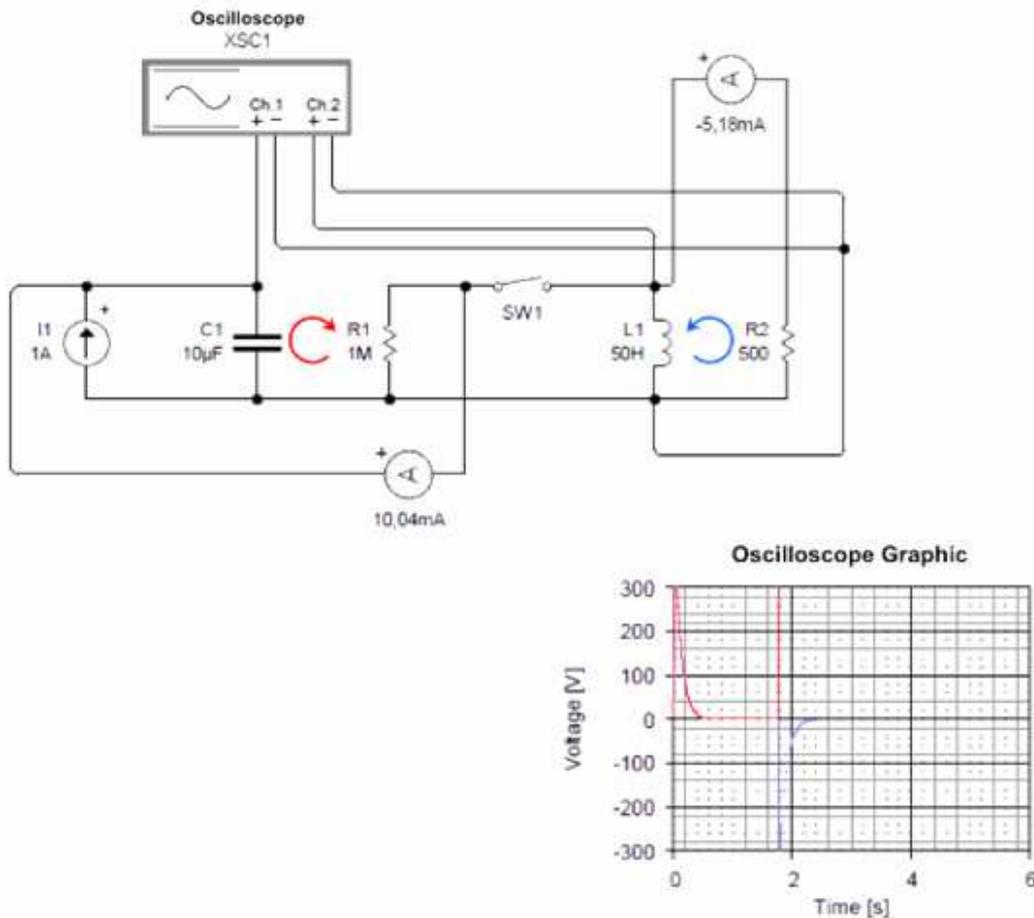
We see in Figure 5 an electrical equivalent of the mechanism described above. The circuit that complies, approximately, with the previous mechanism is the RL (formed by a resistance (R) and an inductor (L)). The direction of circulation of the current in the circuit of the deep level is inverse (levorotatory) concerning that which had the surface level (dextrorotatory). This change of direction (clockwise → anticlockwise) is justified in Figure 6.

Fig. 6. Parallel circuits



The above diagram represents the two levels of the PAU transformed into parallel circuits, where the surface level (S) represents the current source (I) that circulates clockwise through the capacitor (C) and the inductor (L). When the switch is opened, the current flows in the same direction as the surface resistance (R_s) as a consequence of what is stored in the capacitor (C). While it circulates in the opposite direction by the resistance (R_p) of the circuit that represents the deep level (P), as a product of what is stored in the inductor (L) (Figure 7).

Fig. 7. Simulation with livewire© Copyright © New Wave Concepts Limited.

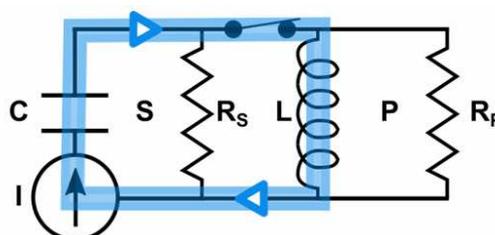


In RL circuits there is a phenomenon of self-inductance or inductance, which response to the property of the circuit to oppose variations in current intensity. This phenomenon is responsible for the delay of the current (i) concerning the voltage (v) applied and therefore that a certain time elapses until reaching its maximum level (equivalent to the time it takes the neuron to reach the threshold potential). The inductive property is manifested by the creation or induction of an opposite voltage (v_{ind}) whose value changes (increase \cong summation) moment by moment. The induced voltage (v_{ind}) is directly proportional to the rate of variation of the flow cuts. It will be maximum and will oppose with a value almost equal to the applied voltage when a zero level of external voltage and current is reached. The latter is equivalent, in the neuron, to have reached the “threshold potential” and triggered an 'action potential.' When the current is constant, there is no induced voltage (Siskind, 1972, p.216).

4.3 Dendrite-soma complex - PAU

When we close the circuit switch that represents the two levels of the PAU (Figure 8), it becomes a resonant circuit.

Fig. 8. Resonant circuit

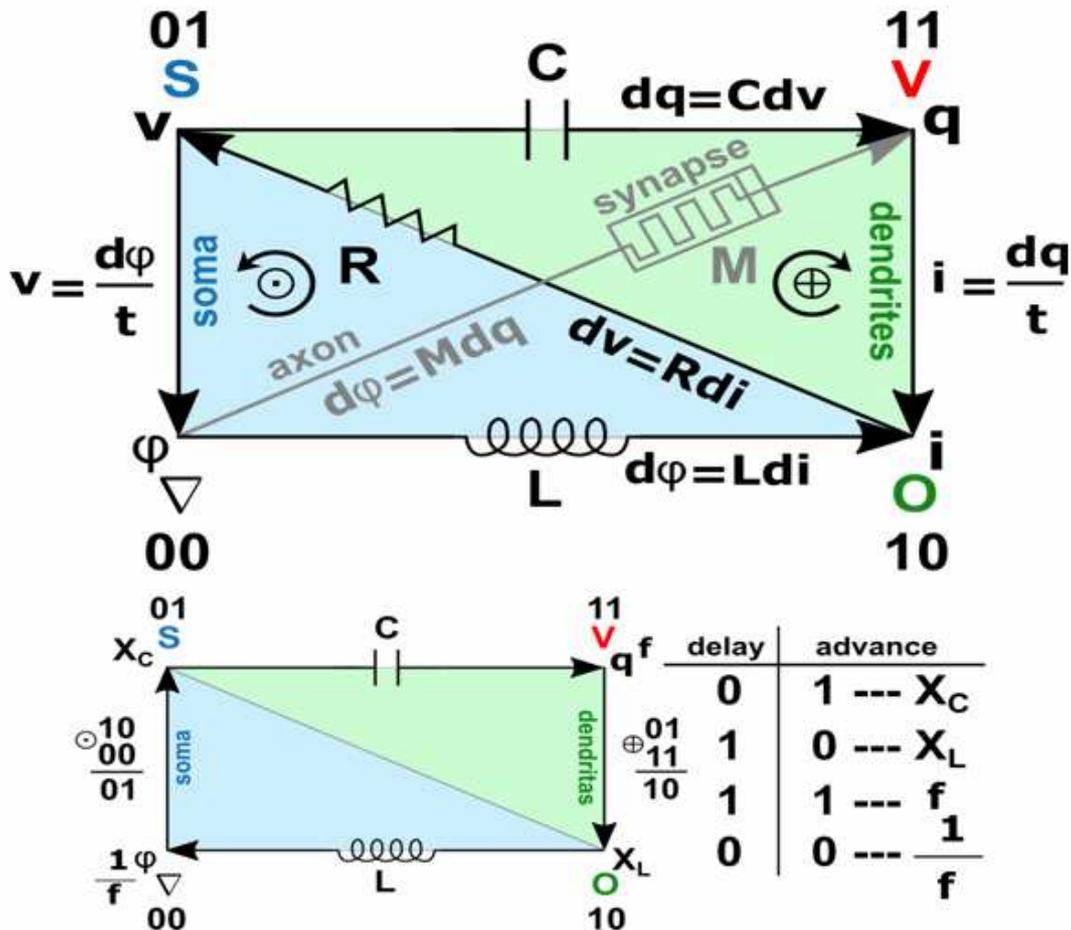


References: I: current - C: capacitor - L: inductor - R_S : superficial resistance R_P : profound resistance
 - S: superficial level - P: profound level

The previous one is an RLC circuit (composed of resistors, inductor, and capacitor) in parallel, to which if an alternating current is applied it can enter into resonance when the total current (i) is in phase with the applied voltage (v). Under these conditions, the resulting reactance is zero. Two fundamental properties of the inductive reactance (X_L) and the capacitive reactance (X_C) make possible the resonance: a) they are opposite since they delay or advance the current by 90° , respectively and b) their opposite behavior against the frequency: directly proportional and inversely proportional, respectively (Ibidem, p.356).

In the case of the hypothetical neuron that we are considering, when we analyze it as a complete PAU, it behaves like an RLC circuit in series where an alternating current circulates (Figure 9).

Fig. 9. Neuron as a resonant circuit



References: C: capacitor - L: inductor - X_C : capacitive reactance. X_L : inductive reactance - q: charge
 - ϕ : magnetic flux - f: frequency \otimes : XOR - \ominus : XNOR

The resonance of a series circuit is independent of the resistance, that is, it is as if the resistance of the RLC circuit did not exist. It is only a function of the values of inductance and capacity, or what is the same, of the magnetic flux (ϕ) and the charge (q). For this reason, was elaborated the lower scheme in the previous figure. There, everything is planned to reach resonance, by varying the impedance (reactance + resistance) of the circuit. There are three ways to achieve the

above: 1) varying the frequency, 2) varying the inductance, or 3) varying the capacitance. It is assumed that, if the resistance is stable, the circuit will come into resonance if: a) for a particular frequency (f), the inductance (L) and the conductance (C) are fixed; b) for a particular value of L , f and C are fixed; or c) for a particular value of C if f and L are fixed. (Ibid, p.358). All these possibilities can be deduced from the table attached to the scheme, through the respective operations (\otimes and \odot) between the elements of this group that constitutes a PAU.

In the particular case, we are analyzing, a special type of PAU has been constituted, which is called “cyclical.” In this elementary arrangement, the dynamics of both levels (superficial/profound) is activated by a single operation (transformation) or using both simple operations at the same time. This way of projecting the transformations causes that, in some way, breaks with the 'golden rule' of the TL, which is: “The deep level of PAU cycles in the opposite direction to the superficial level.” Here, the profound level is 'dragged' by the superficial level with which a single cycle is formed (dextrorotatory or levorotatory, in an alternative way) that correctly defines the transformations present in the analyzed system. This alternation is nothing else than the phenomenon of resonance, which makes the system cycle at a certain frequency (frequency modulation), and with an adaptation of its phase (phase modulation). These characteristics would allow the neuron to specify (tune in) the system (biological, psychic or sociocultural) for which it has to prepare the response and do it correctly according to the experience acquired or learn a new way of responding.

4.4 Axon-synapse complex – plasticity – “bycyclic” PAU

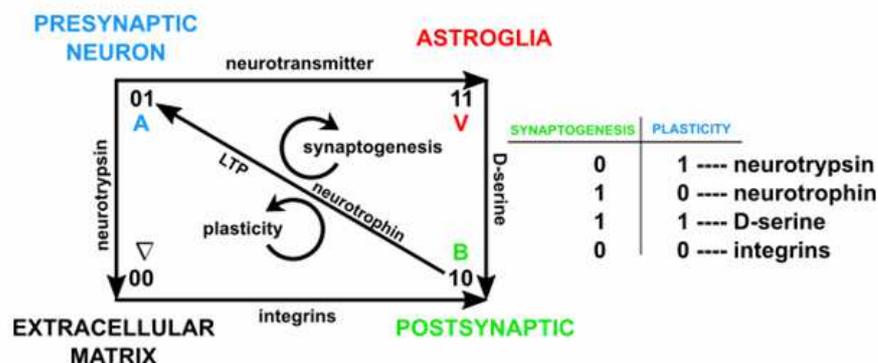
The active way of conducting the 'action potential' generated in the initial segment (SI) along the axon, sometimes at a great distance, is through the voltage-activated ion channels. These channels (Na^+ and K^+) open and close with such a temporal precision that they can reverse, transiently, the 'membrane potential' (depolarization) that travels through the axon at a speed of 120 m / s. The longitudinal (passive) electrotonic propagation depends on the “cable” properties of the axon, that is, a succession of RC circuits in parallel (Randall et al., 1997, p.167).

When depolarization reaches the synapse, a complex series of modifications (not detailed) are produced that allow a modification of the excitability of the postsynaptic membrane, ensuring the conduction of the stimulus.

The chemical synapse as we have considered it forms a bipartite system in which the signal is transmitted between pre and postsynaptic cells. In the first decade of this century, an additional parameter was discovered that must be taken into account in the synaptic function. This component is astroglia, (tissue formed by astrocytes, the main and most abundant glial cell), participating in the control of the neuronal microenvironment (“tripartite synapse” hypothesis) (Pickel & Segal, 2014, page 379).

Another aspect that has recently become evident as a regulator of neuronal function and plasticity is the role played by the surrounding extracellular matrix, where arises the “quadripartite synapse hypothesis.” (Dityatev & Rusakov, 2011) emerging (Figure 10).

Fig. 10. PAU Tetrapartite synapse



The presynaptic neuron, according to the previous scheme, is the one that releases the neurotransmitter. Most information in the brain is processed through excitatory glutamatergic synapses. The presynaptic neuron is the one that releases the *glutamate* (neurotransmitter). Another of its activities has to do with the release of *neurotrypsin*, using which it controls the surrounding “Extracellular Matrix” (EMC). *Neurotrypsin* determines the production of *agrin* by the EMC that promotes, on the one hand, the development and maintenance of the neuromuscular junction. But on the other, one of the degradation products of agrin triggers the formation of “dendritic filopodia.”

It is accepted that Long-Term Potentiation (LTP), that is involved in neuronal plasticity, in the mechanism of memory and learning is expressed at the level of the postsynaptic neuron (as in the Hippocampus). But it may depend on other mechanisms that control and modulate the release of neurotransmitters. Examples of independent presynaptic LTP are those that originate in the parallel cerebellar fibers and the LTP of the corticothalamic terminals (Pickel & Segal, 2014, p. 72). This intensification in signal transmission between neurons can last from minutes to several months.

“Astroglia” intervenes in the regulation and absorption of glutamate released by the presynaptic neuron. Also, it releases a coagonist (D-serine) from “glutamate receptors” (NMDA), which allows regulating, remotely, the activation of these receptors, which induces LTP.

The extracellular matrix (EMC) is involved in the induction of neuronal plasticity, which is dependent on NMDA receptors. The cleavage of *agrin* does not only require the release of *neurotrypsin*, as we have seen but also the activation of the postsynaptic neuron (see Figure 10). The above constitutes another mechanism “simultaneity detector” that in this case triggers the “structural plasticity,” according to the principles elaborated by Hebb (Dityatev & Rusakov, 2011).

The EMC also controls the NMDA traffic through the *integrins*. On the other hand, it interconnects pre and postsynaptic protein complexes, stabilizing the interaction of both cells.

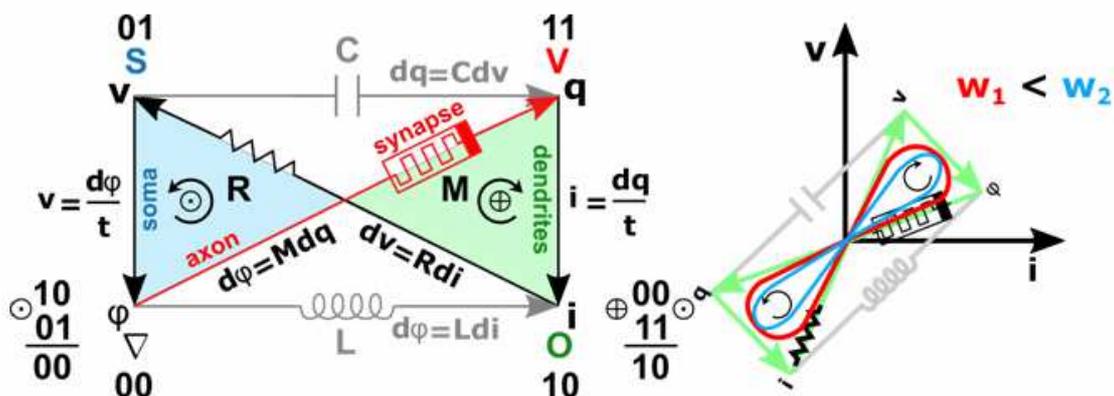
The postsynaptic neuron releases *neurotrophin* that stimulates neuronal growth and survival and promotes synaptogenesis. It can also produce LTP, as we have already mentioned.

Therefore, we can identify several forms of LTP:

- LTP Hebbian: simultaneous activation of pre and post-synaptic neurons (hippocampus, cortico-cortical, amygdala).
- LTP non-Hebbian: purely presynaptic (Hippocampus, thalamocortical, cortico-striatal).
- Anti-Hebbian LTP: requires that the postsynaptic neuron does not activate (interneurons).

The previous classification shows that the LTP mechanism is involved in all the circuits defined in the theory of the psychic apparatus taken as reference, as controllers of the different aspects of reality that has to deal with, a human.

Fig. 11. Bicyclic PAU of structural memory



The synapse not only constitutes an adequate connection between neurons so that a certain stimulus can be transmitted to the effector organ, but it is part of the memory. The first to suggest this was Sigmund Freud (1895) when he expounded his theory of “contact-barriers” [synapses]:

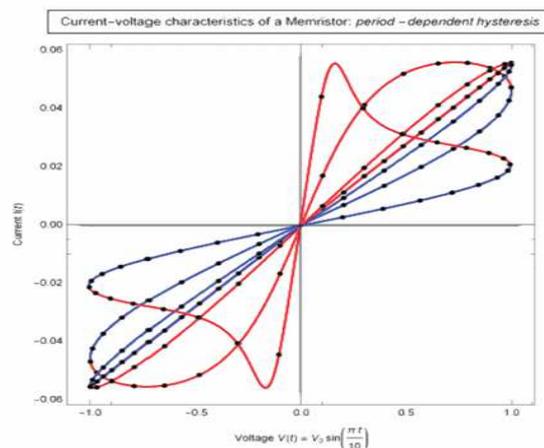
“There are two kinds of neurons. In the first place, those that let the excitement pass as if they had no contact-barrier, and therefore after each excitatory course remain in the same state as before, and, secondly, those whose contact-barriers oppose a difficulty to the passage of excitement. These, after each excitement, may remain in a state other than before, and thus result in a possibility of constituting the memory.” (Volume I AE, 1992, p.343).

The second that proposed a similar mnemonic mechanism was Donald Hebb in 1949 when in his book “*The organization of behavior*”, introduces the idea of a very particular synapse, which is what has come to our days as “Hebbian synapses.” This mechanism assumes that the persistence or repetition of a reverberant activity tends to induce lasting cellular changes that point to cellular stability. (Hebb, 2002, p.62) This rule supports the basic algorithm of learning through artificial neural networks while explaining how conditioned reflexes work and suggesting a possible mechanism of memory.

From the electrical point of view, Figure 11 shows that the synapse has been represented by a memristor, one of the components proposed for the construction of non-volatile memories used in computing. Thus, we have formed an RM (resistor-memristor) circuit. Memristors are 'resistors with memory,' hence their name (See Appendix). This behavior is based on the change between two resistive states (high and low) according to the direction of the electric charge (q). If the voltage (v) is disconnected, this special resistance 'remembers' until the next time it is connected, the resistance that was generated on the previous occasion. Chua says that all non-volatile memory based on a 'resistor switching' is a memristor. This fundamental element is a dynamic system that has a linear behavior (where there is a proportional relationship between cause and effect) and a non-linear behavior (where the previous proportionality disappears). But also, a memristor can be discreet or continuous. In this way, we can approach it without problems from the TL, since it behaves like a PAU.

All memristors exhibit a distinctive 'fingerprint' characterized by a “hysteresis loop” confined to the first and third quadrants of the $v-i$ plane, as shown in the diagram on the right of Figure 11. Its outline changes with the amplitude and frequency of any periodic 'sinusoidal wave,' a source of input voltage (v) or current source (i). This hysteresis loop that has the shape of the infinity symbol (∞), contracts and tends to a straight line as the frequency increases. ($\omega_1 < \omega_2$ of the scheme). Moreover, if a critical frequency is reached, the memristor behaves like a common resistance (Adamatzky & Chua, 2014, p.21) (Figure 12).

Fig. 12. Yogesh N. Joglekar, "Current-Voltage Characteristics of a Memristor"



<http://demonstrations.wolfram.com/CurrentVoltageCharacteristicsOfAMemristor/>
Wolfram Demonstrations Project

In Figure 12 we see a simulation of the hysteresis loop of a memristor using software, whose analytical results arise from an original investigation carried out by Joglekar & Wolf in 2009. In the scheme, different recordings have been superimposed, varying the period of an alternating current. It is illustrative how the shape of the loop changes as we change the frequency. That is, the response of the memristor becoming more linear, approaching the behavior of a common resistance, as the frequency decreases (or the period increases).

Everything we have said It allows to demonstrate the generation of cyclic behavior, whose frequency can be 'remembered.' In the theory about the psychic apparatus that we have proposed, a similar mechanism is invoked to record, by 'storage' of frequencies, how the sequence was since a stimulus entered (from the real biological, psychic or sociocultural system), what Neurological structures were put into operation to elaborate a response (depending on whether we have already done this task before), and finally, on what system we should project it, leaving a record if necessary, of having learned a new routine. All this is perfectly represented in the dynamics of the "Bicyclic PAU" of Figure 11. This is a new type of PAU that allows considering its two levels (superficial and deep, linear and non-linear, discrete and continuous), but in alternating form, mimicking the hysteresis loop of a memristor.

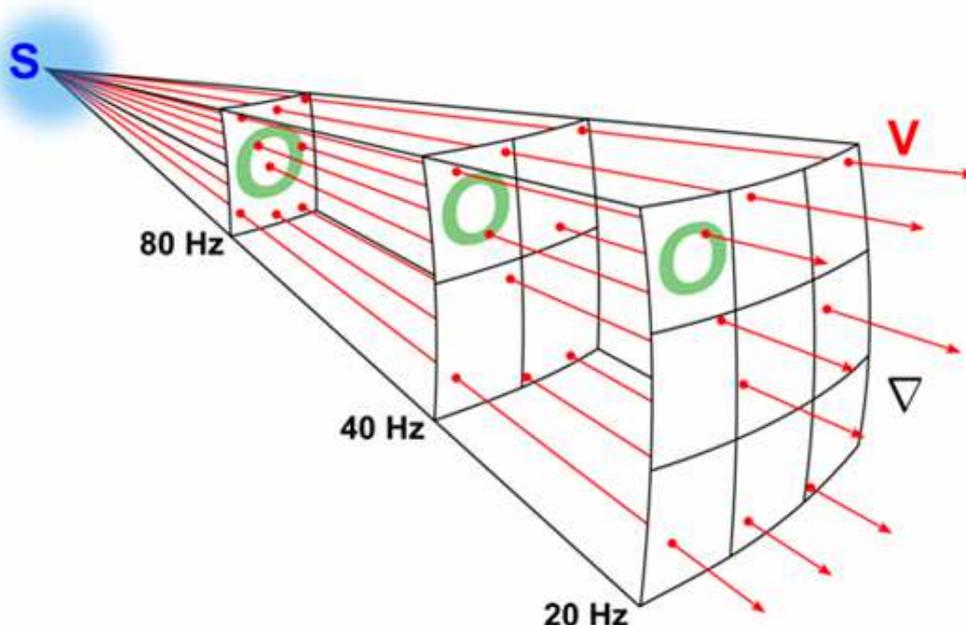
5.0 CONCLUSION

We have been able to verify throughout this work that it is possible to emulate, through TL, the fundamental neural processes, using a model that integrates the three basic passive electrical elements (that dissipate or store energy): a capacitor, a resistor, and an inductor.

Through the different circuits generated by the combination of the above elements, a neuron could: capture a certain frequency, that is, "perceive" a real system. Trigger an "action potential" as a response and synchronize that response with the perceived real system.

If you add to this elementary circuit, as the fourth electrical component a memristor, the neuron could "store" in its synapse, to remember later, the "frequency" (or the real system) that generated the learning and what was capitalized as knowledge, in addition to "knowing" about over what "real system" should project its response.

Fig. 13. Structural memory



References: S: subject - O: perceived object - V: the transformation that relates S and O - ∇ : reference system. 80 Hz: bio-external system - 40 Hz: psycho-internal system - 20 Hz: socio-cultural system.

Figure 13 is intended to represent the theoretical disposition that would have the "structural memory," which is where it is supposed to reside the "psychic structure" or "history" of a subject. The use of a memristor in the electric model that we have proposed would allow to "capture" and "store" in non-volatile form, the relations raised by a "real fact" (relations of an S and O through a V transformation) perceived to have "sense" for the subject. The "density of transformations" (in the form of a beam of light) affecting the perceived objects is inversely proportional to the frequency that governs the respective real system, maintaining as background the same reference system (∇) that is not other than the "subjectivity" that determines the reality in which we are immersed.

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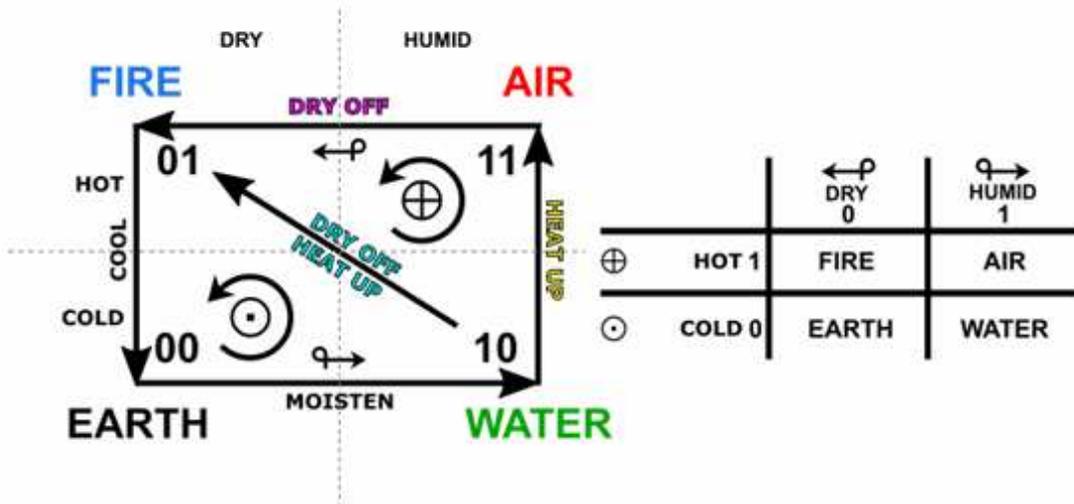
APPENDIX

MEMRISTOR

In the year of 1971 a professor of electrical engineering at the University of California, Berkeley L. Chua, predicted the existence of a fourth fundamental device, called the *memristor* verifying that it was not possible to create a duplicate of this element with the combination of the other three devices, by, therefore, according to this statement the *memristor* is a fundamental device.

To better understand the theoretical studies of Leon Chua, it must be said that he was based on an ideography that dates back to the thought of Aristotle and his disciples (Figure 1A).

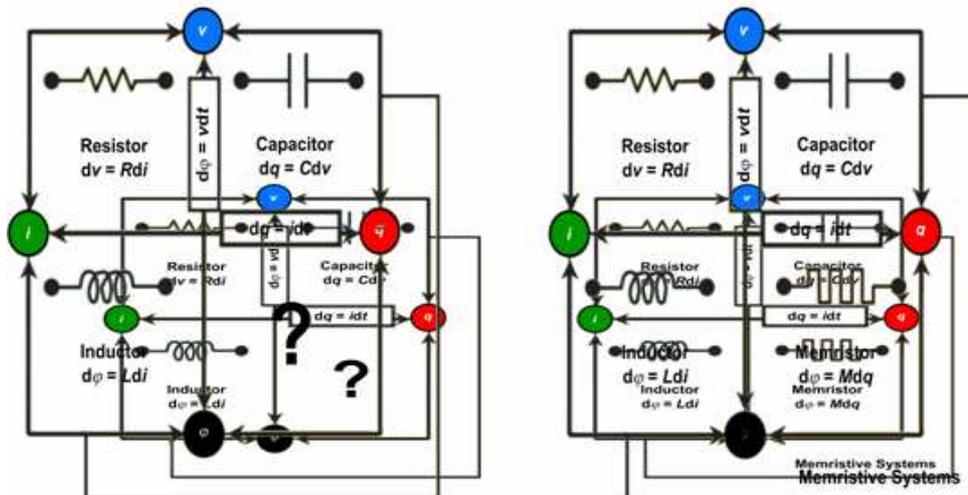
Fig. 1A. PAU of the Fundamental components of the matter



Aristotle assumes that all things have as distinctive aspects a matter and a form, that is, they make up a system or set of elements (matter), provided with structure (form). Thus, it relates the four elements with which matter was explained in the ancient Greek world: Earth, Water, Fire, Air, which link with four elements originated by their combinations: Heat, Cold, Moisture, Dryness.

Figure 2A shows the existence of the three fundamental elements, and it was there that Professor L. Chua justified the existence of a fourth passive element for electronics, elaborating the theory of what is known as *memristor*.

Fig. 2A. Integration of memristive systems



It is not trivial to define the generic mathematical form that describes the behavior of the *memristor*, for it is taken as an initial hypothesis the fact that the Memristor is a resistance and that implicitly must be measured in Ohms (Ω).

The fundamental relationship of electric charge and magnetic flux are variables that define the *memristor* as the fourth element of circuit theory and can be expressed by two integrals:

$$d\varphi(t) = v(t)dt \rightarrow \varphi(t) = \int v(t)dt$$

$$dq(t) = i(t)dt \rightarrow q(t) = \int i(t)dt$$

It can be said that a memristor can be controlled by electric charge, if the relation between the magnetic flux and the electric charge is expressed as a function of the electric charge q ; and it can be said that a memristor can be controlled by magnetic flux, if the relation between the magnetic flux and the electric charge is expressed as a function of the flux φ .

$$\frac{v(t)}{i(t)} = \frac{df(q)}{dq} = M(q)$$

(q) , is called the memristance which has the unit of resistance, and defines a linear relationship between current and voltage, as long as the electric charge did not change. Then M is a constant; therefore, a memristor behaves like a resistor.

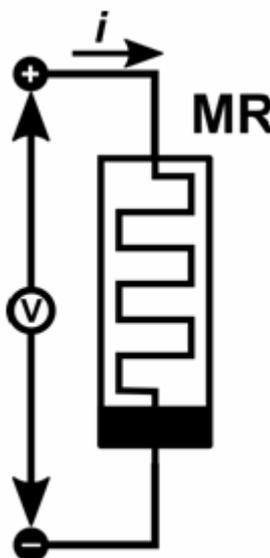
For a *memristor* controlled by magnetic flux,

$$q = f(\varphi)$$

(φ) , is called the *memductance* which has the unit of conductance.

The memristance is a property of the memristor, when the electric charge flows in one direction through a circuit, the resistance of the memristor increases. The resistance of the memristor decreases when the electric charge flows in the opposite direction in the circuit. If the applied voltage disconnects, then the charge flow ceases, so, the memristor "remembers" the last resistance that passed through the memristor. When the charge flow starts again, the resistance of the circuit will be what it was when it was active (Figure 3A).

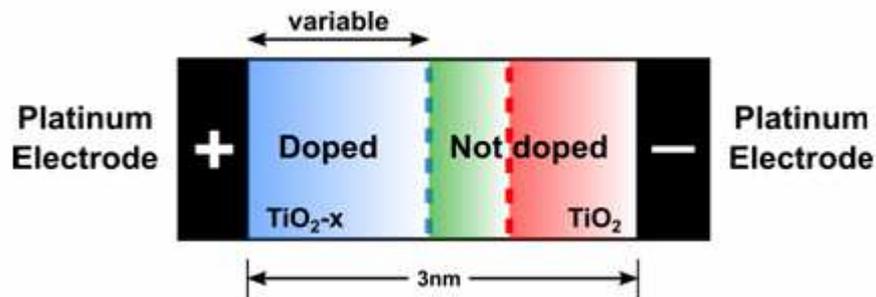
Fig. 3A. Memristance



The memristor belongs to the dynamic systems, given its ability to "remember" with a linear and non-linear behavior. It must be remembered that the state of a static system depends only on the present conditions and not on the past. In contrast, the state of a dynamic system depends on what happened in the past, usually because there is some type of energy storage in the system. Dynamic systems are also known as "memory systems". Therefore, the memristor is a passive and dynamic system that has memory but is not an energy storage device. The properties of the memristor are perceptible, only, on a small scale (nanoscale).

It consists of a pure platinum substrate, to which titanium dioxide (TiO_2) is deposited in its upper part, then another deposit of titanium dioxide followed by another platinum substrate. The difference between the two oxides lies in the fact that one is missing oxygen atoms (TiO_{2-x}), these missing atoms act as charge carriers. (This announcement was made by Williams in 2008) (Figure 4A).

Fig. 4A. Composition of memristor



This configuration is as good a conductor as metals. When oxygen atoms are removed from titanium dioxide, the "holes" they leave (absences of negative charges) behave as positive charges, similar to electrons in a classical PN junction. A positive tension pushes the positive charges to the right inside the other TiO_2 , as illustrated in the anterior figure, in this way the thickness of TiO_{2-x} "increases" at the same time as the thickness of TiO_2 "decreases." After a while, the separation between the dioxides stops being the one marked by the blue line to become the one marked by the red line. By placing a negative voltage, we can invert the process and increase the thickness of TiO_2 .

Selfie and Marketing of Domestic Tourism

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ABSTRACT

Selfie is a trending technology around the world. Various studies have documented on selfie but few related to marketing of domestic tourism. The aim of this paper was to examine selfie and marketing of domestic tourism with the specific objective of establishing the relationship between selfie usage and promotion of domestic tourism. Theoretical framework approach is guided by diffusion theory. The study area is Dar es Salaam, Tanzania. Snowballing sampling technique was used and survey semi-structured questionnaires were sent to a sample size of 60. The collected quantitative data was subjected to descriptive statistics, Chi-square test and ANOVA. Among the ANOVA findings in the relationship between selfie usage and promotion of domestic tourism revealed that there is a statistically significant relationship between using selfie to learning about tourist attractions visited and marketing activities uses effective means of promotion and advertising for domestic tourism ($p = 0.032$). The study contributes knowledge about selfie and marketing of domestic tourism in the context of Tanzania.

Keyword: *selfie, marketing, domestic tourism, Tanzania*

JEL Code: M39

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1.0 INTRODUCTION

Selfie as a personal media is considered to be popular (Cruz & Thornham, 2015). Advances in technology and continuous changes within the society particularly the knowledge society has created the need for information sharing. Various articles have researched issues in relation to selfie (Edmondson, 2014; Cruz & Thornham, 2015; Paris & Pietschnig, 2015; Senft & Baym, 2015; Loveless *et al.*, 2016; Elmahdy, Haukeland & Fredman, 2017; Hockert, Luthje & Iloa, 2017; Kadir & Zulfakho, 2017). The study by Edmondson (2014) examined practices of personal archive, self

fashion and gender in contemporary photo album. Other scholars such as Elmahdy et al (2017) were investigating tourism megatrends and mentioned that one of the megatrends in tourism is social media where people share information while Pearce and Moscardo (2015) studied social representations of tourist selfies by examining photo taking and photo sharing behaviour on social media.

Although selfie is a phenomenon under study by various scholars, there is still limited research on selfie and marketing of domestic tourism. Previous research highly focused on selfies in terms of trends, behaviour and its impact on some tourist destinations. Tanzania like other countries face challenges in promoting attractions and this is a problem which has been mentioned by previous and current scholars (Mariki *et al.*, 2011; Macha, 2016). In addition, promotion challenges exist particularly in engaging new trends such as selfie in marketing of domestic tourism. Therefore, in adding knowledge to the phenomenon of selfie as a technology for the knowledge society in relation to domestic tourism, this study examines selfie and marketing of domestic tourism. The specific objective of this study is to establish the relationship between selfie usage and promotion of domestic tourism.

2.0 LITERATURE REVIEW

2.1 Concepts Definition

Selfie is generally defined as a photograph that one has taken of oneself or self-portrait photography taken using a digital camera or phone camera held in the hand or supported by a selfie stick (Merriam-Webster, 2014; Kwon & Kwon, 2015; Pearce & Moscardo, 2017; Safna, 2017). These selfies are then shared with social media platforms like Facebook or Twitter (Safna, 2017). The popularity of selfies taken during travels has prompted hotels to offer guests with selfie sticks (Paris & Pietschnig, 2015). Selfies are also considered as a new form of digital tourist photography (Larsen, 2008). For marketers, selfies indicate that individuals are young, fun and connected (Senft & Baym, 2015). For purposes of this study, selfie is a photograph taken of oneself in tourist attractions using a digital camera or phone camera.

2.2 Marketing of Domestic Tourism

Marketing involves 7Ps and according to Al-Debi (2014), the 7Ps are product, price, place, promotion, people, physical evidence and process. In marketing of domestic tourism for the knowledge society, this study is interested in the 4th Marketing mix called promotion. Tanzania faces a number of promotion challenges for domestic tourism including inadequate use of media, high transport costs, travel culture and tourism awareness (Anderson, 2010; Lwoga, 2011; Mariki *et al.*, 2011; Macha, 2016). Recent studies indicate that marketing engages promotion of domestic tourism whereby television is also widely used in Tanzania for TV programs showing national parks (Mkwizu, 2016; Mkwizu, 2017a, 2017b; Mkwizu, Matama & Atuzarirwe, 2017; Mkwizu, 2018). This paper focuses on marketing of domestic tourism in the context of Tanzania. For this study, marketing of domestic tourism refers to the promotion of travel within Tanzania by residents visiting tourist attractions through information sharing such as social media.

2.3 Theoretical Literature Review

The Diffusion theory is a theory which was initially developed by Ryan and Gross in 1943 (Surry, 1997). Diffusion theory assumes the existence on the spread of ideas and actions within social systems in relation to innovations (Rogers, 1995; Surry, 1997; Green, Ottoson, Garcia, Hiatt & Roditis, 2014). Furthermore, Green *et al.* (2014) indicated that the occurrence of diffusion of ideas or rather innovation is characterized by repetition, opposition and adaption. Selfie as a technological phenomenon is considered to be popular and has spread among users particularly the youth. From previous studies such as Paris and Pietschnig (2015), Kadir and Zulfakho (2017), and Safna (2017), it can be concluded that selfies as a technological innovation has undergone stages of repetition,

opposition in the sense that the impact of selfies is both negative and positive and thus individuals will adapt the selfie innovation depending on various situations or personality traits.

Over the years the Diffusion Theory has developed from the assumption of the spread of ideas and actions to its association with innovation. Other scholars have used the Diffusion Theory to study aspects in tourism. For instance, Anderson (2010) used the Diffusion Theory to explain investment in tourism development. While other studies used Diffusion Theory on investment issues related to tourism, this study adopts the Diffusion Theory to guide the analysis of selfie usage in relation to marketing of domestic tourism. Selfie as a trendy technology is spreading in various parts of the world including Tanzania. This study hypothesizes that there is a statistically significant relationship between selfie usage and promotion of domestic tourism.

2.4 Empirical Literature Review

Selfie as a technology has been made popular through social media platforms like Wechat and Facebook (Kadir & Zulfakho, 2017). Individuals searching for information on places to go also use social media platforms where there is access to selfies taken in various destinations. Selfies taken by individuals during their travels allow others to experience new and unknown destinations (Elmahdy *et al.*, 2017). The study by Elmahdy *et al.* (2017) was conducted in Norway using a Delphi methodology approach and found that one of the megatrends in tourism particularly for nature based tourism is technological trends in terms of ICT which includes the use of social media platforms for information dissemination.

On the other hand, a study by Safna (2017) researched in Sri Lanka explored impacts of selfies on youth and using a descriptive methodological approach found that there were negative impacts of selfies on the youth which include skin damage, loss of confidence and self esteem. Whereas other studies on selfies concentrate on trends and impact, the research by Paris and Pietschnig (2015) was interested on personality traits of travel selfies. Paris and Pietschnig (2015) conducted a study in the United Arab Emirates and findings using multiple regression analysis revealed that agreeable individuals showed more positive attitudes towards taking selfies when travelling. Although the study by Paris and Pietschnig (2015) was on travel selfies related to tourism, there is still limited literature on selfies as a phenomenon in the perspective of marketing domestic tourism.

In Africa, Stone and Nyaupane (2017) indicated that there is limited research on domestic tourism in Botswana and Africa in general. Other studies (Mkwizu & Matama, 2017; Singa'mbi & Lwoga, 2017; Mbilinyi, 2017) have contributed literature on various issues on domestic tourism such as millennials, heritage and culinary but these are still very few studies according to Stone and Nyaupane (2017). There is also the persistent problem particularly in marketing domestic tourism where promotion efforts need to be increased so as to boost domestic tourism. A number of scholars in Africa have highlighted on insufficient promotion of domestic tourism (Macha, 2016, Stone & Nyaupane, 2017). A recent study by Mkwizu (2017a) indicated that domestic tourists contribute 40.5% of total visitors to national parks in Tanzania. However, there is limited literature from previous studies on selfies in relation to tourism, and there is even less research in the context of Tanzania. Therefore, in filling the knowledge gap, this study examines selfie and marketing of domestic tourism.

2.5 Conceptual Framework

The conceptual framework for this study is guided by diffusion theory and empirical literature review. The independent variable is selfie and the dependent variable is marketing of domestic tourism. The hypothesis H_1 states that there is a statistically significant relationship between selfie usage and promotion of domestic tourism.

3.0 DATA & METHODOLOGY

This study used quantitative research approach to facilitate the testing of hypothesis H₁ which states that there is a statistically significant relationship between selfie usage and promotion of domestic tourism. Area of study is Dar es Salaam in Tanzania at The Open University of Tanzania. Unit of analysis is university graduates who are selfie users for domestic tourism purposes. Survey semi structured questionnaires were sent out to a sample size of 60 respondents by email using snowballing sampling since the number of selfie users is not known. The measurement for the variables of selfie usage were adopted and customized from Pearse and Moscardo (2015), and Kwon and Kwon (2015). Selfies usage was measured using eleven statements.

The eleven statements for selfie usage are; use selfie to seek a particular photographic image of tourist attractions (SU1); use selfie as a motivation to connect the tourist attractions I have visited (SU2); use selfie to learn about tourist attractions I have visited (SU3); use selfie to build self awareness of tourist attractions I have visited (SU4); use selfie to share photographic images of tourist attractions with family and friends (SU5); use selfie as a motivation to connect with friends and families on the tourist attractions (SU6); use selfie to take photographs alone in the visited tourist attractions (SU7); take selfies as a group in the visited tourist attractions (SU8); use selfie to share with friends & family on tourist attractions I have visited (SU9); use selfie to share my photographs on social media platforms such as Facebook, Instagram, WhatsApp and Twitter on tourist attractions I have visited (SU10); and visited tourist attractions and taken selfies (SU11).

The measurement for marketing of domestic tourism using promotion were adopted and customized from Al-Debi (2014), and Singh and Bhowal (2011). Promotion was measured using six statements coded as P1, P2, P3, P4, P5 and P6: uses of effective means of promotion and advertising (P1); focuses on personal selling as an effective means of promotion (P2); there is adequate allocation of budget for promotional activities (P3); rich information and data about domestic tourism from the internet (P4); experiences from others that they enjoy sharing information on domestic tourism (P5); and promotion prices from tourism authorities or entities in tourist attractions that I visit (P6). The scale of measurement used for the statements are five-Point Likert scale of strongly disagree (1) to strongly agree (5).

Validity and reliability was done using a pilot study and Cronbach's alpha. The Cronbach's alpha for selfie usage (0.869), and marketing for domestic tourism (0.804). Field (2014) mentioned that for reliability, the Cronbach's alpha value of 0.70 and above is acceptable. In order to describe the sample characteristics and test the hypothesized relationships of this paper, the returned 35 questionnaires were subjected to quantitative analysis using descriptive statistics, Chi-Square test and ANOVA supported by SPSS Version 20. Due to the small sample size of this study, ANOVA as a non- parametric was used for analysis of the collected data. Fagerland (2012) and Nahm (2016) mentioned that non parametric tests are useful for small sample size.

4.0 FINDINGS AND DISCUSSION

The characteristics of the respondents are shown in Table 1. The findings show that a majority of the respondents are aged between 26 to 35 years (51.4%), male (60%), earn a monthly income above TZS 300,000 (97.1%), are university graduates (100%), and take selfies using a smart phone (82.9%). This suggests that respondents are young male adults with monthly income above TZS 300,000 and are university graduates who take selfies using smart phones.

Table 1. Characteristics of Respondents

Variable		Frequencies (n)	Percentage (%)
Age :	26-35	18	51.4
	36-45	13	37.1
	46-55	4	11.4
Gender:	Male	21	60
	Female	14	40

Income per month:			
	Tanzania Shillings (TZS)		
	< 300,000 TZS	1	2.9
	>300,000 TZS	34	97.1
Highest Education:	University	35	100
Selfie taken by:	Smart Phone	29	82.9
	Digital Camera	3	8.6
	iPad	1	2.9
	Tablet	1	2.9
	Others	1	2.9

Source: Field data (2018)

The findings of Chi-square test in Table 2 show that there is a statistically significant relationship between selfie usage and promotion of domestic tourism which is explained by (i) (SU3) using selfies to learn about tourist attractions that respondents visited and (P5) hear experiences from others that they enjoy sharing information about domestic tourism ($p = 0.007$), (ii) (SU4) using selfies to build self awareness of tourist attractions that respondents visited and (P5) hear experiences from others that they enjoy sharing information about domestic tourism ($p = 0.054$), (iii) (SU5) using selfies to share photographic images with family and friends and (P5) hear experiences from others that they enjoy sharing information about domestic tourism ($p = 0.040$), (iv) (SU7) using selfies to take photographs alone in the visited tourist attractions and (P1) marketing activities uses effective means of promotion and advertising for domestic tourism ($p = 0.012$).

Furthermore, the findings in Table 2 show that there is a statistically significant relationship between selfie usage and promotion of domestic tourism which can be explained by v) (SU7) using selfies to take photographs alone in the visited tourist attractions and (P5) hear experiences from others that they enjoy sharing information about domestic tourism ($p = 0.032$), vi) (SU8) using selfies as a group in the visited tourist attractions and (P5) hear experiences from others that they enjoy sharing information about domestic tourism ($p = 0.000$), vii) (SU9) using selfies to share with friends and family on tourist attractions visited and (P1) feel that marketing activities by tourism authorities and agents focuses on personal selling as effective means of promoting domestic tourism ($p = 0.032$).

Findings of Table 2 also revealed that there is a statistically significant relationship between selfie usage and promotion of domestic tourism through, (viii) (SU9) using selfies to share with friends and family on tourist attractions visited and (P5) hear experiences from others that they enjoy sharing information about domestic tourism ($p = 0.002$), xi) (SU11) have visited tourist attractions and taken selfies and (P1) marketing activities uses effective means of promotion and advertising for domestic tourism ($p = 0.046$), and x) (SU11) have visited tourist attractions and taken selfies and (P5) hear experiences from others that they enjoy sharing information about domestic tourism ($p = 0.025$). All the remaining statements were not statistically significant.

Table 2. Chi-square test selfie usage and promotion of domestic tourism

	Value	Asymp.Sig. (2-sided)
Pearson Chi-square for (SU3 and P5)	32.980 ^a	0.007
Pearson Chi-square for (SU4 and P5)	25.991 ^a	0.054
Pearson Chi-square for (SU5 and P5)	27.114 ^a	0.040
Pearson Chi-square for (SU7 and P1)	31.364 ^a	0.012
Pearson Chi-square for (SU7 and P5)	27.919 ^a	0.032
Pearson Chi-square for (SU8 and P5)	54.088 ^a	0.000

Pearson Chi-square for (SU9 and P1)	27.996 ^a	0.032
Pearson Chi-square for (SU9 and P5)	37.542 ^a	0.002
Pearson Chi-square for (SU11 and P1)	26.572 ^a	0.046
Pearson Chi-square for (SU11 and P5)	28.892 ^a	0.025

Source: Field data (2018)

ANOVA findings in Appendix 1 shows that (i) there is a statistically significant relationship between *using selfie to learn about tourist attractions I have visited and marketing activities uses effective means of promotion and advertising for domestic tourism* ($p = 0.032$), and (ii) there is a statistically significant relationship between *using selfie to learn about tourist attractions I have visited and feel that marketing activities by tourism authorities and agents focuses on personal selling as an effective means of promoting domestic tourism* ($p = 0.024$). The rest of the relationships were insignificant. The ANOVA findings in Appendix II shows that there is a statistically significant relationship between using selfie as a motivation to connect with friends and families on the tourist attractions I have visited and hearing experiences from others that they enjoy sharing information about domestic tourism ($p = 0.048$). The rest are not statistically significant. ANOVA findings in Appendix III shows that there is a statistically significant relationship between taking selfies as a group in the visited tourist attractions and hearing experiences from others that they enjoy sharing information about domestic tourism ($p = 0.002$). The rest are not statistically significant. ANOVA findings in Appendix IV shows that (i) there is a statistically significant relationship between *using selfies to share with friends and family on tourist attractions I have visited and I feel that marketing activities by tourism authorities and agents focuses on personal selling as effective means of promoting domestic tourism* ($p = 0.008$), and (ii) there is a statistically significant relationship between *using selfies to share with friends and family on tourist attractions I have visited and hearing experiences from others that they enjoy sharing information about domestic tourism* ($p = 0.024$). The rest of the relationships are not statistically significant. The characteristics results of this study differs from the study by Safna (2017) suggesting that there are no negative impacts in selfies and this is because the young male adults in this current study use selfies widely with their smart phones and further results by Chi-square test and ANOVA indicate that there is a statistically significant relationship between selfie usage and promotion of domestic tourism. The results of this study further support the diffusion theory and that selfie as innovation is spread amongst university graduates and widely used for tourism purposes.

5.0 CONCLUSION

This main objective of this paper was to examine selfie and marketing of domestic tourism. This study specifically establishes the relationship between selfie usage and promotion of domestic tourism. Results indicated that there is a statistically significant relationship between selfie usage and promotion of domestic tourism which is explained by a) using selfie to learn about tourist attractions visited and marketing activities uses effective means of promotion and advertising for domestic tourism, b) using selfie to learn about tourist attractions visited and feel that marketing activities by tourism authorities and agents focuses on personal selling as effective means of promoting domestic tourism, c) using selfie as a motivation to connect with friends and families on the tourist attractions visited and hear experiences from others that they enjoy sharing information about domestic tourism, d) taking selfies as a group in the visited tourist attractions and hear experiences from others that they enjoy sharing information about domestic tourism, and e) using selfie to share with friends and family on tourist attractions visited and feel that marketing activities by tourism authorities and agents focuses on personal selling as an effective means of promoting domestic tourism.

The implications of the study outcome is for the tourism sector to encourage selfies in tourist attractions that are visited by tourists such as university graduates due to the statistically significant results between selfie usage and promotion of domestic tourism. Theoretically, the study

results of statistically significant relationship support the diffusion theory in that selfie as an innovation is widely used amongst university graduates through the use of smart phones or other gadgets like tablets and iPad serve as information source to share photos and tourists attractions with friends and family within the society, and thus help in creating tourism information for the knowledge society. Future researchers can examine similar relationships amongst international tourists visiting tourist attractions in order to enrich the understanding of the selfie phenomenon.

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APPENDIX

Appendix 1. ANOVA results for Selfie Usage and Promotion of Domestic Tourism

		Sum of Squares	Mean Square	F	Sig.
Marketing activities uses effective means of promotion and advertising for domestic tourism.	Between Groups	13.043	3.261	3.047	0.032
	Within Groups	32.100	1.070		
	Total	45.143			
I feel that marketing activities by tourism authorities and agents focuses on personal selling as an effective means of promoting domestic tourism.	Between Groups	10.936	2.734	3.287	0.024
	Within Groups	24.950	0.832		
	Total	35.886			
I feel there is adequate allocation of budget for promotional activities for domestic tourism.	Between Groups	3.134	0.783	0.513	0.727
	Within Groups	45.838	1.528		
	Total	48.971			
I feel there is rich information and data about domestic tourism from the internet.	Between Groups	8.534	2.133	1.176	0.341
	Within Groups	54.438	1.815		
	Total	62.971			
I get to hear experiences from others that they enjoy sharing information about domestic tourism.	Between Groups	3.750	0.937	0.767	0.555
	Within Groups	36.650	1.222		
	Total	40.400			
I get promotion prices from tourism authorities or entities in tourist attractions that I visit.	Between Groups	8.962	2.241	0.901	0.476
	Within Groups	74.638	2.488		
	Total	83.600			

Source: Field data (2018)

Appendix 2. ANOVA results for Selfie Usage and Promotion of Domestic Tourism

		Sum of Squares	Mean Square	F	Sig.
Marketing activities uses effective means of promotion and advertising for domestic tourism.	Between Groups	3.173	0.793	0.567	0.688
	Within Groups	41.970	1.399		
	Total	45.143			
I feel that marketing activities by tourism authorities and agents focuses on personal selling as an effective means of promoting domestic tourism.	Between Groups	7.921	1.980	2.124	0.102
	Within Groups	27.965	0.932		
	Total	35.886			
I feel there is adequate allocation of budget for promotional activities for domestic tourism.	Between Groups	1.007	0.252	0.157	0.958
	Within Groups	47.965	1.599		
	Total	48.971			
I feel there is rich	Between Groups	6.037	1.509	0.795	0.538

information and data about domestic tourism from the internet.	Within Groups	56.934	1.898		
	Total	62.971			
I get to hear experiences from others that they enjoy sharing information about domestic tourism.	Between Groups	10.764	2.691	2.724	0.048
	Within Groups	29.636	0.988		
	Total	40.400			
I get promotion prices from tourism authorities or entities in tourist attractions that I visit.	Between Groups	10.873	2.718	1.121	0.365
	Within Groups	72.727	2.424		
	Total	83.600			

Source: Field data (2018)

Appendix 3. ANOVA results for Selfie Usage and Promotion of Domestic Tourism

		Sum of Squares	Mean Square	F	Sig.
Marketing activities uses effective means of promotion and advertising for domestic tourism.	Between Groups	9.012	2.253	1.871	0.142
	Within Groups	36.131	1.204		
	Total	45.143			
I feel that marketing activities by tourism authorities and agents focuses on personal selling as an effective means of promoting domestic tourism.	Between Groups	4.937	1.234	1.196	0.333
	Within Groups	30.948	1.032		
	Total	35.886			
I feel there is adequate allocation of budget for promotional activities for domestic tourism.	Between Groups	7.344	1.836	1.323	0.284
	Within Groups	41.627	1.388		
	Total	48.971			
I feel there is rich information and data about domestic tourism from the internet.	Between Groups	6.796	1.699	0.907	0.472
	Within Groups	56.176	1.873		
	Total	62.971			
I get to hear experiences from others that they enjoy sharing information about domestic tourism.	Between Groups	17.096	4.274	5.502	0.002
	Within Groups	23.304	0.777		
	Total	40.400			
I get promotion prices from tourism authorities or entities in tourist attractions that I visit.	Between Groups	8.902	2.226	0.894	0.480
	Within Groups	74.698	2.490		
	Total	83.600			

Source: Field data (2018)

Appendix 4. ANOVA results for Selfie Usage and Promotion of Domestic Tourism

		Sum of Squares	Mean Square	F	Sig.
Marketing activities uses effective means of promotion and advertising for domestic tourism.	Between Groups	5.890	1.473	1.125	0.363
	Within Groups	39.253	1.308		
	Total	45.143			
I feel that marketing activities by tourism	Between Groups	13.005	3.251	4.263	0.008
	Within Groups	22.881	0.763		

authorities and agents focuses on personal selling as an effective means of promoting domestic tourism.	Total	35.886			
I feel there is adequate allocation of budget for promotional activities for domestic tourism.	Between Groups	4.180	1.045	0.700	0.598
	Within Groups	44.791	1.493		
	Total	48.971			
I feel there is rich information and data about domestic tourism from the internet.	Between Groups	3.995	0.999	0.508	0.730
	Within Groups	58.977	1.966		
	Total	62.971			
I get to hear experiences from others that they enjoy sharing information about domestic tourism.	Between Groups	12.274	3.069	3.273	0.024
	Within Groups	28.126	0.938		
	Total	40.400			
I get promotion prices from tourism authorities or entities in tourist attractions that I visit.	Between Groups	6.094	1.523	0.590	0.673
	Within Groups	77.506	2.584		
	Total	83.600			

Source: Field data (2018)

The Impact of Human Capital on Access to Financial Services for SMEs: A comparative Study of Botswana and Tanzania

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ABSTRACT

The paper aims to analyze the impact of human capital on access to financial services for SMEs by comparing results of two developing countries, Botswana and Tanzania. The objective of this study is to examine the impact of human capital for male and female entrepreneurs on access to financial services. This study used a survey questionnaire to collect primary data in the manufacturing sector from a sample size of 115 SMEs for Gaborone in Botswana and 81 SMEs for Dar es Salaam in Tanzania. Descriptive statistics and one way ANOVA were deployed to analyze the data. In Botswana, the majority of SMEs (52.2%) were females while in Tanzania males were (54.3%). The findings indicate that there is a statistically significant impact of human capital on access to financial services for Botswana in terms of education ($p=0.002$), work experience ($p = 0.000$), years of experience as owner manager in business ($p = 0.000$), and lapse of time of attending training related to business ($p = 0.002$). Findings also show that there is a statistically significant impact of human capital on access to financial services for Tanzania in terms of work experience ($p = 0.009$), and years of experience as owner manager in business ($p = 0.048$).

Keyword: human capital, financial services, SMEs, Botswana, Tanzania

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1.0 INTRODUCTION

Entrepreneurship development is evident in countries that have radically reduced poverty (Edoho, 2015). Female entrepreneurship is vital for economic advancement of numerous economies and is positively related to local development of developing countries (De Vita, Mari and Poggesi, 2013). The rate of female entrepreneurial activity in developing countries is 45.5% (Global Entrepreneurship Monitor, 2010). An area of focus in female entrepreneurship is the motivational factors that drive women into entrepreneurship. Gender differences in these motivations are noted by Rey-Marti, Porcar and Mas-Tur (2015).

Numerous studies have sought to establish the effectiveness of entrepreneurial training on success of entrepreneurs. Some findings affirm this notion (Murugesan and Jayavelu, 2015; Pedrini *et al.*, 2017) while others disprove it (Ahmed *et al.*, 2017; Shamsudin *et al.*, 2017). Human capital and entrepreneurship grew as a field of enquiry since the first publication by Dolinsky *et al.*, in 1993. A study by Ngatno *et al.* (2016) applied the human capital theory to examine human capital in relation to Small and Medium Enterprises (SMEs) performance. Much of the literature determines the impact of human capital on entrepreneurial intention but the authors have found few on how human capital affects actual entrepreneurial activity. This study adds to the scarce literature by applying human capital theory to analyze the impact of human capital on access to financial services for SMEs. Specifically, this study examines the impact of human capital for male and female entrepreneurs on access to financial services.

2.0 LITERATURE REVIEW

2.1 Definition of Concepts

2.1.1 Human Capital

The ability to exploit resources and source financial capital, as well as the ability to identify and create new opportunities, is largely determined by human capital (Davidsson and Honig, 2003; Ucbasaran *et al.*, 2008). SMEs that are least likely to be granted financial access rarely apply for it (Cowling *et al.*, 2016). The definition of the concept of human capital is documented in previous studies (Schultz, 1993; Marimuthu *et al.*, 2009; Joseph and Aibieyi, 2014). For example, Schultz (1993) defined human capital as a key element in improving a firm assets and employees in order to increase productivity and sustain competitive advantage. Human capital also refers to processes that relate to training, education and other professional initiatives to increase knowledge and skills (Marimuthu *et al.*, 2009). In this study human capital refers to the education, personal capabilities, work experience, years of experience as owner manager, training and work experience of SMEs in the business.

2.1.2 Male Versus Female Entrepreneurship

Often it is found that social roles of women contradict with the endeavour of entrepreneurship. Thus, an often difficult position must be taken by women entrepreneurs to uphold their social roles to the detriment of the entrepreneurs. Striking a balance between the two roles of an entrepreneur and being a caregiver is challenging (Kim and Ling, 2001). Female entrepreneurship has received attention from governments and academics on issues of innovations and dynamism of the economy (Orhan and Scott, 2011). However, because of discrimination even in entrepreneurial activities, there is gender disparity in the type of enterprises chosen by women. In Africa, the largest cluster of female entrepreneurial engagement is in the retail sector while the male entrepreneurial activities span over a larger range of economic sectors such as, information technology, manufacturing, mining and engineering (Smith-Hunter, 2004). These differences in entrepreneurial activity are thought to be attributable to country circumstances. For example, Minniti (2010) found per capita Gross Domestic Product (GDP) to be associated with the gender gap in entrepreneurial behavior. In addition, Okurut and Ama (2013) pointed out that the motivations for women as SMEs include creation of employment opportunities and improvement of household income.

Estrin and Mickiewicz (2011) found that women are less likely to engage in entrepreneurial activity where the state sector is larger. Other scholars (Richard and Mori, 2012; Swai *et al.*, 2016; Mkwizu *et al.*, 2018) have also conducted research related to banking, Small and Medium Enterprises (SMEs) and industrial products. The Report by UNIDO (2013) Tanzania is to shift from agriculture-based to an industry-based economy. This study considers male and female entrepreneurs in SMEs in the manufacturing sector.

2.1.3 Access to Financial Services

SMEs not using bank services is an indicator of the extent of barriers to economic development linked to financial access (Beck *et al.*, 2009; Inoue and Hamori, 2016). Financial access is still a problem in developing countries and unfortunately has not been a policy agenda in many of these same countries (Claessens, 2006).

Women are treated less favorably by lenders, they are less likely to have the relevant education and experience (Richard and Mori, 2012), and they are unable to build a credit rating, and there are inherent gender biases (Okurut and Ama, 2013). It is perhaps due to the above stated reasons that other studies revealed that more men than women actually apply for debt capital because of the belief that it will not be granted. This reality creates a situation in which these entrepreneurs fail to capitalize on opportunities because of a distinct financial inability to do so. They are voluntarily excluded from accessing financial services. In this study, access to financial services refers to ease of access.

2.2 Theoretical Framework

The human capital theory was first developed by Gary Becker in 1964 (Blaug, 1976). The human capital theory draws on the neoclassical economic model and posits that investment in skills development for individuals produces pecuniary and non-pecuniary benefits (Hodgson, 2007; Tan, 2014). It has been proven that in general, a higher level of education correlates with higher income (Becker, 1994). Health and nutrition are areas of such investment though much of the literature has focused on the investment in education because it is thought that education has a bearing on the former (Sweetland, 1996).

Studies in the field of business generated interests in human capital for organisational success (Joseph and Aibieyi, 2014; Ngatno *et al.*, 2016). Joseph and Aibieyi (2014) used human capital theory to study human capital in relations to approaches and management dynamics. Ngatno and others applied human capital theory for examining human capital in connection with entrepreneurial capital and SMEs performance by looking at the mediating effect of competitive advantage. Louangrath (2018) examined firm level labor productivity versus the national level labor productivity using the Solow-Swan model which according to Sato (1964) is a response to inadequate classical model of economic development. Louangrath found that at the national level, the increase in skills of the workforce contributes to aggregate output. This study applies the human capital theory to guide the analysis of the impact of human capital on access to financial services for SMEs. Thus the following hypothesis is posited: *Human capital significantly impacts access to financial services for SMEs*

2.3 Empirical Literature review

An analysis of financial services in Africa using literature analysis revealed that the financial services are as heterogeneous as the countries in the continent citing low financial literacy, constraints in access to credit and gender among common features (Makina, 2017). However, Makina (2017) noted that mobile money innovation is a promising innovation that has the potential to foster financial services.

Kapunda *et al.* (2011) conducted a study in Botswana and examined the relationship between SMEs' financing, development and trade. Kapunda and others applied both descriptive statistics and estimation methods to analyse data and findings showed that only 34.5% of women

were having economic activities in the manufacturing and construction sectors as opposed to men (65.5%), and access to finance was a problem because of failure to prepare business plans and lack of collateral by the SMEs. Additional findings indicated that more females (27.1%) agreed to lack of funds compared to males (10.2%).

In Uganda, most SMEs (87%) mentioned that they have capabilities to start business (GEM, 2010). Richard and Mori (2012) carried out a case study in Tanzania and investigated SMEs access to financial services by applying both quantitative and qualitative approaches. The qualitative approach involved interviews with bank officers dealing with SMEs and the content analysis results showed that the number of banks that offer financial services to micro business is still few. Further findings in the study by Richard and Mori revealed that there is lack of knowledge on financial management by SMEs as well as lack of awareness of different products offered by different bank.

A previous study in Tanzania mentioned that there is very limited knowledge on financial management by SMEs (Richard and Mori, 2012). Several studies (Okurut and Ama, 2013; Rametse and Huq, 2013; Sharma, 2013; Akinboade, 2015; Udell, 2015; Cowling *et al.*, 2016; Swai, *et al.*, 2016; Mkwizu, *et al.*, 2018) researched on various issues related to SMEs and access to finance, whereby most have concentrated on growth, regulations, bank portfolio, banking innovations, industrial products and women in SMEs.

Although there is documentation on SMEs (GEM, 2010; Kapunda *et al.*, 2011; Richard and Mori, 2012; Okurut and Ama, 2013; Swai, *et al.*, 2016; Makina, 2017; Mkwizu, *et al.*, 2018), there is less literature on human capital in terms of tacit and explicit knowledge in relation to financial services measured by ease of access through online banking and online transaction. This study fills the literature gap specifically by examining the impact of human capital for male and female entrepreneurs on access to financial services.

2.4 Conceptual Framework

The conceptual framework for this paper is guided and developed from the theoretical and empirical literature review in the analysis of the impact of human capital on access to financial services. The independent variable is human capital while the dependent variable is access to financial services. We hypothesize that there is a statistically significant impact of human capital on access to financial services for SMEs.

3.0 DATA AND METHODOLOGY

This study uses a written survey to collect primary data and uses quantitative approach. The study areas are in Gaborone in Botswana, and Dar es Salaam in Tanzania. The collected data focused on SMEs in the manufacturing sector. SMEs population for Botswana was obtained from Central Statistics Office of Botswana (CSOB) while in Tanzania the list of SMEs in the manufacturing sector is those registered with the Tanzania Food and Drugs Authority (TFDA). The sample size is based on small sample with a sectoral focus of manufacturing sector due to the development emphasis in the economies of Botswana and Tanzania. Krejcie and Morgan (1970) method was used to determine the sample size for the respondents, $n = 115$ for Gaborone, Botswana and $n = 81$ for Dar es Salaam, Tanzania using convenience sampling. Descriptive statistics and one way ANOVA are used as analytical tools.

The demographic items were adopted and customized from Per and Benson (2003). Measurement statements for human capital as the independent variable were adopted and customised from (Pishghadam *et al.*, 2011). Human capital statements (6 statements) are from the perspectives of tacit and explicit knowledge. The dependent variable of access to financial services was measured using ease of access (6 statements) which consider digital era in relation to online transaction and banking. The measurement items on access to financial services were adopted and customized from studies by Per and Benson, and Robb (2013). Reliability was done using Cronbach's Alpha in order to test internal consistency of responses. An alpha value of 0.70 or above

indicates that the questions generate consistent results (Pallant, 2011). The Cronbach's Alpha values are 0.877 for human capital, and 0.905 for access to financial services.

4.0 FINDINGS AND DISCUSSION

The findings of descriptive statistics in Table 1 indicate that a majority of respondents from Botswana (52.2%) are females compared to Tanzania (54.3%) are males. Further findings show differences between Botswana and Tanzania in terms of years of operation, type of business, registration status and size of business. The results suggest that majority of SMEs in Botswana are females above 21 years old who are sole proprietors (58.3%) with above 5 years of operation (46.1%), not registered (51.3%) and have 2-4 employees (85.2%).

On the other hand, the results for Tanzania suggest that most of the SMEs are owned by middle aged males who are sole proprietors (46.9%) with 2-5 years of operation (48.1%), registered (90.1%) and have 1 employee (48.1%). Therefore, in this study, the similarity between Botswana and Tanzania for SMEs is on the type of business where both countries show that it is sole proprietors but differences are on age, gender, year of operation, registration status and size of business. The results of this study are in line with Okurut and Ama (2013) who stated that the motivation for women as SMEs is to create employment. The variations in results for this study complement Okurut and Ama (2013) because majority of SMEs in Botswana who are women have 2-4 employees and thus create more employment opportunities within the manufacturing sector as opposed to the majority of SMEs in Tanzania who are males and employ 1 person.

Table 1. Demographic Information of Respondents

Demographic Information	Botswana	Tanzania
Age	21-30 years (34.8%)	31-40 years (32.1%)
Gender	Female (52.2%), Male (47.8%)	Female (45.7%), Male (54.3%)
Year of Operation	Above 5 years (46.1%)	2-5 years (48.1%)
Type of Business	Sole Proprietor (58.3%)	Sole Proprietor (46.9%)
Registration Status	Not registered (51.3%)	Registered (90.1%)
Size of Business	2-4 employees (85.2%)	1 employee (48.1%)

Source: Field data (2018)

Table 2 shows the frequencies and percentages of human capital for Botswana and Tanzania. Descriptive statistics for human capital revealed that for Botswana, majority of respondents have high school education (54.5%), personal capabilities as teamwork (60%) with work experience 1-5 years (38.3%) and years of experience of 1-5 years (47.8%), most have not attended training recently (61.7%) and are full time in business (96.5%). The human capital findings for Tanzania show that most respondents have high school education (32.1%) and University education as undergraduates (32.1%), have personal capabilities as teamwork (71.6%), have work experience 1-5 years (38.3%), and years of experience 1-5 years (33.3%), last time attended training in business is 6 months (51.9%) and work in business full time (74.1%).

The results suggest the human capital in Botswana has higher percentages in terms of high school education, years of experience as owner managers, not having attended a training session related business and work experience in the business on full time. Comparatively, Tanzania scored higher percentages on capabilities of teamwork. The results further suggest that work experience of 1-5 years is the similarity of human capital between Botswana and Tanzania. These results differ from a similar study by Kapunda *et al.* (2011) which highlighted lack of funds by female SMEs compared to male SMEs. The results of this study also differs from GEM (2010) which showed that SMEs in Uganda mentioned having capability to start business whereas this study found that not

just capabilities for SMEs but the variations in these results can be attributed to personal capabilities of SMEs as teamwork.

Table 2. Human Capital

Human Capital	Botswana	Tanzania
Education	High School (54.5%)	High School (32.1%) Undergraduate (32.1%)
Personal Capabilities	Teamwork (60%)	Teamwork (71.6%)
Work Experience	1-5 years (38.3%)	1-5 years (38.3%)
Years of experience as owner manager in business	1-5 years (47.8%)	1-5 years (33.3%)
When was the last time you attended a training session related to your business?	Not all (61.7%)	0-6 months (51.9%)
Work experience in the business	Full time (96.5%)	Full time (74.1%)

Source: Field data (2018)

The findings of access to financial services between Botswana and Tanzania in Table 3 show that for the statement of access to online banking (majority 72.8% of respondents in Tanzania strongly agreed compared to 31.3% for Botswana); ease of transaction using online banking (majority 88.9% of respondents in Tanzania strongly agreed versus 31.3% for Botswana); use online banking to access bank statements for my business (majority 90.1% of respondents in Tanzania strongly agreed versus 29.6% for Botswana); use email to communicate business products and services to my friends & family members (majority 92.6% of respondents in Tanzania strongly agreed versus 38.3% for Botswana); refer friends and family members to my business website/social media account frequently (majority 88.9% of respondents in Tanzania strongly agreed versus 53% for Botswana).

From the descriptive statistics results of access to financial services, it is evident that there are differences between Botswana and Tanzania. This suggests that SMEs from Tanzania have access to financial services using online banking, ease of transaction, use email communication in business and refer business website/social media to friends and family compared to SMEs in Botswana. This implies that stakeholders in Botswana, particularly financial institutions, should work on sensitizing SMEs to use financial services such as online banking for transactions and access to bank statements.

The results of this study from Botswana sample respondents differ from Makina (2017). The differences in results show that while Makina cited innovation such as mobile services can foster access to financial services, this study shows that for Botswana there is still low levels in accessing financial services in terms of ease of access. On the other hand, results from Tanzania complement the prediction by Makina that innovations can foster access to financial services, and this study shows that majority of SMEs for Tanzania access financial services using online banking for transactions and bank statements for business purposes.

Table 3. Access to Financial Services

Ease of Access	Botswana	Tanzania
I have online banking	31.3%	72.8%
I have access to transaction using online banking	31.3%	88.9%
I use online banking to access bank statement for my business	29.6%	90.1%
I use email to communicate business products and services to my friends and family members	38.3%	92.6%
I refer friends and family members to my business	53%	88.9%

website/social media account		
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Source: Field data (2018)

In Table 4, one way ANOVA analysis for Botswana that education on access to financial services is statistically significantly ($p = 0.002$), work experience on access to financial services is statistically significantly ($p = 0.000$), years of experience as owner manager in business on access to financial services is statistically significant ($p = 0.000$), and lapse of time of attending training related to business ($p = 0.002$). Personal capabilities ($p = 0.346$), and work experience in the business ($p = 0.239$) have no significant on access to financial services. The results suggest that for Botswana, the human capital for male entrepreneurs is statistically significant on access to financial services in terms of education, work experience, years of experience as owner managers in business, and lapse of time of attending training related to business. Therefore, this study accepts the hypothesis that there is a statistically significant impact of human capital on access to financial services and this supports the human capital theory. The results of this study are different from Kapunda *et al.* (2011) and the variations are explained by education, work experience and years of experience as owner managers in business for the sampled SMEs.

Table 4. One Way ANOVA Findings of Human Capital and Financial Services for Botswana

	Sum of Squares	Mean Square	F	Sig.
<i>Education / FS</i>				
Between Groups	1031.106	343.702	5.298	0.002
Within Groups	7200.338	64.868		
Total	8231.443			
<i>Personal capabilities / FS</i>				
Between Groups	241.088	80.363	1.116	0.346
Within Groups	7990.356	71.985		
Total	8231.443			
<i>Work experience / FS</i>				
Between Groups	1857.260	552.420	9.327	0.000
Within Groups	6574.184	59.227		
Total	8231.443			
<i>Years of experience as business owner / FS</i>				
Between Groups	1256.383	418.794	6.665	0.000
Within Groups	6975.061	62.838		
Total	8231.443			
<i>Last time attended F/S training</i>				
Between Groups	1165.232	291.308	4.535	0.002
Within Groups	7966.21	64.238		
Total	8231.443			
<i>Work experience in the business / FS</i>				
Between Groups	100.741	100.741	1.400	0.239
Within Groups	8130.703	71.953		
Total	8231.443			

Note: FS refers to Financial Services . Source: Field Data (2018)

In Table 5, one way ANOVA for Tanzania show that work experience on access to financial services is statistically significantly ($p = 0.009$), years of experience as owner manager in business on access to financial services is statistically significant ($p = 0.048$). Education ($p = 0.568$), personal capabilities ($p = 0.149$), lapse of time of attending training related to business ($p = 0.130$), and work experience in the business ($p = 0.065$) have no significance on access to financial services. The results suggest that for Tanzania, the human capital for male entrepreneurs is statistically significant on access to financial services in terms of work experience and years of experience as owner managers in business. Therefore, this study accepts the hypothesis that there is a statistically significant impact of human capital on access to financial services and this supports the human capital theory.

Table 5. One Way ANOVA Findings of Human Capital and Financial Services for Tanzania

	Sum of Squares	Mean Square	F	Sig.
<i>Education / FS</i>				
Between Groups	29.493	7.373	0.740	0.568
Within Groups	757.396	9.966		
Total	786.889			
<i>Personal capabilities / FS</i>				
Between Groups	52.372	17.457	1.830	0.149
Within Groups	734.517	9.539		
Total	786.889			
<i>Work experience / FS</i>				
Between Groups Work Experience/FS	110.164	36.721	4.178	0.009
Within Groups	676.725	8.789		
Total	786.889			
<i>Years experience as business owner / FS</i>				
Between Groups	92.208	23.052	2.522	0.048
Within Groups	694.681	9.141		
Total	786.889			
<i>Last time attended business training / FS</i>				
Between Groups	69.519	17.380	1.841	0.130
Within Groups	717.370	9.439		
Total	786.889			
<i>Work experience in business / FS</i>				
Between Groups	33.353	33.353	3.497	0.065
Within Groups	753.536	9.538		
Total	786.889			

Note: FS refers to Financial Services. *Source:* Field Data (2018)

From one way ANOVA results, the comparative statistically significant impact of human capital on access to financial services between Botswana and Tanzania reveal that for Botswana, the statistically significant impact of human capital for female entrepreneurs is related to work experience, years of experience as owner managers in business, and lapse of time of attending

training related to business. For Tanzania, the statistically significant impact of human capital for male entrepreneurs is related to work experience and years of experience as owner managers in business. Whereas other studies (Richard and Mori, 2012; Makina, 2017) show that there is lack of knowledge, lack of awareness of products offered by banks, and low levels of literacy in relation to access to financial services, the results of this study differs in that the sampled SMEs indicated statistically significant relationship between human capital and access to financial services which is attributed to work experience, years of experience as owner managers in business and the last time SMEs attended a training related to business.

5.0 CONCLUSION

This paper analyzed the impact of human capital on access to financial services for SMEs with a comparative study between Botswana and Tanzania. The objective of this study was to examine the impact of human capital for male and female entrepreneurs on access to financial services. The findings of this study showed that majority of SMEs in Botswana are females whereas in Tanzania it is male. Female SMEs in Botswana are mainly characterized as sole proprietors, above 5 years of operation, not registered and employ 2 to 4 employees while the male SMEs in Tanzania are mostly middle aged, sole proprietors with 2-5 years of operation, registered and have 1 employee. Further findings on human capital indicate that majority of female SMEs for Botswana had high school education, and for Tanzania the male SMEs had high school and university education (undergraduate). The results from Tanzania of mostly male SMEs with high school and university education differ from a previous study by Richard and Mori (2012).

This study shows that for Botswana, there is a statistically significant impact of human capital on access to financial services in relation to education, work experience, years of experience as owner managers in business, and when was the last time you attended a training related to business. In comparison to Tanzania, there is a statistically significant impact of human capital on access to financial services in relation to work experience and years of experience as owner managers in business. The significant results of this study support the human capital theory and that SMEs from both countries can benefit from access to financial services such as online banking through work experience and years of experience as owner manager in the business.

The outcome of this study has implications for the two developing countries. For Botswana, stakeholders such as the government and policy makers need to consider education, work experience, years of experience as owner managers in business, and training related to business as human capital necessary for female SMEs to access financial services. On the other hand, for Tanzania, stakeholders like the government and decision makers should consider work experience and years of experience as owner managers in business as human capital for male SMEs to access financial services.

This study has limitations on the manufacturing sector only. Therefore, future researchers can explore other sectors.

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Validity and Reliability of Survey Scales

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ABSTRACT

The objective of this paper is to evaluate Likert and non-Likert scales for quantitative survey. The data used in the evaluation of the scale is the scale components. The scales used for the evaluation include the following types: (0,1,2,3), (1,2,3,4,5), (1,2,3,4,5,6,7), and (1,2,3,4,5,6,7,8,9,10). These scales are categorized into two types, namely Likert and non-Likert. The scale (0,1,2,3) is classified as non-Likert; the remaining scales are Likert scales. The efficacy of various scales is evaluated on the basis of fitness. We defined fitness as the ratio between shape and scale of the scaled obtained through the QQ plot linear equation. We found that scale (0,1,2,3) is the most effective scale type for quantitative response choice. The efficacy of the scale was measured by the absolute error of the scale's fitness CDF. The absolute error of the CDF of the fitness were 0.14, 0.22, 0.25 and 0.26 for the following types: (0,1,2,3), (1,2,3,4,5), (1,2,3,4,5,6,7), and (1,2,3,4,5,6,7,8,9,10), respectively. The results of GOF under the likelihood ratio test, Wald statistic and Lagrangian multiplier shows that the non-Likert scale (0,1,2,3) has the best fit in the probability space of the unit circle: 0.71, 0.68, and 0.70, respectively. Response in a form of (0,1,2,3) is the best form of response scale for quantitative survey. This finding is a contribution to the field because the common use of the Likert scale has made findings and conclusion in many cases in social science research lacking validity due to low accuracy.

Keywords: Gautama scale, instrument calibration, Likert scale, Monte Carlo, non-Likert scale, reliability, validity

JEL Code: C80, C82, C89

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1.0 INTRODUCTION

1.1 Likert Scale and its usage

This paper is motivated by the needs to look for response scale that is a better alternative to the Likert scale. The Likert scale is commonly used in social science research. Despite its convenience and common usage, the Likert scale is not an accurate tool to gauge respondent's opinion on a sequential scale. This problem is blinded by the fact that when researchers seek to explain the "reliability", the most commonly measure is Cronbach's alpha. This paper points out that Cronbach's alpha is not a proper measure for instrument evaluation. A key to evaluate the instrument, i.e. survey, is the measure of accuracy of the response scale.

Research in social science commonly employed written survey as an instrument to collect data. In quantitative survey, the survey may employ one of any number of response scale types. These scale types include: (0,1,2,3), (1,2,3,4,5), (1,2,3,4,5,6,7), and (1,2,3,4,5,6,7,8,9,10). The scale in a form of (0,1,2,3) may be called non-Likert scale. These scales: (1,2,3,4,5), (1,2,3,4,5,6,7), and (1,2,3,4,5,6,7,8,9,10), may be called Likert scales. This paper evaluates the validity or accuracy of the Likert and non-Likert scales in quantitative survey.

Likert scale was introduced by Rensis Likert in 1932 (Likert, 1992). It is commonly used for collecting response data in social science research. The scale may be in any of the following forms: (1,2,3,4,5), (1,2,3,4,5,6,7), or (1,2,3,4,5,6,7,8,9,10). There are two defects in these scales. First, the scale does not contain zero. The absence of zero limits data analysis to only continuous distribution for purposes of hypothesis testing. Secondly, by using 1 as the lowest value, the scale produces an artificial "lowest" value. The value 1 in any of the Likert scale form does not represent the "true lowest" value. Thirdly, the all Likert scale forms produce artificially higher mean; therefore, inflates the mean and, thus, creates greater potential for Type I error. In light of these weaknesses of the Likert scale, the non-Likert scale (0,1,2,3) may present a more logical alternative.

One critique of the Likert scale is that it is used as non-numerical or non-quantitative, linear modeling may not be appropriate tool for analysis (Knapp, 1990). Respondents may also cause confusion of whether the choices between components of Likert scale have equi-distance (Dawes, 2008). In a case where the Likert scale is descriptive, it must be converted to number scale before it could be analyzed (Kuzon et al., 1996). For Likert supports, in order to make the scale reliable, it must contain at least six items (Carifer, 2008; Carifero, 2007). Some claimed that the Likert 5 and 7 item scales are reliable (Vicker, 1999). However, this claim is not convincing. Vickers' study on responses to reported that the Likert-type single question of pain yielded a higher mean value than the same question posed to the same group using a Visual Analog Scale; Vickers concluded that the Likert-type response was "a more responsive measure." This is a misinterpretation of the finding. The evidence shows precisely the problem of the Likert scale; it creates an artificially inflated mean. This inflated mean is created by non-zero minimum and the inflation intensifies with more choices. For example, 5-points scale (1,2,3,4,5) has a mean of 3 and the 7-points scale has a mean of 4. Therefore, we treat Vickers' conclusion as Type 2 error. Type 2 error occurs when the null hypothesis is falsely rejected (Shermer, 2002). The Likert scale produces artificially high mean, thus, gives a pretense of proving the hypothesis and rejects the null hypothesis. This is a false proof because the Likert scale produces a false mean. In light of the inefficiency of the Likert scale and other developments in survey response (Reips and Funke, 2008), we urge using other alternatives that are more reliable than the Likert scale. In this paper, we present (0,1,2,3) as an alternative scale.

1.2 Non-Likert scale as better alternative

The non-Likert quantitative scale in a form of (0,1,2,3) was introduced by Gautama Buddha 2600 years ago. This Buddhist scale categorizes levels of all things into two category; things that is extinguished is called zero (*sunyatha*), and things that persists may be measured in three levels, namely low (1: *pathama*), medium (2: *machima*) and high (3: *paramatra*). Any written works on

quantitative scale in a form of (0,1,2,3) subsequent to Gautama Buddha were only the re-discovery of older works in Buddhism.

The Gautama scale (0,1,2,3) contains zero. This allows respondents to give the true value for “lowest” level of the response; as the result, the mean is not artificially inflated. The zero and non-zero components of the (0,1,2,3) scale, allows the researcher to engage in both discrete and continuous probabilities as tools for hypothesis testing.

It is a common mistake to report alpha Cronbach as the indicator of reliability or validity. The Cronbach alpha cannot verify the reliability or validity of the instrument. The Cronbach alpha measures the consistency of responses in a set of survey. This is a measurement of responses; it does not measure the efficacy of the instrument itself. If the survey is defective for lack of accuracy, no matter how high the Cronbach alpha may be, a defective instrument remains defective. Consistency of responses represents no more than consistent result of defective instrument. Cronbach wrote that: “I no longer regard the alpha formula as the most appropriate way to examine most data. Over the years, my associate and I developed the complex generalizability (G) theory.” Cronbach *et al.* (1963, 1973).

In this paper, our evaluation of the response scale is the tool to verify whether the instrument is valid. The function of validity test is to verify the accuracy of the response. What good can the consistency of responses do when the instrument itself is not accurate?

Accuracy is defined as precision. Precision is minimal error between the observed and expected values. The expected value is defined as the center of probability space in the unit circle where the cumulative distribution function (CDF) is at 0.50 or 50% point. A valid instrument is defined as one that produces responses or potential responses that lie closest to the center of the center of the unit circle of the probability space or $CDF = 0$.

The purpose of this paper is to verify that among these types of response scale, which scale is the most accurate: (0,1,2,3), (1,2,3,4,5), (1,2,3,4,5,6,7), and (1,2,3,4,5,6,7,8,9,10) ? Accuracy is defined as zero or minimal error between the CDF of the fitness of the responses produced by each scale compared to the ideal location at $CDF^* = 0$.

This paper asks: “which type of response scale is more accurate and reliable?” Accuracy is the indication of validity. Response scale in survey that is not accurate would fail the test of validity of the instrument. Reliability is the test for consistency. However, consistency must be read with validity in order to avoid false reading of the scale.

2.0 LITERATURE

Opinion survey involves psychological measurement called psychometrics. They are commonly used in social science research, particularly psychology and education (Kaplan and Sacuzzo, 2010). The measurement may employ survey that requires respondents to give answer in multiple choice of scale or dichotomous answer of yes or no (Andrich and Lou, 1993). There are three theoretical approaches that laid the foundation for psychometrics, namely *Classical Test Theory*, *Item-Response Theory* (Emberetson and Reise, 2000; Hambleton and Swaminathan, 1985), and the Rasch model (Rasch, 1960/1980).

Firstly, the Classical Test Theory (CTT) asserts that the observed score is a sum of the true score and error score. the aim of CTT is to understand and improve psychological testing method. The goal of CTT is to obtain the index of reliability in the response space. CTT depends on three components: observed test score (X), true variance of the test score (σ_T^2), and variance of the observed error of the test score (σ_x^2), the reliability ratio is given:

$$\rho_{xT}^2 = \frac{\sigma_T^2}{\sigma_x^2} \quad (1)$$

which may equivalently be written as:

$$\rho_{xT}^2 = \frac{\sigma_T^2}{\sigma_x^2} = \frac{\sigma_T^2}{\sigma_T^2 + \sigma_E^2} \quad (2)$$

The expression in (1) and (2) are called signal-to-noise ratio. In the context of reliability of responses of test score, reliability is high when the variance of error is low.

The reliability sought under CTT is obtained through the result of the responses, not the instrument used to obtain the responses (Pui-Wei and Wu, 2007). CTT relies heavily on correlation coefficient among response items. This is a point that this paper diverge; we are seeking the means to determine the reliability of the instrument, not the reliability of the response (Hambleton *et al.*, 1991).

The second theoretical approach to psychometrics is Item Response Theory (IRT). In IRT, questions do not have the same level of difficulty. For instance, in a Likert scale response space, each item is treated with the same level of difficulty; thus, the Likert scale is called parallel instrument (Van Alphen *et al.*, 1994). In IRT, treats the difficulty of each item as a separate score that needs to be examined in context of the entire test items (Ostini *et al.*, 2005; Nering and Reise, 2000). Thus, it is seen as a better approach in comparison to CTT (Embretson *et al.*, 2000).

The robustness of IRT is attested in its approach to provide a verifiable modeling of reliability of the test score. The modeling approach under IRT comes in two forms: three-parameter logistic model (3PL) and two parameters logistic model (2PL). The 3PL is presented by:

$$p_i(\theta) = c_i + \frac{1 - c_i}{1 + e^{-a_i(\theta - b_i)}} \quad (3)$$

where θ = person's ability which may be modeled from normal distribution; a = discrimination, scale, slope where the maximum slope is $p'(b) = a \cdot (1 - c) / 4$, b = level of difficulty, item location: $p(b) = (1 + c) / 2$, the half-way point between c_i (min) and 1(max) where the slope is maximized; and c = pseudo-guessing, chance, asymptotic minimum $p(-\infty) = c$.

The 2PL model assumes that there is no guessing (Thissen and Orlando, 2001). However, the items could vary in location (b_i) and discrimination (a_i). The 2PL approach is called normal-ogive model. The 2PL model is given by:

$$p_i(\theta) = \Phi\left(\frac{\theta - b_i}{\sigma_i}\right) \quad (4)$$

where Φ = cumulative distribution function (CDF) of a standard normal distribution curve, b_i = level of difficulty, and σ_i = discrimination. The standard deviation of the measurement error for item i is equal to $1/a_i$.

The third approach to psychometric test is called the Rasch model (Rasch, 1960/1980). The Rasch model has been used in marketing research (Bechtel, 1985). The Rasch model has general applicability in many fields in social science (Wright, 1977). Rasch model is similar to IRT (Linacre, 2005). Rasch claimed that unlike IRT, the Rasch model can accommodate specific objectivity (Rasch 1977). There are three types of Rasch models; each model depends on the type of data.

The first type of Rasch model deals with dichotomous data. Dichotomous data are binary. Binary data are those that had been generated by questions soliciting “yes” or “no” response. The

“yes” is scored as 1 and “no” is scored 0. The probability of the expected outcome for the Rasch model for dichotomous model is given by:

$$\Pr\{X_{ni} = 1\} = \frac{e^{\beta_n - \delta_i}}{1 + e^{\beta_n - \delta_i}} \quad (5)$$

where β_n = person’s ability, σ_i = level of difficulty of item i , $\Pr\{X_{ni} = 1\}$ = probability of success upon interaction of person and the assessment test, $\beta_n - \delta_i$ = correct responses; and δ_i = difficulty.

The second type of Rasch model deals with polytomous data. Polytomous data are defined as non-binary data where the answer choices consists of a range of values, for instance score of (0,1,2,3) as response choice. In polytomous case, the Rasch model is explained the partial credit model where $X_{ni} = x \in \{0,1,\dots,m_i\}$ is integer of random variable where m_i is the maximum score of item i . The term X_{mi} is random variable that can take value from 0 to m_i . The probability of the outcome $X_{ni} = x$ is explained by Master (Master, 1982) as:

$$\Pr\{X_{ni} = x, x > 0\} = \frac{\exp \sum_{k=1}^x (\beta_n - \tau_{ki})}{1 + \sum_{j=1}^{m_i} \exp \sum_{k=1}^j (\beta_n - \tau_{ki})} \quad (6)$$

$$\Pr\{X_{ni} = 0\} = \frac{1}{1 + \sum_{j=1}^{m_i} \exp(\beta_n - \tau_{ki})} \quad (7)$$

where τ_{ki} is the k^{th} threshold of item i , β_n = location of person n on same continuum, m_i = maximum score for item i . The partial credit model could be rewritten as:

$$\Pr\{X_{ni} = x\} = \frac{\sum_{k=0}^x (\beta_n - \tau_{ki})}{\sum_{j=0}^{m_i} \exp(\beta_n - \tau_{ki})} \quad (8)$$

where τ_{0i} is selected for convenience in computation: $\sum_{k=0}^{m_i} (\beta_n - \tau_{ki}) = 0$.

The third Rasch model is called the rating scale model (Andrich, 1978). The model is given by:

$$\Pr = \{X_{ni} = x\} = \frac{\exp \sum_{k=0}^x (\beta_n - (\delta_i - \tau_k))}{\sum_{j=0}^m \exp(\beta_n - (\delta_i - \tau_k))} \quad (9)$$

where δ_i = difficulty of item i , $\tau_k = k^{th}$ threshold of the rating scale common to all items, and τ_0 is chosen for computational convenience.

The three psychometric methods: CTT, IRT and Rasch models are tools for evaluating the outcome of the survey. They are not tools to evaluate the reliability of the survey or instrument used to collect the data. Therefore, existing literature on psychometrics has room to further contribution. This paper intends to examine the reliability of the survey, not the consistency or reliability of the responses to the survey.

2.1 Validity of an instrument

Validity test is a test of precision between the observed and the expected observation (Brains and Manhein, 2011). Traditionally, validity test in the literature is concerned with experimental design, not instrumental design (Cronbach and Meehl, 1955). When discussing experimental designs, the following sub-issues of validity are discussed: construct validity (Cronbach and Meehl, 1955); content validity (Pennington, 2003; Guion, 1980); face validity (Holden, 2010; Gravetter *et al.*, 2012);

criterion validity (Satu *et al.*, 2017); concurrent validity (Sackett *et al.*, 2007); and predictive validity (Messick, 1955).

In this paper, we discuss the validity of the instrument used to collect data. Specifically, the paper evaluates various response scales used in written survey to collect data in field research. We assert that if the instrument is not accurate, the data, analysis and conclusion would also be inaccurate. An instrument that produces inaccurate result is not a reliable instrument.

2.2 Reliability of an instrument

Reliability is the measure of consistency (Davidhofer *et al.*, 2005). They are various methods used for testing reliability; for instance, Kuder-Richardson formula (Cotina, 1993), Cronbach's alpha (Ritter, 2010) or Spearman-Brown (Eisiga *et al.*, 2012). In this prior literature, the reliability test focuses on the results of the survey. This approach may not be accurate measure for reliability.

Two questions about reliability must be answered: (i) how is consistency of result and reliable instrument different? and (ii) what is the indicator for reliable instrument? Consistency refers to the similarity or uniformity or lack of significant difference in repeated measurements. Consistency of result refers to the uniformity of the result of the survey. A survey may be inaccurate in measuring the construct yet can solicit consistent erroneous result among respondents. For example, a measuring scale that uses to determine the weight of an object may consistently produce the same or similar reading; however, if the scale is defective, the consistently erroneous results would not make the scale a good scale. In terms of reliability, it could only be said that the weight scale consistently produces wrong reading or it is reliably erroneous. Similarly, for the survey used to solicit responses from respondents, if the survey is poor, it is no different than the defective weight scale in the example. Reliability must be examined with Validity.

Validity is the measure of accuracy. In the weight scale example, the scale is reliable in giving the wrong reading. In terms of accuracy it is, the wrong reading makes it fail in validity test due to the lack of accuracy. In the response scale of the survey, validity test is verified to minimal error by which the random values created by the response scale filled the unit circle in the probability space.

An accurate instrument may produce consistently inaccurate result. If reliability is the focus of the test, that reliability would not be accurate for purposes of instrument testing because even with consistently wrong answer, the indication for reliability would have been high, i.e. highly reliable, but wrong answers. For this reason, we assert that an instrument failing validity test also fails reliability test. A reliable instrument is one that could produce accurate result and such result shows consistency in repeated measurements. In this paper, we propose a test for instrument reliability.

3.0 DATA AND METHODOLOGY

3.1 Data obtained through scale components and Monte Carlo simulation

Each data scale provides a range of values. Possible responses in a quantitative survey fall within this range. The descriptive and inferential statistics are provided in Table 1. The term \bar{X} is the mean value of the actual scale and μ represents the expected value of the scale.

Table 1. Descriptive and inferential statistics of survey response scale

Scale	Type	\bar{X}	SD	μ	σ
(0,1,2,3)	Non-Likert	1.50	1.29	0.44	1.29
(1,2,3,4,5)	Likert	3.00	1.58	1.84	1.58
(1,2,3,4,5,6,7)	Likert	4.00	2.16	2.66	2.16
(1,2,3,4,5,6,7,8,9,10)	Likert	5.50	3.03	3.93	3.03

Following a Monte Carlo simulation, for each scale type, we use the minimum and maximum values in the scale as the range and calculated how many repetition must there be in order for the probability of each point of measurement to produce normal distribution at 99.98% confidence level. This requirement is achieved by:

$$\lim_{n \rightarrow R} \Pr \left\{ \frac{1}{N} \sum_{i=1}^N \xi - \mu \right\} \leq 0.998 \quad (10)$$

In a random variable set of values $\{X_i\}$, where there are minimum and maximum values, the error of the Monte Carlo is given by:

$$\varepsilon = \left(\frac{\max - \min}{2} \right) / 50 \quad (11)$$

The number of repeat tests needed for the Monte Carlo simulation is determined by:

$$N = \left(\frac{3\sigma_{xi}}{\varepsilon} \right)^2 \quad (12)$$

where σ_{xi} is the estimated standard deviation of three values: $X_1 = \max$, $X_2 = \min$, and $X_3 = (\max - \min) / 2$. The expected mean is determined by: $\mu = \bar{X} - S(T(S/\sqrt{n}))$.

Table 2. Skew and kurtosis of response scale

Scale	Type	Skewness	Kurtosis	Monte Carlo*
(0,1,2,3)	Non-Likert	0.00	1.20	22,228.10
(1,2,3,4,5)	Likert	0.00	1.20	24,080.44

(1,2,3,4,5,6,7)	Likert	0.00	1.20	23,051.36
(1,2,3,4,5,6,7,8,9,10)	Likert	0.00	1.20	22,593.99

*The Monte Carlo N repetition for 6-sigma is 23,413.60.

3.2 Procedures for scale accuracy evaluation

We employed three steps to verify the accuracy of the scale in the group of scales: (0,1,2,3), (1,2,3,4,5), (1,2,3,4,5,6,7), and (1,2,3,4,5,6,7,8,9,10). Step 1 involves the construction of the linear equation for each scale. Step 2 defines the fitness of each scale by using the ratio of the shape and height created by the scale inside the probability space of a unit circle. Step 3 evaluates the accuracy of each scale in the groups of scales though the absolute error of the fitness CDF. These three steps are explained in detailed below.

Step 1. Construct linear equation for the scale. Each scale is converted into a QQ plot and a linear equation in a form of $Y = a + bX$ is obtained through the following process:

$$F(t) = \frac{i - 0.3}{n + 0.4} \quad (13)$$

$$X = \ln\left(\frac{1}{1 - F(t)}\right) \quad (14)$$

$$Y = \ln(\text{scale}) \quad (15)$$

$$I = n \sum XY - \sum X \sum Y \quad (16)$$

$$II = n \sum X^2 - (\sum X)^2 \quad (17)$$

$$b = \frac{I}{II} \quad (18)$$

$$a = \bar{Y} - b\bar{X} \quad (19)$$

Step 2. Define the fitness of the scale. Use the ratio of the shape and height of the expected value of the scale to define the fitness of the response points.

$$Fit = \frac{\beta}{\exp(a)} \quad (20)$$

where β is the shape of the distribution of the scale components obtained by $\beta = 1/b$ and $\exp(a)$ is the scale or the height of the response scale.

Step 3. Determine the error of fitness CDF. Evaluate each scale as a member of a group of various scale to determine which scale type has the most fit using 1.00 of the unit circle as the threshold value. The absolute error of the CDF of the individual scale compared to the center of the probability space in the unit circle determines the accuracy or validity of the scale. Larger the error produces lower accuracy, and lower error produces higher validity indication. Given various scale to be evaluated: $s_i : (s_1, s_2, \dots, s_3)$ has individual fitness: $Fit = \beta / \exp(a)$ compared to the total probability in the unit circle 1.00, individual difference of fitness is obtained as $d_i = Fit - 1$. The CDF of each d_i is determined and compared to the center of the circle or $F(0) = 0.50$. The

absolute value of the error defines the accuracy of the scale: $|E| = \Phi(\hat{fit}) - 0.50$. The most accurate response scale is determined on the basis of lowest percentage error or $\% \text{ error} = 1 - |E|$.

3.3 Goodness-of-fit testing to evaluate scales and cross validating the proposed scale accuracy evaluation method

The focus of our evaluation is the instrument used to obtain the data, not the data obtained by the instrument. The evaluation of reliability or validity the literature looked at the responses, not the instrument. In keeping with conventional testing for validity or test for precision, we employed the following fitness tests as part of the cross validation against our proposed simplified version of fitness indicator. The goodness-of-fit (GOF) testing methods presented in this paper include: (i) Cramer-Rao lower bound test, (ii) likelihood ratio test, (iii) Wald statistic, and (iv) Langrange multiplier test. The rationale for using various GOF tests is to determine the accuracy of each scale. The application of the Monte Carlo simulation, couple with NK landscape simulation method allowed us to test for the consistency of the scale.

3.3.1 Cramer-Rao Lower Bound Test

The Cramer-Rao Low Bound test is used to verify the efficiency of the Likert and non-Likert scales. Efficiency is defined as the optimality of the scale, i.e. experimental design (Everitt, 2002) or hypothesis testing procedure (Nikulin, 2001). More efficient procedure needs less observation, i.e. if the model is efficient, the required response choices should be less. The efficiency of an unbiased estimator, T , for parameter θ is defined as:

$$e(T) = \frac{1/I(\theta)}{\text{var}(T)} \quad (21)$$

where $I(\theta)$ is the Fisher information of the sample and $e(T)$ is the minimum possible variance of an unbiased estimator divide by its actual variance (Fisher, 1921).

The Cramer-Rao bound is used to prove that $e(T) \leq 1$. Efficiency is achieved at $e(T) = 1$. This is proved by the Cramer-Rao inequality for θ . The Cramer-Rao bound is given by:

$$\text{var}(\hat{\theta}) \geq \frac{1}{I(\theta)} = \frac{1}{-E \left[\frac{\partial^2}{\partial \theta^2} \log f(X | \theta) \right]} \quad (22)$$

Note that for the Fisher information of $X \rightarrow N(\mu, \sigma^2)$, the solution for $-\infty < X < \infty$ is:

$$I(x | \mu) = \log f(x | \mu) = -\frac{1}{2} \log(2\pi\sigma^2) - \frac{(x - \mu)^2}{2\sigma^2} \quad (23)$$

The first and second derivatives are found by: $I'(x | \mu) = \frac{(x - \mu)}{\sigma^2}$ and $I''(x | \mu) = \frac{1}{\sigma^2}$. In summary, the Fisher information is simply reduced to:

$$I(\mu) = -E[I''(x | \mu)] = \frac{1}{\sigma^2} \text{ which is the inverse of the expected variance: } \sigma^2.$$

3.3.2 Likelihood Ratio Test

The likelihood ratio test is based on chi square distribution with degree of freedom of $df = df_2 - df_1$ (Huelbeck, 1997). The ratio calculation is the likelihood of the null divided by the likelihood of the proposed model. The test statistic was given by as $\Lambda(x)$ by Wilk (1938) as:

$$\Lambda(x) = \frac{L(\theta_0 | X)}{L(\theta_1 | X)} \quad (24)$$

or equivalently:

$$\Lambda(x) = \frac{L(\theta_0 | X)}{\sup\{L(\theta | X) : \theta \in \{\theta_0, \theta_1\}\}} \quad (25)$$

where $L(\theta | X)$ is likelihood function, *sup* is the supremum function. The decision rule is governed by if $\Lambda > c$ do not reject the null hypothesis and if $\Lambda < c$ then reject the null hypothesis. The rejection point is the probability $\Lambda = c$. The variable c and q are selected at specified alpha (error) level whose relationship may be summarized as: $qP(\Lambda = c | H_0) + P(\Lambda < c | H_0) = \alpha$. The likelihood ratio test is a tool against Type I error. Type I error occurs when the null hypothesis is wrongly rejected. In the seminal literature, the likelihood ratio test has been classified as a power test (Neyman & Pearson, 1933). Casella and Berger (2011) wrote (10) and (11) as:

$$\Lambda(x) = \frac{\sup\{L(\theta | x) : \theta \in \theta_0\}}{\sup\{L(\theta | x) : \theta \in \theta\}} \quad (26)$$

Equations (23), (24) and (25) yield the same result.

3.3.2 Wald Statistic

The third test to assess the likelihood function is the Wald statistic. For a single-parameter scenario, the Wald statistic is given by:

$$W = \frac{(\hat{\theta} - \theta_0)^2}{\text{var}(\hat{\theta})} \quad (27)$$

This test is compared to the chi square in case where the data distribution is not normal. In case where the data is normally distributed, the Wald test is given by:

$$W_N = \frac{\hat{\theta} - \theta_0}{\text{se}(\hat{\theta})} \quad (28)$$

where *se* is the standard error of the MLE estimate which is given by:

$$\text{se} = \frac{1}{\sqrt{I_n(MLE)}} \quad (29)$$

where I_n is the Fisher information (Harell, 2001, Fears *et. al.*, 1996, Engle, 1983, and Agresti, 2002).

3.3.4 Lagrange Multiplier (Score Statistic)

The Lagrange multiplier test is also called the score test. The score test had been explained by several authors, such as Bera (2001), Lehman and Casella (1998), Engle (1983), and Cook and Demets (2007). The score test is more appropriate where the deviation between $\hat{\theta}$ and θ is small; this is the case of the adjusted log likelihood proposed by this paper. The score test is given by:

$$U(\theta) = \frac{\partial \log L(\theta | X)}{\partial \theta} \quad (30)$$

The null hypothesis is $\theta = \theta_0$. If the null hypothesis cannot be rejected, the data is treated as chi square distribution. The test statistic is given by:

$$S(\theta_0) = \frac{U(\theta_0)^2}{I(\theta_0)} \quad (31)$$

where $I(\theta_0)$ is the Fisher information or $I(\theta_0) = -E \left[\frac{\partial^2}{\partial \theta^2} \log L(X | \theta) | \theta \right]$. For normally distributed data, the score test is given by:

$$S^*(\theta) = \sqrt{S(\theta)} \quad (32)$$

4.0 FINDINGS AND DISCUSSION

4.1 Fitness ratio for scale validity

Following our proposed procedure in step 1, a linear equation for each type of scale was obtained through the QQ plot method where the time function, F(t) was used to construct the linear equation. Table 1 present the linear equation and their respective critical value. The T value is the critical T for the correlation coefficient between X and Y:

$$T_r = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad (33)$$

The critical T value is then converted into its Z equivalent in the unit normal distribution table by:

$$Z = ((1.15 * T) - 1.64) + 1.40 \quad (34)$$

With known Z, the percentage probability is obtained by:

$$F(Z) = \frac{1}{1 + \exp(-\sqrt{\pi}(\beta_1 Z^5 + \beta_2 Z^3 + \beta_3 Z))} \quad (35)$$

where $\beta_1 = 0.0004406$, $\beta_2 = 0.0418198$ and $\beta_3 = 0.9000000$.

A linear equation for each scale type may be constructed through the time function. The rationale for using the time function is that, the elements of the scale is presented in sequence. The respondent examines each element in time sequence. For instance, in a scale (0,1,2,3), the

respondents reads the answer code that 0 = none, 1 = low, 2 = medium, and 3 = high. As the respondent selects the response from the sequence, the mental process follows the sequence in time basis. The linear equation, its statistical test for correlation coefficient, and significance level are presented in Table 1. At this preliminary stage of the examination, there is no apparent difference among the scales. All scale has its own linear equation and significance level.

Table 3. Linear equation and significance test for each scale type

Scale type	Linear equation	T	Z	F(Z)	pValue*
(0,1,2,3)	$Y = -1.63 + 1.83X$	3.36	3.62	0.9999	0.0001
(1,2,3,4,5)	$Y = -1.83 + 1.01X$	2.95	3.15	0.9995	0.0005
(1,2,3,4,5,6,7)	$Y = -1.81 + 0.94X$	3.38	3.65	1.0000	0.0000
(1,2,3,4,5,6,7,8,9,10)	$Y = -1.79 + 0.88X$	3.92	4.27	1.0000	0.0000

*pValue = $1 - F(Z)$

In the second step, the intercept and slope of the linear equation derived in Table 3 was used to obtain the fit ratio. In this paper, we use the shape and height of the response scale to determine the fit ratio. The shape of the data distribution is obtained by $\beta = 1/b$ and the height of the response is $\eta = \exp(a)$. The fit ratio is obtained by dividing the shape by the height: $fit = \beta/\eta$. The result may be greater than one; we took the natural log of the result to bring the fit ratio nearest to 1.00 as a reference level of the unit circle for the probability space. The value nearest to 1.00 or with the least error compared to the unit circle is considered the best fit. This process is illustrated in Table 4.

Table 4. Fitness ratio for response scale

Scale type	$\beta = 1/b$	$\eta = \exp(a)$	Fitness ratio	LN(fit)	Over flow
(0,1,2,3)	0.55	0.19	2.81	1.03	0.03
(1,2,3,4,5)	0.94	0.16	6.20	1.82	0.82
(1,2,3,4,5,6,7)	1.07	0.16	6.52	1.88	0.88
(1,2,3,4,5,6,7,8,9,10)	1.14	0.17	6.81	1.92	0.92

The last step in evaluating which type of scale is the most accurate in capturing scaled responses in the probability space. Tables 3 and 4 illustrate this last procedure. The LN(fit) is compared to the threshold of 1.00 of the unit circle; the difference between the observed LN(fit) and 1.00 is d_i from which the standard score (Z) may be calculated to determine error level (d_i) (Table 3). Note that d_i is the overflow of the fit ratio descaled to fit into the unit circle of 1.00

Table 5. Scale evaluation on fitness indication

Scale type	LN(fit)	Threshold	d_i	Z	F(Z)	pValue
(0,1,2,3)	1.03	1.00	0.03	-0.36	0.3603	0.64
(1,2,3,4,5)	1.82	1.00	0.82	0.59	0.7225	0.28
(1,2,3,4,5,6,7)	1.88	1.00	0.88	0.66	0.7462	0.25
(1,2,3,4,5,6,7,8,9,10)	1.92	1.00	0.92	0.71	0.7613	0.24

In table 5, the error's statistics are used to measure how far away are the errors from the center of the unit distribution center ($Z = 0$). The selection of the scale is guided by the absolute error level. Since the error level is calculated by the distance of how large is the difference between the observed and the center of the circle, the scale type with the lowest error level indicates the most precise scale. In table 6 the scale (0,1,2,3) is found to be the best scale.

Table 6. Scale selection on basis of accuracy in measurement

Scale type	F(Z)	F(0)	E	% error	Accuracy
(0,1,2,3)	0.3603	0.5000	0.86	0.1400	Good
(1,2,3,4,5)	0.7225	0.5000	0.09	0.9100	Poor
(1,2,3,4,5,6,7)	0.7462	0.5000	0.16	0.8400	Poor
(1,2,3,4,5,6,7,8,9,10)	0.7613	0.5000	0.21	0.7900	Poor

|E| = F(Z) – F(Z). The percentage error is determined by: % error = 1 - |E|.

Survey or written questionnaires with quantitative scale is commonly used. Therefore, selecting the most accurate response scale type becomes important. In accurate scale may lead to inaccurate data and wrong conclusion. Among the four types of scale that we examined, we can categorize the scales into two types: one containing zero and the other not containing zero. Scales without zero could only allow researchers to analyze and test the data under continuous probability. A scale containing zero allows the researcher to test the data under both discrete and continuous probability. Among the four scale types examined by this paper, the response set (0,1,2,3) allows both discrete and continuous probability testing.

4.2 Result of goodness-of-fit (GOF) testing

The results of GOF testing show that the non-Likert scale (0,1,2,3) is the most accurate using the 1.0 area of the unit circle as the reference probability space. While in the Cramer-Rao, the results for Likert and non-Likert scales were consistently score at 1.0. We reject the Cramer-Rao test as inconclusive. The remaining tests of goodness-of-fit: Likelihood ratio, Wald statistic, and Langrange multiplier, show that the non-Likert scale (0,1,2,3) has the best fit in the unit circle's probability space.

Table 7. Test for accuracy by various GOF methods

Scale	Cramer-Rao	Likelihood	Wald	Langrange
(0,1,2,3)	1.00	0.71	0.68	0.70
(1,2,3,4,5)	1.00	0.39	0.54	1.24
(1,2,3,4,5,6,7)	1.00	0.34	0.38	1.76
(1,2,3,4,5,6,7,8,9,10)	1.00	0.29	0.27	2.56

Note: The maximum value for GOF is 1.00. Note that the Likert scales: (1,2,3,4,5), (1,2,3,4,5,6,7) and (1,2,3,4,5,6,7,8,9,10) are outside of the probability space of a unit circle.

5.0 CONCLUSION

This paper evaluated two categories of response scales used in quantitative surveys. The two survey types were Likert and non-Likert. The Likert type included: (1,2,3,4,5), (1,2,3,4,5,6,7), and (1,2,3,4,5,6,7,8,9,10). The non-Likert scale type was (0,1,2,3). Reliability and validity were used as indicators to guide efficient scales. Reliability was defined as consistency in the result of the measurement. Validity was defined as the precision of the proposed scale. Efficiency was defined as minimal loss of information. Information loss was measured by $1 - I(\theta)$. We found that the non-Likert scale in a form of (0,1,2,3) were the most robust type. This finding helps to underscore practical tool for instrument calibration. We iterate the erroneous application of the Cronbach's alpha as a tool to measure reliability; the Cronbach's alpha measures the consistency of the responses created by a survey. However, it is not a tool to evaluate the robustness of the instrument. This paper proposed a method of evaluating the robustness of the quantitative scale as a direct and empirical means to assess the efficacy of the instrument, and, thus, serves as a practical tool for instrument calibration. A defective instrument creates defective data; any conclusion drawn from such data fails to meet scientific empiricism. A well calibrated instrument, on the other hand, renders the data free from defect; a conclusion made from such data is more credible.

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