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Presenting the "Pipe Theory" for the Social Sciences: Delineating some Uses of the Pipe Theory for Various Fields of the Social Sciences

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Abstract: The objective of this paper is to introduce and propose what we may refer to as pipe theory. A pipe usually refers to an elongated and cylindrical object with equally sized apertures at both ends. This would differentiate it from a funnel where the beak is much larger than the lower opening or aperture. As a matter of fact, we propose that equal size openings at both ends would represent equal chances of an object entering or exiting a piper ceteris paribus, and all other things being equal, and this would constitute the foundation of pipe theory. There may or may not be internal processes involved, though the latter would vary depending on the circumstances. In some cases, there could be intake and discharge or leakage in the middle, and segmental analysis can also be performed. Intake and discharged may be guaranteed or uncertain; they could also increase or decrease either based or not based on a contingency; i.e. contingent on some other event occurring or happening. Both static and diachronic analysis can be performed, and comparative statics used as well. This analysis can also be combined with cause and effect analysis, and compositional analysis among others, for greater efficacy. We also present a large number of examples such as population analysis, order pipelines, intake and outtake analysis, and the like. This paper can eventually become a springboard for more complex downstream analysis, both qualitative and quantitative, and must be according its pride of place in twenty-first century science, particularly in the social sciences.

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I. INTRODUCTION

The objective of this paper is to introduce and propose what we may refer to as pipe theory. A pipe usually refers to an elongated and cylindrical object with equally sized apertures at both ends. This would differentiate it from a funnel where the beak is much larger than the lower opening or aperture. As a matter of fact, we propose that equal size openings at both ends would represent equal chances of an object entering or exiting a piper ceteris paribus, and all other things being equal, and this would constitute the foundation of pipe theory. There may or may not be internal processes involved, though the latter would vary depending on the circumstances. In some cases, there could be intake and discharge or leakage in the middle, and segmental analysis can also be performed. Intake and discharged may be guaranteed or uncertain; they could also increase or decrease either based or not based on a contingency; i.e. contingent on some other event occurring or happening. Both static and diachronic analysis can be performed, and comparative statics used as well. This analysis can also be combined with cause and effect analysis, and compositional analysis among others, for greater efficacy. We also present a large number of examples such as population analysis, order pipelines, intake and outtake analysis, and the like. This paper can eventually become a springboard for more complex downstream analysis, both qualitative and quantitative, (it can lead to more statistical and qualitative techniques being developed and furthered, and we have always championed the idea of quasi-statistical research for the social sciences) and must be according its pride of place in twenty-first century science, particularly in the social sciences.

- *What is a Pipe?*

Let us begin this discussion by defining what a pipe is. A pipe may be defined as some kind of tube or a tubular structure that is used to convey fluids such as water, oil, chemicals, sludge, slurry, or other liquids. Therefore, a pipe is most commonly a hollow, cylindrical tube made or concrete, plastic, or metals such as copper, that is used to transport fluids from one location to another. The flow is generally unidirectional, though there could be exceptions. The flow rate may also vary from time to time. The term is used across diverse fields such as engineering and construction, plumbing, and the diameter of a pipe usually represents its inner diameter, which is equal at both ends, though it is sometimes measured on the outside. The term is less frequently used in computer science to refer to a one

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way channel that feeds the output into another process in a continuous and an interlinked chain. A pipe must also be distinguished and differentiated from a funnel; the latter has a wide opening on one side, and a narrow opening on the other side, and essentially restricts or curtails the flow of liquid, and its rate of discharge. The idea and the concept of a funnel is sometimes used in a figurative and a metaphorical sense, and we may have a sales or a marketing funnel for example, or a decision funnel. We also then have other forms and shapes such as pipettes and burettes. A pipette is a precision liquid mover that is used to transfer measured amounts of liquids from one place in the laboratory to another, and examples of pipettes include dropper pipettes and micropipettes. Sometimes, burettes are also used to deliver precise amounts of liquid drop by drop. Sometimes, test tubes or culture tubes are used in the scientific laboratory for holding and mixing liquids. [1]

- *What is a Pipeline?*

But what exactly is a pipeline? A pipeline may be defined as a sequence or series of inter-connected steps that move a substance, usually a liquid, from start to finish, where each step complete its part before transferring the result along a chain. A pipeline is also used in a non-concrete – i.e. a figurative or a metaphorical sense such as a sales order or a job pipeline. Therefore, a pipeline is essentially a pipe made of several stages, not just a single tube without vestibules. However, a pipe may have several sequential stages as well. What then is a pipeline analysis? A pipeline analysis is the structured and systematic process and methodology of evaluating the various sequential stages, speeds of flow or transition, and efficiency of a multi-step workflow—this kind of an analysis is commonly in found is sales, and is used to track deals, to manage data flow, or to identify obstructions and bottlenecks that impede data flow. It is also used to optimize performance, increase throughput, and thereby efficiency of the entire process. Types of pipeline analysis include sales pipeline – sales prospects, qualification, proposal preparation, actual sales order, etc and candidate pipelines for job interviews – first round of interview, second round of interview, elimination round of interview, final selection, employment, etc. Pipeline analysis is also used to dissect and quantify success rates and conversion rates, thereby helping in process improvement. We also propose to make a fundamental difference between pipe analysis and pipeline analysis, given that a pipe analysis analyzes what happens within, not before.

Let us now analyze some more concepts. What is queue theory? Queue theory, which is less commonly called or known as queuing theory, is a mathematical study of waiting lines, or queues, and such studies are used to predict queue lengths and customer waiting times in order to optimize service efficiency. Queue theory is a branch of operations research, and it models systems such as requests received by call centers, incoming or inbound traffic, or loads in computer networks, most often in situations or instances where demand for a service is in excess of its capacity to deliver. Sometimes, Poisson distribution is also used in this kind of analysis. in pipe theory, inputs and outputs would be central and pivotal. Inputs refer to any data inputted into a pipe or an entity for further processing or transfer to subsequent stages. An input therefore drives a system's functionality or its processing intelligence. Inputs can be at the beginning of the work chain, or it can be at the beginning of each stage in a process. An output is anything that comes out of a system or a process, and may be at the end of a stage, or may represent the final output. The terms input and output are widely used in computing, technology, engineering, physics, economics, accounting and business. Another important concept is that of throughput which was popularized by Eliyahu S. Goldratt in his book, "the goal", in reference to bottlenecks and unbalanced processes. We may also measure flow rate which is the number of units that pass through a process at any given duration of time. [2]

We also have the concept of discharge which most often and typically refers to the release, removal, or emission of something from a pipe, either by design or by accident. Leakage on the other hand, is mostly inadvertent, and the term is widely used in fields as wide apart as physics, engineering and economics as well. We may also conveniently make used of several other terms based on the nature of problem being studied, or the issue at hand; examples of other useful terminologies and concepts could include guaranteed exit, uncertain exit, impossible exist, conditional exit, constant intake, constant discharge, increasing intake, increasing discharge, decreasing intake, decreasing discharge, percentage increases, geometric increases, conditional increases, conditional decreases, intake at the middle, discharge at the middle, normal discharges and leakages, abnormal discharges and leakages, etc. we can also have segmental analysis. A segment is a distinct and distinctly defined section or a portion of a pipe that must be probed, investigated or analyzed separately for the purpose or a more rigorous and critical examination. We may also have bottlenecks; then, we may also have synchronized or unsychronized flow. A bottleneck was also be caused by an internal or external constraint. A bottleneck is usually defined as a point of congestion in a system, while a constraint is a limitation. In addition, there may or may not be internal processes involved; a process usually is an operation that modifies the rate or direction of flow in this case. This technique may also be used in combination with composition analysis; a composition analysis is the nature of

[1] Huff, Darrell; Irving Geis (1954). *How to Lie with Statistics*. New York: Norton.

[2] Gigerenzer, G (2004). "Mindless statistics". *Journal of Socio-Economics*. **33** (5): 587–606

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composition of sub entities within a larger entity, and the field is as such used in population studies, for example. [3] [4] [5]

➢ *Population Studies*

Population studies is an increasingly important and vital multidisciplinary field of study that is focused on the scientific analysis of human population dynamics, including factors and parameters such as population size, population composition, population distribution across parameters such as age groups, and changes over time, driven by factors such as total fertility rate, infant and maternal mortality, and immigration or emigration. The total fertility rate is the most widely used variable in population studies, and refers to the number of children born to an imaginary woman based on current birth rates. The total fertility rate is a purely synthetic rate. The replacement fertility rate is taken a 2.1 children per woman, because the additional five percent is used to factor in other contingencies. In some poorer and less developed regions, the replacement total fertility rate may be higher than 2.1 children per woman given the higher mortalities involved. In situations and cases where the birth rate is above 2.1 children per woman, the number of children born tends to get progressively higher and higher, and there will be more and more cohorts eventually eligible for marriage. In situations and cases where the birth rate is below 2.1 children per woman, the number of children born tends to get progressively lower and lower, and there will be less and less cohorts eventually eligible for marriage. In cases where maternal mortality rates and infant mortality rates are high, it will negatively impact future population sizes as well. Therefore, we need a time-based, or a diachronic analysis, and a mixed method approach – combining both qualitative and quantitative research methods. We have also called for a quasi-statistical approach in many cases, for the social sciences; primarily qualitative analysis, but with quantitative research methods and techniques thrown into the mix as required. Therefore, the number of births will be the input into the pipe, while the number of deaths will be the output from the pipe. The number of deaths can occur at any age, including below or above the expected human longevity. [6]

Therefore, the birth death gap can be factored in for analysis, and a root cause analysis, or a cause and effect analysis performed for low or high births, or low or high deaths. We may also make use of visual techniques such as a population pyramid or an inverted population pyramid for better analysis. Other aspects such as a population explosion and population implosion can also be studied, along with their upstream causes and downstream effects. Other types of studies can also be performed; for example, we can study the number of children in the 0-5 age group with other quantitative and qualitative attributes such as malnutrition, obesity, diseases, and morbidities. Likewise, We can also study the numbers, attributes and characteristics of number of children in the 0-15 age groups, number of people in the 0-30 age group, number of people in the 0 -64 age group. We can also arrive at derived figures; for example, we can study the number of middle aged people between 30 and 64, and the number of elderly people above the age of sixty-four. We can also perform an internal cause and effect analysis, or an inter-segmental analysis; for example, if child mortality rates are high, how will it impact the population of adolescents? If the child marriage rates are high, how will it impact the future total fertility rates and birth rates?

Many different types of analyses are possible such as the following. For example, it is a well known fact that the total fertility rates in most countries were high until recently. Total fertility rates have however begun to fall sharply of late, and in such as case the number of children has already begun to decline in most nations with the sole exception of Africa where birth rates are way higher than replacement. For example, the number of young children below the age of fifteen has begun to decline in India since the year 2011, and this is amply borne out by statistical data. Consequently, the number of people in India below the age of thirty may have peaked in the year 2026. This is however only an approximation, and not an exact figure. This is because there could have been fluctuations in birth rates and death rates in the intervening years, and these also need to be factored in. The life expectancy of people in India is also increasing, and people are living longer and longer due to increased well-being. However, in some cases, life style induced morbidities are also increasing. All these issues need to be factored into any complex analysis with different types of quantitative and qualitative analyses employed and applied. [7] [8]

In countries where birth rates have already fallen below the replacement rate of 2.1 children per woman, population will still continue to grow on account of what is called population momentum; population will level off when the number of births equals the number of deaths, and this generally happens some three decades after total fertility rates hit replacement level – sometimes sooner, sometimes later. In some countries such as China, populations may already be in decline, and this has been happening since the early 2020's. However, in such cases, the number of children will decline faster relative to the decline in

[3] Warne, R. Lazo; Ramos, T.; Ritter, N. (2012). "Statistical Methods Used in Gifted Education Journals, 2006–2010". *Gifted Child Quarterly*. **56** (3): 134–149

[4] Wegner, T. (2010). *Applied Business Statistics: Methods and Excel-Based Applications*, Juta Academic

[55] Bjerklie, David (January–February 1998). "The Art of Renaissance Engineering". *MIT's Technology Review*: 54–59

[6] Blockley, David (2012). *Engineering: a very short introduction*. New York: Oxford University Press

[7] *Madhavan, Guru (2015). Applied Minds: How Engineers Think. W.W. Norton.*

[8] Elia, G.; et al. (June 2021). "Management Engineering: A New Perspective on the Integration of Engineering and Management Knowledge". *IEEE Transactions on Engineering Management*. **68** (3): 881–893

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the total populations. As the number of cohorts reduces, populations will fall off a cliff once the older generations die off. Likewise, the number of elderly people is likely to keep increasing for several decades before that number also declines. All these forms of complex analyses can indeed be performed, and the sky is the limit. Such studies can be formalized through pipe theory. We prefer and recommend quasi-statistical approaches. However, other statistical approaches may be reliably and productively derived from such analyses by future researchers.

These techniques may be used for other forms of analyses as well. For example, we may have a cistern or a reservoir, and we may like to measure the rate of intake or discharge; we may also like to imagine a reservoir as a series of interconnected tanks, and perform an analysis accordingly. We may either perform a static analysis – analysis at a given point in time, or we may perform a diachronic analysis – to understand diachronic shifts as needed. We may also use comparative statics –to analyze two different statics either at the same point in time (based on two segments of the pipe, or the same segments of two different pipes), or static analysis at two different points in time. We may also perform a comparative analysis of two different pipes in some cases. As explained, we may attempt a combination with cause and effect analysis – both internal to the pipe, and external. Other types of analytical analysis may be used, for example, we may perform an analysis based on ethnicity, linguistic group, age group, gender, socioeconomic group, socio cultural group, occupational group, etc. We may also perform an analysis with extraneous factors in some cases, such as government policy on birth rates. We may use this technique to study other aspects such as immigration and emigration, brain drain and reverse brain drain, calorie intake and calorie burning, fluid intake and fluid discharge, pipeline of jobs interviews versus job offers, pipeline of sales leads versus sales deals clinched, pipeline of sales prospects versus sales deals clinched, interview candidates versus offer letters issued, input into stage A versus output from stage B, leakages within segments, leakages between segments etc. indirect and unintended causes, and indirect or unintended effects may also be identified wherever necessary. Quantification techniques may be used too wherever available data is qualitative.

II. CONCLUSION

The objective of this paper was to introduce and propose what we had referred to as pipe theory. A pipe usually refers to an elongated and cylindrical object with equally sized apertures at both ends. This would differentiate it from a funnel where the beak is much larger than the lower opening or aperture. As a matter of fact, we propose that equal size openings at both ends would represent equal chances of an object entering or exiting a piper ceteris paribus, and all other things being equal, and this would constitute the foundation of pipe theory. There may or may not be internal processes involved, though the latter would vary depending on the circumstances. In some cases, there could be intake and discharge or leakage in the middle, and segmental analysis can also be performed. Intake and discharged may be guaranteed or uncertain; they could also increase or decrease either based or not based on a contingency; i.e. contingent on some other event occurring or happening. Both static and diachronic analysis can be performed, and comparative statics used as well. This analysis can also be combined with cause and effect analysis, and compositional analysis among others, for greater efficacy. We also present a large number of examples such as population analysis, order pipelines, intake and outtake analysis, and the like. This paper can eventually become a springboard for more complex downstream analysis, both qualitative and quantitative, and must be according its pride of place in twenty-first century science, particularly in the social sciences.