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The Establishment Of A Relationship Between Worship Time And Attendance In An Orthodox Church In Port-Harcourt - Nigeria

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***Abstract*—Due to the growing concern on dwindling attendance and the renewed zeal for evangelism, as well as a concerted effort at improving membership and church management, this investigative paper seeks to establish a relationship between worship duration and church attendance by members of a protestant church in Rivers state - Nigeria. The weekly attendance of members as well as Sunday service duration for eighty-six different services were compiled and collated for this research. The Single-Input Single-Output (SISO) transfer function analysis was adopted in establishing a transient relationship between these two variables. The resulting impulse response function of 209.04, showed the impact of service duration on attendance, whereas the steady-state gain of 1149.78 obtained, signaled the influence on attendance, when service duration is held constant over time. The study showed a remarkable impact of worship time on members' attendance based on the model developed, thereby establishing that a relationship exists between these two variables, as a change in worship duration affects attendance of members in direct proportionality and with no delay in period of time before impact. Based on these findings, the organization and church authorities across Africa's emerging population, when guided by this informative outcome, will ensure that its futuristic worship plans and gospel propagation, are sustainable based on prevalent circumstances.**

Keywords—Auto-correlation function, impulse response function, steady-state gain, evangelism, church, worship

1. Introduction

The dwindling rate of attendance to church services in recent times has over the years constituted a major source of concern to the Christendom all over the world. Commenting on this, [1], observed that the number one reason for the decline in church attendance is that members attend with less frequency than they did just a few years ago. She explained that if the frequency of attendance changes, then attendance will respond accordingly.

According to [2], as recently as 30 years ago, 67 percent of Americans attended and supported a local church, but the most recent poll by the Pew Research Center reported that just 37 percent of Americans attended church weekly. He noted that this reduction in attendance stayed on the trend with declining attendance reported at religious services from 2007 to 2014, as about one-third of Americans now say they worship weekly and two-thirds say they rarely or never attend a service.

[3], observed that less than 20 percent of Americans regularly attend church, which is half of what the pollsters are reporting. The magazine pointed out that by using statistical models, which included multiplying a church's membership number by the denomination's membership-to-attendance ratio, that the findings reveal that the actual rate of church attendance from head counts is less than half of the 40 percent the pollsters report, as numbers from actual counts of people in Orthodox Christian churches (Catholic, mainline and evangelical) show that in 2004, 17.7 percent of the population attended a Christian church on any given weekend.

Locally in Nigeria, the decline in church attendance has also been a serious concern to the orthodox Christian leaders. According to [4], the Catholic Bishop of Sokoto Diocese – Bishop Matthew Hassan Kukah pointed out that as for him, as a bishop of the Catholic Church, he can see very clearly that their influence in the public space is gradually reducing. However, she counseled that "the Catholic Church can take solace in the fact that this change (decline) is not just in Nigeria, as Churches all over the world are seeing a reduction in attendance."

The gospel as preached in various worship centers, world over, would be in vain without an ardent, attentive and dedicated membership/audience. The important role the congregation plays will not be over-emphasized as therein lies the key to the sustained growth and development of not just the church but the gospel being preached.

Therefore, attendance/membership rise or fall has a huge impact in the Christendom and all measures geared towards increased capacity in membership will be a welcome development. For therein lies the insinuation that the dropping membership for the church under review, is a factor of its service duration hence giving rise to this explorative research.

2. Literature Review

According to [5], the unpredictability of social, cultural, economic, technological and demographic impact on worshippers in a New Zealand community, led to challenges of population shift experienced by the church. [6], also compared church attendance data for a US church using different approaches in which they concluded that surveys give more accurate information when identifying patterns in religiosity of a group of persons within a community.

[7], applied a systematic approach in analyzing determinants of individual participation in religious activities. They concluded by comparing the roles of race, sex, income, social class and education as it correlates with the attendance to religious activities.

Based on this foregoing, it is intuitive to note that the emphatic role of worship duration and its impact on membership/attendance is yet to be investigated as is exhaustively being considered in this research study, using a church in the predominantly Christian state of Rivers state, Southern Nigeria. Besides the above premised assertion, the reassessment of the propagation of the gospel and the attendant impact on the masses, is also a front burner here, as the availability of an audience assures the church of adequate digest and dissemination of its ideologies and theological teachings across generations.

The use of the transfer function approach is also apt as it captures the dynamic nature of the scenario presented by this worship center in its service time and attendances' obvious stochastic behavior.

Varied applications of the transfer function applications to time series analysis abound. [8], applied transfer function modelling for quality control analysis of metal sheet forming production process and so also did [9], in developing empirical models for quality control in plastic injection moulding process wherein an Auto Regressive Integrated Moving Average (ARIMA) process was applied to the time series.

[10], also applied the transfer function approach, to model the monitoring and control of carbon IV oxide production in a gas furnace. Furthermore, the works of [11 - 12], were all to model electricity prices using transfer function modelling approach. So also did [13], who developed a model to determine the relationship between engineering efforts and sales volume in an enterprise, which aided the company's planning.

This influenced the approach in this research paper on the use of the transfer function, as well as the works of [14], which modelled the Brazilian inflationary process and suggested the removal of Government controlled price levelling based on findings, thereby disrupting expectations leading to higher inflation rate.

3. Methodology

The Orthodox Church implied here is situated in the heart of Port-harcourt city and runs two sessional services of 7-10am and 10am – 1pm, whereas it's combined services runs from 8am through 1pm. The data on attendance is as compiled by the church ushers and as evidently displayed on subsequent church service bulletins.

The sessional service data collated spans from a varied compilation which commenced from 2018 to date. The 86 observed church services compiled for this study was further re-grouped into 70 observations for model training and 16 observations for model testing. Attendance for subsequent service durations arising thereof, was also forecast using the model developed.

The transfer function (also called network function) is simply a mathematical representation, in terms of spatial or temporal frequency, of the relation between the input and output of a (linear-uniform-time) system. It is also useful in measuring the transient input-output relationship of non-equilibrium systems.

Mathematically a linear transfer function model is represented by:

$$Y_{\infty} = gX \quad (1)$$

Here, Y_{∞} represents the steady state output

g represents the steady state gain

while X represents the steady state input

Prior to the determination and computation of the Transfer function model, and ARIMA model is first established as a prerequisite.

The ARIMA model according to [15], as shown in equation 2.

$$y = c + \varepsilon + \sum_{i=1}^{p} \varphi y_{t=i} + \sum_{j=1}^{q} \theta \varepsilon_{t=j} \quad (2)$$

The collated data was transformed in line with the ARIMA steps for stationary data and in determination of the Autoregressive (φ) and the Moving Average (θ) operators. Prior to this orders (p,d,q) for the ARIMA process were obtained from the Auto-Correlation Function (ACF) and Partial Auto-Correlation Function (PACF) plots.

The discrete transfer function model for a system according to [10], is given as

$$Y_t = \partial^{-1}(B)\omega(B)X_{t-b} + N_t \quad (3)$$

Where ∂ and ω denote the autoregressive and moving average operators and N_t is the noise term of the transfer function model.

4. Results and Discussion

The obtained time series data for 70 observations was transformed using differencing to obtain a stationary data fit for the analysis, and was achieved after first differencing as shown in table 1.

Table I: Primary and secondary data for analysis

S/N	SERVICE DURATION(Y)	Diff. (Y)	ATTENDANCE (X)	Diff. (X)
1	3		822	
2	3	0	872	-50
3	3	0	30	842
4	5	-2	990	-960
5	3	2	608	382
6	3	0	229	379
7	5	-2	1154	-925
8	5	0	1417	-263
9	5	0	1000	417
10	5	0	1299	-299
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
67	3	2	718	802
68	3	0	383	335
69	5	-2	1318	-935
70	3	2	1045	273

Therefore, Figures 1 and 2 depicts a stationary trend with the patterns as displayed. The transformed time series data may further be subjected to other to tests to confirm that the data is stationary.

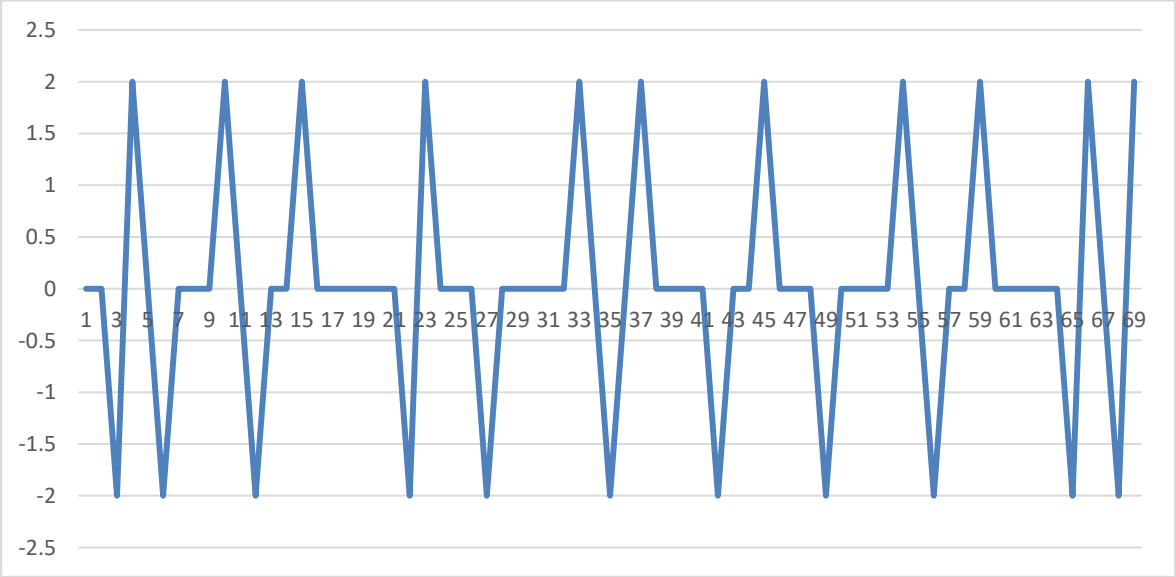

Fig. 1 Transformed time series plot of Worship duration for 70 observations

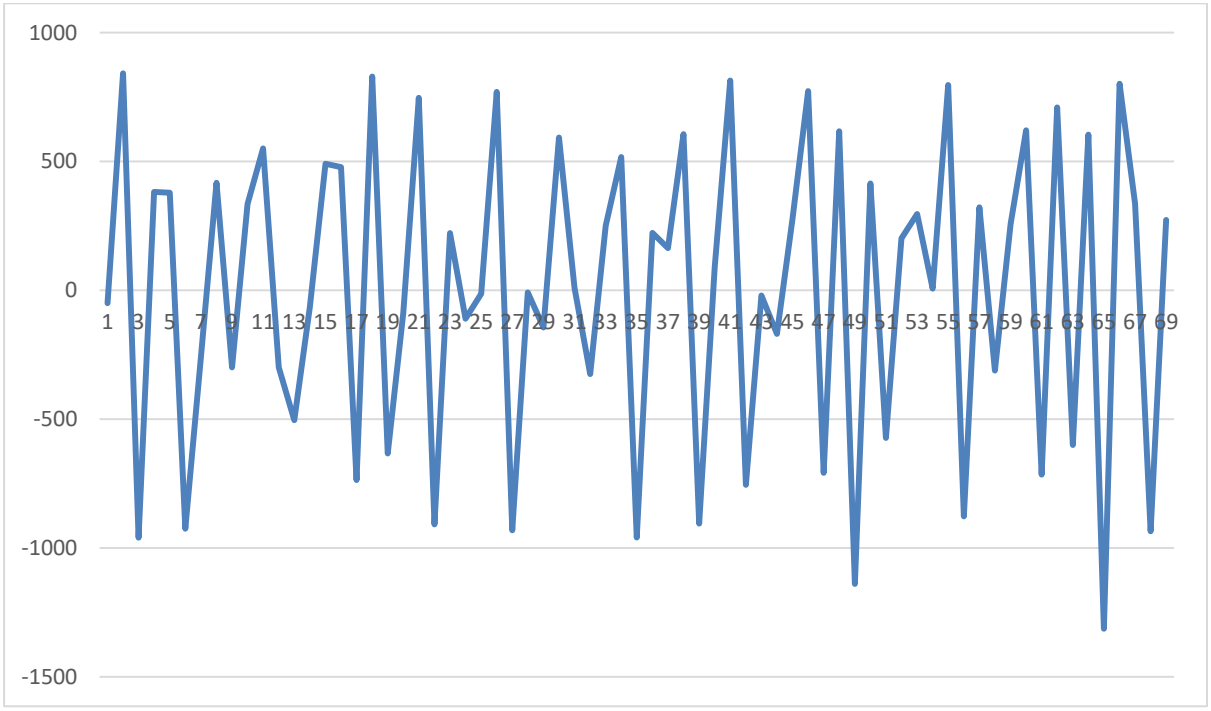

Fig. 2 Transformed time series plot of worship attendance for 70 observations

The Autocorrelation Function plots in Figures 3 and 4 were made using the Minitab software and they were also used in the determining the autoregressive operator (φ) which was chosen from the most significant lag. The Partial Autocorrelation Function also plotted showed that serial correlation has died down.

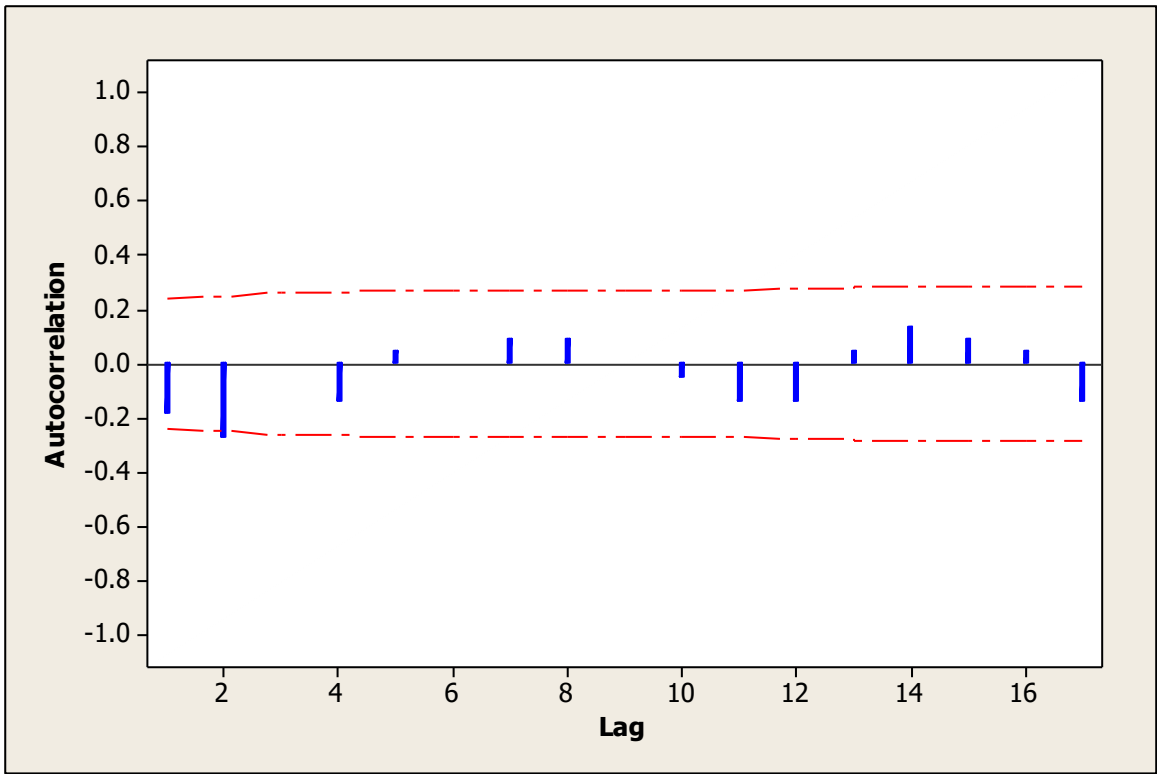

Fig. 3 Autocorrelation Function Plot of the Service duration

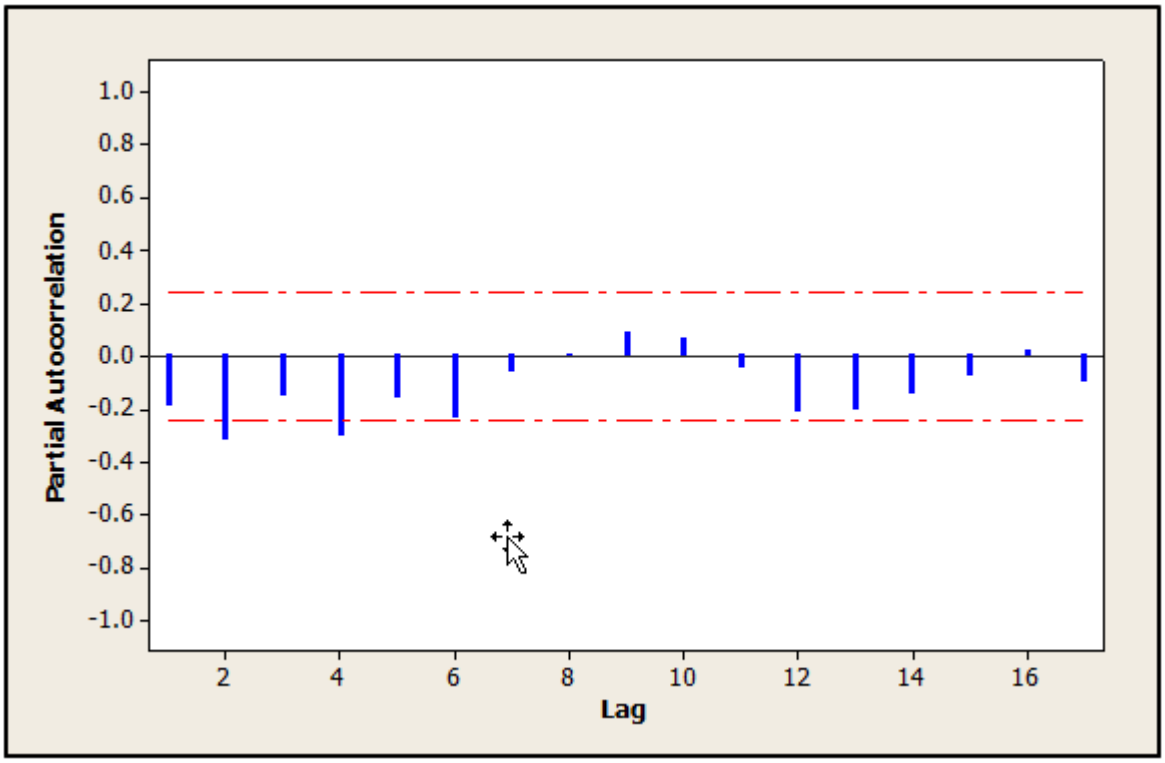

Fig. 4 Partial Autocorrelation Function Plot of the Service duration

The Autoregressive model obtained thereof is as shown in equation (4)

$\nabla X_t = -0.1818\nabla X_{t-1}$(4)

A univariate model was fitted to the input and output series. The estimated pre-whitened input and pre-treated output series were used for the analysis. The Cross Correlation Function (CCF) determination from which the r, s, and b parameters for the transfer function model developed is depicted in Fig 5.

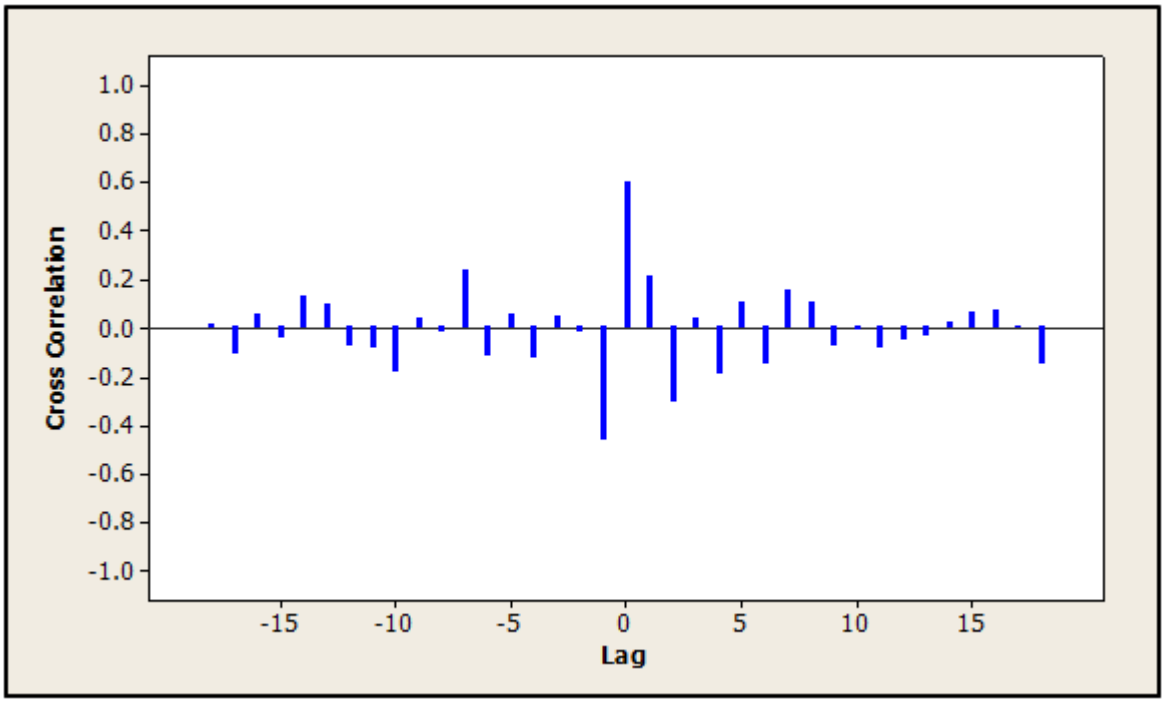

Fig. 5 The Cross Correlation Function Plot of the residuals

The CCF plot also enabled the estimation of the impulse response function $\nu(B)$. The significant lag on the CCF is at zero. Therefore, the parameter r, s, and b of the transfer function that supports such CCF pattern,

according to [16], are 1, 0, 0 respectively. Based on the forgoing, the CCF supports the developed transfer function model.

$$Y_t = 290.04x_t + N_t \quad (5)$$

The forecast diagram for transfer function model alone is shown in figure 6.

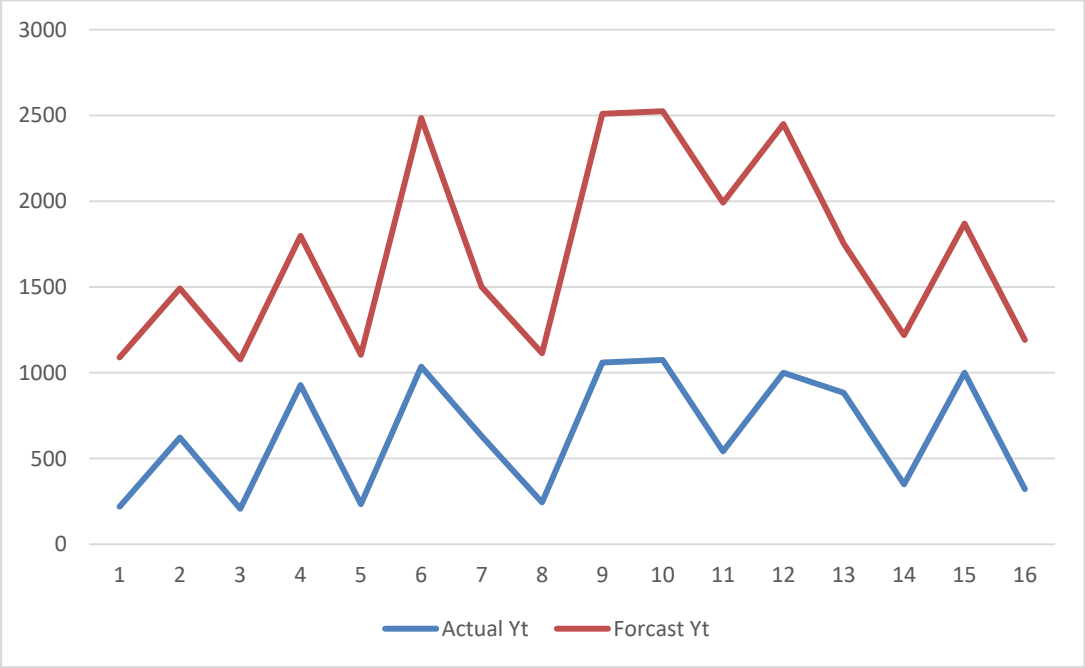

Fig. 6 Forecast diagram for Transfer function model alone

Arising from the steady-state gain

$$g = \sum_{k=0}^{\infty} V_k \quad (6)$$

Table II: Steady-state gain determination table

Lags	CCF	V_k	$/V_k/$
0	0.6003	289.59	289.59
1	0.2111	101.84	101.84
2	-0.2971	-143.31	143.31
3	0.0378	18.22	18.22
4	-0.1808	-87.22	87.22
5	0.1038	50.08	50.08
6	-0.1479	-71.33	71.33
7	0.1558	75.16	75.16
8	0.1071	51.66	51.66
9	-0.0734	-35.43	35.43
10	-0.0011	-0.54	0.54
11	-0.0786	-37.91	37.91
12	-0.0443	-21.37	21.37
13	-0.0232	-11.18	11.18
14	0.0270	13.02	13.02
15	0.0592	28.55	28.55
16	0.0797	38.44	38.44
17	0.0117	5.64	5.64
18	-0.1436	-69.30	69.30
		Steady-state gain	**1149.78**

Whereas the impulse responses are absolutely sum-able, the system is said to be stable. This is also an evidence of model meaningfulness. When the impulse response function $\nu(\mathrm{B})$ in the transfer function model is not absolutely sum-able, the system is said to be unstable. Table 2 shows the summarized values of the impulse response function $\nu(\mathrm{B})$ for the lags obtained from the Cross Correlation plot in Figure 5 wherein the computed absolute values of $\nu(\mathrm{B})$ are

summed up to determine the steady state gain of the system being studied.

The resulting impulse response function of 209.04, revealed the impact of service duration on attendance, while the steady-state gain of 1149.78 obtained, showed the influence on church attendance, when the duration of service is held constant over time.

The study has shown a significant impact of worship time on members' attendance based on the model developed, thereby establishing that a relationship exists between these two variables, as a change in worship duration affects attendance of members in direct proportionality and with no delay in period of time before impact.

5. Conclusion

A transient relationship has been established between attendance and service duration, using the transfer function approach. The impulse response function $\nu(\mathrm{B})$ developed in the model represents the impact of the service duration on the attendance, when held constant. The steady-state-gain achieved is a feature of the systemic stability and also proof of model meaningfulness. However, the developed model's efficacy in futuristic application is suspect due to the observed marginal errors leading to inaccuracy.

The incorporation of the noise model arising thereof, into the transfer function model will aid in correcting this when computed accordingly. In furtherance to this, administrators and church leaders may adopt this informative research in their plans for membership drive and growth.

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