

*Full Length Research Paper*

# Impact of socio-economic characteristics of GSM-owner on the use of global system for mobile communication (GSM)

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The wide use of the global system for mobile communication (GSM) and its influence on various aspects of the society is yet to be empirically investigated. This paper examined the relationship between GSM usage and socio-economic characteristics (sex, marital status, age, education, income, occupation and employment) of the GSM-owners. The study sample consisted of 2,500 households in the study area. Systematic sampling technique was used to select every tenth building on the identified streets. In a multi-family dwelling, random sampling was used to select one household. The data collected were analysed using multiple linear regression. The study reveals that the higher the socio-economic status of GSM-owners, the higher the use of GSM phone ( $F_{2,494}^5 = 214,503$ ,  $p \leq 0.05$ ). Education ( $\lambda^2 = 22.5\%$ ) and occupation ( $\lambda^2 = 27.7\%$ ) were the most significant explanatory variables in the use of GSM phone. The paper recommended that transport planners in Lagos need to develop alternative intra-city transport systems. This can be achieved through a shift to the development of other land transport systems by policy makers.

**Key words:** Global system for mobile communication (GSM), intra-city, transport, travel pattern, socio-economic characteristics.

## INTRODUCTION

Spatial interaction in urban setting could be of at least two types namely: those that involve physical contacts like day-to-day movements of people and those that do not require such contact like telephoning. This is because they represent both a function and a process (Ayeni, 1979; Axhausen and Garling, 1992). They function as long as they perform the duty of maintaining the status quo in the spatial relation of different parts of the city, while they are processes when changes in their volume, intensity and direction come to determine the pattern of growth and organization of the spatial structure of the city. Transportation is very vital to urban life because it is an absolutely necessary means to an end. It allows people to carry out the diverse range of activities that made up daily life (Filani, and Osayinmese, 1979; Filani, 1991, 1993). For the fact that cities consist of spatially separated, highly specialised land uses such as, food stores, hardware stores, banks, drug stores, hospitals, libraries, schools, post offices and so on, people must travel if they want to obtain necessary goods and

services.

Urban travel takes place when inhabitants of urban centres carry out their different activities in different places whether by necessity or by choice. Studies (Ayeni, 1974; Adeniji, 1981, 1985; Ojo, 1990) have shown that in general, people tend to travel in order to obtain access to a variety of other people, services and facilities that are not available at the beginning of their journeys. To what extent, how far and by what means they travel is a result of a complex interaction of socio-economic, political and physical factors (Adeniji, 1991). The nature and degree of influence of these factors however vary from city to city and even within a given urban centre (Hausa and Schwab, 1987; Gordon et al., 1988; Rimmer, 1986; White, 1990; Garling et al., 1994; Bhat and Koppelman, 1999).

The socio-economic and cultural growth of any nation can be measured through the efficiency of its transportation network and its judicious provision of telecommunication facilities. There exists a strong

relationship between movement pattern and the locational distribution of activities over geographic space (Goddard, 1970). However, what is unclear is the relationship between telephone interaction pattern and the location of activities within the urban or sub-urban centres. Fundamental to this relationship is the role and impact of telecommuting technologies such as the telephone (Cherry, 1970; Clark, 1973). This relationship, however, is determined by certain underlying variables, which are neither similar nor transferable from the developed areas of the world to the developing areas, particularly, the African countries (Adeniji, 1991, 2000). Abler (1968), Clark (1973) and Elliot-Hurst (1974) recognised the geographical and socio-economic importance of communication flow and its role as agent of change within the spatial system.

Short-term or daily movement consists of trips involving such activities as work, shopping and recreation, whereas long-term or more permanent movement involves changing residence. With recent advancement in telecommuting technologies, movement patterns of urban residents might have changed considerably. With the Federal Government of Nigeria in March 2001 granting licenses to three GSM operators in the country, it is believed that telecommunication and transportation would improve considerably. Lagos, the commercial capital of Nigeria, stands to benefit from this development and to ease the city of ever growing transportation complexities and problems. It is believed that this new technology would help to shape the movement pattern of people in the city thereby easing traffic congestion and delay in transit. All too often, telecommunications facilities are treated as an alternative to transportation systems and as a substitute for the physical movement of people and service. The growing use of telecommunications facilities like global system for mobile communication (GSM) is doing far more than influence where people work and live. It is likely to change the character of activities that occur in the home, workplace, social activities and business activities.

Lagos metropolis is being considered as a study area because it has an increasing demand of intra-city travel pattern. This has contributed to the highest rate of traffic congestion in Nigeria and the expectation is that the use of GSM will reduce this congestion by affecting the travel behaviour of people. Also, it is the commercial capital of Nigeria and it stands to benefit from the development of telecommunication especially GSM which can ease the ever-growing transportation complexities and problems.

There is need to understand the correlation or relationship between GSM and the socio-economic characteristics of GSM owners. The justification for this study is that GSM is a notable innovation in information communication technology (ICT) industry and its effect on spatial interactions needs to be examined. The trip pattern of urban residents in Lagos metropolis is haphazardly characterized between different activities in the city. This

had led to unnecessary delay, long travel time, evasion of traffic rules/law and traffic congestion because of lack of necessary information to aid pre-arrange contacts to ease traffic flow and ensure smooth traveling and mobility. Productive use of time is also inhibited as a result of long journey or travel time that characterizes the transport situation in Lagos metropolis. Intra-city trips are more pronounced and haphazard in Lagos metropolis.

## METHODOLOGY

### Study area

Nigeria is located in the Western part of Africa, bordering the Gulf of Guinea, lying between latitudes  $4^{\circ} 20'$  and  $14^{\circ} 30'$  east of Greenwich (Adeleke, 2003). Lagos State lies approximately between longitudes  $2^{\circ} 42' E$  and  $3^{\circ} 42' E$  and latitudes  $6^{\circ} 22' N$  and  $6^{\circ} 52' N$ .

The 180 km long Atlantic coastline forms the Southern boundary of the state, while its Northern and Eastern boundaries are shared with Ogun State. On the western side, the Republic of Benin borders the boundary (Balogun et al., 1999).

Lagos Metropolis occupies 2,910 sq. km out of the 3,577 sq. km land area of Lagos State. Fifteen of the 20 Local Governments in Lagos State are located within the Lagos Metropolitan Area. The Local Governments are: Agege, Alimosho, Apapa, Amuwo-Odofin, Eti-Osa, Ikeja, Ifako-Ijaiye, Kosofe, Lagos Island, Lagos Mainland, Surulere, Mushin, Oshodi-Isolo, Ojo and Somolu (Lagos State 2003 Digest). 5.7 million people or 6.4% of the population of Nigeria (88.5 million people in 1991) live in Lagos State (Nigeria National Population Census, 1991). In 1997, Lagos State population was estimated at 6.9 million out of which Lagos Metropolitan Area has 5.2 million (Nigeria National Population Commission, 1997). By projection the population of Lagos Metropolitan Area was estimated to be 12.9 million by 2000 and 24.5 million by 2015 (UN, 1996).

Transportation and communication facilities are poorly developed in Lagos metropolis. According to the metropolitan Lagos Master Plan, year 2000, the transportation land areas occupy 3202 hectares (18.6%). The figure alone can be traced to the beginning of transportation problem in the metropolis. An ideal transportation land use areas should be 25% of the total land use area (Lagos Master Plan, 2000).

Despite the fact that Lagos metropolis is the largest commercial, economic and industrial centre in the country, its transportation and communication do not commensurate with its status, as it has the worst in terms of mobility and communication problems in Nigeria. There is no adequate, effective, efficient and inexpensive communications and means of mobility. And where available they are often too expensive, inefficient and considered as elitist affair. Less than 10% of its population has access to efficient telecommunication facilities. In most cases and places where available it is grossly inefficient. Nigeria with GDP of US\$527 has a total teledensity penetration of 0.43% (fixed line generation is 0.4% for mobile line). Thirty percent of this alone is in the metropolis, yet inefficient and unreliable (Source: Policy News magazine, Vol. 6, No.16, April 16-22, 2001). The working hypothesis postulated for testing is that, the usage of GSM in metropolitan Lagos is a function of socio-economic characteristics of residents.

### Data collection

Data were collected from primary and secondary sources. Systematic sampling technique was used to select every tenth

building on the identified streets. In a multi-family dwelling, random sampling was used to select one household. Multiple regression analysis was employed to examine the impact of socio-economic characteristics of respondents on the use of global system of mobile communication (GSM).

**THEORETICAL AND CONCEPTUAL UNDERPINNINGS**

**Telecommunication and travel behaviour**

The concept of telecommuting and travel gives a better understanding of the telecommunication technology in respect to transport in most of the literatures. Conventional wisdom about social and economic behaviour holds that the use of telecommunication is a natural substitute for transportation. For instance, telephone calls can replace travel to meetings and electronic messages can substitute for courier or postal delivery. Thus, the moving of information can replace the moving of people and goods. Vehicle traffic on national transportation infrastructure can be replaced by digital traffic on what is now called the National Information Technology (NIT).

This means using telecommunications to replace commuting between home and work. Giuliano, (2001) viewed telecommuting as consisting of those who have a regular workplace provided by the employer but who work at home or partly at some other place using electronic technology or telephone. Jack (1973) invented the term telecommuting to describe home or neighborhood based working using computers and telecommunications technology. Tele based communication was seen as solution to the problem of congested urban environments and problem of congested urban environments and long commuters to centralized offices. It was assumed that telecommunications would simply substitute electronic flow for the transportation of people and freight along more polluting road, rail and air networks. An attempt to apply this concept of telecommuting in U.S. shows that telecommuting has a potential to save between 1.3% national energy consumption.

To be precise, the most emphasized relationship between transportation (travel) and telecommunication is substitution and complementarity. It is therefore, likely that communication serves as both substitute and complement to transportation at the same time. However, while the substitution is direct, the complementarity is due to a reduction of the constrained resource, the time available for non-work travel.

**Trip generation models**

Of equal relevance to this study are the trip generation models. They are essentially analytical techniques used in household trip generation in the literature and they include the growth factor, cross-classification or category analysis and multiple linear regression (Stopher and Meyburg, 1975; Ortuzar and Willumsen, 1990; Oyesiku, 1995).

**Growth factor**

The growth factor model attempts to estimate future number of trips by households for a specific purpose by any of specific categories of household attributes based on current trip rates. Formally, the model is of the form in Equation 1.

$$T_i = F_i t_i \tag{1}$$

when  $T_i$  = future trips in zone;  $t_i$  = the current trips in the same zone;  $F_i$  = the growth factor.

The growth factor ( $f_i$ ) is defined as in Equation 2.

$$F_i = f (P_i^d I_i^c C_i^d) / f(P_i^c / I_i^c C_i^c) \tag{2}$$

where 'f' = direct multiplicative functions; P.I.C = variables such as population; income and car ownership respectively; d, c = the future and current situations respectively.

The growth factor assumes that the average trip rates will remain constant. Based on this estimate, future number of trips can be projected. Because of the assumption of constant trip rates, the model has been described as crude and tending to over estimate the total number of trips (Bruton, 1995; Ortuzar and Willumsen, 1990) and therefore better suited for estimating trip ends for 'external/ internal' and through movements (Oyesiku, 1995).

**Cross classification or category analysis**

Cross-classification or category analysis is a similar model to the growth factor because it also attempts to estimate the number of trip productions on household basis for a given trip purpose as a function of household attributes. Furthermore, the model assumes that trip generation rates are relatively stable over time for certain household categories. The model in its standard form is in the form of Equation 3.

$$t^p (h) = T^p (h) / H(h) \tag{3}$$

where:  $t^p (h)$  = the total average number of trips with purpose P by households of type h at a time period t;  $T_p(h)$  = the observed trips by members of households of type h for a purpose p;  $H(h)$  = the number of household in types h.

Like the growth factor model, the cross classification model in its rudimentary form has some drawbacks. The most important of these is that it has no statistical goodness-of-fit measures and requires extremely large samples of households (Wooton and Pick, 1967; Douglas and Lewis, 1971).

**Multiple regression model**

Multiple regression model is among the commonly used tools in research for the understanding of functional relationships among multi-dimensional variables (King, 1969; Ayeni, 1979; Ademiluyi, 1996; Hanson, 1995; Oyesiku, 1990, 1995, 1996). The multiple regression model makes use of multiple regression analytical techniques to account for the influence of many variables on rate of trip generation in an area at a particular period. It is indeed the most wide spread method of trip generation study in the literature. Regression is a mathematically based procedure which has been programmed for most high-speed electronic computers. The techniques are therefore readily available to the analysts. In regression model, trip generation rate is treated as a dependent variable which is a function of one or more independent variables.

In mathematical form, the multiple regression model is of the form as presented in Equation 4.

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + \dots b_n X_n + e \tag{4}$$

where: Y = dependent variable; a = slope/intercept;  $b_1, b_2, b_n$  = regression coefficients;  $X_1, X_2, X_n$  = independent variables; e = error term or residuals.

The approach of this model is entirely mathematical. Therefore statistical test of reliability of the derived relationship can be applied with ease. Generally, the use of regression models is based on some assumptions which include normality, linearity, independent variables to be measure error free, no autocorrelation, and that the samples are randomly selected from the sample frame (Gould, 1970; Lewis-Beck, 1980; Ayeni, 1974). Violation of some of these assumptions may result in the equation containing co-efficient

with theoretically incorrect signs, thus limiting the use of such equations in explaining the structure of the pattern under study.

The regression model performs two basic functions: explanatory and predictive (Blalock, 1963; Hauser, 1974; Oyesiku, 1995). The explanatory function of the model is concerned with an attempt to explain the separate influence of the independent variables in order to establish the importance of each or some combination of some of them on the dependent variables. The predictive function of the model is concerned with the aggregate or combined influence of all the independent variables on the dependent variable.

An important advantage of the multiple regression model over others in trip generation modelling is its capacity to allow dummy variables to be included in the model. A number of household variables as trip generation determinants could not be measured or calibrated at interval, ratio or continuous scales, but in binary or dichotomous forms. The inclusion of the dummy or binary variables in the regression model is a process that increases the application of the model and does not cause its estimates to lose any of their properties (Lewis-Beck, 1980).

Although, using the derived equation form multiple regression analysis for prediction purpose has to be based on assumption that the regression co-efficient obtained at a given time will be relevant in the future. The technique has been widely accepted as a reliable tool in trip generation studies (Lewis-Beck, 1980; Oyesiku, 1990; Hanson 1995). In this study, the multiple regression techniques are used to model the urban trips generation in Lagos metropolis. Two main reasons accounted for the choice of this model (multiple regressions) among other trip generation models (growth factor and cross classification or category analysis). The first is its wider applicability, the ease of inclusion of dummy variables as determinants of household trip demand, and the disaggregated nature of the data in trip generation as utilized by Ayeni (1978), Lewis-Beck (1980) and Oyesiku (1990). Secondly, there is its explanatory function identifying the separate influence of the socio-economic and demographic variables of the households in order to establish the importance of the relationship between each of these variables and volume of trip generated (Wootton and Pick, 1967; Wilson, 1974; Stopher and McDonald, 1983; Ogunjumo, 1986).

## RESULTS AND DISCUSSION

### Relationship between usage of global system for mobile communication and socio-economic characteristics of GSM-owners

Here, the study examines the socio-economic characteristics of the GSM-owners as determinant of GSM usage. The general assumption is that the higher the socio-economic characteristics of GSM owners, the more the person is likely to use the GSM phone.

#### Choice of variables and the model

Multiple linear regression analysis was used to provide explanations between the GSM usage and socio-economic characteristics of GSM owners. The general model can be expressed as:

$$Y = a + b_1x_1 + b_2x_2 + \dots + b_nx_n + e$$

Where  $y$  = is a dependent variable or GSM usage of GSM owners;  $B_1, b_2, b_n$  = Partial regression coefficients;  $x_1, x_2, x_n$  = Independent variables or socio-economic

characteristics of GSM-owners;  $e$  = error term or residual. The multiple regression analysis is used to examine the relationship stipulated in the regression equation given in the foregoing. The usage of GSM is taken as the dependent variable, while the age, the level of education, income per month, occupational status and employment status are taken as the independent variables or predictors. An aspect of regression model that deserves consideration here is the use of dummy variables. Dummy variables are used for data in binary or dichotomous form rather than interval or ratio scale as required by multiple regression technique. It is a process that increases the application of the regression model and does not cause its estimates to lose any of their properties (Lewis-Beck, 1980; Gasper and Glaeser, 1998; Oyesiku, 1995b). A dummy variable is an index which is constructed with considerable arbitrariness but in a way relevant to the influence of the factor concerned (Kontsoyiannis, 1973). Examples of such variables in binary or dichotomous form in this study are age, employment status, occupational status, educational background, income per month and so on. Such variables were mutually and exclusively calibrated by assigning normal value of 0 and 1. Incorporation of dummy variables into regression analysis has been favoured in geographic and planning researches. Examples include the works of Berry (1961), Odugbemi (1982), Oyesiku (1990, 1995a b), Gasper and Glaeser (1998), Okoko (2000) and Solanke (2004).

Table 1 reveals the overall effect of age, level of education, monthly income, occupational status and employment status on GSM usage. The multiple correlation coefficient (Multiple R) is computed to be 0.76, while the  $R^2 = 0.58$ . There is a positive relationship between the five chosen socio-economic characteristics and GSM usage. The analysis shows that the higher the socio-economic characteristics of GSM owners, the higher the use of GSM. This implies that those with higher education, income, age, occupation and employment status have higher means of using GSM in metropolitan Lagos.

The computed F-value of 14.503 is significant at 5% level. Hence, the relationship between the socio-economic characteristics of GSM owners and its usage is positive and significant. In other words, we can predict usage of GSM using the socio-economic characteristics of GSM owners. Also, the stated hypothesis that usage of GSM in metropolitan Lagos is a function of the socio-economic characteristics of the residents, at 5% level of confidence.

The effect of the individual socio-economic characteristics on GSM usage, is also presented in Table 2.

The specific regression equation specifying the relationship between GSM usage and socio-economic characteristics of GSM owners is:

$$\text{GSM usage} = 1.23 + 0.00033(\text{age}) + 0.020(\text{edu}) + 0.0025(\text{income}) + 0.013(\text{occup}) + 0.015(\text{employ}).$$

**Table 1.** The relationship between GSM usage and socio-economic characteristics of the GSM owners.

Estimation	Sum of squares	Degree of freedom	Mean square	F-value	Observed significance value	R	R Square
Regression	3.809	5	0.762	14.503	0.00	0.76	0.58
Residual	131.011	2494	0.053				
Total	134.820	2499					

Source: Author's survey.

**Table 2.** Multiple regression results of the relationship between GSM usage and the socio-economic characteristics of GSM owners.

Variable	Characteristics	Regression coefficient (B)	Standardized coefficient (Beta)	Observed significance value	Calculated t-value	Contribution of variable
Model	Constant	1.23		46.18	46.18	
X1	Age	0.00033	0.001	5.073	-0.54	0.20
X2	Education	0.020	0.109	0.048	2.13	22.54
X3	Income	0.0025	0.016	6.237	1.01	3.13
X4	Occupation	0.013	0.125	0.340	3.17	27.71
X5	Employment	0.015	0.03	1.446	0.96	6.42

Source: Author's survey.

The relationships specified between the individual socio-economic characteristics and GSM usage show that they are all positive predictors of GSM usage. In other words, as the socio-economic characteristics increase, the rate of use of GSM also increases. To confirm the regression analysis stated earlier, the students' t-test was conducted and the t-values for education and occupation are the only one significant at 5% level of significance.

## Conclusion

Education and occupational status of respondents are the socio-economic characteristics that mostly determine GSM usage in metropolitan Lagos. This implies that those with higher education and occupational status have higher means of using GSM in metropolitan Lagos. The relationship between GSM usage and socio-economic characteristics of GSM owners, that is, effect of age, level of education, monthly income, occupational status, employment status on GSM usage, the study revealed further that there is positive relationship between five socio-economic characteristics and GSM usage. This means, the usage of GSM in Lagos metropolis is a function of the socio-economic characteristics of residents.

It is also observed that interaction for the purpose of working, business, recreation, shopping and social through telecommunications in the metropolis is unlikely to be restricted to just a few. However, majority are still expected to depend much on the physical movement by road and perhaps by telecommunications. This study

suggests strongly that a shift to the development of other land transport systems by policy makers is desirable in the long run. This is in order to maximize the mobility of the people and enhance their level of interaction and development.

## REFERENCES

- Abler RF (1968). The geography of Communication – Transportation Geography: comments and reading. New York: McGraw-hill Books Company. 26(2): 40-52.
- Adeniji K (1985). Urban Transportation System in Nigeria ODU: J. West Afr. Stud., 28: 81-97.
- Adeniji K (1991). Urban Mobility Crisis, where do we go from here? Paper delivered at Ogun State Public Service Forum Gateway Hotel, Abeokuta.
- Adeniji SA (1981). Public Transportation and Urban Development strategy in Nigeria. Unpublished Ph.D Thesis University of Wales, Pontain.
- Adeniji K (2000). Transport challenges in Nigeria in the next to a declares. Transport studies Unit NISER Ibadan. p. 24.
- Axhausen KW, Garling T (1992). Activity Based Approach to Travel Analysis. Conceptual Framework, Models and Research Problem Transport Reviews 12(4): 323-341.
- Ayeni B (1979). Concepts and Techniques in Urban Analysis Croom Helm Ltd, London. p. 17695.
- Ayeni MAO (1974). Predictive Modelling of Urban Spatial Structure: the example of Jos, Benue-Plateau State, Nigeria. Unpublished Ph.D. Thesis, University of Ibadan.
- Balogun Yinka, Odunmosu Tayo, Ojo kayode (1999). Lagos State in Maps" Ibadan Rex Charles Publication. www.lagosstate.gov.ng/index.php.
- Bhat CB, Koppelman FS (1999). A retrospective and prospective survey of time use research. Transp., 26: 119-139.
- Cherry C (1970). Human Communication: Technology and Urban Planning in D. Jones (Ed), Communication and Energy in Changing Urban Environments, Butterworths London, pp. 117-130.

- Clark D (1973). Communication and the Urban Future. A case study of Trunk Telephone call patterns in Wales" Reg. Stud., 7(3): 315-321.
- Elliot-Hurst ME (1974). Transportation Geography: Comments and Readings.
- Filani MO, Osayinmese IZ (1979). Intra-city Traffic Flow Problems in Nigeria. Niger. Geogr. J., 22(1): 17-31.
- Filani MO (1991). Mobility Crisis in Nigeria Federal Government's Mass Transit Programme. Annals of the Social Science Council of Nigeria 3:13-30.
- Filani MO (1993). Transport and Rural Development in Nigeria. J. Trans. Geogr., 1(4): 248-254.
- Garling Kwan T, Golledge RG (1994). Computational Process Modelling of household activity scheduling. Transp. Res., 28B(5): 355-364.
- Gasper J, Glaeser EL (1998). (eds). Information Technology and the future of cities. J. Urban Econ., 43:136-156.  
www.ideas.repec.org/pnbnr/nberwol/
- Giuliano G (2001). Urban Design, Telecommunication and Travel Forecasting. Keynote address. Texas Transportation Institute.
- Goddard JB (1970). Functional Regions within the City Centre: A study of factor analysis of Taxi flows in Central London. Inst. Br. Geogr. Trans., 49: 161-182.
- Gordon P, Kumaar A, Ricahrdson HW (1988). Beyond The Journey to work. Transp. Res. A., 22: 419-426.
- Hausa S, Schwab M (1987). Accessibility and Intra urban travel, Environment and Planning, pp. 735-748.
- Okoko E (2000). Urban Transportation planning and Modelling (Akure, Millennium Printers). pp. 189-193.
- Ojo OE (1990). Urban Travel-activity Pattern: A Case Study of Ibadan, Nigeria Unpublished Ph.D. Thesis, University of Ibadan.
- Oyesiku OO (1990). Inter-Urban travels pattern in Nigeria. A Case Study of Ogun State. Unpublished Ph.D Thesis University of Benin City, Nigeria.
- Oyesiku OO (1995). An Analysis of Demand for Later-city trip Generation Attributes of a Developing State in Nigeria in Journal of transport Studies Vol. 11(1,2), 12(1,2): 112-130.
- Oyesiku OO (1996). Inter-City Travels and Telecommunications relationship: an Explorative Study in Nigeria. J. Ife Soc. Sci., University of Ife Press. pp. 37-49.
- Rimmer PJ (1986). Rikisha to rapid transit: Urban Public Transport Systems and Policy in South East Asia Sydney: Pentagon. pp. 265-275.
- White PR (1990). Inadequacies of Urban public transport systems" in Dimitriou HT (ed), Transport Planning for Third World Cities London Routledge, pp. 85-116.