Ioana Teodora MEȘTER, PhD (corresponding author)
imester@uoradea.ro
University of Oradea, Romania

Ciprian ȘIPOȘ, PhD
ciprian.sipos@e-uvt.ro
The West University of Timișoara, Romania

Andreea Oana BEGU, PhD
andreea.enache@csie.ase.ro
Bucharest University of Economic Studies, Romania

Răzvan VASILE, PhD Candidate
razvan.vasile@csie.ase.ro
National Institute of Economic Research "Costin C. Kiritescu" Romanian Academy, Bucharest, Romania

Digital Transformation in the Offer of Cultural Consumption Services - Digitalisation and Best Practices

Abstract. *Europe is characterised by the richness and diversity of its cultural heritage. Culture has the potential to play an important role in making the EU stronger and more democratic, uniting European citizens by providing a sense of identity, while contributing to individual well-being, social cohesion, and inclusion. In order to outline the impact of information technology on today's society and economy, the evolutionary patterns of the past and the main trends of the present and future must be understood. Thus, starting from the industrial revolution that is associated with the creation of the first business models aimed at mass production and continuing with the technological progress of the last decades in the field of digitisation of informational resources and communications, all these have generated profound changes in the economic sector and, respectively, in society. We propose to analyse digitalisation and its implications in cultural tourism, by identifying the main trends of digitalisation in cultural consumption and highlighting the economic and specific variables in the tourism sector. The Eurostat data series used in the analysis is relating to 27 countries in Europe, between 1990 and 2022. Using linear panel type models we will investigate and quantify the influence of independent factors on tourism and present the results obtained from data processing.*

Keywords: *tourism activities, digitalisation, cultural consumption, economic models, econometric modelling.*

JEL Classification: L83, Z01, Z19,Z03, Z32, C05.

DOI: 10.24818/18423264/58.4.24.08

1. Introduction

The European Union supports digitisation objectives through programs and a range of policy actions set out in successive work plans for culture in the periods 2015-2018 and 2019-2022. At the same time, digitisation programs help create easy access to IT resources, leading to increased digital competitiveness.

Thus, the work plan for culture (2015-2018), adopted in November 2014, established a series of priorities for European cooperation in the development of cultural policies — inclusive and accessible culture, promotion of cultural heritage, support for the flourishing of cultural and creative sectors, promotion cultural diversity and culture in the EU's external relations. The Work Plan for Culture (2019-2022), adopted in November 2018, set out five key priorities - sustainability and cultural heritage, cohesion and well-being, an ecosystem supporting artists, cultural and creative professionals, and European content, gender equality and international cultural relations.

In order to outline the impact of information technology on today's society and economy, the evolutionary patterns of the past and the main trends of the present and future must be understood. Thus, starting from the industrial revolution that is associated with the creation of the first business models aimed at mass production and continuing with the technological progress of the last decades in the field of digitisation of informational resources and communications, all these have generated profound changes in the economic sector and, respectively, in society.

Information technology has meant a number of transformations, some of them of great amplitude, with an essential impact on our daily lives. The new business models are a response of organisations to the changes generated by technology in the economic, but also social, plan. Technological progress has also seriously influenced the coordination and management mechanisms within organisations and gainful activities, placing a special emphasis on the use of the potential of human resources and the formation of skills. In this way, the knowledge-based economy and the increasing importance of the role of technological progress in the new economy have led to the emergence of new business sectors and the restructuring of existing ones or even the creation of new social statuses.

Specialists in the field are of the opinion that the transformation process is a generator of the permanent redefinition of the economy. Technological progress, as a generator of the changes that took place mainly in the economy, but also in other sectors such as culture and cultural heritage, has changed the way people carry out their activities, redefining the role of their capabilities and potential, as well as the formation of collaborative relationships with other organisations in order to access knowledge and informational resources.

With the rapid evolution of information and communication technologies and the globalisation of all public life areas, information has become increasingly important in society's development. Thus, traditional cultural institutions face significant challenges in preserving cultural heritage while ensuring the satisfaction

of society's updated needs regarding access to cultural resources (Tsvetkova et al., 2020).

Technological evolution has determined significant changes in the tourism industry, impacting the relationship between demand and supply and broadly affecting customers' travel patterns.

Due to its impact on extensive changes in the business environment, business strategies, and consumer behaviour, digitalisation has become vital in shaping the future of tourism (Bekele & Raj, 2024).

The promotion of access to culture through digital means was achieved following the implementation of some policies and strategies for the development of the audience of the consuming public in the cultural sector. Digital technologies have changed the way people access, produce, and use cultural content. Cultural tourism derives from this, a branch of the tourism sector in which both tangible and intangible cultural heritage elements are promoted. The impact of digital change on development policies and attraction of consumers of cultural tourism develops the areas of knowledge at the national and international level, involving a multitude of social and economic factors that will contribute to the change of existing institutional programmes and to the identification and implementation of good practices in the field of cultural tourism.

2. Literature review

The stage of centralised computing through main-frame computers represents the period in which a computer with a large processing and storage capacity could be used by several users simultaneously (Zlatanov, 2016).

The personal computer stage emerged with the mass production and marketing of affordable personal computers (Morris&Morris, 2002). The main characteristic of information systems specific to this period consists in the access, use, and processing of information resources by a single user through the personal computer, an aspect that led to the decentralisation of processing power.

The current stage, that of information ubiquity, differs from the first two in that several information systems simultaneously serve the needs of one or more users, at any time and in any place (West, 2011). Advances in areas such as information technology and telecommunications have led to the interconnection of information systems with multiple and different functions, such as cloud computing, big data, and artificial intelligence, ensuring the creation of a ubiquitous information environment (Friedewald&Raabe, 2011).

The international community recognises the importance of protecting cultural heritage and reaffirms its commitment to combating intentional destruction in any form so that cultural heritage can be passed on to future generations (UNESCO, 2003).

Digital technologies offer new opportunities to preserve cultural content and facilitate access to cultural heritage for all audiences.

Cultural heritage is evolving rapidly thanks to digital technologies. Unprecedented opportunities brought by technologies such as Data, AI, 3D, and XR are bringing cultural heritage sites back to life. The term "cultural heritage" has considerably changed its content in recent decades and does not end at monuments and collections of objects (UNESCO, 2003).

Digitisation facilitates the preservation of the original heritage object under optimal circumstances and also provides a digital equivalent available for use by the general public (Dore&Murphy, 2012).

Advances in digital technologies have made it easier to view and study heritage artefacts as a whole, in minute detail, by incorporating zoom technologies at every level (Elabd et al., 2021).

According to researchers Rachel Paschoalin and Nigel Isaacs, the most important reason for putting 'Cultural Heritage' online is to improve accessibility so that we provide students, teachers, and researchers with the means to explore and connect with our past (Paschoalin&Isaacs, 2021).

Gutierriz, Ferreira, and Fernandes (2023) underlined in their research study that digital transformation tends to be a positive factor that is valuable for both public and private businesses and also for visitors when applied in tourism. Furthermore, recent research studies highlighted that digitalising cultural heritage destinations positively affects tourist attitudes (Li et al., 2024; Alyahya&McLean, 2022).

But beyond all the advantages associated with the digital transformation of the cultural heritage, as pointed out by Ocón (2021), the awareness of the risks associated with it, as well as the implications of an ethical, economic, political, environmental, or legal nature is required.

According to the American Library Association, it is essential to monitor at-risk areas, support, and raise awareness about conflict and disaster prevention. There are many threats to the survival of cultural heritage, including war and occupation, and illicit trafficking in cultural objects (ALA, 2017).

3. Data and methodology

The data series used in the analysis were taken from Eurostat statistics. We used series relating to 27 countries in Europe, between 1990 and 2022. The countries (Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, Iceland, United Kingdom) were selected based on available data. The meaning, the symbol used in the econometric models, the source (Eurostat name and source table code), and the nature of the series is described in the following table:

Table 1. Data series

Symbol	Signification	Eurostat source:	Nature of series
Arrivals	*Arrivals at tourist accommodation establishments* - hotels; holiday and other short-stay accommodation; camping grounds, recreational vehicle parks and trailer parks)	"Arrivals at tourist accommodation establishments" [tour_occ_arnat]	I(0)
Nights	*Nights spent in tourist accommodation establishments, number* – hotels; holiday and other short-stay accommodation; camping grounds, recreational vehicle parks and trailer parks)	"Nights spent at tourist accommodation establishments" [tour_occ_ninat]	I(0)
GDP	*Gross domestic product at market prices,* chain-linked volumes 2010, million euro)	"GDP and main components" [nama_10_gdp]	I(1)
GDPc	*Gross domestic product per capita, at market prices,* chain-linked volumes, index 2010=100)	"Main GDP aggregates per capita" [nama_10_pc]	I(1)

Source: EViews calculations based on EUROSTAT data.

The objective of the paper is to analyse digitalization and its implications in cultural tourism, by identifying the main trends of digitalization in cultural consumption and highlighting the economic and specific variables in the tourism sector, quantifying their influence on tourism.

The variables used in our analysis are the Arrivals, Nights, GDP and GDP/capita as presented in Table 1. The choice of the appropriate model will be made after an analysis of the characteristics of the data.

Panel stationarity tests were employed for all variables used in the models (Levin, Lin & Chu – for common unit roots, respectively Im, Pesaran&Shin W-stat, ADF - Fisher Chi-square, and PP - Fisher Chi-square – for individual unit roots). Granger causality tests and Dumitrescu-Hurlin homogeneous causality tests were used to investigate the existence of causal relationships between the selected variables.

We will continue our analysis with the estimation of linear panel type models between the selected dependent variables (Arrivals and Nights) and exogenous variables (GDP and GDP/capita). Validation tests will be performed in order to ensure the performance of the models.

The variables used in the models represent the main indicators used in tourism analysis and for which databases are available. The use of the panel in the presented analysis allows the knowledge of the tourism phenomenon in its dynamics and captures its image in almost continuous movement. The presented model meets all the statistical tests necessary for this approach, so we can say that the model has a high degree of verisimilitude.

Table 2. Granger causality tests (lag: 1) and Dumitrescu-Hurlin panel homogeneous causality tests (lag: 2), 1990-2022

The null hypothesis:	Prob.
d(GDP) is not Granger causal for ARRIVALS	0.0133
d(GDP) it does not cause homogeneously ARRIVALS	0.0438
d(GDPc) is not Granger causal for ARRIVALS	0.0280
d(GDPc) it does not cause homogeneously ARRIVALS	0.0383
d(GDP) is not Granger causal for NIGHTS	0.0002
d(GDP) it does not cause homogeneously NIGHTS	0.0531
d(GDPc) is not Granger causal for NIGHTS	0.0082
d(GDPc) it does not cause homogeneously NIGHTS	0.0532
NIGHTS is not Granger causal for ARRIVALS	0.0098
NIGHTS it does not cause homogeneously ARRIVALS	2.E-12
ARRIVALS is not Granger causal for NIGHTS	0.016*)
ARRIVALS it does not cause homogeneously NIGHTS	0.0024

*) lag = 4

Source: EViews calculations based on data described in Table 1.

We test the existence of causal relationships between the variables Arrivals, Nights, GDP and GDP/capita. The description of the series is as in Table 1.

Standard causality tests assume stationarity of the time series. The series Arrivals, Nights are stationary, and GDP and GDPc are non-stationary, integrated of order 1. Under these conditions, the non-stationary series, I(1), were introduced by simple differentiation. The results of the Granger causality tests and the homogeneous causality tests in the Dumitrescu-Hurlin panel are presented in Table 2.

Except for the hypothesis "ARRIVALS is not Granger causal for NIGHTS", all other non-causality hypotheses are rejected (the said hypothesis is rejected for lag ≥ 4).

The panel tests identify causal relationships (in the Granger sense, respectively, Dumitrescu-Hurlin) between the mentioned variables, but these techniques do not assess the sign of the respective relationships or the strength of the link. As a result, causality tests can represent the starting point in identifying econometric-type relationships between the variables analysed.

4. Results and discussion

The relationship between the series Arrivals in tourist accommodation units and Gross Domestic Product is explained as follows:

The general form of the linear panel type model is written as follows:

$$Y_{it} = a_0 + a_1X_{1,it} + ... + a_kX_{k,it} + \alpha_i + \beta_t + e_{it},$$

where Y_{it} is the endogenous (explained) variable for country i, in year t, X_1, ..., X_k are the explanatory variables and e_{it} is the idiosyncratic error. The parameter a_0 is a homogeneity coefficient, a_1, ..., a_k are the impact parameters of the exogenous variables, α_i evaluates the individual specific effects (the particularities of each

country in relation to the analysed processes), and β_t measures the specific effects over time (the particularities of each year).

Arrivals in tourist accommodation units depend on the particularities of each country (climate, history, geography, culture, etc.). If we consider that these particularities are, to a certain extent, invariant in time, then by applying the differentiation operator (dY_{it}) the respective characteristics will be eliminated.

To evaluate the relationship between arrivals in tourist accommodation units (arrivals symbol) and macroeconomic dynamics (GDP), we estimate a panel model, as follows:

$$dln(arrivals_{it}) = a_0 + a_1 \cdot dln(GDP_{it}) + \beta_t + e_{it}$$

We used the evolution in real terms of the GDP as a proxy for macroeconomic dynamics. The model in logarithms has the advantage that the parameter a_1 admits the interpretation in terms of elasticities (in the previous representation, ln(.) is the logarithmization operator). Redundancy tests reject the presence of individual specific effects (at the 8% threshold). The estimation results are as follows:

$$d\ ln(arrivals_{it}) = \underset{(0.0042)}{-0.010554} + \underset{(0.1259)}{1.412698} \cdot dln(GDP_{it}) + \beta_t + u_{it}$$

(under estimators, in parentheses – standard deviation). The model explains 81.4% of the variation from the mean of the values of the endogenous variable, the estimators are significantly different from zero at the 1% threshold (risk), the errors are not autocorrelated (DW = 1.85), and the individual specific (fixed) effects are not redundant (at a threshold < 10^{-4}). For the analysed European countries (Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, Iceland, United Kingdom), the elasticity of Arrivals in tourist accommodation units in relation to macroeconomic dynamics (in real terms) is positive and bigger than one ($\hat{a}_1$= 1.41).

We also note the strong and negative period effect recorded for 2020 (in the context of the crisis generated by the COVID-19 pandemic).

To evaluate the relationship between arrivals in tourist accommodation units and the level of economic development, we used, as a proxy for the level of economic development, the gross domestic product/capita (symbol GDPc). The panel model estimation results are as follows:

$$d\ ln(arrivals_{it}) = \underset{(0.003952)}{-0.007121} + \underset{(0.120018)}{1.390024} \cdot d\ ln(GDPc_{it}) + \beta_t + u_{it}$$

(under estimators, in parentheses – standard deviation). The model explains 81.9% of the variation from the mean of the values of the endogenous variable, the

estimators are significantly different from zero at the 1% threshold (risk), the errors are not autocorrelated (DW = 1.89), and the individual specific (fixed) effects are not redundant (at a threshold < 10^{-4}).

The results are close to those obtained for the previous model: the elasticity of Arrivals in tourist accommodation units in relation to the level of economic development is positive and above-unit, $\hat{a}_1 = 1.39$ (in relation to macroeconomic dynamics, the estimated elasticity is 1.41). As in the previous model, for the year 2020, a strongly negative period effect was registered (β_{2020}= - 0.683).

To evaluate the relationship between the number of nights spent in tourist accommodation units (nights symbol) and macroeconomic dynamics, we estimate a panel model, as follows:

$$d\ ln(nights_{it}) = a_0 + a_1 \cdot dln(GDP_{it}) + \beta_t + e_{it}$$

The results are as follows:

$$d\ ln(nights_{it}) = \underset{(0.0050)}{-0.016865} + \underset{(0.1520)}{1.345060} \cdot dln(GDP_{it}) + \beta_t + u_{it}$$

(under estimators, in parentheses – standard deviation). We excluded individual specific effects from the model (the probability attached to the null hypothesis in the redundancy test is 0.3854). The model explains 72.6% of the variation from the mean of the values of the endogenous variable, the estimators are significantly different from zero at the 1% threshold (risk), the errors are not autocorrelated (DW = 2.03), and the individual specific (fixed) effects are not redundant (at a threshold <10^{-4}).

For the analysed European countries, the elasticity of the number of nights spent in tourist accommodation units in relation to macroeconomic dynamics (in real terms) is positive and above the unit ($\hat{a}_1 = 1.345$). We also note the strong and negative period effect (-0.635), recorded for the year 2020 (in the context of the crisis generated by the COVID-19 pandemic).

In order to evaluate the relationship between the number of nights spent in tourist accommodation units (symbol nights) and the level of economic development, we also used the gross domestic product/capita (symbol GDPc) as a proxy for the level of economic development. The estimation results are as follows:

$$d\ ln(nights_{it}) = -0.03291 + 1.324524 \cdot d\ ln(GDPc_{it}) + \beta_t + u_{it}$$

(under estimators, in parentheses – standard deviation). The model explains 73.1% of the variation from the mean of the values of the endogenous variable, the estimators are significantly different from zero at the 1% threshold (risk), the errors are not autocorrelated (DW = 2.05), and the individual specific (fixed) effects are not redundant (at a threshold < 10^{-4}). The results are close to those obtained for the previous model: the elasticity of the number of nights spent in tourist accommodation units in relation to the level of economic development is positive

and above-unit, $\hat{a}_1 = 1.324$ (in relation to macroeconomic dynamics, the estimated elasticity is 1.345). As in the previous model, for the year 2020, a strongly negative period effect was registered ($\beta_{2020} = - 0.637$) (Jula, Jula, 2022).

The analysis of the relationship between the series Nights spent in tourist accommodation units and Arrivals in tourist accommodation units could provide information regarding the average number of accommodation nights/person registered in tourist accommodation units. The model used for econometric estimations is as follows:

$$(nights_i)_t = a_0 + a_1 \cdot (arrivals_i)_t + \{control\ variables\} + \alpha_i + \beta_t + e_{it}.$$

As a control variable, we considered the gross domestic product/capita, calculated as a change compared to 2010 = 100%. In the homogeneous model,

$$(nights_i)_t = a_1 \cdot (arrivals_i)_t + a_2 \cdot dln(GDPc_i)_t + e_{it},$$

the errors have an AR(2) autoregressive structure:

$$nights_{it} = 2.679683 \cdot arrivals_{it} + 57692.53 \cdot dlnGDPc_{it} + e_{it},$$
$$(0.0157) \qquad (4.666.28)$$
$$u_{i,t} = 0.869813 * u_{i,t-1} + 0.100829 * u_{i,t-2}$$

(under estimators, in parentheses – standard deviation, $R^2 = 0.97$, DW = 1.89, solution method: Pooled EGLS – Cross-section SUR).

The estimation results suggest that, at the level of the analysed European countries (Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, Iceland, United Kingdom), the average length of stay is 2.68 nights/person. This value is differentiated by country. Results of a model with specific individual impact effects:

$$(nights_i)_t = a_0 + a_i \cdot (arrivals_i)_t + a_2 \cdot dln(GDPc_i)_t + e_{it}$$

identifies average values of length of stay / person above the average of the homogeneous model (2.68) in countries with a high share of tourism in total economic activities: Cyprus (5.94), Greece (4.30), Croatia (4.23), Spain (3.63), Bulgaria (3.37), Denmark (3.24), Italy (3.02), Austria (2.81), Portugal (2.72). For Romania, the average number of nights spent in tourist accommodation units for a person arriving in the respective units is below the European average: 1.77.

5. Conclusions

Thanks to digital technologies, cultural heritage is evolving rapidly in all the European countries analysed. The push is to preserve and bring our cultural heritage into this digital decade.

Unprecedented opportunities brought by technologies such as Data, AI, 3D and XR are bringing cultural heritage sites back to life. In many European countries, virtual museums are created to allow visitors to see works of art in context and experience objects or sites inaccessible to the public in conventional ways. They are transforming the entire tourism sector, facilitating online access to cultural materials.

In this context, the study's first conclusion for the European countries considered is that the elasticity of arrivals in tourist accommodation units in relation to macroeconomic dynamics in real terms is positive and supraunitary. Also, the elasticity of the number of nights spent in tourist accommodation units in relation to the macroeconomic dynamics in real terms is positive and over the unit, even if it is slightly lower than in the case of arrivals in tourist accommodation units.

Many European countries rely heavily on tourism for income. In this sense, another interesting result of our study is there are average values of the length of stay/person above the average of the homogeneous model in the countries with a high share of tourism in the total economic activities.

As is very well known, the tourism sector faced severe economic difficulties following the COVID-19 pandemic, with a significant return after 2022. The European Commission is strengthening its support by promoting local and sustainable tourism throughout Europeana – a programme designed to discover Europe's digital cultural heritage. Tourists now have more opportunities to discover the rich diversity of Europe's culture and nature in their own country or another EU country all year round.

In addition, more digital technologies such as immersive, virtual, augmented reality, and three-dimensional images are increasingly essential success factors when attracting tourists to a destination. They are supporting the offer of new modes of creative expression and have the power to inspire both new and returning audiences.

References

[1] Alyahya, M., McLean, G. (2022), *Examining tourism consumers' attitudes and the role of sensory information in virtual reality experiences of a tourist destination*. *Journal of Travel Research,*61(7), 1666-1681.

[2] Bekele, H., Raj, S. (2024), *Digitalization and digital transformation in the tourism industry: a bibliometric review and research agenda*. *Tourism Review,* Vol. ahead-of-print No. ahead-of-print, available online at https://doi.org/10.1108/TR-07-2023-0509.

[3] Dore, C., Murphy, M. (2012), *Integration of historic building information modeling and 3D GIS for recording and managing cultural heritage sites.18th International Conference on Virtual Systems and Multimedia: Virtual Systems in the Information Society,* Milan, Italy, 369-376, available online at https://ieeexplore.ieee.org/ document/6365947.

[4] Elabd, N.M., Mansour, Y.M., Khodier, L.M. (2021), *Utilizing innovative technologies to achieve resilience in heritage buildings preservation.Developments in the Built Environment*, 8.

[5] Friedewald, M., Raabe, O. (2011), *Ubiquitous computing: An overview of technology impacts*.*Telematics and Informatics*, 28(2), 55-65.

[6] Gutierriz, I., Ferreira, J.J., Fernandes, P.O., (2023), *Digital transformation and the new combinations in tourism: A systematic literature review. Tourism and Hospitality Research,*0 (0).

[7] Jula, D., Jula, N.M. (2022*), Econometrie*, Editura Mustang, București, 365, Romania.

[8] Li, Y., Jiao, L., Zhou, M. (2024), *How does cultural heritage destination digitalization influence tourists' attitudes? The role of constructive authenticity and technology-destination fit. Journal of Travel & Tourism Marketing*, 41(2), 221-234.

[9] Morris, L.J., Morris, J.S. (2002), *The changing role of middlemen in the distribution of personal computers, Journal of Retailing and Consumer Services*, 9(2), 97-105.

[10] Ocón, D. (2021), *Digitalising endangered cultural heritage in Southeast Asian cities: preserving or replacing?*. *International Journal of Heritage Studies*, 27(10), 975-990.

[11] Paschoalin, R., Isaacs, N. (2021), *Holistic renovation of historic and heritage buildings: comparing New Zealand and international scenarios. International Journal of Building Pathology and Adaptation,* 39(4), 602-618.

[12] The State of America's Library Association (2017), *A Report from the American Library Association*. The Magazine of the American Association, Special Report, available online at https://www.ala.org/sites/default/files/news/content/State-of-Americas-Libraries-Report-2017.pdf.

[13] Tsvetkova, E., Savova, E., Vasileva, H. (2020), *Digitalisation of cultural and historical heritage: challenges and prospects*. *INTED 2020 Proceedings*, 5478-5482.

[14] UNESCO Declaration concerning the Intentional Destruction of Cultural Heritage, (2003), available online at http://portal.unesco.org/en/ev.php-URL_ID=17718& URL_DO=DO_TOPIC&URL_SECTION=201.html.

[15] West, M.T. (2011), *Ubiquitous computing, Proceedings of the 39th annual ACM SIGUCCS conference on User services*, San Diego, California USA November 12-17, 175-182.

[16] Zlatanov, N. (2016), *Digital Signal Processing using ADC and DAC.* IEEE Computer Society, available online at https://www.researchgate.net/publication/296485822_ Digital_Signal_Processing_using_ADC_and_DAC#fullTextFileContent.