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The influence of Lean adoption on operational performance in the Greek citizen's service centers

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Abstract

Purpose: The study aims at determining the influence of Lean adoption on operational performance ina specific Greek public services sub-sector namely Citizen's Service Centers (CSCs).

Design/methodology/approach: An online questionnaire was distributed to all the Greek CSCs, which included items reflecting Lean adoption and the operational performance of public organizations.Six hundred and seventy-two employees responded and fully completed the questionnaire. Exploratory and Confirmatory Factor Analyses were applied to assess the measurement model reliability and validity. The influence of Lean adoption on the operational performance of CSCs was determined through Structural Equation Modelling.

Findings:According to the findings, Lean adoption has a significant influence on the operational performance of the Greek CSCs.

Researchlimitations/implications: The small percentage of the responding employees of the Greek CSCs, given their large population, and the subjective nature of the data collected constitute the main limitations of the present study.

Practical implications:The findings of this research will serve as a reference source for managers and decision makers of CSCs in order for them to set the foundations for successfully adopting the Lean principles and therefore improve the operational performance, in the current era which is characterized by a financial and energy crisis.

Originality/value: Building on the public sector literature, this is the first study that evaluates the influence of Lean adoption on the operational performance of public services organizations such as the Greek CSCs.

Key words: Lean principles, public sector, operational performance, Citizen's Service Centers

Paper type: Research paper

Introduction

In recent years, the worldwide economic downturn and shrinking budgets (Costa *et al.,* 2020) combined with the ever-changing demands of citizens, in a rapidly evolving environment, highlight the need to reform public administration in order to be able to serve citizens better, with new tools and reduced cost. Public administration is an important part of the economy in every country in the world and regardless of its operation or service (Rodgers and Antony, 2019), provides social justice and influences citizen’s quality of life (Costa *et al.,* 2020). However, to combine efficiency and economy in public organizations, it is necessary to reduce the administrative burden for governments (Caiado *et al.,* 2020). Thus, the need to adapt to the new environment is pushing public organizations to implement continuous improvement methodologies, which focus on quality improvement, eliminate waste, reduce cost and crack down on bureaucracy (Fletcher, 2018;Vadivel *et al.,* 2021). Such approaches are aligned with the Lean philosophy(Costa *et al.,* 2020; Rodgers *et al.,* 2021).

The literature review shows that in general there have been several initiatives that indicate that the awareness and adoption of Lean in various public sector organizations has

increased quite sharply in recent years (Madsen *et al.*,2019;Antony *et al.*, 2019; Rodgers *et al.*, 2019a; Abdelmalek and Houfaidi, 2022).Accordingto Costa *et al.* (2020) Lean has been successfully applied in the armed forces while Lukrafka *et al.* (2020) point out the application of Lean by both central and local governments. In addition,Rodgers *et al.*(2021) and Psomas *et al.* (2022) emphasize that Lean is the most widely used methodology in many areas of the public sector.

However, empirical studies that highlight the application of Lean methodology in the public sector are relatively few (Antony *et al.*, 2019; Fredriksson, 2020;Abdelmalek and Houfaidi, 2022).According to the published literature there is a growing body of research on leadership, readiness and success factorsand Lean as a system (Rodgers *et al.*, 2019b). However, these studies do not focus on the operational performance of Lean management in specific public administration organizations (De Almeida *et al.*, 2017; Lukrafka *et al*., 2020; Caiado *et al.*, 2020). According to Bakar *et al.* (2017) there is a severe deficiency of bibliography regarding the investigation of the influence of Lean management on operational performance in the public service sector and in particular in the context of local government.In other words, the issue of Lean adoption in the public sector remains largely under review (Fredriksson, 2020; Pollalis and Angelopoulos, 2021).

Thus, many future research suggestions have been made by several authors in terms of Lean adoption in the public sector.Antony *et al.* (2017a), Vadivel *et al.* (2021), Costa *et al.* (2020) and Psomas *et al.* (2022) indicate that studies are needed in various public services organizations and different sub-sectors such as, local governments. In addition, various research work such as those conducted by Madsen *et al.* (2017), Antony *et al.* (2017b), Sony *et al.* (2020), Costa *et al.* (2020) and Rodgers *et al.* (2019a) and Vadivel *et al.* (2021) also, highlighted the fact that there is a strong need for credible studies on the influenceof Lean on the public sector. In addition, Rodgers and Antony (2019), Lukrafka *et al.* (2020), Costa *et al.* (2020) and Patel and Patel (2021), suggest further research to develop a generalized framework to guide the implementation of Lean in some specific sectors, such as the public sector. Finally, Keramida*et al.*(2022) suggest further research on the influenceof Lean adoption in Greek CSCs.

From the above identified gap in the literature as well as the suggestions of authors for further studies, it is apparent that there is a need for a broader and more in-depth treatment of Lean in the public administration sector. Against this background the purpose of the present study is todetermine the influence of Lean adoption on the operationalperformance of public administration services and in particular the Greek CSCs.

CSCs were established by the Greek Government in 2002, stimulated by the principles of the New Public Management (NPM) and quality management theory. These centers are located all over Greece in approximately 1,000 locations, providing over 1,000 certified administrative processes (ekep, 2022). They constitute a sub-sector of the Greek public administration and operate as one-stop shops aiming at providing assistance to citizens in order for them to effectively accomplish administrative processes which refer to almost all bodies of the public sector. It is worth noting that more than 77 countries across the globe have established physical and/or digital CSCs to better serve their citizens (Fredriksson, 2020). However, empirical research concerning the assessment of these services is limited (Psomas *et al.*, 2020; Fredriksson, 2020). So, the CSCs, as innovative public service organizations in Greece, constitute fertile ground for evaluating the quality

of the services, citizens' satisfaction and therefore the quality improvement programs (Keramida *et al.*, 2022).

It is worth noting that, while the number of publications has been increasing steadily on an almost year on year basis, as has the number of countries in which Lean has been applied in various parts of the public sector (Rodgers *et al.*, 2021; Rodgers and Antony, 2019; Abdelmalek and Houfaidi, 2022), this study focuses exclusively on the research that has been done in the Greek public sector.Thus, according to the literature review, regarding the adoption of Lean in the Greek public sector, only four studies were identified.However,in the research of Angelopoulos and Pollalis (2019), Pollalis and Angelopoulos (2021) and Psomas and Antony (2018), CSCs, were outside their scope and objectives, as these studies investigated the Critical Success Factors (CSFs) of Lean and the degree of adoption of Lean principles while theyconcerned services and enterprises of the wider public sector public such us utility organizations that specialize in renewable energy sources (e.g power, water), municipalities, organizations of ministries and central government etc.Only,Keramida *et al.* (2022) investigated CSCsbut examined the CSFs of Lean.

In other words, to the best of the authors' knowledge, no research studies were found linking Lean principles to results achieved by public organizations and in particular by CSCs. Thus, from the above mentioned the originality and the contribution of the present study are apparent.The present study contributes to the existing body of literature by empirically determining how the adoption of Lean methodology in the public sector and in particular in the Greek CSCs influencesoperational performance.The findings of this study can help public services organizations adopt more effectively Lean principles in their effort to reduce waste, improve quality and efficiency.

The rest of the paper is structured as follows: In the next paragraph, a relevant literature review is presented and the research questions are formulated. The research methodology, the findings of the study and their discussion follow. The next part presents the conclusions, the theoretical and practical implications. Study limitations and future research suggestions are summarized in the final section.

Literature review and research questions

Lean in the public sector

Lean is a management concept which is inspired by ideas and practices developed by the Toyota car company several decades ago. Lean can be understood in four different ways, as an organizational trend, a management philosophy, a set of principles, or a set of practices (Madsen *et al.*, 2017; Gupta *et al.*, 2016). Some Lean users view it as an abstract concept (e.g., philosophy or culture) or a philosophical approach guided by specific principles (Allaoui and Benmoussa, 2020)while others have a stronger emphasis on the use of concrete Lean-related tools and techniquessuch asPokaYoke, Kanban and Value Stream Mapping (Lukrafka *et al.*, 2020). Allaoui and Benmoussa (2020) state that in order for Lean to be successfully implemented in the public sector, it is necessary to firstly understand its principles and then comes the phase of using Lean tools and methods to apply this philosophy.

In recent years, several studies have been conducted on how and to what extent Lean principles can be successfully applied in public sector organizations, (Bateman *et al.*, 2018; De Almeida *et al.*, 2017;Madsen *et al.*, 2019; Abdelmalek and Houfaidi, 2022). These

studies are based, among others, on the following five fundamental principles identified by Womack and Jones (2003): define value precisely from the perspective of the end customer, identify the entire value stream and eliminate waste, make the remaining value-creating steps flow, follow the pull approach and pursue perfection. Although these principles sound clear, in order to apply them correctly and be useful for the organization, it is imperative that they are clear and shared by all staff at all levels of a public organization in order to be best practiced (Zefaz, 2020).

At the same time, these studies indicate that Lean in the public sector, is used in different ways and that different actors apply the Lean concept (e.g., different Lean principles and tools) to different degrees, depending on the type of services provided (Bateman *et al.,* 2014; Lukrafka *et al.,* 2020; Psomas and Antony, 2018; Madsen *et al.,* 2019).According to Gupta *et al.* (2016) and Lukrafka *et al.* (2020) though the Lean principles are more or less the same and generally appropriate,for the entire service industry, each attempt of incorporation is unique and specific for every organization. So, every attempt to intergrade the principles of Lean Management must be developed individually depending on the needs of each public organization and its employees (Antony *et al.,* 2019), as well as according to the specificities of public administration (Bateman *et al,.* 2018; Caiado *et al.*, 2020).

Radnor and Walley (2008) examined whether public services organizations regard Lean merely as a set of tools and techniques or whether they also consider Lean principles as prerequisite conditions for its sustainable implementation. Although all the service organizations studied implemented all five principles of Womack and Jones (1996), however each individual public organizationplaced different degrees of adoption on Lean principles. In the same line, the studies of Madsen *et al.* (2017; 2019) and Psomas and Antony (2018) found that public services adopt the five Lean principles to varying degrees. In addition, according to Womack *et al.* (1990)Lean can be adopted by any organization regardless of size, culture, and geographical location. However, it must be taken into account that organizations should not copy Lean practices to the letter, but rather adapt them to their work environment and their sector of activity (Benkarim and Imbeau, 2021). According to Toyota, organizations that copy its processes exactly are generally doomed to failure(Bateman *et al.,*2018).

Operational Performance in the public sector

The issue of the performance of public sector organizations is considered critical to a country's economy and is a topic that is receiving increasing attention. Alkunsol *et al.* (2018) refer to operationalperformance as the actual results or outputs of an organization as measured against that organization’s intended outputs. The measurement of the performance of the public sector is a process of assessing the progress of work against pre-determined goals and targets, including information on efficiency in the production of goods and services, the quality of goods and services, the results of activities compared to the intended purpose, and the effectiveness of actions in achieving the goals, vision and mission of the organization (Silitonga and Widodo, 2017).According tode Almeida *et al.*(2017), it is essential to measure performance in the public sector, as it helps ensure that citizens enjoy high quality services and enables governments to ensure that taxpayers receive value for money.This also concerns the Lean adoption as many studies in the public sector have shown that Lean has had a significant impact on improving operationalperformance (Antony *et al.,* 2019; Caiado *et al.,* 2020; Benkarim and Imbeau,

2021; Abdelmalek and Houfaidi, 2022).More specifically, proponents of Lean (e.g. Lean "gurus" and consultants) generally argue that the concept can help organizations improve operational performance and productivity by reducing waste (e.g. time and resources spent on unnecessary and non-value-generating activities and processes).

Since operationalperformance is a multidimensional concept several researchers in the literature have proposed various indicatorsto measure operationalperformance in the public sector, usingmeasures suchasefficiency, quality, productivity, flexibility, profitability, production cost, citizens satisfaction etc.Especially, Ammons (2022) argues that the main criteria for measuring the operational performance of public services include efficiency, quality and effectiveness.Vadivel *et al.* (2021) investigated the influence of adoption of Lean methodology on the operational performance of public post offices by including multidimensional measures such as productivity, employee performance, employee process understanding, cleanliness, inventory reduction, cycle time reduction, human errors.In the same vein, Bakar *et al.* (2017) used internal productivity, service quality,complaint response time, waiting time, on-time service delivery, process completion time and citizen satisfaction to measure operationalperformance in local government.Zefaz (2020) revealed benefits derived from Lean implementation in public sector (municipality) by focusing on items describing service quality, employee efficiency and effectiveness, process completion time, productivity, human errors, among others.To measure operationalperformance of Lean adoption in the public sector, Madsen *et al.* (2017; 2019) based their study on measures with regard to productivity, quality, resource utilization, flexibility and response time.In addition, Patel and Patel (2021) through a literature review in various service industries, including public, revealed operational performance indicators related to service and process quality, productivity, human errors, process cycle efficiency in services, the waiting time of citizens-customers, the speed-time of receiving a service, the cycle time, the understanding of the process, etc.

The influence of Lean adoption on operational performance

Lean has been successfully deployed in public services and has shown the promise to improve public service quality (Antony *et al.*, 2017b). According to the international literature, the adoption of Lean principles positively influences the operational performance of a public organization (Sony *et al.*, 2020; Benkarim and Imbeau, 2021; Abdelmalek and Houfaidi, 2022).

In particular, Psomas and Antony(2018) found that the adoption of Lean methodology can help public services organizations reduce waste and cost and thus improve quality and the services they provide to citizens.Lean can be used by governments to improve the operational performance of public services (Sony *et al.*, 2020; Vadivel *et al.*, 2021; Madsen *et al.*, 2017; 2019).Antony *et al.* (2017b) reported that Lean is a robust methodology that can be incorporated by all public sector organizations, bringing significant benefits such as increasing efficiency, improving process and quality, saving resources, reliable and timely provision of services and therefore an increase in citizen satisfaction. Similarly, Angelopoulos and Pollalis (2019) and Pollalis and Angelopoulos (2021) highlighted the positive influence of Lean on operational performance in the Greek public sector and in particular on improving productivity and quality.

Fletcher (2018) identified that public organizations can, in fact, incorporate Lean philosophy and methodology to streamline and improve organizational processes, produce cost-savings, improve organizational culture and improve the quality of goods and services

and therefore increasing citizen satisfaction. Caiado *et al.*(2020) reviewing the literature in public administration showed that Lean methodologies are private sector practices that when implemented in a public organization, bring a number of benefits related to costs, service and process quality, efficiency, innovation, saving space and resources, reducing the response time to citizens' requests and, in general, the modernization of public services.

From the above, it is obvious that different researchers use alternative indicators to measure Lean operational performance.The theoretical framework of Lean performance formulated in the present study is in line withBakar *et al.* (2017), Zefaz (2020) and Vadivel*et al.* (2021) and it include measures such as employee efficiency, employee effectiveness (degree of achievement of goals) and service quality.

The present study contributes to the literature by formulating a framework of Lean adoption operational performance measures in specific public organizations called CSCs. Thus, having this in mind, the purpose of the present study, the existing literature gap and the future research proposals suggested by several authors, the following research question is formulated and examined:

H1: The adoption of Lean in public administration, i.e. CSCs, has a significant positive impact on operational performance.

At this point, it is worth noting that, given that the organizations of interest of the present study are non-profit public service organizations, as they have no economic or administrative autonomy, they have fixed budgets with no relation to performance and they also have no competitors (Psomas *et al.,* 2020) the financial or market performance indicators were excluded from the measured variables collected.

Methodology

Questionnaire development and Sample

In order to answer the above formulated research questions, a research project was carried out within the Greek CSCs, using a structured questionnaire as the data collection method.The population of the present study includes all the employees of the Greek CSCs. The main goal of the data collection process was to obtain a representative sample of the employees of the CSCs throughout the Greek territory.The questionnaire was checked by three academicians and two practitioners to further confirm its content validity. Moreover, a sample of 20 Greek employees of CSCs was asked to ensure that all items could be clearly understood with no ambiguity. The final questionnaire consisted of three parts. The first part contained questions regarding the respondents' profiles. The second part contained statements reflecting the five Lean principles. The third part contained statements reflecting measures of operational performance of Lean adoption. Respondents were asked to indicate the degree of agreement or disagreement with these statements using a seven-point Likert scale, where 1 represented "strongly disagree" and 7 represented "strongly agree".The measured variables of operational performance were drawn from the studies of Bakar *et al.* (2017), Zefaz (2020) andVadivel *et al.* (2021).

An e-survey was carried out similar to the research studies conducted in the public sector by Klein *et al.* (2022). The Uniform Resource Locator (URL) of the questionnaire survey was sent via e-mail nationwide to all CSCs, i.e. a total of 1060CSCs(Klein *et al.*, 2022). The email invitation also contained a brief explanation of the purpose of the study, as well as an explicit instruction to the recipient to forward the email to all employees (from all hierarchical levels) of the specific CSC (Madsen *et al.,* 2017; Angelopoulos and Pollalis, 2019; Pollalis and Angelopoulos, 2021). This URL led potential respondents to the

questionnaire home page, which provided information on the research objectives, confidentiality, and anonymity.The survey was completed within two months (March to April of 2022) and six hundred and seventy two employees of the CSCs fully completed the questionnaire,giving a response rate equal to 29.21%.

Preliminary analysis

At first, the respondents of the first and second month of the survey were compared in terms of their profile (Mann Whitney Test) and the questionnaire items (T-test) and no statistically significant differences were found. So, from the above, it is apparent that non-response bias is not a cause for concern in this study.

A preliminary analysis was also applied to check the accuracy of the data. All respondents completed the questionnaire individually and independently while the number of the responding employees in the present study is large enough (672) for multivariate data analysis (Hair*et al.*, 2017). Before multivariate data analysis we examined the assumptions regarding the sample size, outliers, variables (continuous – categorical), their multicollinearity and multivariate normal distribution(Hair *et al.,* 2017). Observed variables that caused violations in meeting these assumptions were excluded from the analysis.Consequently, calculating the Mahalanobis (D^2) distance, no observations exceeded the threshold value of 3 (or 4 for large samples) and so, no more data points were deleted from the analysis (Hair *et al.,* 2017).Finally, based on the correlation coefficients among the variables included in the model ($r < 0.85$), the histograms, p-p and q-q plots, skewness and kurtosis ($< \pm 1$) and the standardized residuals ($< \pm 2.5$) of the variables used in the proposed model, it is concluded that there are no serious indications that the basic assumptions of multivariate analysis are violated. The Lean principles were validated through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Lean adoption is described as a second-order factor in terms of the main Lean principles. The structural relationships between Lean adoption and operationalperformancewere examined through Structural Equation Modelling (SEM). The Statistical Package for Social Sciences (SPSS 28) and Analysis of MOment Structures (AMOS 28) were used for data processing.

Data analysis and results

The respondents are adequately distributed among all Greek administrative as the survey involved respondents - CSCs employees from all over Greece. Almost half of them work in CSCswith one or two employees, while out of the remaining employees of the sample, 135 work in CSCs with 3-4 employees and 161 work in CSCswith more than 5 employees. In addition an equal percentage of males (50.4%) and females (49.5%) participated in the survey. As far as the hierarchical level of the respondents is concerned, 7.89% of them are managers, 11.9% of them are heads of departments, while the remaining 80.21% are simple employees (without subordinates). The majority of respondents is at least university graduates (74.71%) and have more than 11 years' experience in the CSCs (81.56%).

Exploratory and confirmatory factor analysis

First, EFA (varimax rotation method) is applied in order to extract the latent constructs of Lean principles.Low loading items (< 0.5) were excluded from the subsequent data analysis in order to guarantee the convergent and discriminant validity.Thus four latent factors (constructs) were established into which the Lean principles are analyzed (Kaiser-

Meyer-Olkin=0.826, Bartlett's test of Sphericity=3786.711, p=0.000, Measures of Sampling Adequacy (MSA)>0.735, eigenvalue>1, cumulative variance=78.303% and Cronbach's alpha>0.858).These constructs are explained based on the measured variables' loadings (>0.729) and can be labeled as follows: understanding customer needs, establishment of value streams, creating flows within the value streams and value perfection.From Table I we observe that the factor loadings (EFA) are well above the threshold of 0.5, which means that each measured variable is significantly related to the respective latent construct at $p < 0.001$.In order to determine whether the extracted latent factors show acceptable fit to the empirical data, the CFA (maximum likelihood estimation technique) is also applied in addition to EFA in Lean principles model. Thus, a series of tests are performed to further determine the construct validity of the latent factors.It is worth noticing that their standardized regression weights are all above 0.680(Table I). Table IIpresents the goodness of the model fit to the observed data. The fit indices indicate that the measurement modelis appropriate (Hair *et al.,* 2017).

The mean values of all the latent constructs varied from 4.29 to 5.71, which indicate that the public services organizations (i.e.CSCs) adopt the Lean principles at a medium to highdegree.From Table I, it is apparent that, among the Lean principles considered in the present study, "Establishment of value streams" (5.71), "Understanding customer needs" (5.15) and "Creating flows within the value streams" (5.11)are those mostly adopted by the public services organizations. The construct "Value perfection" (4.29) was the least important.Also, from Table I, it is apparent that Lean operational performance is achieved at a high level by the CSCs (mean value = 5.49).

The reliability of all the extracted factors is confirmed through Cronbach's alpha coefficients that are higher than 0.746 (Hair *et al.,* 2017), indicating that all factors are measured by reasonably reliable items (Table III).Similarly the Cronbach's alpha reliability coefficient of the operational performance measures is 0.780 (Table III).According to Hair *et al.* (2017) construct validity was confirmed through the CFA by evaluating convergent validity (standardized regression weights>0.680, AVE>0.515, construct reliability>0.705), discriminant validity ($AVE>Corr^2$) (Table III), face-content validity (questionnaire review by experts on the field) and nomological validity (significant correlations among the latent constructs in the measurement model). Based on the above, the construct validity of the extracted latent constructs is strongly confirmed.

According to Hair *et al.* (2017) when there is a latent factor with several correlated dimensions and furthermore the structural relationships between the dimensions and the latent factor are strongly supported by the literature, then a second-order factor model is applicable. The second-order model explains the co-variations among first-order factors in a more parsimonious way (Hair *et al.,* 2017). Having assured the reliability and validity of the first order latent factors – the Lean principles – (Table II) and in order to determine whether a higher order latent factor is extracted (that would represent Lean adoption), a second order CFA is applied. So, in the case of the present study, a higher order model is constructed using "Lean adoption" as a second-order factor that explains the four first-order factors (the Lean principles). In the second order factor model, it is hypothesized that the "Lean adoption" factor explains the association between the four first-order dimensions of Lean principles, thus avoiding the problem of correlated measurement errors (Hair *et al.,* 2017). The second order model is represented in Figure 1.The fit statistics of the second-order CFA indicate a good fit of the second-order measurement model.

Furthermore, in the second-order model, the standardized regression weights of the four first-order latent factors are positive and statistically significant at $p < 0.001$.This means that a high amount of the variance of Lean principles is explained by the second order latent factor (Lean adoption). This is also obvious from the Target value=0.906 (Table II) that, according to Runge *et al.* (2004) if it ranges between 0.8 and 1.0, a higher order latent factor can be extracted explaining the covariance among the first order latent factors.The results of CFA confirmed the tow sub-models revealed by EFA. Thus, the extracted latent factors show acceptable fit to the empirical data (Table II). Finally, construct, convergent, discriminant and nomological validity are confirmed indicating strong evidence that the proposed latent factors meet rigorous tests of these types of validities (Table III).

Table I: Exploratory and confirmatory factor analysis

Measured variables	**FL[a]**	**SRW[b]**
Lean Principles		
Understanding customer needs*(Mean Value=5.15)*		
I know the utility of the services I offer (VAR_01)	0.882	0.950
I am continuously interested in increasing the utility of the services I offer (VAR_02)	0.866	0.840
I know how satisfied the citizens are with the services I offer (VAR_03)	0.874	0.837
Establishment of value streams *(Mean Value=5.71)*		
I know which services my actions contribute to (VAR_04)	0.876	0.840
I am continuously coordinating my actions with the actions of other colleagues involved in providing the same services to citizens (VAR_05)	0.854	0.710
Creating flows within the value streams*(Mean Value=5.11)*		
Reducing the time it takes to process citizens' requests is a daily main goal of my work and that of the colleagues involved (VAR_06)	0.841	0.833
My workspace is by definition designed in such a way as to ensure the smooth and delay-free execution of my duties (VAR_07)	0.895	0.878
My supervisors and colleagues have the decision-making skills to solve problems should they arise in the execution of my duties (VAR_08)	0.871	0.832

Value perfection *(Mean Value=4.29)*		
Citizen complaints that are documented and correct are taken into account to improve the procedures (VAR_09)	0.729	0.728
Actions to avoid mistakes are determined in cooperation with the employees involved (VAR_10)	0.806	0.680
I identify opportunities to improve processes and the corresponding services offered to the citizen (VAR_11)	0.784	0.742
Organizational Performance		
Operational performance *(Mean Value =5.49)*		
Employee efficiency (VAR_12)		0.620
Employee effectiveness (degree of achievement of the objectives) (VAR_13)		0.858
Service quality (VAR_14)		0.731

Notes:[a]Factor Loading (EFA), [b]Standardized Regression Weights (CFA)

Figure 1: The second order model

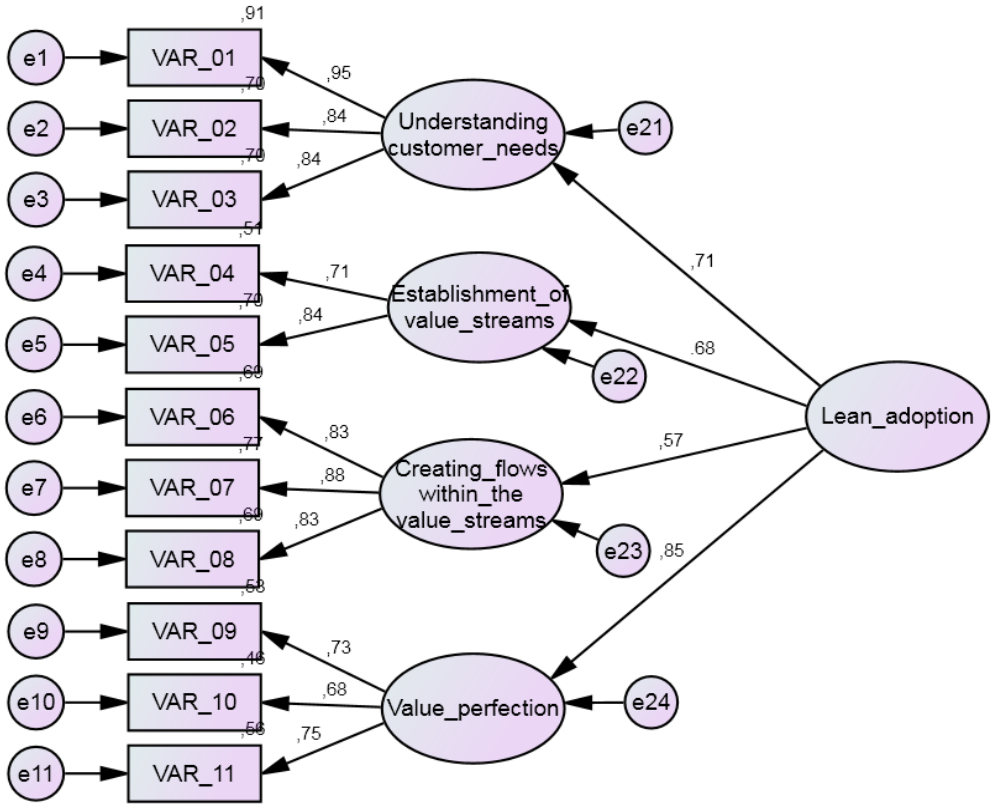


Table II: Goodness of fit measures

Goodness of fit measures	Lean principles model (1st order)	2nd order of Lean	CFA Model (overall)	Structural model
Target coefficient (x^2 of 1st order CFA/$x^2$of 2nd order CFA)	0.906			
The basics of goodness of fit				
Chi-square (χ^2)	75.904	88.168	132.666	132.666
Degreesoffreedom (df)	38	40	72	72
Probabilitylevel	0.00[a]	0.00[a]	0.00[a]	0.00[a]
Absolute fit indices				
Chi-square/degrees of freedom (χ^2/df)	1.997	2.204	1.843	1.843
RootMeanSquareofApproximation (RMSEA)	0.039	0.042	0.035	0.035
Standardized Root Mean Square Residual (SRMR)	0.021	0.033	0.033	0.033
Goodness of fit index (GFI)	0.980	0.977	0.973	0.973
Incremental fit δείκτες				
Normed fit index (NFI)	0.980	0.977	0.971	0.971
Incremental Fit Index (IFI)	0.990	0.987	0.986	0.986
Tucker-Lewis coefficient (TLI)	0.985	0.982	0.983	0.983
ComparativeFitIndex (CFI)	0.990	0.987	0.986	0.986
Parsimonious fit δείκτες				
Parsimonious ComparativeFitIndex (PCFI)	0.684	0.718	0.780	0.780
Parsimonious Normed FitIndex (PNFI)	0.677	0.710	0.768	0.768

Notes:[a]According to Hair *et al*. (2006) in case of n >250, m (variables) ≥ 30, RMR < 0.08, RMSEA < 0.07, CFI > 0.90.

Table III: Model reliability and validity

Latent constructs	Cronbach's alpha	Average variance Extracted*	Construct Reliability**	$(Corr)^2$***
Lean Principles				
Understanding customer needs	0.907	0.769	0.887	0.388
Establishment of value streams	0.746	0.605	0.705	0.170
Creating flows within the value streams	0.884	0.718	0.799	0.213
Value perfection	0.760	0.515	0.791	0.388
Organizational performance				
Operational performance	0.780	0.552	0.884	0.140

Notes: *AVE = $\Sigma\lambda_i^2/n$, (number of items i = 1 . . n, λ_i = standardized factor loading); **CR = $(\lambda_i)^2/[(\lambda_i)^2 + (\delta_i)]$, (number of items i = 1. . .n, λ_i = standardized factor loading, δ_i = error term); ***the highest squared correlation between the construct of interest and the remaining constructs

The structural model

In this study, the two-step procedure approach is chosen as the most suitable for testing the hypothesized structural model. In the first step CFA is conducted, while in the second step the hypothesized model is tested (Hair *et al.,* 2017).Soinitially, CFA was applied between the extracted latent factors of Lean principles and the unobserved operational performance factor.Latent factors show acceptable fit to the empirical data (Table II). Finally, construct, convergent, discriminant and nomological validity are confirmed indicating strong evidence that the proposed latent factors meet rigorous tests of these types of validities (Table III).

Thus and according to the literature we specified the relationships between the latent constructs that express respective research sub-hypotheses and then we examined the structural model's fit to the observed data.In Table II, we observe that the structural model provides a good overall fit, while as far as the goodness of fit indices there are no differences with the respective indices of the CFA model.The measurement model and the hypothesized structural model are depicted in Figure 2 and Figure 3 respectively. As shown in TableIV,research hypothesis (H_1) is supported.So, we conclude that "Lean adoption" significantly influencesoperational performance.

Figure 2: The measurement model

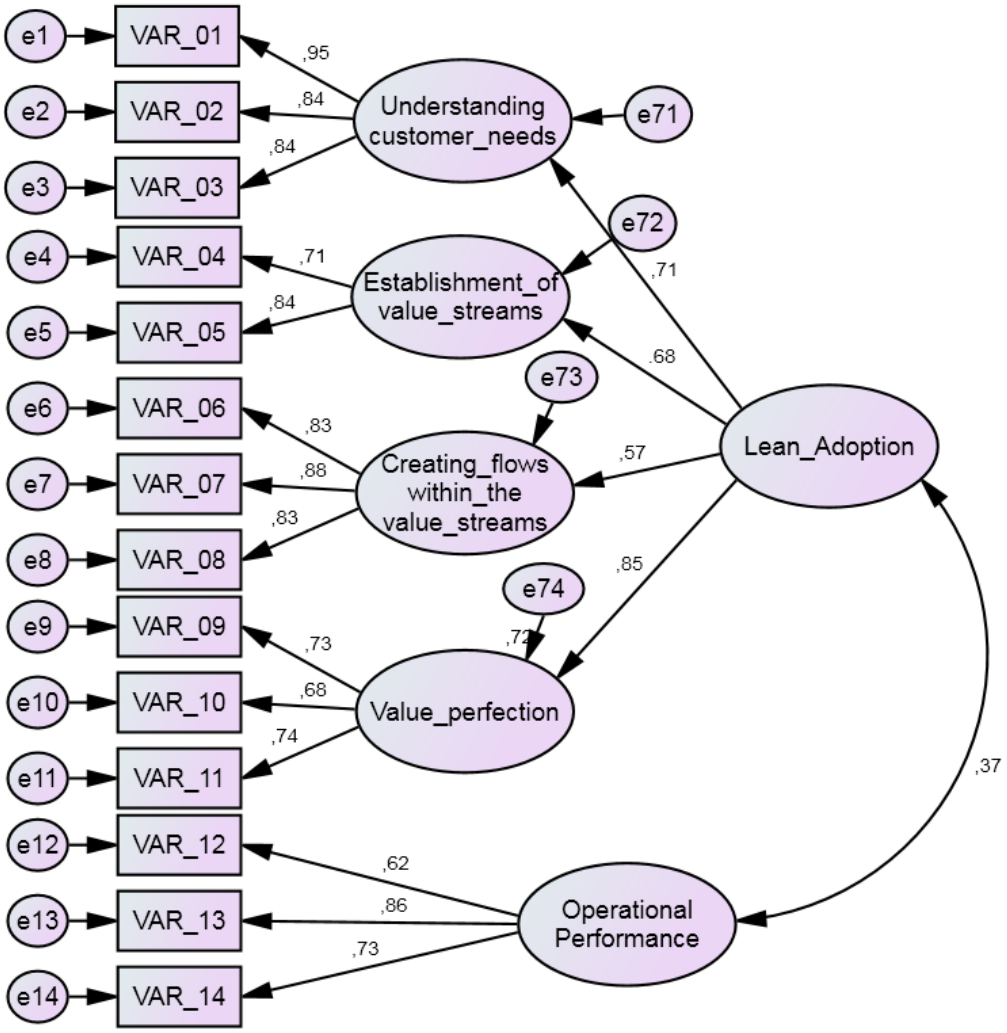
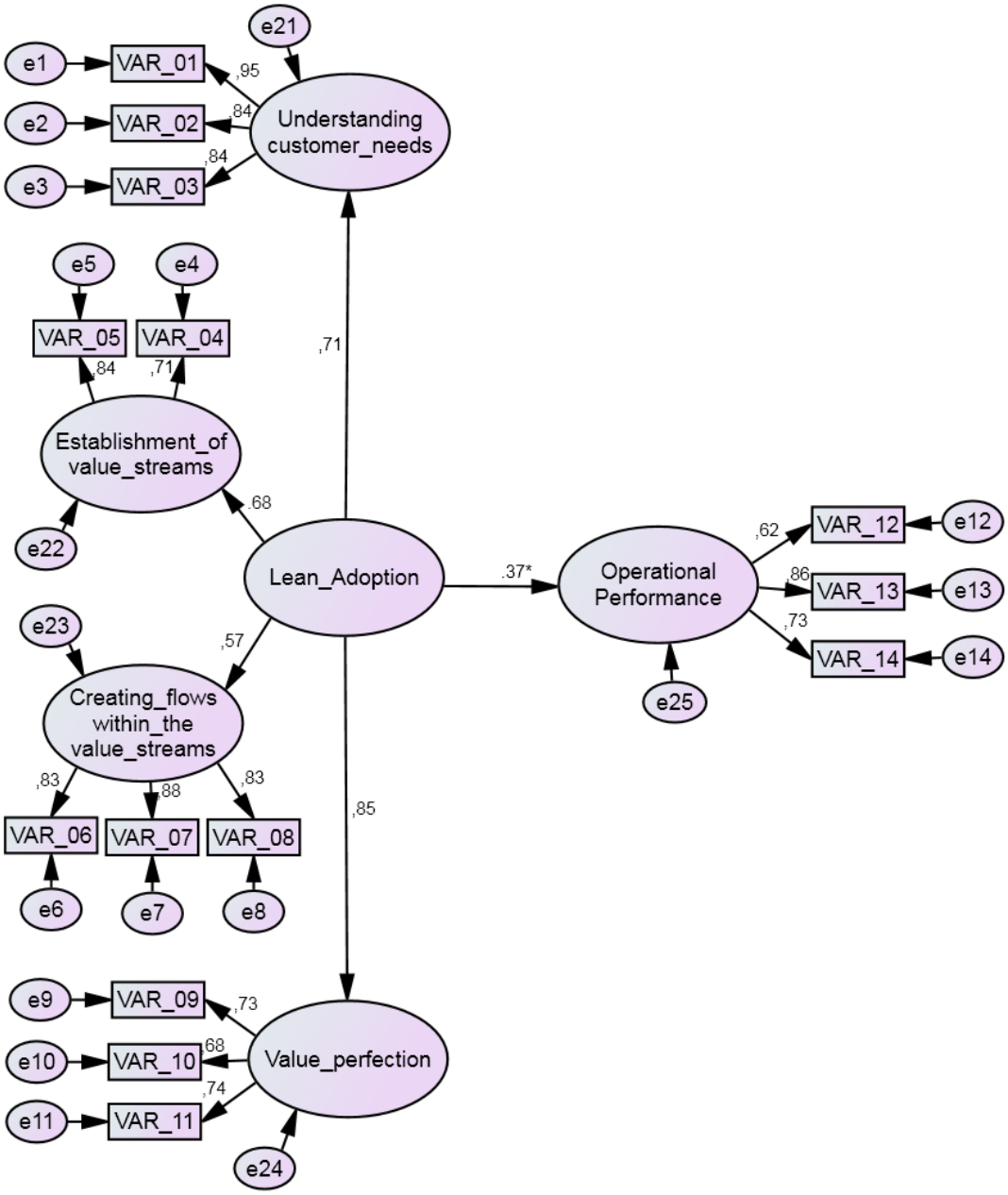


Table IV: Results of the basic research hypothesis

Relationships	Standardized regression weights	Standard error	p-Value	Hypothesis test results
H_1:Operational Performance => Lean adoption	0.375	0.087	***	Accepted

*** statistically significant at p = 0,001

Figure 3: The hypothesized structural model



Notes: *statistically significant at p=0.001

Discussion

Employees of CSCs from all over Greece participated in the survey, which means that the respondents are adequately distributed among all Greek administrative districts and furthermore, they are almost equally distributed among all CSCs throughout the Greek territory.

In terms of profiles of the employees of the CSCs, the majority of them are simple employees (without subordinates), highly educated and with ample experience. Similarly, the employees participating in the study of Psomas and Antony (2018) in public sector

were highly experienced professionals with sufficient competence to evaluate the Lean degree of their work environment.

This study offers empirical evidence on the contribution of Lean adoption to operational performance in the public sector and in particular CSCs. Data analysis, applying EFA and CFA, revealed four latent constructs that represent the main principles that describe the adoption of Lean namely: understanding customer needs, establishment of value streams, creating flows within the value streams and value perfection.Assessing the importance of these constructs, using the mean valuesof the latent constructs, we observe that the Greek CSCs adopt these four Lean principles at a medium to high extent, similar to the public services organizations studied by Psomas and Antony (2018). Among the Lean principles considered in the present study, "understanding customers' needs" and "establishment of value streams" are those mostly adopted by CSCs than "creating flows within the value streams" and "value perfection". These findings are also consistent with the researches of Psomas and Antony (2018) and Madsen *et al.* (2019). However, the results of this study did not validate the application of the "pull approach" principle, as all its measured variables were dropped due to their very low loadings (< 0.5).In the same vein, Psomas and Antony (2018) and Madsen *et al.* (2019) demonstrated that the above four Lean principles are mostly adopted in the public sector in contrast to the application of the pull approach which is adopted to a moderate or very low degree.Netland and Powell (2017) claim that the five fundamental principles of Womack and Jones (1996) are not necessarily universally applicable. For example, in the service sector there is ambiguity as to the pull principle (Bateman *et al.,* 2014). The broader idea of pull in a service is considered to be providing a service, as and when required by the customer, in which case then the wording of "pull" may be a misnomer (Bateman *et al.,* 2014). Bateman and Hines (2017) suggest that "demand readiness" is a more appropriate term than pull in the context of public services where the withdrawal and replenishment materials are not necessarily the signal for authorizing work.In addition, Madsen *et al.*(2017; 2019) reported that public services vary in terms of how they interpret and apply the Lean principles, with most developing their own "home-made" Lean model.

Furthermore, the present study investigated the influence of Lean adoption on operational performance of Greek CSCs. Hypothesis testing revealed that Lean adoption contributes statistically significantly and positively to operational performance.More specifically, the findings of this research revealed that the adoption of Lean principles in the CSC environment can reduce the time required to provide services by limiting the excessive movement of people among public departments, reduce the response time to citizen requests while reducing the waiting time of citizens to receive the service. Bureaucracy is suppressed and productivity is enhanced by reducing waste, simplifying the process with systematic flows and saving time procedure. In fact, human errors are reduced, the quality of services provided is improved and the organization can become more effective and efficient.

The findings of this work are in line and confirm the similar study by Zefaz (2020) and Madsen *et al.* (2017; 2019)according to which the Lean adoption in the public sector contributes to operational performance (better use of resources, improved quality and enhanced productivity). In the same vein Antony *et al.*(2017a) demonstrated that the Lean methodology positively affects the operational performance of public organizations. In particular they revealed a set of benefits including internal customer satisfaction, process

effectiveness and efficiency, employee engagement and morale, service quality, productivity and process innovation. The essential role of Lean adoption in the operational performance of a public service became alsoevident in the researchesof Vadivel *et al.* (2021), Bakar *et al.* (2017), Fletcher (2018) and Caiado et al. (2020).

Conclusions

The Greek CSCs constitute an unexplored sub-sector of public administration in terms of Lean. This fact, as well as the gap identified in the literature and the future research studies suggested by experts, has motivated the authors of the present study to focus on the impact of Lean adoption in specific public service organizations operating in Greece, namely CSCs.

The main conclusion to be drawn from this study is that there are four key areas that should be considered by the CSCs that seek to adopt Lean. These areas constitute the main Lean principles that require attention and are the following: understanding customer needs, establishment of value streams, creating flows within the value streams and value perfection.Thus, they reflect the underlying structure of Lean adoption in CSCs that require attention. If these latent constructs are carefully taken into consideration in the Lean transformation program, it is more likely to gain success and ensure the sustainability of Lean in public services organizations such as the CSCs. Furthermore, the empirical research presented in this paper revealed the positive influence of Lean adoption on the operational performance of CSCs.

Finally, the findings suggest that Lean constitutes a dynamic management paradigm which can help public service organizations to eliminate waste, reduce costs and human errors, increase added-value activities, improve production processes and the quality of the services providedand therefore increase citizens satisfaction.

Practical Implications

Significant implications arise from the present study findings from the practical as well as academic-research perspective.More specifically, the latent constructs of the Lean principles revealed will serve as a source of reference for the managers and decision-makers of innovative public services organizations such as the CSCs, in order for them to set the foundations for successfully adopting the Lean methodology and therefore, harvesting its potential benefits.Lean adoption is described as a second-order factor in terms of four underlying dimensions.By focusing on the improvement of these dimensions, managers and decision makers of the respective Greek public service organizations could develop and measure Lean adoption and accordingly direct their efforts to further increase its adoption degree.In addition, the findings suggest that the adoption of Lean can significantly contribute to making improvements in the operational performance of public organizations,in order for the effectiveness and the quality of the services offered to citizens to be improved.In other words, adopting the Lean principles revealed can certainly be strong motives not only for the public servants themselves but also for the public managers and policymakers to help organizations eliminate all waste and costs, improve quality management initiatives and satisfy the end recipients of their services and generally all stakeholders (citizens, workers, government, etc.) The unsatisfactory adoption of these Lean principles in CSCs will lead to the failure of the overall attempt aiming at the reshaping these public services organizations.

The present study findings also benefit academics and researchers. This study offers a theoretically developed and empirically proven reliable and valid model to measure the Lean adoption to operationalperformancein specific public service organizations, in CSCs.So, the existing knowledge about the Lean adoption in the services sector or the general public services sector is expanded, updated and modified accordingly based on the conditions of the CSCs. Nevertheless, this is the first study to propose a construct second order CFA to measure the Lean adoption and its contribution to the performance of public organization. This represents the significant contribution of this study to the existing literature in the area.

Finally, the model formulated can also help academics and researchers develop valid theoretical models that relate Lean principles to the operational performance of these organizations or serve as a reference to generate new research ideas that will have major practical significance.

Limitations and future research agenda

The present study suffers from some limitations that should be carefully considered while generalizing the findings. The small percentage of the responding employees of the CSCs, given their large population, and the subjective instead of objective nature of the data collected constitute the main limitations of the present study. Given the specific research area of the present study meaning the Greek CSCs, the generalization of the findings to other public services sub-sectors operating in Greece, should be carefully considered. In other words, while the present study findings derived from the CSCs may be relevant to other Greek public services organizations, they should be carefully interpreted to fit to the whole Greek public sector. The same also applies to the public services organizations operating to other countries worldwide which are similar to the Greek CSCs.

The above-mentioned limitations provide directions for further research. Firstly, it is suggested increase the sample of the respondents from the CSCs throughout Greece approximating the population of these employees.In addition, expanding the present research to more public services sub-sectors in Greece and in many other countries is strongly suggested, diachronically.Finally, it is proposed that the model of this study be further investigated so that it can be validated in other public sector services. Thus, based on such studies, the structure of Lean adoption and benefits in the public sector in general can be validated, while the relationships between Lean adoption and operational performance can be further explored,in other public services as well.

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