Developing a Measurement Scale of the Public Sector's Ability to Adopt Lean

Ismail Ait Abdelmalek[1] · Souad Houfaidi[1]

Abstract

The purpose of this article is to develop a measurement scale of the public sector's ability to adopt Lean. The study focuses on the exploring phase of the Churchill paradigm. The scale measurement is constructed from the treatment of data from the survey carried out on a sample of 430 employees of administrations and territorial communities in Morocco. The exploratory research highlight five dimensions that might be used to assess the public services' ability to implement the Lean approach. The five dimensions of the construct are: Leadership and team spirit, customer orientation, communication, employee training and continuous improvement.

Keywords Public services · Lean management · Measurement scale · Churchill paradigm

Introduction

Public services are characterized by an absence of competition, a lack of profitability requirements, slow and bureaucratic processes (Anacleto et al., 2010), heterogeneity and a lack of standardization (Fitzsimmons & Fitzsimmons, 2005; Slack et al., 2007; Looy et al., 2003). These dysfunctions lead to a lot of waste and a total disengagement of employees. Consequently, the public sector is called to take on many challenges to meet the expectations of citizens. This requires rigorous methods and tools to improve performance. Thus, public service reform has continued around the world, frequently using private sector management techniques and methods.

✉ Ismail Ait Abdelmalek
ismailmalek.74@gmail.com

Souad Houfaidi
souad.houfaidi@gmail.com

[1] Laboratory of Mechanics, Production and Industrial Engineering (LMPGI), High School of Technology (ESTC). CED: Engineering Sciences Center for Doctoral Studies, National High School of Electricity and Mechanics (ENSEM)of Hassan II Université, Casablanca, Morocco

Lean Management, or Toyota Production System (TPS) to give it its original name, remains one of the fascinating manufacturing methods adopted by public services.

The term "Lean" literally means meagre, it appeared first time in the book "The machine That changes the world" written by Womack et al. (1990), which inspired companies around the world to adopt Lean thinking. The authors describe Lean as a way to "add value, reduce waste and initiate a process of continuous improvement". They formulate five fundamental principles, characterizing the Lean approach, namely:

- *Define value*: The first principle, as defined by Womack and Jones, is to define value from the customer's need in order to increase the value of the product or service by eliminating unnecessary activities.
- *Map the flow of value*: Customer value is the basis for defining the value chain, which means planning and analyzing the activities in the process and determining how they add value to the product or service.
- *Create a continuous flow*: This means streamlining products throughout the process rather than producing them in batches. By creating a continuous flow, waste can be reduced in the processes.
- *Work in pull flow*: Goods and services are produced only when an internal or external customer requests them. For this purpose, the *Kanban* system is used to achieve a minimum stock at any point in the production chain.
- *Tend to perfection*: While Deming has described continuous improvement as "improvement initiatives that increase success and reduce failure" (Sundar et al., 2014), Womack and Jones suggest that the principles that ensure continuous improvement should be viewed as a continuous and iterative process. Hines et al. (2008) argue that continuous improvement is the most important goal for the long-term success of the Lean program since the capacity for improvement increases over time.

These principles are reformulated into rules at three levels. The first level is about the value produced by the company. This value must be defined from the customer's point of view and flow continuously down the value chain to immediately reveal the problems. The second level relates to the productive scheme of the company, which must derive its production according to demand and be based on standardized production processes. Finally, the third level of analysis relates to the attitude of managers who must help operators find solutions when a problem arises (Houy, 2008).

According to Elias and Davis (2018), Lean is a systemic approach focused on managing value streams that public sector organizations can use to improve their services. Therefore, given their need for efficiency, public administrations have introduced Lean principles and tools into their organizations to improve workflow and reduce administrative waste (Tapping & Shuker, 2003).

In fact, the problems confronting public services today were present in industrial activities long before they introduced Lean management to improve their performance, particularly to simplify procedures and reduce waste. Thus, Lean is common in Denmark (Pedersen, 2011), the United Kingdom (Douglas, 2017) and in many other countries.

In recent years, Lean has aroused the interest of researchers. However, there is a lack of prospective surveys on the ability of public sector organizations to implement Lean management. Therefore, it is necessary to discuss the specific requirements for adopting Lean in the public sector. Indeed, to successfully adopt the Lean approach, public services must meet certain prerequisites. Involvement of all stakeholders, cooperation, customer focus, communication, and a clear definition of objectives and roles are listed as prerequisites for Lean implementation in the literature.

This study aims to develop a scale for measuring the public sector's ability to implement the Lean approach. Based on the Churchill paradigm, the scale is constructed using descriptive data gathered through a questionnaire. The selected sample comprises of 430 Moroccan public service employees.

Methods

The methodological approach used to construct the measurement scale of the public services' ability to adopt the Lean approach is based on the Churchill paradigm (Churchill, 1979). Although this paradigm is contested today (Rossiter, 2002), it remains relevant because it proposes precise rules and simple measures for constructing measurement scales. In addition, it is particularly appropriate for this study because it involves developing an original multi-item scale.

The object of a measuring instrument is to achieve a perfect assessment of the phenomenon studied using the "True score theory" (Evrard et al., 1993). This theory states that if there are no measurement mistakes, every observation has a true score (T) that can be seen accurately. However, an error (E) often results in a deviation of the observed score (X) from the true score, as shown below:

$$X \quad = \quad T \quad + \quad E$$
$$\text{Observed score} \quad \text{True score} \quad \text{Error}$$

There are two sorts of measurement errors: random and systematic. Random error results from a set of unknown and uncontrollable external factors that influence some observations but not others. For example, some respondents may be in a better mood than others at the time of assessment, which may influence how they answer to the measurement items. However, it is impossible to predict which subject is in which type of mood or to control the effect of mood in research studies. Hence, the random error is considered as "noise" in the measurement and is generally ignored. As to the systematic error is caused by factors that have a consistent impact on all observations of a construct.

Churchill recommends four steps to construct a measurement scale: (1) specification of the construction domain and construction of the items; (2) constitution of the database; (3) purification process by exploratory factor analysis; (4) verification process by confirmatory factor analysis. Details of this process are described in the following paragraphs.

Generation of Items

The items of the measurement scale for the public services ability to adopt Lean were generated on the basis of the literature on the one hand, and on the other hand on discussions with employees of a Moroccan public service to enrich the evaluation criteria resulting from the literature review. Thus, 34 items are generated. Professional advice and discussions with employees allowed us to judge the relevance of the items generated to measure the concept. Then we discarded 8 items and reformulated some statements. A total of 26 items were selected to evaluating the construct studied.

A four-point Likert-type scale is used to measure items as follows:

- The first degree corresponds to: Strongly Disagree;
- The second degree corresponds to: Disagree;
- The third degree is: Agree;
- The fourth degree is: Strongly agree.

The Likert scale proposes a list of affirmative statements that can be used to characterize a construct. The respondent might use this list to express their level of agreement or disagreement with the proposed judgment.

Data Collection

The selected sample includes employees from public administrations and local communities (LC) in Morocco. Thus, the authors have chosen a sample of 430 employees of certain LCs. The survey questions are written in basic and easy-to-understand language, and the objective of the study is clearly stated by insisting on the anonymity and secrecy of all information provided.

The study was carried out from February to October 2020, on a voluntary basis with Moroccan employees working in local communities. Data collection is done in two distinct ways. First, the authors distributed the questionnaires to the participants, giving them enough time to respond. The circumstances relating to Coronavirus, such as confinement and social isolation, slowed and even halted the recovery of the questionnaires. Therefore, the authors created an electronic version of the questionnaire using Google Forms and shared it with public-sector personnel through social media groups.

In total authors received 303 responses, resulting in a 70.46% response rate. The authors then discarded 19 questionnaires that contained missing data. Finally, 284 questionnaires are maintained, resulting in 66.05% exploitation rate.

The Fig. 1 summarize the distribution of respondents by gender, age and functional level.

Purification of the Measuring Instrument

In order to determine the dimensions of the measurement scale of the Moroccan public services' ability to adopt the Lean approach principles, the authors carried out an exploratory analysis of the data collected.
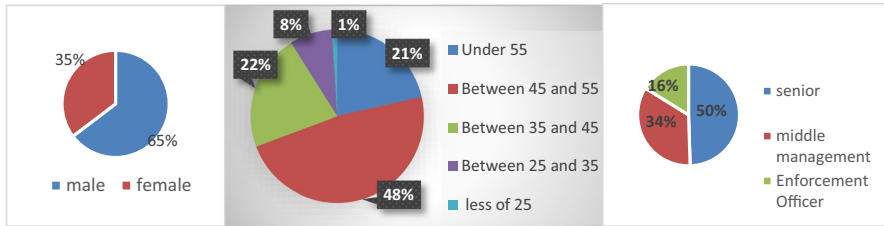
Fig. 1 Description of the sample

The factor analysis and reliability tests, recommended by Churchill's paradigm during the exploratory phase, are used to analyse the data collected.

The Factor analysis (FA) makes it possible to explore the relationships between several variables and thus to discover the underlying structure of a concept. It seeks to reduce a large amount of information to a few dimensions. In other words, it tries to explain the higher part of covariance by a few possible variables (called dimensions or factors). The term "latent variables" is used to denote variables which are not measurable, but which exist in the conceptual model only.

The Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity test allow appreciating the possible efficiency of factor analysis. According to Galtier (2003), the KMO test must be greater than 0.5 and Bartlett's test must be significant (p < 5%) for the FA to be feasible.

The Principal Component Analysis (PCA) permits checking whether the scale used is uni- or multi-dimensional and determining the number of dimensions composing thes scale. The PCA is carried out by applying the KMO criterion which recommends keeping the factors that have an eigenvalue greater than or equal to 1. These factors must have a minimum percentage of explained variance in order to be kept. Philippeau (1986) proposes the following thresholds:

– Explained variance > 0.8, the variable is very well represented;
– 0.65 < explained variance < 0.8, the variable is well represented;
– 0.40 < explained variance < 0.65, the variable is moderately represented.

The examination of the correlation matrix constituting the final step of the factorial analysis, it allows to test the structure stability of the factors obtained. If the factors are strongly correlated (correlation > 0.3), an oblique rotation (oblimin) is adequate. On the contrary case, it is necessary to orient towards an orthogonal rotation (Varimax) (Galtier, 2003). In this article, the Varimax rotation was used. Indeed, it is frequently employed because of the absence of a strong correlation between the factors.

The estimation of the reliability will complement the factor analysis. The reliability of a measuring instrument represents its ability to produce similar results if it is administered several times to the same population (Roussel, 1996). A Cronbach's alpha should be between 0.6 and 0.8 for an exploratory study (Evrard et al., 1993). A value greater than 0.70 allows concluding that the scale has good internal

consistency. However, Nunnally (1978) suggests that a Cronbach's alpha of 0.5 is acceptable.

The purification of the measurement scale was carried out on The SPSS (IBM software) version 25, and the main results will be presented below.

Results and Discussion

The purification of the measurement scale required four successive principal component analysis (PCA). Indeed, as soon as the authors remove a variable from the analysis, they proceed to check the relevance of a factorization of the data. All KMO tests are > 0.5, and the Bartlett's sphericity test indicates, each time, a high score with significance ($p < 0.001\%$), which rejects the hypothesis of no correlation. This, therefore, justifies the use of principal component analysis and makes it possible to conclude that the data are, each time, factorisables. The Table 1 summarizes the results of the last PCA.

The four PCAs lead to exclude 14 items, either because they were poorly explained by the factors retained (a communality score was less than 0.5) or because they were loaded on several factors.

The results of the PCAs give at the end a factorial structure of five dimensions, which restore 73.25% of the total variance for a KMO coefficient of 0.718 and show that all items present an excellent quality of representation (> 0.50). The authors have excluded the other factors because they do not well explain the variance and their eigenvalues are less than 1 (Table 2).

The examination of each element's contribution to the factors helps identify those that are misrepresented by the factors and should be eliminated. The item contributions in each component after Varimax rotation are presented in Table 3.

This factorial structure shows that all items have factorial contributions greater than 0.50 on each common factor. In addition, each item associated with a factor presents a rich saturation on the axis of this factor.

Then, the authors completed the purification process by examining the reliability of the five dimensions identified by the PCA.

Reliability Analysis

The traditional way of describing reliability is that the result of a study would remain the same if it were redone. However, this is not possible in many

Table 1 KMO coefficient and Bartlett test

Kaiser-Meyer-Olkin Index for measuring the sampling quality.		,718
Bartlett's sphericity test	Chi-square approx.	**1006,354**
	Degrees of Freedom (Dof)	**66**
	Signification	**,000**

Value of KMO Coefficient and Bartlett test are presented in bold

Table 2 The results of the principal component analysis

Rotation of the component matrix

	Components				
	1	2	3	4	5
My immediate supervisor succeeds in making people work together	,882				
My immediate supervisor facilitates my work	,869				
My immediate supervisor is attentive to what I say	,864				
My job has an excessive number of tasks		,755			
My work requires speed of execution		,753			
In my work, importance is given to the needs and demands of citizens		,733			
In the execution of my tasks, I meet several interruptions and disruptions			,866		
I receive contradictory orders from my superiors			,848		
My job forces me to learn new things				,860	
My job requires a high level of qualification				,824	
My work allows me to make decisions independently					,804
I have the liberty to decide how I do my job					,735

Table 3 The contributions of the items in each component after Varimax rotation

Total variance explained

Components	Initial eigenvalues			Sum extracted from the load square		
	Total	% of variance	cumulative %	Total	% of variance	cumulative %
1	,057	25,472	25,472	3,057	25,472	25,472
2	,250	18,754	44,225	2,250	18,754	44,225
3	,351	11,255	55,480	1,351	11,255	55,480
4	,129	9,408	64,888	1,129	9,408	64,888
5	,003	8,358	73,246	1,003	8,358	73,246
6	692	5,769	79,015			
7	599	4,993	84,008			
8	545	4,541	88,550			
9	437	3,644	92,194			
10	394	3,286	95,480			
11	286	2,387	97,867			
12	256	2,133	100,000			

case studies. Rather, reliability can be seen as a hypothetical test that another researcher gets the same findings and conclusions on the same study and at the same time.

The reliability of the measurement scale is checked by calculating the Cronbach's alpha for each factor retained and for the entire scale (Table 4).

The Factor reliability indices used in the survey are well above the norm of 0.6, except for factor 5 with an index of 0.509, which is also acceptable in exploratory research according to Nunnally (1978).

Cronbach's alpha allows concluding that the items are correlated and consistent with each other and that they can be added to constitute a scale score (Kaiser & Rice, 1974). Regarding the entire scale, it presents good reliability, with a Cronbach's alpha of 0.687. Indeed, the quality of the coefficient is a necessary condition to associate the items of these four scales with the same questionnaire.

Thus, the authors conclude that each item is perfectly consistent with all the other statements of the scale to which it belongs and that all items share a common notion. After they specify the item weights in the matrix and establish the structure of the factors from the significant weight variables in the column for each factor. By referring to the labels of the items in the questionnaire and looking at the associated variables, the authors proceeded to name the latent construct measured by each factor. The result is as follows:

Factor 1: Leadership and team spirit.
Factor 2: Customer focus.
Factor 3: Communication.
Factor 4: Employee training.
Factor 5: Continuous improvement.

This instrument shows that five factors are required to increase the use of Lean principles in the public sector. These factors are leadership and team spirit, focus on customer needs, communication, employee training and continuous improvement.

Furthermore, the successful adoption of lean by public services depends crucially on another essential factor, namely organizational culture. Organizational culture is a set of mechanisms that allow public services to be adjusted to internal and external requirements. Indeed, this factor is essential for any organization to implement a successful strategy such as Lean management. According to Abels (2014), public administration must adopt best management practices and create new form of collaboration in services by installing good organizational culture.

Table 4 Cronbach's alpha for each factor used and for the entire scale	Factor	Cronbach's alpha	Number of elements
	1	0,868	3
	2	0,624	3
	3	0,706	2
	4	0,681	2
	5	0,509	2
	Entire scale	0,687	12

Conclusions

The aim of this study was to develop a measurement scale of the public services' ability to adopt the principles of the Lean approach. This scale should allow us to determine the capacity of Moroccan public services to adopt the Lean approach successfully.

Thus, the authors have presented in detail the different stages which led us to construct a measurement scale according to the Churchill paradigm. The generation of items was based on the literature review and on the results of interviews with public services employees.

The results of the exploratory research highlight five dimensions. They show that each dimension is made up of many components, which show the relevance and effectiveness of the choice of items. The authors are named the five dimensions as: leadership and team spirit, focus on customer needs, communication, employee training and continuous improvement.

In order to refine our measurement scale, the authors performed principal component factor analysis and calculated Cronbach's alpha coefficient to ensure the reliability of the measurement scale.

The scale developed will allow public services to measure their ability to adopt and adapt the principles of Lean management to their context, and to coordinate their efforts to provide that accessible, transparent and high-value services to citizens.

Like all studies, this study has limitations. For example, while the survey method is useful for getting a picture of the ability of public services to adopt lean, it does not offer much "deep" information about a particular service's ability to implement Lean approach.

Declarations

Conflict of Interest The author has no conflicts of interest to declare that are relevant to the content of this article.

Informed Consent This research does not involve human participants and/or animals.

Ethics Approval The author has no relevant financial or non-financial interests to disclose.

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Ismail Ait Abdelmalek received the Master degree in Logistics Engineering from the Hassan II University, faculty of sciences Ain chock, Casablanca, Morocco. He is currently pursuing a Ph.D. degree with National High School for Electricity and mechanics, Hassan II University, Route d'El Jadida, km7, BP : 8118, Oasis, Casablanca, Morocco. His research interests include, manufacturing engineering and technology, Lean management and innovation in the public sector.

Souad Houfaidi A higher education professor in the Hassan II University, High School of Technology, Route d'El Jadida, km7, Casablanca, Morocco. She had obtained her highest degree from the University of Henri Poincaré, Nancy 1, Faculty of sciences and Techniques. She has published original articles in the area of her studies. Her research interests include, but not limited to, statistics, mathematics, operational search, quality.