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## Lean and Six Sigma practices in the public sector: a review

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**Continuous Improvement Methodologies in the Public Sector: a systematic review**

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## Lean and Six Sigma Practices in the Public Sector: a review

### Abstract

**Purpose** – This paper provides a critical analysis of publications relating to the use of Continuous Improvement (CI) methodologies such as Lean, Six Sigma and Lean Six Sigma over a seventeen-year period, to identify the themes and gaps and informing the development of a future research agenda.

**Methodology** – The systematic literature review identified 121 papers published between 2000-2017, from searches of over 1400 peer reviewed academic journals and identifies the application of Lean, Six Sigma and Lean Six Sigma across the public sector.

**Findings** – This research compares the scale and breadth of the public sector with the application of CI methodologies and finds that such application is unstructured and, in some areas, sporadic. The research identifies common themes and research gaps including areas such as lack of shared understanding of Lean, gaps in strategy development and leadership and an over focus on tools alone.

**Research Limitations/implications** – The methodology focussed on journals rated in the ABS Journal Guide 2015, which allowed manual searches for accuracy and relevance to the area of investigation. It is recognised that this may exclude some articles which have been published in other journals but allowed for a structured and detailed investigation. The research identifies some very clear gaps which can inform future research agendas.

**Practical Implications** – The paper details the implications and challenges to the public sector generally and to executive leadership specifically and in particular covers the common issues and concerns, which in turn will assist public sector organisations in implementing, reviewing or refreshing their CI initiatives.

**Originality/Value** – No similar work has been identified and while some individual areas such as health and education have been the subject of more focus, this research explores the public sector as a whole and considers the patterns of research in that context.

**Keywords:** Lean, Six Sigma, Lean Six Sigma, public sector, continuous improvement

## Introduction

The public sector is a significant part of the economy of any country in the world and regardless of specific function or service or country of operation, have many challenges and operating restrictions in common. Public Sector services are informed and directed by political policies and priorities which can be changeable. They compete for a share of an overall budget and must deliver their services within the affordability of budget and this is a key consideration in the strategic management of public sector services (Poister and Streib, 1999). Often the services provided are to the most vulnerable in society and sometimes are not wanted or desired by the recipients. The services to a greater or lesser degree are also provided regardless of the customers' ability to pay (Flynn, 2007).

This systematic literature review explores the extent of the use of Lean, Six Sigma and Lean Six Sigma in the public sector with a view to assessing how these continuous improvement methodologies are used by both managers and staff, prioritised and linked into business planning and strategy. The focus on the methodologies stated reflects the ongoing debate of the impact of lean in particular within the public sector (Carter *et al.*, 2016; Procter and Radnor, 2016; Antony *et al.*, 2016; Radnor and Osborne, 2013).

The rationale and drivers for undertaking this review was in the first instance driven by the development of research into the application of Lean Six Sigma in the civil emergency services in the UK (Police, Fire and Ambulance services) The aim of the overarching research is to explore the factors which impact on creating and sustaining a culture of continuous improvement. This systematic literature review is intended to identify the extent and use of such methodologies as well as identify gaps and themes. There are common factors and 'supply chain' links between public sector agencies, for example meeting basic human needs or treating physical or mental health may impact on crime figures as it removes core drivers of criminality or offending. The efficient and effective gathering of taxation impacts on the budget allocation to other services and the efficient, effective and targeted provision of any service may release budget for other services. This understanding therefore led to a much wider research focus on the public sector in general given the ways in which public sector functions are politically, financially and collaboratively linked.

The principle purpose of the review has been firstly to identify what has been covered by previous scholars, secondly to place the included articles in the context of understanding the scale, breadth and effectiveness of the use of Lean, Six Sigma and Lean Six Sigma in the public sector and to provide new ways to synthesis the body of work and to shed a light on the gaps in research (Booth *et al.*, 2012).

### The definition of public sector

One of the early challenges in undertaking a systematic literature review in this area is the absolute definition of the 'public sector'. Collins English Dictionary defines the public sector as; *'the part of a country's economy which is controlled or supported financially by the government'* (Collins Dictionary 2017). This very broad definition would be supported in the broadest terms by Lane (2000) where she suggests the broadest formal definition would be *'Government activity and its consequences'*. The challenge in becoming more specific is expressed by Flynn in his book *'Public Sector Management'* (2007). He states that:

*The boundary between the public and private sectors is neither clear nor permanent. In some cases, the boundary is well defined: assets get transferred from the public to the private sector through privatization: assets that remain in state ownership are clearly public. The process of outsourcing, whereby private companies provide all or part of services, make the boundary less clear. (Page 1).*

The ultimate final test if there has been any dubiety over the inclusion of a paper has been the one applied by Flynn (2007), where he states that the main defining characteristic of a public service is whether goods and services are only supplied to people who can pay for them and whether they are freely available for money or if people cannot pay they are excluded from that good or service. In the same way, organisations which sit within the private sector, whether in manufacturing or service choose or target who they provide their goods or services to. Within the government owned or directed sector no such client selection takes place. What is clear however, is that the public sector is an important aspect of every country in the world and the scale and cost of the public sector cannot be underestimated. The International Labour Organisation identifies the state as the largest employer in almost every country in the world (ILO, 2017) consequentially, the efficiency and effectiveness of the public sector across the world is of interest and importance to all economies.

## Methodology

The review has initially followed the nine steps in a systematic review process recommended by Dickson et al. (2014);

Step 1: Performing scoping searches, identifying the review question and writing the protocol

Step 2: Literature searching

Step 3: Screening titles and abstracts

Step 4: Obtaining papers

Step 5: Selecting full text papers

Step 6: Quality assessment

Step 7: Data extraction

Step 8: Analysis and synthesis

Step 9: Writing up and editing.

Within the research protocol, the time frame selected for the review was 2000-2017. The commencement date was selected due to the pre-existence of Lean and Six Sigma and the first publication of research which suggested the integration of Lean and Six Sigma. It was also noted that the public sector was not an early adopter (Elias and Davis, 2018) of either methodology individually and therefore the period from 2000 was likely to appropriately identify early applications in the public sector. The key words identified for the searches were:

Police	Lean
Fire	Six Sigma
Ambulance	Lean Six Sigma
Criminal Justice	
Health	
Education	
Government	

Table 1: Key words used for searches.

Scoping searches were utilised using the key words shown above as well as 'public sector'. This term was removed as it was not utilised globally or consistently. The key word search terms were paired one from the left column and one for, the right leading to a total of twenty-one searches overall. Initially four major databases were selected as part of the methodology: SCOPUS; EBSCOHOST; ScienceDirect; Web of knowledge.

The searches failed to identify some publications which were already known and as such was not seen as a reliable approach by the researchers. The main challenge shown through the scoping searches was the identification of what was considered to be within the public sector and whether it was referenced as being within the public sector. This led to the adaptation of the approach initially adopted as the scoping searches identified that frequently initial assessment of the title and abstract could fail to identify a relevant paper for inclusion and this led to the nine steps becoming blurred in the process in order to minimise the exclusion of relevant papers. The initial search results are shown in Figure 1 along with further explanation of the systematic search approach.

The additional challenges identified in the scoping searches were the broad use of key words such as 'government', 'lean', 'fire', 'education' and so on in research in other areas. This identified a large number of publications which would require to be excluded. An alternative approach was identified in order to ensure systematic searches. The Association of Business Schools (ABS) in the UK publish an academic journal guide every three years which is intended to provide business and management researchers to identify suitable journals. This was deemed appropriate to the focus of the research given the three high level areas of lean, Six Sigma and Lean Six Sigma in the Public Sector. The 2015 guide includes over 1400 journals (The Association of Business Schools, 2015) and while it is published in the UK includes journals in the fields of business and management from across the world. It was also noted that part of the editorial process adopted by ABS they additionally utilise major databases operated by Thomson Reuters and Elsevier to identify journals.

The identification of this guide for use as part of the systematic review also supported two other inclusion criteria for the systematic review of journals in the English language and peer-reviewed journals. English language was used as an inclusion criterion due to the language limitations of the researchers and peer-reviewed journals were used as inclusion criteria to maximise the quality and to exclude 'grey literature' (Rothstein and Hopewell, 2009), where the work of consultants or practitioners may present a bias around the use of Lean Six Sigma in the public sector. This approach was intended to minimise that bias while maximising the number of included articles. As a final measure to balance the use of the ABS Journal guide in this systematic literature review. The searches used were also applied to the initially identified databases and no additional articles were identified for inclusion. The overall process is shown below in figure 1.

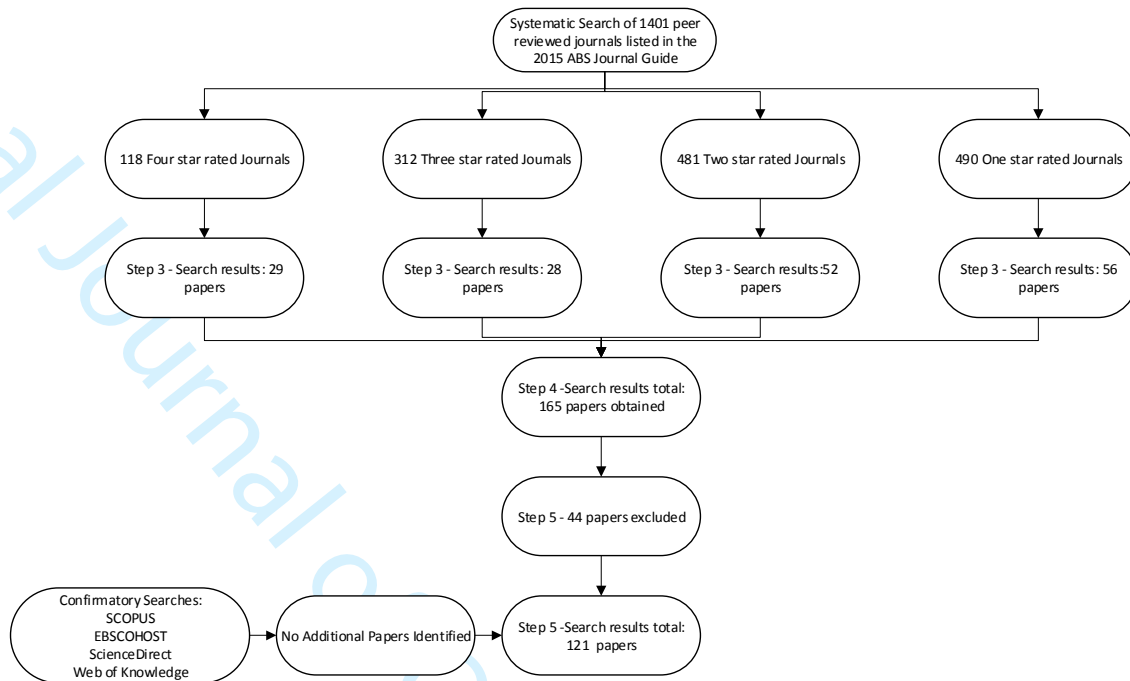


Figure 1: Overview of initial systematic search results

### Findings - Thematic and Descriptive Analysis

Following the final application of the inclusion and exclusion criteria outlined in the methodology, 121 peer reviewed journal articles were included in the systematic literature review. The articles were published in a total of forty-two separate journals from the 1401 journals searched as part of the review. Figure 2 shows the eight journals which have most frequently published articles on Lean Six Sigma in the public sector.



Figure 2: List of journals which have published three or more relevant articles

As can be seen, the eight journals shown account for seventy-eight of the included articles (64% of the overall number). Two of the journals focus on healthcare, one on Human

Resource Management, one on education, one on Public Sector Management and the remaining three on quality and performance management subjects. The remaining thirty-four journals identified which published articles related to Lean Six Sigma in the public sector published either one or two articles during the seventeen-year period of the research.

When considering the spread of articles categorised by journal, the International Journal of Healthcare Quality Assurance published fourteen articles between 2007-2017 the majority of these were published from 2012 onwards. The fourteen articles published in Public Money and Management were between 2008-2015, however twelve of these articles were published in a special issue of the journal in 2008 focusing on “Does Lean enhance Public services?” The most even spread of articles was in Total Quality Management and Business Excellence whose twelve articles were spread between 2004-2017.

The Association of Business Schools Academic Journal Guide (2015) lists thirty-three journals in its section on Public Sector and Health Care of these, seven have published an article on Lean Six Sigma in the public sector between 2000-2017. When the scale of the public sector is considered, a total of 121 articles over a period of seventeen years does initially appear to suggest significant research gaps in this area. This is discussed further when country and sector are considered as part of this analysis.

### Findings - Temporal analysis

The 121 articles included in the systematic literature review were published between 2004 and 2017. The breakdown by year of publication is shown at Figure 3 below.

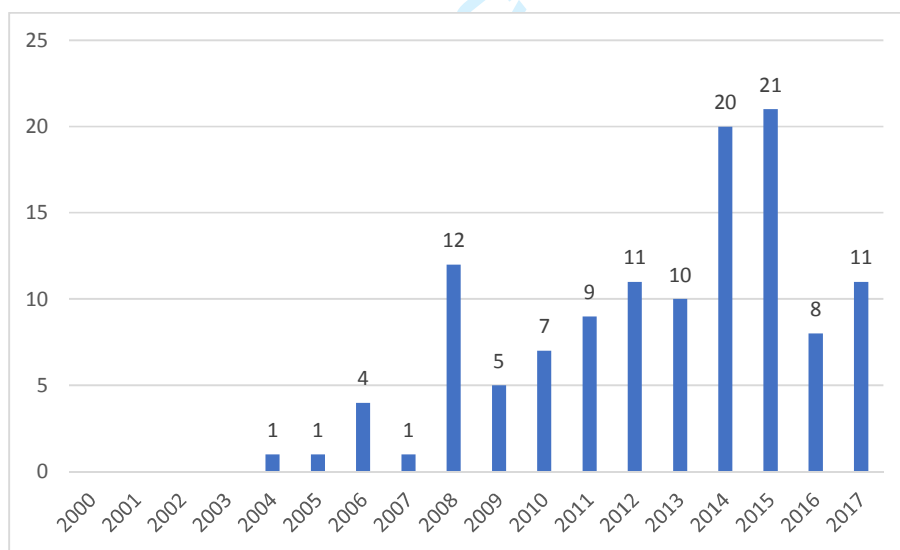


Figure 3: Number of articles by year of publication

No articles were identified prior to 2004 which suggests that the search criteria did, as intended, capture some of the first publications focussed on the public sector. The very first article identified in this area related to the application of Six Sigma in the office of the Chief Technology Officer in local government in a US City (Bigio et al., 2004). The general trend in terms of the number of publications is upwards with more than three quarters of the articles included being published in the last third of the period, between 2011 and 2017.



The pattern is therefore clearly an increase in the number of publications and an apparent increase in the interest of the use of Lean Six Sigma in the public sector in the last few years. It is noted however that the increase appears to be continuous improvement practitioners and academics developing an interest in the public sector rather than public sector focussed researchers developing an interest in continuous improvement. This is suggested when combining the data in Figure 3 with the summary in Figure 2 which shows that relevant articles are predominantly published in journals focussed on quality management rather than journals focussed on public sector services more generally.

### Findings - Geographic analysis

In considering the geographic focus of research in this area, figure 4 breaks down the articles by country of focus and year of publication to consider the spread of public sector research in this area across the seventeen-year period of the literature review. It is emphasised that despite the UK focus of this systematic literature review, the research approach identified and has included articles from a total of twenty-one countries.

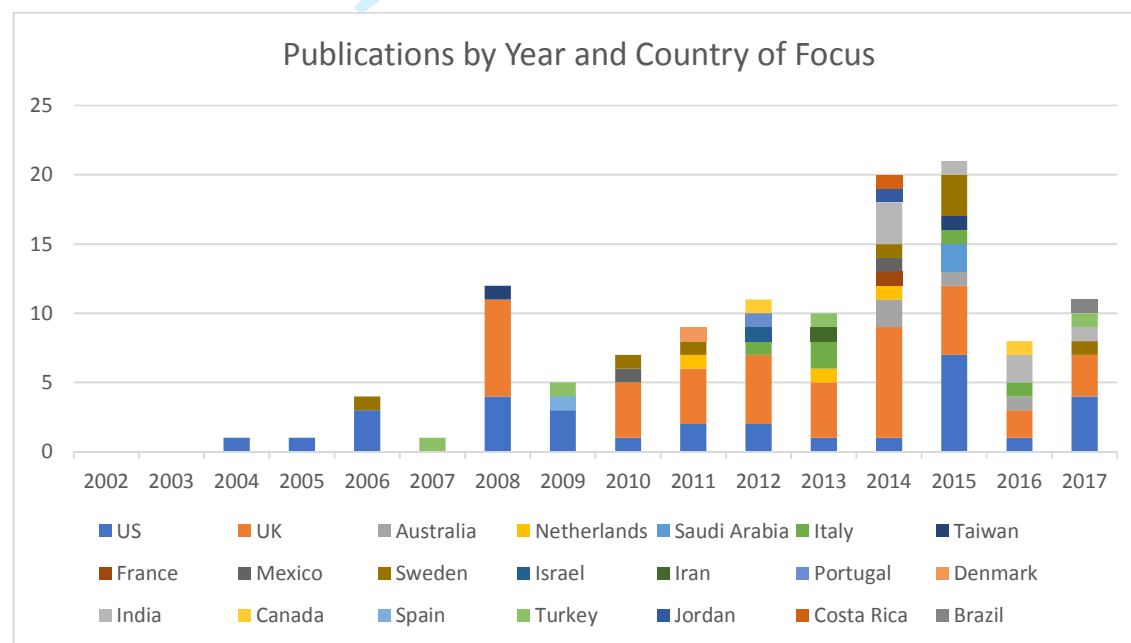


Figure 4: Number of articles by year and country of focus

It can be seen from the figure that early publications in 2004-2006 were centred on the US with only one publication being identified from the first five-year period of the research period. During the second five-year period of the research, publications from Sweden (2006), Turkey (2007) and Spain (2009) emerge. The first publications included from the UK were in 2008 and are accounted for by the special themed issue of Public Money and Management which focusses on Lean in public services.

During the years 2000-2010 of the research period a total of thirty-one articles from only seven different countries were published. In terms of activity by year, in only three of those years did the publications focus on more than two countries and only one year (2010) included publications from more than three countries (Sweden, Mexico, UK and US). This is

then contrasted with the period 2011-2017 where ninety-one articles from a total of twenty different countries are included and the proliferation of research is evidenced by the inclusion of articles from ten different countries during 2014 and eight different countries in 2015 and while this does reduce to 6 different countries in both 2016 and 2017, the final year of the research also sees the first publication from Brazil, which suggests continuing spread of interest.

When the countries of focus are considered by continent some gaps are more emphasised North American Countries are represented by US, Canada and Mexico: European Countries by UK, Netherlands, Italy, France, Sweden, Portugal, Denmark and Spain: Asian Countries by Saudi Arabia, Taiwan, Israel, Iran, India, Turkey and Jordan: Oceania is represented by Australia. The first representation from South American appears in a paper published from Brazil in 2017, however there is no representation from African Countries. The absence of papers from these continents may be reflective of the very disparate deployment of lean, Six Sigma and Lean Six Sigma in the public sector and the fact that their use is still relatively new, and their appropriateness actively debated. This possible explanation is supported by papers exploring the impact of 5S in hospitals in Tanzania (Kamiya et al., 2017) and additionally whereby a systematic literature review of the use of Lean Six Sigma in any business sector only cited one example from Brazil and one example from South Africa from any industry (Zhang et al., 2012). The sample number of papers by country is shown below in figure 5.

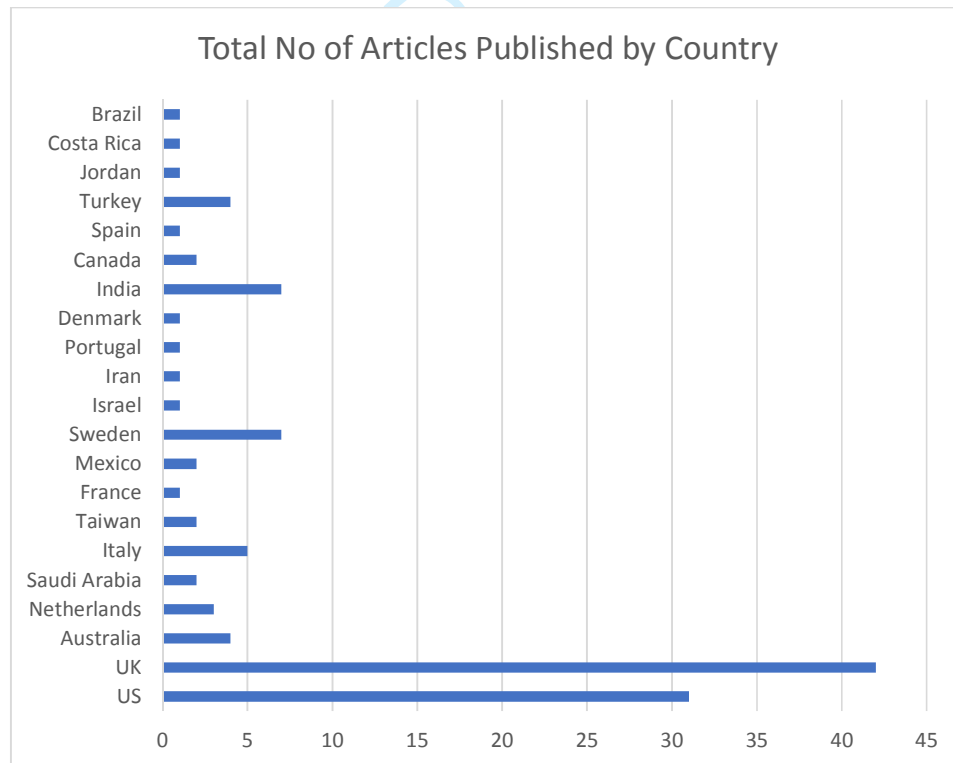


Figure 5: Total number of articles published by country

To try to contextualise this with the size of the public sector in the respective countries consideration was given to available data on the number of public sector employees as a percentage of total employment in the respective countries (Figure 6). The Organisation for

Economic Cooperation and Development was formed in 1960 and currently has thirty-five-member countries (OECD 2017).

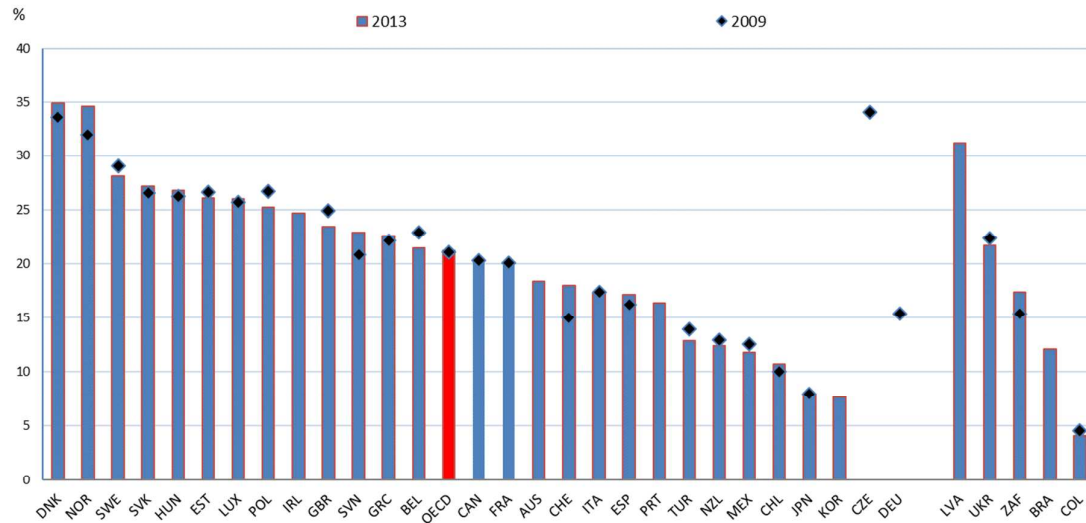


Figure 6: Public sector employment as a percentage of total employment 2009 and 2013 (Source: OECD 2015)

Fifteen of the twenty-one countries who have published articles on lean, Six Sigma or Lean Six Sigma in the public sector are members of the OECD. Figure 6 also demonstrates that the OECD member country average is 21.3% of all people in employment are employed in the public sector. Given that the average shown here is that one in five people are employed in the public sector and particularly given the number of countries who have never published any research on Lean, Six Sigma or Lean Six Sigma in public sector areas, it does again appear to demonstrate the significant research gaps in the area. In addition, there is no apparent relationship between the size of the public sector and the level of research when figure 5 and figure 6 are compared. The next section of the analysis therefore starts to explore the type of public sector area, function or department where research on the application of the methodologies has been explored.

### Breakdown of findings by public sector areas

While the scale of the public sector may vary, as has already been referenced they remain a significant employer, if not the most significant employer in each country in the world. The blurred lines of public sector have also already been discussed and for clarity of comparison the 121 papers included in this study have been grouped into five clear categories which are further explored in this section.

**Health** – Includes all aspects of healthcare identified

**Education** – Includes all levels and aspects of education

**Local Government** – This allows for comparison of regional or city government and would include, State, Municipal or county functions which sit below the national or federal functions. This may include Policing, local authorities, roads, social work, housing and so on

**Central Government** – All national functions such as defence, taxation, benefits, pension and so on. The clear demarcation for the Local and Central Government papers is the context of what level of government is the subject of research within the paper.

**Public Sector** – The review includes some papers that simply explore Lean Six Sigma in the public sector without referencing any individual branch, department or function.

The breakdown by business area is shown in overview in Figure 7.

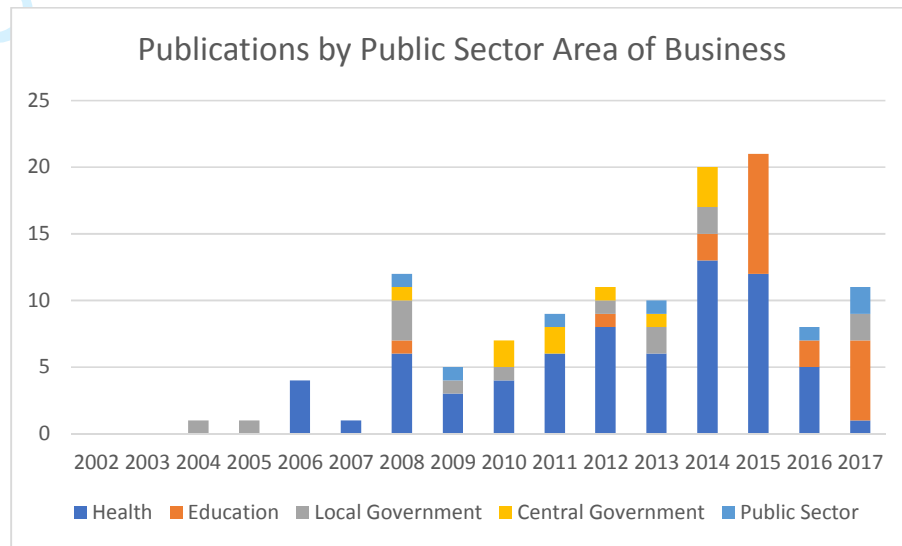


Figure 7: Publications by public sector area of business

It can be seen from figure 7 that Health is strongly represented in published papers which focus on LSS and make up a total of sixty-nine of the one hundred and twenty-one papers identified in this systematic literature review. From 2006 to 2016 the majority of the included papers in each year are health related and have shown a steady rate of publication with notable increases in both 2014 and 2015 when thirteen papers were published in each of these years. This level of publication however drops off in 2017, where the largest volume of included papers focusses on Education.

The earliest papers identified in this review were in 2004 and 2005 and both related to local government functions, there are a small (fourteen of one hundred and twenty-one) but steady number of publications over individual years around local government but the largest number in any single year was three in 2008. Central government functions have seen a similar rate of publication with ten of the one hundred and twenty-one papers identified and again the largest number of papers in any single year being three in 2014.

There have been twenty-one papers published with specific reference to education. Interestingly, nine of these were published in 2015. This can in part be attributed to a special issue of the International Journal of Quality and Reliability Management focussing on “Lean Six Sigma for Higher Education”. In 2017, 6 papers were published, which although a smaller amount, was the first year that more papers were published focussed on education than on health. This is suggestive of a growing interest in LSS in education. Finally, seven papers were published which more broadly explored the use of LSS in the public sector generally.

LSS has been used as an umbrella term throughout this paper, however different deployments have focussed on only Lean or Six Sigma or have compared and critiqued Lean and Six Sigma in the public sector or of course explored an integrated Lean Six Sigma approach. The papers included in the review are shown in Figure 8 broken down by which methodology or approach has been applied each of the individual papers.

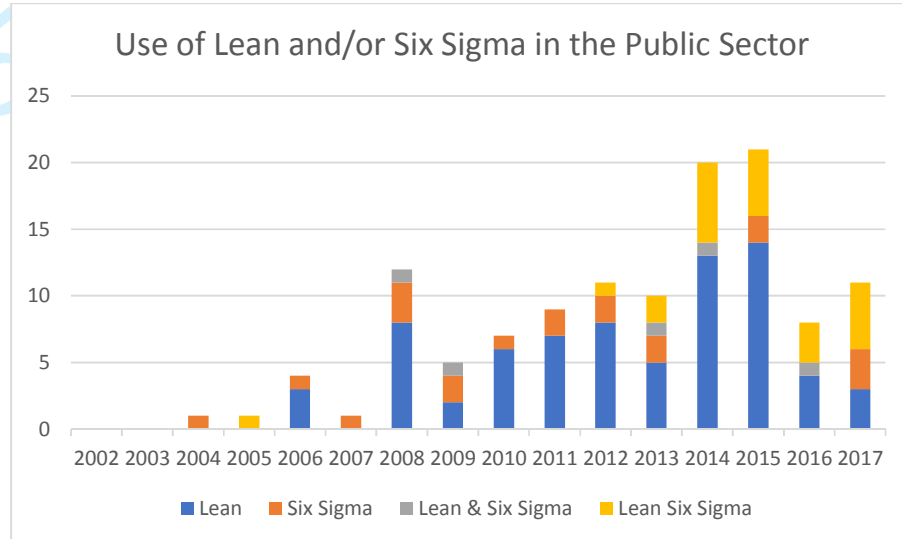


Figure 8: Use of lean and/or Six Sigma in the public sector

Seventy-three of the one hundred and twenty-one papers examined, exclusively explored the use of lean in the public sector. When this is broken down by year from 2008 until 2016 it is the most used methodology in the public sector and saw a peak in the number of publications in 2014 through to 2015 which was suggestive of the use of lean continuing to increase in the public sector. Twenty of the papers included made use of Six Sigma alone and the publications are spread across the period of the review. From 2012 there has been an increase in the use of Lean Six Sigma in the public sector with a growth in 2014 and 2015 albeit not to the extent of the continued use of Lean alone. In 2017, for the first time the number of papers which focussed on Lean Six Sigma was larger than the number of papers published on lean alone. Finally, there were five papers included in this research which examined, compared and contrasted the use of Lean and the use of Six Sigma, this was predominantly in the context of exploring the advantages and disadvantages of each methodology.

## Discussion

As can be seen by the breakdown across different elements of the public sector, central and local government departments show focus on individual case studies of Lean in particular and question the suitability and applicability to the public sector whereas there is more agreement that this is the case in health and education albeit still discussion over the acceptance of the academics and medical staff rather than administrative staff and functions. Moreover, it is evident from our review that there is a growing emphasis on the wider implementation planning, strategy and leadership as well as staff involvement and empowerment in the areas of health and education and to a greater extent than in other areas of the public sector. The

emerging themes which show from this review of the literature as well as the research gaps are discussed further in the next two sections.

### **Emerging themes**

This section explores the most frequently discussed common themes from the analysis of papers included in this systematic literature review.

#### ***Applicability of LSS to the public sector***

Many of even the most recent papers reviewed include commentary on the origins of Lean and Six Sigma in the manufacturing sector and discuss the question of their applicability to the public sector (Leggat *et al.* 2015; McCann *et al.* 2015; Bamford *et al.* 2015). These papers are balanced by others which argue to suitability of Lean and Six Sigma to the public sector (Antony *et al.*, 2017). The evidence of successful use of Lean or Six Sigma is growing annually as shown by this literature review, however the scale of the public sector means that there are significant functions, departments and services where there is no published record of application of continuous improvement methodologies such as LSS. This literature review demonstrates that the most researched area is healthcare to the extent that some scholars argue that the potential of Lean across healthcare is clearly evidenced (Waring and Bishop, 2010), where other scholars comment on the range of healthcare functions where there is as yet little or no evidence of the application of Lean or Six Sigma (Liberatore, 2013). Where there is general agreement is that there is a focus on individual projects or case studies but there is a lack of commentary on organisation wide deployment of continuous improvement methodologies.

A further element of the discussion on the suitability of Lean Six Sigma to the public sector is whether the methodology is new and whether it is simply a facet of Taylorism imported from the manufacturing system and an aspect of New Public Management (NPM) as introduced to the public sector in the 1990's as part of the drive to introduce private sector business methods to the public sector (Carter *et al.* 2011; Carter *et al.*, 2012; Lindsay *et al.*, 2014; Radnor and Osborne 2013). It is derived from these views that the question remains in some scholars' minds, whether Lean, Six Sigma or Lean Six Sigma are suitable to deliver efficiency and effectiveness in the public sector or whether its introduction is simply part of a much wider government approach to bring a range of private sector policies and approaches to the public sector utilising the logic that any private sector is driven to be efficient and any aspect can be transferrable to improve the public sector. There remains the further question of whether consideration has been given to adapting methodologies to the public sector context (Hines *et al.*, 2008) or indeed whether or not this is necessary.

#### ***Dominance of lean in the public sector***

This literature review demonstrates that Lean is the dominant methodology used in many areas of the public sector, Proudlove *et al.* (2008) comment on this regarding healthcare, while Radnor and Osborne (2013), comment on the focus on Lean more generally in the public sector. The pattern of the literature tends to describe the methodology and then discuss the application to the function or area but does not reference what criteria were used to select the methodology, how it was compared with strategic aims or organisational culture literature, there is therefore very little in the literature which identifies why a methodology

was selected although in healthcare it was identified that there was evidence of staff being steered away from Six Sigma (Chiarini and Bracci, 2013), there is also evidence of scholars arguing for the early adoption of Six Sigma in healthcare (Proudlove *et al.*, 2008).

However, when exploring the literature there is extensive comment as well that although Lean is utilised; there is a growing amount of evidence that the whole methodology has not been adopted, nor even a wide range of tools and techniques with commentary around overreliance on rapid improvement events (Radnor *et al.*, 2012; Kinder and Burgoyne, 2013; Radnor and Osborne, 2013). This again links back to the planning and preparation to incorporate continuous improvement into public sector organisations and this is supported by observations of rushed implementation (Papadopoulos and Meralli 2008) and the need to build a friendly and enabling environment for Lean (Hines *et al.*, 2008).

It is therefore observed that although much of the research indicates Lean deployments in various areas of the public sector, it is not well understood why Lean was selected but there are a large number of instances where there has been an overreliance on individual tools rather than incorporating the philosophy (which includes cultural change in particular) into the organisation. This is potentially not helped when there is additional evidence of a lack of shared understanding of what Lean is, as discussed below.

### ***Shared understanding of Lean***

Despite the public sector apparent focus on Lean alone in several areas, there is also a clear body of evidence identified by the systematic review to suggest that one of the challenges is also a lack of shared understanding of what lean is. In a higher education context, the different understanding between managers, academic and administrative staff is highlighted (Thirkell and Ashman, 2014) or more basically where narrow tools and techniques approaches were observed and there was no communication of the broader approach or philosophy (Thomas *et al.*, 2015). Indeed Waterbury (2015) comments that lean itself challenges some of the core theoretical frameworks in some disciplines and as such a shared agreement is challenging.

In healthcare, it is observed that leaders find difficulty in describing lean to employees (Waring and Bishop, 2010) and that there is a failure to understand the complexities and demand led nature of healthcare. As such, lean is not effectively articulated (Radnor *et al.*, 2012). Radnor and Osborne (2013), raise the wider issue of this lack of wider understanding of Lean as part of overall business models and structures within the public sector more generally. There are however additional arguments that the focus on tools or improper implementation of Lean in particular are simply attempts to restart a management fad. (McCann *et al.*, 2015)

These are only some examples of the apparent confusion over what lean actually is within the context of the public sector, attributed by various scholars to lack of leadership understanding, miscommunication, lack of understanding of customers or culture in the public sector or different viewpoints of different types of professionals within organisations. This adds to the developing theme identified in this review of the importance of preparation, of readiness within the organisation and of clear planning and linkages to the vision, strategy and culture of the organisation.

### ***Role of Human Resources***

The next strong theme emerging around the deployment of Lean Six Sigma in the Public Sector identified through this systematic literature review is the role of employees and human resources functions or departments. As part of the broad debate over the implementation of Lean in HMRC in the UK there are a number of papers which discuss the impact on people (Carter *et al.*, 2011) and debate the nature of whether there was empowerment to employees at all (Carter *et al.*, 2012), (Procter and Radnor, 2014).

The debate around Lean outcomes leading to work intensification for staff is also evident in healthcare (Stanton *et al.*, 2014). It can be seen to derive from the public-sector budget challenges and focus on cost reduction leading to fewer employees and more work for those that remain. A survey of staff experiences (Lindsay *et al.*, 2014) identified mixed results where some staff felt that mundane tasks had gone and allowed a focus on high value tasks, but some staff felt left behind and negatively impacted. This leads back to the strategic focus and rationale for continuous improvement and a gap in discussion around disbenefits in Lean application as well as benefits and how these are articulated and balanced.

However, a lack of staff involvement is discussed across public sector areas, the inclusion of front-line staff in the setting up and implementation of continuous improvement initiatives is recognised (Abdallah, 2014) along with the fact that different staff groups may have dissimilar needs, understanding and roles in such initiatives. There is evidence of initiatives being implemented without the involvement of staff who deliver the services which are being reviewed despite the stated importance of their involvement (Lodge and Bamford, 2008; Barton, 2013; Di Pietro *et al.*, 2013). The clear challenge then is there is evidence of negative impact on staff through work intensification but a clear need to involve staff in any continuous improvement initiative to separate value and waste and improve service provided.

The role of positive and enabling HRM as part of any successful continuous improvement initiative (de Koejier *et al.*, 2014) is commented upon and the associated benefits to employee well-being, trust and organisational performance. Earlier in this review the debate over the suitability of Lean and Six Sigma to the public sector was raised in HR terms it is also suggested in the literature that while elements and tools and techniques were transferred some of the learning from HRM practices in the manufacturing sector have not been considered (McIntosh *et al.*, 2014).

### **Research gaps**

It can be seen that the common themes drawn from this review incorporate a number of issues which are part of the bigger picture around implementing any continuous improvement initiative and while the paucity of papers compared with the wide range of public sector functions across the world is noted, there are a number of identified gaps beyond simple functions, services or countries which again impact on the more strategic issues of organisational change, culture and efficiency and effectiveness.



### ***Strategic alignment***

A common theme in published papers is the budget pressure on public services (Barton, 2013; Douglas *et al.*, 2015; Balzer *et al.*, 2015) although there are small pockets of recognition that lean or Six Sigma are not exclusively about cash savings (McNarry, 2008). What is not referenced is how any continuous improvement programme aligns with an organisations strategic goals, where the organisations see themselves in the future and how will lean, Six Sigma or Lean Six Sigma contribute to that vision and support that journey. It is argued that there will always be questions of sustainability of any continuous improvement programme if it sits aside from the core focus and aims of the organisation, an example of this is found in Svensson *et al.*, (2015).

### ***The Three Stages of deployment: Readiness, implementation and sustainability***

While there are some examples of discussion around strategic elements such as leadership (Waterbury, 2015) and readiness (Antony, 2014) for Lean Six Sigma in education, and similarly those elements in a small number of papers on health (Waring and Bishop, 2010), (Stanton *et al.*, 2014), these are more recent considerations and perhaps reflect a maturity in organisations which have been using Lean and Six Sigma for longer and is not reflected in other areas of the public sector who have utilised Lean or Six Sigma or Lean Six Sigma.

More broadly there is a distinct lack of published research about preparation for implementation, communication, staff briefing and training, vision and strategy and relationship with performance metrics or processes. It is implied through the number of papers referring to budgetary challenges as part of the drivers that 'quick wins' (de Souza and Pidd, 2011), are the focus of the public sector and embedding a culture and considering long term sustainability are not features in the thinking of those implementing continuous improvement programmes.

In this context, it is suggested that implementations are rushed (Papadopoulos and Meralli, 2008) often in the belief that this may relieve immediate budget pressures, and this may account for the lack of evidence on organisation wide use of continuous improvement methodologies in any form (D'Andreanatteo *et al.*, 2015). The importance of a planned use of continuous improvement methodologies, assessing organisational readiness, then having a clear implementation plan and a plan for sustaining the continuous improvement initiative are not discussed out with a small number of more recent papers as shown above.

### ***Role of government***

Government policies have an element of impact on all sectors of business but clearly are particularly relevant to the public sector as government are not only the providers of the budget, but policies and programmes derive from the political strategy or viewpoint (Kettl, 2000). Therefore, it is not only the leadership of the department or function in the public sector which will impact on the success or otherwise of a culture of continuous improvement but also the leadership of the national or local elected members.

There is a significant gap in the literature around whether any governments have led either effectively or ineffectively in this area and how that has influenced the holistic success of attempts to improve public sector services or more broadly led public sector reform (Christensen and Laegreid, 2007). It is additionally noted that there is a gap around evidence

of organisation wide implementation of continuous improvement initiatives which it is suggested also speaks to the apparent gap in governmental leadership in this area.

### ***Internal and external customers***

The voice of the customer is not fully understood across a range of public sector organisations and it is recognised that the concepts of the public as service user is one aspect, but in addition the public as customers who have not used the service but may need to one day, in cases such as policing or health, or simply the public as the tax payer who funds the service.

This is further complicated by the public sector service supply chain where the internal customers may rely on other departments or services as part of the efficient and effective delivery of public services. There is some recognition in the literature that this is not fully understood and further research is required (Hines and Lethbridge, 2008; Heath and Radcliffe, 2010; Radnor and Osborne, 2013), It is suggested that in line with the building picture of research gaps identified through this review, a shared understanding of the customer and how the continuous improvement programme will consider the needs and views of internal and external customers as part of the strategic aims and implementation planning are critical to success.

### ***Organisational Culture***

The literature does broadly recognize the importance of employee involvement across some areas of the public sector (Stanton *et al.*, 2014; De Koejier *et al.*, 2014; McCann *et al.*, 2015). In some cases, there is positive comment on the level of involvement of employees (Radnor and Whalley, 2008). Public Sector employees, while not completely altruistic, are more likely to value intrinsic rewards in recognition of their service (Perry *et al.*, 2010) and linked to their motivation. These include, a sense of accomplishment, of progress, of recognised competence are all important aspects of any reward or recognition for positive performance, this may be considered to be a particular strength within the public sector. When considering continuous improvement methodologies intrinsic reward may be considered to be choosing how to perform a role or task and by definition involvement in designing the process. As such, organisational culture could be a positive support to the introduction of a continuous improvement programme. There is however, very little identified in the literature that comments on this and considers how employees would be rewarded and or recognised for their efforts and involvement.

### ***Conclusion, limitations and future research agenda***

It is unclear from the literature review how public-sector organisations select their continuous improvement methodology and why, for example Lean is selected over Six Sigma and what criteria is used to inform the selection. However, the literature does show an apparent pre-occupation with tools and techniques as shown in individual case studies. These case studies do show individual savings and benefits, but no evidence is presented of the embracing of Lean or Six Sigma or Lean Six Sigma as a business process improvement strategy integrated into the working practices of a business model.

This paper contributes to research in this area by being the first identified systematic review on the application of Lean and Six Sigma across the public sector. It identifies themes and gaps which can provide stimulus to the research community in this area. In terms of practice, this review further identifies and comments on the over focus on tools and techniques and the importance of a more holistic approach to implementation through strategic alignment, consideration of cultural fit and such wider considerations. Finally, the importance of involving the public as the customer in the development of public services is discussed and shown in this paper as a research gap, but this has a clear potential impact on society when considered as part of the delivery of public services.

This stated, the review has two major limitations. Firstly, the methodology applied focuses only on journals listed in the ABS journal guide, albeit the reasons for this are explained in the methodology. Secondly, the experience of the authors is that there are continuous improvement programmes being deployed in the public sector which have not been published in academic journals.

It is recognised that public sector budgets are still impacted by the global financial crisis in 2007 and associated pressures transfer into year on year budget reductions and the need for 'quick wins' (Antony et al., 2016). This has the potential to impact on the way in which organisations select and implement continuous improvement methodologies.

Certainly, it is argued that lean is applicable to all sectors (Womack and Jones, 2003) and there is evidence of success of Six Sigma in Government IT functions, human resources healthcare and banking (Antony et al., 2006) but the public-sector shares experience with the service sector and challenges have been experienced with shared definitions, lack of evidence around critical success factors and barriers and challenges to implementation (Gupta et al., 2016).

The question then is whether the individual case studies denoting success are evidence of the applicability of Lean, Six Sigma and Lean Six Sigma in the public sector or whether, as Leggat et al. (2015) suggests, unsatisfactory methodologies limit the conclusions?

This literature review identifies the apparent lack of a systematic approach or model within which continuous improvement methodologies are applied in the public sector. There is some small reference to readiness factors within higher education (Antony, 2014) but this is not considered in other areas, the role of leadership appears likewise to be little commented on.

The debate continues over the applicability of lean, Six Sigma and Lean Six Sigma in the public sector. The case studies of individual usages demonstrate to some extent how the methodologies can bring benefits. However, the gaps in the literature include;

1. Evidence of the use of continuous improvement as a system,
2. How customer voice is captured and applied to change and improvements.
3. How senior leadership commit too and support the development of a culture of continuous improvement.
4. How staff are trained, supported and valued for their knowledge, skills and involvement.
5. How individual involvement is recognised and rewarded in a public-sector context, and,

6. How continuous improvement is aligned with the values, beliefs and strategic direction of public sector organisations or bodies.

Perhaps evidence of these questions being answered will assist in answering the much wider debate around the future of lean, Six Sigma and Lean Six Sigma in the public sector.

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Reviewer's comments	Authors' response
<b>Reviewer 1</b>	
<p>Introduction: CI is much more than lean, six sigma and lean sigma. Please explain the rationale behind the particular focus.</p>	<p>We have amended the title of the paper as per the reviewer's suggestion at point 4 below and have amended the introduction to reflect this change and ensure it is consistent.</p>
<p>Methodology: After reading this section it was not clear what the methodology was. This section was mainly about rationale and drivers. I suggest that you change the name from Methodology.</p>	<p>Thank you, on re-reading, part of the issue seems to be that the similarity in headings for the methodology and the sub-headings for Approach and Design are so similar that it is not clear they are sub-headings.</p> <p>We have taken the initial paragraphs out and moved them into the introduction and elevated the sub-headings to main headings to assist with clarity and flow of the article.</p> <p>We have also re-worded all of the article headings in the hope of better signposting and a better flow to the article.</p>
<p>Change from et al to et al.</p>	<p>Thank you, this has been changed and made consistent throughout the paper.</p>
<p>Title: Is it CI or Lean and Six sigma?</p>	<p>We have amended the title as suggested.</p>
<p>Public sector not an early adopter? I agree but please provide a reference – e.g. Elias, A. A. and Davis, D. (2018). Analysing public sector continuous improvement: a systems approach. International Journal of Public Sector Management, 31(1): 2-13</p>	<p>Thank you, this reference has been added</p>
<p>It is not clear why the term public sector was removed from the search</p>	<p>The term was not used consistently across different countries and was commonly not used within relevant journal articles. We have now made a clear statement in this regard within the article.</p>
<p>Figure 2: What about journals on Public</p>	<p>Figure 2 shows the journals which most</p>

<p>Sector? E.g. Journal of Public Sector Management, Public Management Review?</p>	<p>frequently published articles which met the inclusion criteria. As stated in the methodology all 1401 journals listed in the 2015 ABS guide were searched and this includes the 33 journals listed in the 'Public Sector and Healthcare' section which includes these journals.</p>
<p>The implicit assumption that continuous improvement is limited to lean, six sigma and lean six sigma. This assumption is fundamentally flawed. Please address this concern and modify the paper.</p>	<p>We have changed the title as referenced above and adapted the introduction to reflect this.</p>
<p>The importance of 'public sector' needs further focus. For example, how has this literature explored the Public Sector context? Has it been thoroughly understood while planning and executing CI initiatives? How deep were these investigations to comprehend the public sector context in this literature?</p>	<p>This SLR had the stated intention of identifying which methodologies were used in the public sector and where. In addition, it was intended to identify emerging themes and gaps. We would agree that the context of public sector is an important area of investigation but would respectfully suggest is a matter for future research. There is no evidence identified in this review to provide a detailed discussion of whether public sector context was or was not considered.</p> <p>We have touched on the question of suitability of CI methodologies in the public sector and we have changed some of the wording in this section to reflect the point made by the reviewer and more explicitly state it as a gap within the context of the still ongoing suitability debate.</p>
<p>This needs to be discussed using a thorough review of 'Public Management' journals</p>	<p>As referenced above, all journals relating to public management which are listed in ABS 2015 were included in the SLR but we would respectfully suggest that a change in focus of the article to a discussion on the context of the public sector would change the nature of the article and this element of our research and move it away from an SLR.</p>

<b>Reviewer 2</b>	
<p>The paper has potential; however, it needs a major rewrite for it to flow.</p>	<p>We have restructured and renamed the sections and headings in order to improve the flow and readability of the paper and have added independent proofreading to assist with this and check on improvements.</p>
<p>The paper has the potential to provide new and significant information. However, it does not in its current form.</p>	<p>We note and respect the comments of the reviewer but would contend that as per our original abstract, no other such similar work has been identified and this is one of the first papers systematically reviewing this area. The SLR identifies themes in the public sector which are presented holistically for the first time as well as identifying challenges, patterns and gaps which can be practically explored and referenced by both future academics and practitioners. It is also part of an ongoing research project where the gaps will be explored through further empirical research.</p> <p>We also note that Reviewer 1 has stated that the article does make a contribution in its current format and as such we would defer to the final decision of the editor.</p>
<p>A significant reference appears to be missing:</p> <p>Antony, J., Rodgers, B., and Cudney, E. (2017). Lean Six Sigma for public sector organizations: Is it a myth or reality? International Journal of Quality and Reliability Management, 34(9), 1402-1411.</p>	<p>This paper was included within the 122 articles included in the SLR but was not directly referenced in the article. It has now been overtly referenced in line with the reviewer's suggestion.</p>
<p>The second section of the manuscript is entitled "Methodology"; however, it is not a research methodology. It appears to be more of an introduction. Overall, the flow of the paper is confusing.</p>	<p>As per the comments by reviewer one, the methodology section has been restructured and the headings have been reformatted and renamed in order to improve flow and readability.</p>

<p>1 2 3 4 5 6 7</p> <p>It is not clear what the motivation and need for this research is.</p>	<p>This is now clearly stated in the introduction.</p>
<p>8 9 10 11</p> <p>The definition of the public sector is defined after the methodology.</p>	<p>Thank you. This is now immediately after the introduction and before the methodology.</p>
<p>12 13 14 15 16 17 18 19 20 21 22 23</p> <p>Further, the paper contains numerous bulleted lists rather than sentences.</p>	<p>There were a number of bulleted lists used to summarise the information in light of the reviewers comments all but 1 has been removed and replaced by the use of tables or other grammar. The final bulleted list which shows the gaps has been changed to a numbered list which brings it in line with other articles published in the journal.</p>
<p>24 25</p> <p>A trend line in figure 3 is not appropriate.</p>	<p>Thank you, this has been removed.</p>
<p>26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51</p> <p>The implication to research, practice, and society is not clear.</p>	<p>As per our previous comments, we note and respect the comments of the reviewer but would contend that as per our original abstract, no other such similar work has been identified and the SLR identifies themes in the public sector which are presented holistically for the first time as well as identifying challenges, patterns and gaps which can be practically explored and referenced by both future academics and practitioners. We have added several sentences into the conclusion to emphasise the contribution we believe the paper makes to research, practice and society.</p> <p>We also note that Reviewer 1 has stated that the article does make such clear implication in its current format and as such we would defer to the final decision of the editor.</p>
<p>52 53 54 55 56</p> <p>The manuscript contains numerous typos throughout. Further, the manuscript needs a thorough review for English and sentence structure.</p>	<p>We apologise for this and have reviewed the document thoroughly and had it independently proofread to ensure we have minimised the risk of typos and any</p>

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	sentence structure issues.
The flow of the paper is difficult to follow.	We have restructured the headings and renamed them throughout in order to improve the flow of the document. In addition, as stated above we have sought independent proofreading of the document to assess improvements to readers.