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# **A study into the pros and cons of ISO 18404: Viewpoints from leading academics and practitioners**

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## **Abstract**

**Purpose** – This paper aims to present and summarise the arguments for and against the ISO 18404 standard and the perceived advantages and disadvantages of implementing it.

**Design/methodology/approach** – A qualitative interview approach was utilised by interviewing a panel of leading academics and practitioners familiar with Lean Six Sigma.

**Practical Implications and Findings** – The results indicate that Lean Six Sigma professionals have conflicting opinions on ISO 18404. An overwhelming majority of the panel questioned the “quality” of the standard and whether it is “fit for purpose”, while others see the advantages of a common standard in helping continuous improvement deployment.

**Research limitations** – As the standard has not been widely adopted, there were limited examples on ISO 18404 discussion in the literature. Much of the current literature focuses on the theoretical application of the standard with sparse practical examples providing case study deployment. Also, the interviews were short and at a high level. There is an opportunity for further study and analysis. It was difficult to find qualified interviewees who were familiar with the standard. A very real

constraint when conducting research into ISO 18404 is to obtain a balanced view of the standard from those who have a vested interest in its continuation and evolution, or not.

Originality/value – The paper provides a resource for people to obtain insight into the value or non-value add of a standard in Lean Six Sigma and the appropriate details of such a standard. These results can form the basis of a case for the implementation of the standard for those organisations currently trying to decide whether to implement it or not.

Keywords: ISO 18404, Six Sigma, Lean, Lean Six Sigma, Quality, Standards, Continuous Improvement

Paper type: Research article

## Introduction

Management system standards (MSS) have enjoyed enormous success over the last years, both in the sphere of Quality Management (QM), such as ISO 9001, and in that of Environmental Management (EM), such as ISO 14001, and other areas (Tarí, Molina-Azorín and Heras, 2012). The effective integration of an improvement programme with existing management systems, particularly with a Quality Management System (QMS), has been well recognised as an important factor for the successful deployment of continuous improvement initiatives in an organisation. Many have written about the symbiotic benefits of combining and articulating Six Sigma, for example, with the requirements of the quality standard ISO 9001 (Marques et al., 2013). Sá et al. (2020) demonstrated the results of their case study, which showed that the integration of LSS tools and methodologies in ISO 9001 QMS allowed the achievement of gains in efficiency and productivity.

In late 2015, a new management standard was published, ISO 18404:2015, that “defines the competencies for the attainment of specific levels of competency with regards to Six Sigma, Lean, and Lean & Six Sigma (LSS) in individuals, e.g., Black Belt, Green Belt and Lean Practitioners and their organizations” (ISO, 2015). The ISO 18404 standard aims to certify both organizations and individuals in either Six Sigma or Lean, and both Lean and Six Sigma certifications come in three levels. There is a severe dearth of published peer-reviewed journal articles and/or practical case studies on ISO 18404 and its role in Lean and Six Sigma standardization and continuous improvement. While some authors have discussed the advantage of having a LSS standard in theory and discussed the ISO 18404 standard referencing its place in a framework for LSS deployment, very few case studies of practical deployment of the standard are found in the existing literature (Ward and Caklais, 2019; Herrera and Van Hillegersberg, 2019).

Also, commentary by Lean, Six Sigma, and LSS experts and practitioners on the standard’s advantages and disadvantages and whether there was a requirement or need for a standard in the first place has been very limited in the public domain. There has been some discussion on LSS social media blogs and websites (Roser, 2016; LeanCompetency.org, 2016; Morgan, 2016; Morgan, 2017; Bendell, 2016). Most discussion and opinion on the standard have remained among the LSS practitioner’s community. It seems there was minimal involvement of leading academics and practitioners, and their inputs, into the development of the standard. Consequently, this qualitative research study is being carried out to with respect to the following research questions:

- *What are the advantages and disadvantages of ISO 18404?*
- *Is there a benefit or requirement to having a standard in Lean, Six Sigma, and LSS?*
- *Is the current standard fit for purpose?*

This article presents the findings of our research on whether this standard, or indeed any standard, has benefits or not in helping deploy Lean and Six Sigma initiatives and implementing a continuous improvement program.

## Literature Review

The International Standards Organization (ISO) published ISO 18404 in 2015 as a standard for quantitative methods in Six Sigma and competencies for key personnel and their organisations in relation to Lean and Six Sigma implementation. However, it was not the first standard related to Six Sigma published by ISO. There are 12 active standards as of January 2021 related to Six Sigma published by the ISO Technical committee 69 (TC 69), which are mostly related to applying specific statistical techniques such as ANOVA, gauge analysis, and fractional factorial designs, among other methods. Two of the aforementioned twelve standards were published by ISO in 2011; ISO 13053-1 and ISO 13053-2 on “*Quantitative methods in process improvement – Six Sigma – Part 1: DMAIC methodology*” and “*Quantitative methods in process improvement – Six Sigma – Part 2: Tools and techniques*” (International Standards Organisation, 2011a; International Standards Organisation, 2011b). Many commentators consider ISO 18404 a replacement to the ISO 13053 series, which has been largely ignored (LeanCompetency.org, 2016). In a study by Chiarini (2013) of the Six Sigma practices of 107 European companies as compared to ISO 13503, there were considerable practical differences between the deployment of companies studied and the requirements of ISO 13503. These differences were largely related to different points of view about how long the training for Master, Black, Green, and Yellow Belts should be compared to the ISO 13503 standard, and how long a Six Sigma project should last. The desired length of Six Sigma projects is not clear in the standard, nor was the importance of applying some Lean tools integrated into the standard.

There are three levels of competency for Lean and Six Sigma described in the ISO 18404 standard: Lean Practitioner, Leader, and Expert; and Six Sigma Green, Black, and Master Black Belt. However, the Yellow Belt level is not mentioned. The Lean and Six Sigma levels combine the competencies of the equivalent Lean and Six Sigma levels and follow the same belt structure as Six Sigma. For each level, the standard lists competencies, performance criteria, and suggested evidence to demonstrate understanding, application, management, and training of and in the relevant competency.

For Lean Six Sigma projects to be successful Projects Champions and organizational management must be actively involved (Snee and Hoerl, 2018). Unfortunately, these two critical roles are not mentioned in the standard. Management identifies where in the organization improvement is needed, ensures that the resources (funding and personnel) are made available and selects the Project Champions, MBB and sometimes the BB. Project Champion responsibilities include leading the project chartering process, the organizational focus for the project, removing barriers for project success and ensuring the projects are completed on time. The Standard would be much stronger and more useful if these critical roles were addressed in the standard.

This was not the first standard published related to continuous improvement by ISO, as another widely known standard for quality management, ISO 9001, was first published in 1987 and was revised in 2000 and 2015. Currently, ISO 9001 certification can be achieved in any size of organisation, and in the public or private sector (International Organisation for Standardisation, 2015; Tsuyoshi Kikuchi and Suzuki, 2018). This standard has been widely adopted not just in manufacturing but in many other fields and sectors such as construction, engineering, service, and in

the public sector. There is a strong correlation and alignment between ISO 9001 and ISO 18404 in terms of its continuous improvement remit and purpose.

### **Why have standards?**

There are a lot of reasons why an organisation might implement an ISO standard and considerable literature is available, particularly on why ISO standards such as ISO 9000, ISO 14001, or others might be implemented, including pressure from external customers, regulatory pressure, and increased market share (Witcher, 1994; Brown, van der Wiele and Loughton, 1998). In relation to ISO 9000 organisations, typical benefits include improved quality awareness and customer services, better management control, consistency and discipline, standards accepted as good practice, as well as reduced costs of poor quality and ability to stay in business (Douglas, Coleman, and Oddy, 2003; Witcher, 1994; Tarí, Molina-Azorín and Heras, 2012; Tarí, Molina-Azorín and Heras, 2012). The requirements for many organizations to adhere to a standard when quoting for tenders with customers and government bodies, for example, has been a considerable driver in the adoption of ISO 9000 (McTeer and Dale, 1994). The challenges in utilising a standard can be high costs, increased paperwork, and bureaucracy; standards can be difficult to interpret and achieving consistency among assessors can be problematic (Brown, van der Wiele. and Loughton, 1998; Douglas, Coleman, and Oddy, 2003; McTeer and Dale, 1996). Smaller organisations such as small-to-medium enterprises (SMEs) struggle more with implementing standards than larger organizations and often have to utilise external consultants. Criticism directed at consultants and auditors include the lack of assessor's knowledge about particular industries, some assessors being overly pedantic about paperwork, "nit picking" auditors, different interpretations of standards between auditors, and degree of variance between accreditation authority standards. As certification bodies are commercially oriented, there is scepticism about their ethics related to the number of faults found in audits (Brown, van der Wiele, and Loughton, 1998).

### **Reasons for a Lean, Six Sigma, and LSS Standard**

Many organisations see the ISO 9000 series certification as preceding TQM and as a relevant first step in implementing a TQM program (Douglas, Coleman, and Oddy, 2003). It is also apparent that while many organisations would see the wider notion of QM being important, ISO 9000 series certification is considered a good basis from which to start the process of quality and continuous improvement (Pfeifer, Reissiger, and Canales, 2004; Brown, van der Wiele, and Loughton, 1998). Consequently, as the basis of TQM is continuous improvement, building upon ISO 9001 as a foundation with a LSS programme aligned to quality is a logical next step, along with consideration of a standard such as ISO 18404.

The non-standardisation of Six Sigma curricula and Lean curricula have been an issue for both manufacturing and service companies (Antony, 2004; Johannes and Kurt, 2008 ). Herrera and Van Hillegersberg (2019) discussed the requirement for standardisation of continuous improvement in IT services. Different companies set different training and certification standards manifesting an inconsistency issue across companies and countries, although this problem has been addressed partially through the development of ISO 18404:2015 (Antony and Sony, 2019).

## Critical Reception of ISO 18404

There were many critics of the ISO 18404 standard when first presented at the European Educators Conference in 2015. The standard was shared during a presentation by Prof. Tony Bendell who developed the standard in association with the British Standards Institute (BSI) and Royal Statistical Society (RSS). The main criticism being that there was a lack of consultation in the development of the standard with European, Japanese, and American Lean practitioners and, in particular, the Japanese Union of Scientists and Engineers (JUSE) and the American Society for Quality (ASQ), which are the two largest quality provisional bodies in the world (Roser, 2016; Morgan, 2017; Ishiyama, 2016; Morgan, 2016).

Despite developing standard competencies for Six Sigma, the ISO 18404 standard has not been widely adopted (Antony and Sony, 2019). Some limited discussion in the literature on the ISO 18404 standard has appeared from some authors from Africa, Japan, and Russia, for example, whom discussed the short term adoption of ISO 18404 in their various countries as being limited, if non-existent (Kikuchi and Suzuki, 2018; Ishiyama, 2016; Kazakova, 2019).

Ishiyama (2016) stated that *“publication of ISO 18404: 2015 may have little impact on the TQM activities of Japanese companies in the short term,”* but that it may become a requirement for competing for global business contracts. Kikuchi and Suzuki (2018), in their contribution to the book *“Applying the Kaizen in Africa: A New Avenue for Industrial Development,”* stated that ISO 18404 *“does not appear to have much impact on most African SMEs that are operating within the local market and that it is currently inconceivable that African SMEs will move to obtain ISO 18404 certification.”* The themes of the implementation of the standard in SME's being problematic were continued in a Russian study entitled, *Problems of Implementing the ISO 18404:2015 in Enterprise in Russia*, by Kazakova (2019).

ISO 18404 has been largely ignored in European and American literature with no articles related to ISO 18404 in ASQ's flagship practitioner magazine, *Quality Progress*, or flagship research-oriented journal, *Quality Management*. Given that the USA's and Japan's ISO committees voted “NO” to the adoption of the ISO 18404 standard, this is not surprising. In fact, Japan has consistently insisted that the introduction of the standard is premature, but it was finally passed and issued against the opposition of only two countries, Japan and the United States (Ishiyama, 2016). The fact that the ASQ has long established very successfully their own body of knowledge and certification qualification processes and training programs around Six Sigma and Lean belts has resulted in a lack of requirement or uptake for a training and certification in Six Sigma and Lean competencies as offered by the ISO 18404 standard. ASQ certifications are long established and seen across the world as an excellent qualification and certification standard. The certifications are highly sought after by employees and employers alike as evidence of ability in many areas of quality and continuous improvement including Lean and Six Sigma deployment (Quality Magazine, 2010; Ulmer, 2008).

The world's first business to achieve the ISO 18404 standard in 2018 was a British construction company, and in 2019 a Dubai electricity and water authority became the first government organisation in the world to achieve ISO 18404 certification (Ward and Caklais, 2019; BSI.org, 2019). A google search on ISO 18404 certified organizations only yields the aforementioned two examples of ISO 18404 certified organisations - for a standard that has been around since 2015.

### **Advantages of the ISO 18404 standard**

Professor Tony Bendell, who developed the standard in conjunction with BSI and RSS, stated in 2016 that the standard was required as the quality of Lean implementation and training is in many cases questionable, sometimes so bad that it does not just waste money in implementation but costs more, compounded by the absence of internationally recognised reference standards (Bendell, 2016).

Bendell (2016) also added that a LSS practitioner needs considerable additional skills and competences over and beyond knowledge of the tools, such as managing stakeholders, project management and improvement, finding appropriate data to measure current performance, leading and managing a team, motivating, communicating, and managing their own development. All of these competencies are reflected in the standard.

ISO 18404 describes the different Lean roles and training requirements needed by organizations rolling out Lean, to help them implement a standardised program (Herrera and Van Hillegersberg, 2019). In terms of individuals becoming certified, the ISO 18404 standard is a positive one as a) having a training program that is compliant with the standard adds legitimacy and value to the training, b) you can show evidence that your training has followed the standard, and once you are trained you can take the relevant belt competency assessment, and c) assists both Lean and Six Sigma organisations in recruiting practitioners with the required competencies (Morgan, 2017; Rich and Malik, 2019)

The standard assists with listing 23 competencies that are considered relevant in the area of Six Sigma and 18 competencies considered essential when becoming certified in the field of Lean management. As an aside, these competencies were neither tested scientifically, nor has any empirical research been carried out to substantiate the incorporation of these specified competencies. The Standard appears to overlook empirical evidence contained in the available literature on desirable competencies and needed skills such as those discussed in (Snee and Hoerl, 2018b; Snee and Hoerl, 2003).

However, by defining the competencies in the standard, ISO 18404 helps organisations in training, and in developing their LSS programs and personnel. This has the benefits of assisting in constructing what Six Sigma certification level requirements should be for Green, Black, and Master Black Belts. However, if the competencies were developed based on only a few peoples' experience or anecdotal evidence, this standard will lead to a wide chasm between reality and the purported standards instead of assisting practitioners.

### **Disadvantages of the ISO 18404 standard**

LSS has been widely deployed and developed (George, 2001). The ISO 18404 standard aims to certify both organizations and individuals in either Six Sigma or Lean, or both. However, the certification is not in LSS, it is in Lean AND Six Sigma (Roser, 2016). Many authors have referred to the importance of culture as a critical success factor for Lean and Six Sigma deployment and have viewed LSS as a philosophy, which cannot be easily measured (Bhasin and Burcher, 2006). Having a standard for Lean and Six Sigma goes against the ethos of culture and philosophy.

In reference to Lean barriers, the literature indicates that organisations often fail to view Lean as a continuous and never ending process (Saurin, Marodin, and Ribeiro, 2011; Arnheiter and Maleyeff, 2005; Atkinson, 1989; Bhasin, 2012). The disadvantage of any standard, including ISO 18404, is that

there is an emphasis on obtaining and maintaining the (re)certification, and the program can become a paperwork exercise (Roser, 2016).

Organisations often fail to incorporate the true valuation of an organisation's intangible and intellectual assets, and the value of knowledge management in Lean (Vinodh and Balaji, 2011). Lean and Six Sigma initiatives encourage involvement of all levels of the organisation and taking advantage of all levels of knowledge (Sony, Antony, and Naik, 2020). It is important that these initiatives are not only just seen as management and perhaps engineering initiatives to the detriment of involving and developing lower ranks of personnel (Singh et al., 2010).

To aid involvement of all levels of the organizations and other functions outside of manufacturing, the Yellow Belt level was created and is utilised in many organisations' deployment of LSS programs. Many authors have commented that the Yellow Belt (or White Belt) level is not included in ISO 18404:2015 (Pakdil, 2020). Not including a Yellow Belt, which is normally aimed at training and involving lower levels of an organization in LSS, could deem the LSS program elitist and non-inclusive in organisations employing ISO 18404:2015. The lack of a basic belt level (Yellow or White) goes against the ethos of respect for all and inclusiveness in Lean programs. As described by Ohno (1988) and Imai (1989), the second-most important objective of the Toyota Production System (TPS) - second only to the objective of consistency and eliminating waste from the production system - is human capital. Not having a widely inclusive belt program is the antithesis of what is commonly known as the 8<sup>th</sup> waste, which is described by Womack and Jones (2003) as "underutilisation of employee skillsets" or unused human talent and ingenuity.

While ISO 9001 certification is relatively easy to obtain even for a small organization, ISO 18404 certification is much more difficult unless the organization is fairly large. Further, ISO 9000 will likely be a pre-requisite for a company starting out on a continuous improvement route (Kikuchi and Suzuki, 2018). Bhasin and Burcher (2006) have discussed how every organisation's Lean journey starts under different circumstances, so there does not exist a unique recipe. There is no simple formula or directive to follow that guarantees success. Therefore, Lean needs to be viewed as a developing discipline and dynamic, since it is constantly improving. Organisations tend to combine several tools, techniques, and methodologies to create their own bespoke continuous improvement net approach that suits their culture, context, and business environment. It is difficult to reconcile the ISO 18404 standard with this tendency for tailored approaches, making the standard dated (LeanCompetency.org, 2016). Many authors, such as Morgan (2017), have discussed how organizations need to recognise and appreciate the concepts of both Lean and Six Sigma, but apply them in a context that is appropriate to the organisation. A standard with specific criteria and requirements goes against this versatility. The standard does not reference the applicability of deploying LSS in service or public sectors.

The standard presents 23 competencies for Six Sigma and 18 competencies for Lean. However, as described by Rich and Malik (2019), the standard considers these competencies to be consistent across all Sigma levels, and the expectations of a Lean expert will be more demanding than that of lower levels. The 23 competencies for the GB, BB and MBB roles is arguably too much detail to be useful in practice. The information provided is a useful reference, but to implement the standard, the competencies will have to be abstracted and prioritized to be useful to an organization in selection of GB, BB, and MBB. For example high-priority core competencies for these roles are leadership, analytical skills and thinking, respected by the organization, skilled in project management and positive mind-set. Competencies are also dependent on the nature of the organization's business.



Finally, Design for Six Sigma (DFSS) or Design for LSS (DFLSS), which is recognised as an important part of Six Sigma and LSS deployments (Chowdhury, 2003; Yang and El-haik, 2003) is not included in the ISO 18404:2015. ASQ, on the other hand, which publishes books and a body of knowledge on the different levels of certification for GBs, BB, and MBB has Define-Measure-Analyze-Design-Verify (DMADV) and the Identify-Define-Develop/Design-Optimize-Validate/Verify (IDDOV) models of DFSS as integral parts of their curriculum and LSS practitioner competencies (Watson and DeYong, 2010).

## **Research Methodology**

In order to understand the pros and cons of the ISO 18404 standard, the relevance and usefulness of the standard, it was necessary to conduct exploratory enquiries in the form of a qualitative research approach with interviews. The primary research philosophy of this study is based on first having an interpretive understanding of the context (Lopez and Willis, 2004) using an empirical phenomenological approach (Marshall and Rossman, 2010). A method that fulfils this strategy and meets the need of this research is an exploratory study (Stebbins, 2001). Qualitative studies produce a rich description of participants' feelings, opinions, and experiences. It further interprets the meanings of their actions (Denzin and Lincoln, 2011). It helps to unearth participants' perceptions regarding a phenomenon, event, or incident (Flick, 2015). A purposive and convenience-based sampling technique was applied to avoid generalisation, with the focus on gaining in-depth and qualitative insights (Yin, 2005). That is, there was no attempt to obtain a random sample, but rather to sample among those most knowledgeable. This approach is sometimes referred to as the Delphi Method in the literature. The Delphi technique is a widely used and accepted method for achieving convergence of opinion concerning real-world knowledge solicited from experts within certain topic areas (Ab Wahid and Grigg, 2020). It is particularly suitable for a situation where the opinions and judgments of experts and practitioners are needed but time, distance and other factors make it unlikely or impossible for the panel to work together in the same physical location (Yousuf, 2019). In order to determine the sample size, a data saturation technique (Guest, Bunce, and Johnson, 2006) was used that focussed on a point where in no new themes on advantages, disadvantages, benefit and requirement to having a standard in Lean, Six Sigma, and LSS or fitness of purpose of the new standard emerged. Throughout this study, the Standards for Reporting Qualitative Research guidelines were followed (O'Brien et al., 2014).

## ***Procedures***

The study employed a qualitative research methodology with interviews to focus on understanding and describing observations and opinions on the topic from a series of experts (Larkin and Thompson, 2012). In this research, an expert as defined by the research team is a person with at least 10 years' experience in the research discipline either through the research and publications route or via applications in a real-world setting. The qualitative research will contribute towards understanding the ISO 18404 standard, its potential benefits or disadvantages, implications of the standard as either an enabler or barrier to continuous improvement deployment, changing an organisational culture towards continuous improvement, and opportunities to leverage the standard.

The participants' geographical location meant that the nature of the research interviews was adapted to be online. Online group interviews were conducted instead of face-to-face interviews to leverage the benefits of online as a medium (Salmons, 2011). The use of interviews was considered an appropriate methodology in relation to the goal of having an honest discussion and exchange of

opinions through interviewing the interviewees (Rowley, 2012; Gerber et al., 2016; Marshall and Rossman, 2010; Palmerino, 1999; Underwood, 2003). The next step involved the identification of the candidates for the interviews. The authors sent emails to relevant senior professionals with QM, Lean, Six Sigma, and LSS expertise from various backgrounds, including academia, industry, and consultancy as outlined in Table 1. Some respondents declined to participate as they were either unaware of the standard or did not feel they knew enough about it. Interviews were then scheduled with a selection of the respondents who wanted to participate and conducted via online platforms.

**Table 1: Panel of Experts**

Participant Name	Academic	Non-Academic	Organisation	Years of Experience in Lean/Six Sigma/LSS methodology	Position	Location
Christoph Roser	X		Karlsruhe University of Applied Sciences	>20	Professor	Germany
Pauline Found	X		Cardiff University / Prifysgol Caerdydd	>30	Lecturer	Wales
TM Kubiak		X	ASQ	>40	Author/ Consultant & Former Chair of Publication Board of ASQ	USA
Jonathan Hunt		X	Omnex	>35	Consultant	USA
Udo Milkau		X	DZ Bank	>20	Director	Germany
Gabriele Arcidiacono	X		Università degli Studi Guglielmo Marconi	>20	Professor	Italy
Gregory H. Watson		X	Business Excellence Solutions/ex. ASQ	>20	Chairman/Former President (ASQ)	Finland
T N Goh	X		Singapore Management University	>20	Director	Singapore
Sung Park	X		Seoul	>20	Professor	South Korea
Murat Caner Testik	X		Hacettepe University	>20	Professor	Turkey
Pedro Martinez Jurado		X	Centro Universitario de la Defensa de Zaragoza	>10	PDI	Spain

Ayon Chakraborty	X		Federation University	>20	Associate Professor	Australia
Alessandro Laureani		X	KBC Bank	>20	Head of Process Management	Ireland
Arvind Srivastava		X	BorgWarner Inc.	>20	Continuous Improvement Specialist	USA

The project's purpose and aims were explained to all participants when opening the interview, and a participant's right to confidentiality, anonymity, and the right to avoid answering any question, or stop the interview at any moment, were carefully emphasised (Xiang, 2014). In order to eliminate and minimise bias from the interviewees, the researchers assured the participants of each company that their responses to the questions would be kept confidential if required (Politik and Beck, 2004). Participants were also assured that there was no right or wrong answers. The interviews were short and unstructured with one main open-ended question in which the interviewees were asked to answer: "What are the pros and cons of ISO 18404?." Subsequently, we asked various sub-questions around the standard, such as the requirements for a standard and the usefulness or perceived benefits of the standard, as well as how well the standard could be integrated into an organisation's LSS program. Unstructured interviews often start with a broad, open question concerning the research question, with subsequent sub questions dependent on the participant's responses (Holloway and Wheeler, 2010). The benefits of such interviews are that they do not restrict the questions that can be asked and allow respondents to elaborate and elucidate, and are useful when little is known about a topic or in collecting background data (Qu and Dumay, 2011).

In this research, very little was known to many participants about ISO 18404 as it has not been widely deployed and has been available for a relative short period of time. It therefore justifies the use of unstructured interviews. Unstructured interviews can be prone to researcher bias if interviewers are inexperienced, however, which can result in inappropriate questions being asked (Bohnet, 2016). To overcome the above issue, the authors carried out these interviews as they all have extensive experience in conducting such interviews. The interviews were unstructured with the advantage that the respondents could expand, illustrate, and digress (Kvale, 1983). These interviews also allowed the advantage of inquiry, in which the authors used a small number of participants to conduct qualitative interviews to gauge their experience and knowledge of the ISO 18404 standard (Saunders et al., 2012). After the completion of the interviews, all were transcribed.

### Data Analysis

This study used Colaizi method to analyse the transcripts from interviews (Sanders, 2003). The analysis begins with reading the interview transcripts by the authors. This is primarily done to understand the meaning conveyed and recognise the significant phrases, which enables the authors to restate them in general terms to achieve theoretical sensitivity (Corbin and Strauss, 2008). This helps research teams to formulate meanings and validate meanings of interviews through discussions to reach consensus. Further, it helps in identifying and organising themes into clusters and categories, and developing a full description of themes (Liu et al., 2020).

Multiple strategies were used to ensure trustworthiness and credibility of data analysis (Denzin and Lincoln, 2011). The credibility was assessed using peer debriefing, which consisted of the authors analysing the transcripts of interviews independently by bracketing data relative to their preconceived ideas (Chan, Fung, and Chien, 2013). This technique is in line with Colaizzi's method. The findings were subsequently compared and discussed by the team until consensus was achieved. The transferability was established by considering variations of participant characteristics and sufficient quotations collected through in-depth interviews (Liu et al., 2020). The inter-rater reliability was calculated in simple percentages for consensus on themes of pros and cons, benefits, and so on, after each interview, and it was found to be 92%. Wherever there were differences, these were settled through discussion.

### **ISO 18404 - Pros and Cons: Key findings from the interviews**

The authors have discussed the pros and cons of having a standard such as ISO 18404:2015 for continuous improvement, the requirements or need for such a standard and in the context of reviews of the uses of standards in general e.g., ISO 9001. A standard in Lean and Six Sigma can have a place in a continuous improvement program and in the deployment of improvement methodology.

The authors organized a panel of experts in Lean, Six Sigma, LSS, and QM and discussed this topic via interviews. The people who participated in these interviews include some of the leading academics in the field, and quality, Lean, and Six Sigma pioneers and practitioners from over 11 countries and spanning three continents. The common themes around the pros and cons of the ISO 18404 standard and its relevance in a continuous improvement program deployment will be discussed below, after we provide specific responses from some of these leaders in the field.

#### ***Dr. Christoph Roser - Professor of Production Management, Karlsruhe University of Applied Sciences, Germany***

I discussed my opinions on ISO 18404 in my blog entitled "*Lean Standard*" ISO 18404 – *A Questionable Idea...*" in 2016 and my opinions expressed below are unchanged five years on (Roser, 2016).

ISO 18404 is trying to measure "lean-ness" - this is impossible. Lean is a culture, and a culture cannot be measured. The ISO 18404 standard aims to certify both organizations and individuals in either Six Sigma or Lean, or both. Please note that this is not LSS, but Lean AND Six Sigma. Both Lean and Six Sigma certifications come in three levels: The roles of the green/black/master black belts are copied from Six Sigma, being a participant, leader, and coach in Six Sigma implementations. The role of the different Lean levels is the same as the equivalent Six Sigma levels, only for Lean instead of Six Sigma.

To me, this is a very odd list and while most entries are things that I would like to see in a practitioner of Lean, I find it nearly impossible to audit for these qualities. How do you, for example, audit "motivating others," "customer focus," and "leadership development"? You may as well audit the riding of a bicycle purely based on paperwork without watching the person ride. The measures of Lean and Six Sigma will degenerate into "How many VSM's were completed?", "How many Six Sigma tools were deployed?" but with no analysis of what was done with these tools and the follow up improvement programs.

Well, the official reason why Professor Tony Bendell in association with ISO, BSI and the RSS created an ISO 18404 standard for Lean and Six Sigma is due to the bad quality of some of the certificates handed out by some organizations. I agree that many of the Six Sigma certificates handed out are not worth the paper they are printed on. Of course, in my view there is another reason why they created the ISO 18404 standard. Money! Millions of companies have been certified in ISO 9001. With at least a couple thousand dollars per certification (not including preparation), we are talking about billions in licensing fees.

Do not get me wrong, the ISO has made many great and necessary standards, from paper sizes to screw types. In that, I am all for standardization. Yet, in my view, such a complex body of knowledge and experience like Lean cannot be squeezed into a standard. It is not the first time that the International Organization for Standardization has created a certification for a rather fuzzy topic. A certificate shows only that the standards are (probably) followed and gives no clue on how good the standards are. As long as you document it, you (probably) can get certified. The time required for documentation and certification is not to be underestimated. There will be lots of paperwork, with the risk of managers being even more remote from the actual shop floor.

I believe ISO 18404 will play out similar to ISO 9001, but slower. A few early adopters will jump on the bandwagon. These may be companies selling Six Sigma belt certificates or firms that want to have another ISO label to put on their letterhead or website. In all likelihood, this will not increase their “lean-ness” but only their paperwork. I hope it stops at that, with only a few companies getting certified and the rest of the Lean world doing business as usual. But the temptation of putting another label on the resume or homepage will probably be too big, and more people and companies will get certified.

The holy grail (from the ISO point of view) is when large companies require their manufacturers to be ISO 18404 certified similar to ISO 9001 nowadays. If that happens (and I hope it does not), then the ones without an ISO 18404 will have a clear disadvantage and may be forced to do the ISO 18404 paperwork, effort, and licensing fee with little benefit other than not being excluded. Personally, I would prefer that everybody just forgets about it.

In summary, ISO 18404:2015 has tried to describe Lean not Six Sigma; it cannot measure “lean-ness” or “culture” and is trying to fill a perceived market need for something that is not there and will have more overheads than benefits.

***Dr. Pauline Found –Lecturer in Cardiff University/ Emeritus Professor of Lean Operations  
Management in University of Buckingham***

Operational Excellence is the aspiration of many organisations currently, whether they are implementing a Lean or Agile philosophy with or without Six Sigma, or indeed any combination of these, to reduce waste and lead-time, to become more flexible and responsive and to reduce variation. What is common in all of these organisations is the relentless drive for quality through the application of the scientific method, systems thinking and problem-solving.

There is one international standard that supports this and that is the ISO 9001:2015 that takes a process approach to PDCA. Then the proliferation of other standards that take a very basic view of Lean is unnecessary and adds nothing to a well-managed ISO 9001:2015 accreditation. It is simply a waste of money and time implementing yet another standard that can easily be integrated within ISO 9001:2015 that is recognised around the world as the standard for quality. Combined with other

recognised standards such as ISO 14001 for the environment and ISO 45001 for OHAS, the triple bottom line of People, Planet, and Profit are well served.

***Dr. TM Kubiak, Consultant, Current delegate to the Technical Advisor Group (TAG) -69 and Subcommittee 7 of the US International Subcommittee for ISO on Six Sigma/Former Chair of Publication Management Board for ASQ Publications/Co-author of ASQ BB and Author of ASQ MBB Handbook***

I reviewed an early version of the ISO 18404 draft for the ISO International subcommittee 7 on Six Sigma and the USA voted no to this draft. I felt Lean was “tagged” on to the standard which lacked a fluidness and integration and was hard to follow. The competency matrices are not sufficiently instructive to establish a standard. I felt the competency matrices were incomplete and missing certain competencies and inconsistent. Blooms taxonomy was not utilised in writing the competency tables and so there is not an adequate natural level of progression of skills development from left to right in the matrices demonstrating a lack of flow between levels.

As part of the standard the organisations will be reviewed every 3 years as part of a recertification process, but this is measuring professional competencies and not organizational competencies in continuous improvement and LSS. Certifying to the standard and the way it is written is difficult due to a lack of targets, specificity, and measure of the ability to implement.

In terms of having competencies what is appropriate for one organisation in terms of competence may not be appropriate for another organisation. When appropriate practitioners will use Lean and Six Sigma and where appropriate go between both with one being more dominant at the time versus the other. Practitioners need to be comfortable and fluid and the standard does not recognise that. There are no LSS combined competencies in the standard. While Yellow Belts were well established in 2015 when this standard came out and the ASQ had released its Certified Six Sigma Yellow Belt - there is no reference to a Yellow Belt competency. Having a yellow belt level oriented towards lower levels of an organisation helps towards developing a continuous improvement culture and an involvement of everyone and fosters respect which is an important Lean principle.

In summary I do not know why this standard was required in the first place and while it takes 5 years for a systematic review of an ISO standard after implementation there is a systematic review due of ISO 18404:2015 in late 2020/early 2021. It will be interesting to see the results.

***Dr. Alessandro Laureani, LSS Master Black Belt, Dublin, Ireland***

The pros of the standard are that there are too many certifications on the market, with little oversight on the quality, so companies may have difficulty in individuating a good provider/consultant, or even hiring the right candidate, as they cannot validate the credentials. This standard can help address the problem, providing assurances on the quality of their services. For individuals, it can help proving their competencies to prospective employers. The standard also covers both Lean and Six Sigma respective competencies.

The cons of the standard refer to Lean and Six Sigma separately, but not LSS: I would argue we should move more towards an integrated LSS framework.

\* It seems difficult to audit for soft skills competencies (e.g., how can you audit 'customer focus' in an assessment-based test?), so the value of the certification may be questionable.

\* The LSS technical skills are mostly relegated to just one line item, with a reference to ISO 13053-1/2: one could argue that the majority of the skills listed in ISO 18404 are not actually exclusive to LSS, but part of any management/leadership program, while the competencies specific to LSS are relegated to a very small section.

\* There is the risk of this standard becoming an industry in itself, with organizations just focusing on doing the paperwork to qualify for the standards, instead of focusing on actually streamlining their processes.

***Mr. Arvind Srivastava - Continuous Improvement specialist and LSS Master Black Belt at Borg Warner/Member US ISO-TAGs: 176 & 302 -USA***

The standard has a good structure overall with great content on competencies at different levels which will be good for Lean and Six Sigma consulting organizations. On the con side, it is too broad for interpretation with an overkill focus on competencies in the practicing or implementing organization. The roles of sponsor, champion, and process owners also need to be defined as they are also key personnel in a Lean, Six Sigma or LSS implementation. The standard refers to Lean and Six Sigma but not LSS – LSS is not a simple arithmetic addition of Lean and Six Sigma. In reality, it is more complex and needs to be reflected accordingly. Many of the competencies are repeated across Lean and Six Sigma and some of the competencies mentioned while important are not unique to Lean and Six Sigma, e.g., change management, creative thinking, customer focus, presentation and reporting, and project management. In section 4.1, for example, the competency word is confusing. It is being used in both: input and output. I think it is only the output. Overall while it is a good effort, most medium and small organizations may not feel comfortable adding excessive overhead to follow it at the organizational level. The competencies may be used as a guideline only.

***Mr. Jonathan Hunt -Consultant, Omnex, USA***

The ISO 18404 standard standardises requirements/competencies for individuals. Many training courses are combined LSS. It is divided within this standard which I feel is a negative as a lot of tools from both competencies go hand in hand and complement each other if used together. It pushes the two topics apart. The standards competencies here in ISO 18404 are given a framework, however I feel this structure may have restricting effect as individuals/organisations may "box tick" to comply with the standard rather than using the appropriate tools to meet their actual objectives.

The standardisation may reduce or remove ambiguities for both Lean and Six Sigma. A number of the sections within the competencies maybe difficult to quantify and demonstrate in a "snap-shot" in time, therefore making it difficult to audit as well as introducing ambiguity, the very thing the standard is trying to control. The standard will aid in regulation of training companies that offer certifications by making sure they are relevant and working to right the standard.

The requirement of yearly review and submissions of projects/portfolios to keep practitioners certified may incur a problem if these are unable to be submitted due to an individual's work commitments or workload (due to business needs). This may mean a perfectly capable practitioner may lose an accreditation. The fact that the standard states practitioners must submit projects/portfolios yearly for review, will assist in the upkeep of individuals and personnel to the required competency levels. However, the end goal may be focused looking at deliverables rather than front end training requirements.

***Dr. Udo Milkau, DZ BANK AG, Chief Digital Officer, Transaction Banking, Germany***

The work is done by Prof. Tony Bendell and Royal Statistical Society is very valuable, as many derivatives of LSS emerged during the last years and – unfortunately – a number of ‘rogue consultants’ have been selling LSS without a real benefit for the customers. A clear standard provides benefit just by being a “standard”, providing a ‘lingua franca’ for experts, practitioners, academics, and users on the work floor (aligned to the idea of Gemba Kaizen: improve things at the source, where people are doing their daily job). Unfortunately, and from the perspective of practical use “on the work floor”, the new standard lacks some balance between the methodology (and the meta-methodology of certifications) and the elementary approach (i) to change mind-sets of staff AND management and (ii) really listen to the Voice of the Customer. Therefore, the current ISO 18404 for LSS could be enhanced by being a little bit LEANER.

***Dr. Gabriele Arcidiacono, Professor of Machine Design, Head of the Department of Engineering Science (DES), LSS Master Black -G. Marconi University, Italy***

On the plus side in the ISO 18404 standard great attention is dedicated to the adequacy of an organization with regards to its “Lean and Six Sigma” approach and deployment in terms of strategy, architecture, skills and competences. The standard also focuses on maintaining the “Lean and Six Sigma” competence of key personnel: a key factor for its long-term robustness and sustainability. In the competencies tables more emphasis is given to soft skills like Change Management, Creativity Thinking, Motivating others, Interpersonal and Team Leadership Skills.

However, on the negative side it is not fully clear whether this standard integrates or supersedes ISO 13053-1 2011 and ISO 13053-2 2011 (Quantitative methods in process improvement — Six Sigma — Part 1: DMAIC methodology and Quantitative methods in process improvement — Six Sigma — Part 2: Tools and techniques) so misunderstandings may occur. Also why use Lean acronyms only? – e.g., section 3.2). An option could be a new version of ISO 13053-1 with a new LSS integration chapter. No definition of LSS exists within the ISO 18404 standard. We suggest providing definitions and explain why LSS takes the best from the previous two when combining waste reduction and process repeatability. The Yellow belt certification level is not mentioned in 18404 (it is present in 13053). I would recommend treating it as the other belts are treated as equally important to create common language and new mindset towards operational excellence. There is also very little information about the authority that runs the review.

There are no specific criteria to certify the belts that have successfully completed LSS projects. Some recommended criteria (e.g., rate 1 to 5) for LSS projects could be utilised such as: 1. Rigour in DMAIC roadmap usage, 2. usage of quantitative analysis, 3. correctness of LSS tools, 4. significant benefits verified by a financial analyst and good oral presentation. There are no criteria to prevent inactive belts; once certified they should keep doing LSS projects (e.g., at least one project/year) and keep competencies fresh (e.g., through tests/training sessions). The annex tables may look big and complicated to use and fill in. This leads to many “Not applicable” items that may be questionable. For example, last item in table A.2 - 17th row is questionable since a BB should be able to run risk analysis training.

The Yellow Belt certification is not included in this paper. We recommend including it, as it is a frequently neglected layer but not less important than Green, Black and Master Black. Yellow Belt is mandatory to achieve a wide diffusion companywide of a LSS program as it creates common language and mindset towards operational excellence. The ISO 18404 standard takes for granted the



meaning of Lean, Six Sigma and LSS. Since its aim is to facilitate the understanding of these three bodies of knowledge, the writers should provide a deeper definition of the concepts and explain that “Lean and Six Sigma” can be considered one single package to pursue financial efficiency through waste reduction and process repeatability. These two pillars deliver best output when properly merged. For example, a typical Lean tool e.g., 5S can be directly targeted to eliminate special causes of assembly process time, which is a typical Six Sigma objective: one goal met with one set of tools. In section 3.2 a list of abbreviated terms is provided but it refers to a Lean toolbox: we recommend enclosing also the Six Sigma terms described in ISO 13053-1. In the table B.3 – Index 2 column “Competency”-the cell content (“Lean Principles”) is missing.

***Dr. Ayon Chakraborty -Associate Professor, Federation University, Australia***

On a positive note, ISO 18404 as a standard provides a detailed description of the requirements and competencies for Six Sigma and Lean. The list of competencies is pretty exhaustive and helps organizations to really look deeper into each of the methods. As the standards state in the introduction, this document will really be helpful for both suppliers and customers in convincing each other about the level of implementation of respective methods. The standards actually help in collating and synthesizing the “know how” about an organization’s strategy, architecture, human resource, resource management related to deployment of Lean and Six Sigma. These were scattered across different literatures and the standard helps to bring them all together. The standard also focuses on continual improvement which is evident from its statement – section 5.5(d) “review the continued relevance of the metrics and targets and update as appropriate”. This shows that the standard is prompting organizations to continuously look for improvement by checking the adequacy of the metrics and their targets.

On a negative note, ISO 18404 “the document” while exhaustive and trying to provide the state of the art in Six Sigma and Lean looks very prescriptive. This can lead to mechanization of the methods which is one of the criticisms of the standards. The standard follows a uniform narration for both manufacturing and services, but the standards mention the methods as “quantitative methods in process improvement”. These two factors limit the usage of standard for these methods uniformly both in manufacturing and services. The methods though are primarily quantitative but have both hard and soft tools. Service organizations use mostly soft tools (such as check sheet, Pareto, SOPs, Process Mapping, Visual Management, etc.) and require different competencies than manufacturing.

The standards though talk about creativity in competencies but explicitly looking for this competency may hinder the creativity rather than fostering it. To meet the obligations of the standard, individuals/organizations may report certain competencies which are not measured adequately. The standards talk about documentation, which is good, and in these methods projects are documented. But by explicitly mentioning it in the standards it may lead to development of reports which are compliant to standards but have limited practical relevance and usage.

***Pedro Martinez Jurado - PDI en Centro Universitario de la Defensa de Zaragoza, Spain***

The ISO 18404:2015 attempts to standardize competencies for personnel and organizations in Lean, and Six Sigma and, therefore, I consider that this effort by itself would be useful for practitioners. So, I agree with the need for standardization. On the one hand, the Six Sigma side of the Standard (through the joint application of the ISO 18404:2015, 13053-1: 2012, 13053-2: 2012, 17258:2015) is

the most useful part from a practical point of view. However, the Lean side of the standard is insufficient to achieve the expected goals for companies and consultants.

On the Lean side of the standard one of the main problems is the attempt to standardize competencies for organizations. It is inadequate to answer questions established in the standard (e.g., If a supplier says it is deploying Lean, how can a customer be sure of their real abilities?). I thought I was going to find a balanced scorecard to evaluate the maturity level of a Lean strategy but there is no scorecard included. The Standard does not reflect the complexity of Lean as a socio-technical system and, therefore, to carry out an evaluation of its social or “soft side” is a complex task. However, the assessment of the Annex B depends largely on the auditor’s opinion. It is highly subjective. In this regard, some sources of evidence are insufficient (for instance, I do not understand why some columns of the table are not applicable). In addition, other key competencies for Lean personnel (e.g., supply chain side, environmental and social sustainability, etc.) should have been considered.

***Professor Murat Caner Testik, Professor and Chair in the Department of Industrial Engineering, Hacettepe University, Turkey***

The ISO 18404 standard covers and lays out the competencies for personnel and organizations in Lean and Six Sigma implementations. In order to assist in the level of required skills and abilities of the key personnel, this ISO standard is well-received. Especially, the table in the Annexes of the standard, which lists and clarifies the expectations for the abilities and skills of personnel of the Six Sigma organizations, is an important contribution. However, it should be mentioned that these listed competencies are more heavily on the managerial side. These managerial competencies are often difficult to evaluate and answer questions around how to demonstrate evidence of competency and objectively implement in practice can become difficult. Instead, more emphasis on the technical aspects of process improvement for the required skills of personnel might be useful since Lean & Six Sigma is a quantitative method.

Besides, in implementations of the standard, technical skills may be easier evaluated in contrast to managerial skills. How to differentiate the required abilities and skills for the different roles in the organization is another issue, which is often not easy to decide from the tables provided for green, black, and master blackbelts. It should also be mentioned that the required competencies provided in the tables should not be treated equally and in my judgement the technical skills should have higher weights and these weights should depend on the role in the Lean and Six Sigma organization. Finally, the term “appropriate authority” utilised in the standard, which is defined to be an authority either internal or external to the organization, would need further explanations since the term is vague and a standardization of such authorities is also needed.

***Professor Sung Park, Seoul National University, South Korea***

On ISO 18404 -I agree with the policy that such kind of international standard on Six Sigma is published. However, I have some opinions on the published standard with the first point being that firstly the name of ISO 18404 is "*Quantitative methods in process improvement - Six Sigma* -" but the contents of ISO 18404 show that it would be more proper to use the name "*Quantitative methods in process improvement - Six Sigma and Lean*". Secondly, the title of section 6.5.3 is "Master Black Belt and Lean expert". Since plural is used for Green Belts, Lean practitioners, Black Belts and Lean

leaders in 6.5.1 and 6.5.2, the plural form of Master Black Belts and Lean experts should be used in 6.5.3 too. Thirdly, this standard excludes Design for Six Sigma (DFSS). Since DFSS is an important part of Six Sigma, it should be included in this standard. If not, another standard on DFSS should be prepared sooner or later. Fourth, If we look the "Maintaining competence of key personnel" of section 6.5 in page 4, the competence of key personnel is not well defined. Their competencies are very much vague. Also "a portfolio of evidence of work experience" is used for everybody such as green belts, black belts and master black belt. Though some distinctions are made in Annex A (normative), it would be better to list the differences of competencies for green belts, black belts and master black belts.

***Dr. Gregory H. Watson, Consultant Business Excellence Solutions Ltd, Finland and Past President of the ASQ***

The fundamental problem with ISO 18404 is that it does not reflect reality. It structures the Body of Knowledge as if "Lean" is distinguishable from "Six Sigma" and from "Lean Six Sigma." In reality, all disciplines that are addressed come from the same roots – Japanese quality management practices developed at leading companies, such as Toyota, during the period from 1956 through 1985. By 1983 consultants from the Union of Japanese Scientists and Engineers had introduced "Total Quality" tools and methods to companies such as Motorola, Hewlett-Packard, and Xerox. Motorola repackaged these methods under the "brand name" of "Six Sigma" beginning in 1987 through the work of the Motorola Research Institute (although the term "Six Sigma" was coined earlier in 1985). Harry (1993) in his "Vision of Six Sigma" describes methods such as cycle time reduction, mistake-proofing, and waste elimination as elements of the training syllabus for Motorola's initial Six Sigma training program.

The term "Lean" was introduced by Krafchik (1988) to describe the Toyota Production System's approach to improvement through reduced waste and improved quality. Toyota had also incorporated statistical methods into their system; however, Krafchik and his project supervisors James P. Womack, Daniel T. Jones, and Daniel Roos failed to recognize this contribution in their 1991 book "The Machine that Changed the World" (Womack, J.P., Jones, D.T., and Roos, D., 1990) Finally, "Lean Six Sigma" was coined by George (2002) "Lean Six Sigma: Combining Six Sigma Quality with Lean Speed." However, there was no need for this marketing invention as the initial set of training material promoted by Motorola included all of the "Lean" methods described by George (2002). So, this contribution was primarily a "re-branding" of Motorola's program under a new label. Perpetuation of the myth of a lack of integration between these three methods does a disservice to the profession at best and at worst leads potential practitioners of improvement methodologies into the quagmire of "duelling improvement methods" as they seek to solve real-world problems.

While this is my primary objection, a secondary objection is that the ISO committee failed to recognize or include the established body of knowledge about these methods that had been developed by the American Society for Quality based upon the work of Motorola and had been completed over the period from 1997 through 2010. In this body of knowledge there are pre-existing definitions and behavioural objectives established regarding the essential knowledge of individuals at the skill levels noted in ISO 18404. This is perhaps the reason why the American and Japanese delegates to TC69 of the International Standards Organization voted against the approval of this standard. It is a standard that does not deserve to exist in its current form and it also relies upon two related standards which fail for the same reasons.

***Professor T N Goh, National University of Singapore, Singapore***

The ISO 18404 document sets out specific requirements with respect to the various ranks of workers of Six Sigma and its extensions. The usual problems related to conformance (as specified in the standard) can be expected here. For example, there are several places where “evidence of....” is sought: this would be a tricky situation because who is to judge whether there is sufficient “evidence”? In fact, with all the requirements laid out, it is easy for organizations to go through a “check list” and claim that it is ready to be certified to this standard. It is not easy to offer a solution so to speak to such issues; perhaps more views and suggestions can be solicited to make the standard easy to implement in a meaningful way.

**Discussions & Implications**

While most respondents welcomed the ISO 18404:2015 standard in some manner and had some positive comments to make, nearly all contributors listed some negative commentary about the ISO 18404:2015 standard. Nearly one third of those interviewed were vehement in their criticism of the standard or the need for such a standard in the first place. While some respondents were more from a Lean or Six Sigma or a combined LSS background, one common denominator even in those with overwhelming positive statements to make about the ISO 18404 standard was that it needed to be improved in several aspects.

The requirement for the standard to embrace the combined LSS methodology and not just Lean and Six Sigma separately was a dominant theme. Many organisations since 2002 have adopted an integrated approach using the best of Lean and Six Sigma methodologies, despite of their size and nature. Snee and Hoerl (2018) present “Holistic Improvement System” for implementing an integrated approach. Their system utilizes Design for Six Sigma, Risk Management, Quality by Design, Big Data Analytics and Workout in addition to Lean and Six Sigma.

The themes of Lean and Six Sigma as a holistic, philosophical approach to continuous improvement in organisations were brought up by many respondents, and a standard was felt to stifle these aforementioned approaches and organizations’ autonomy in utilising in these methods. Another important theme was the concept of involving and training everyone in continuous improvement programmes and their methods. Several respondents commented on the lack of a Yellow Belt program stifling the promotion and training of all levels of an organisation in a Lean, Six Sigma, or LSS deployment. The concept of trying to measure or audit the levels of Lean or Six Sigma deployment utilising a standard was very much a concern among respondents. The concern that the Lean and Six Sigma competencies, while good to have, may be unclear, difficult to audit and to distinguish between the different skill levels required for progression within the competency framework for belts.

The aforementioned findings in the previous paragraphs matched and agreed with the limited literature and social media commentary in relation to this standard. The findings from this research are a valuable source for Lean, Six Sigma, LSS practitioners and organisations currently deploying these methodologies, anyone considering embarking on a continuous improvement program and/or individuals and organisations considering undertaking training in Lean and Six Sigma settings. The research describes a link between deploying these methodologies and whether a standard such as ISO 18404:2015 would be useful or value-added in considering certification to or training in.

In summary, the opinions of the ISO 18404:2015 were mixed but with an overall majority of the opinion that the ISO 18404:2015 standard is not fit for use or required at all. Based on these findings the authors would recommend that future systematic reviews of the standard by the ISO

organisation take to heart the concerns from the Lean, Six Sigma, and LSS practitioners and academic community. The authors feel that a number of leading experts who have carried out some pioneering work in the field of Lean, Six Sigma, and LSS were never consulted in the development of the standard.

### **Conclusions, Limitations and Future Work**

Standards have a place in aiding continuous improvement. However, there are seven key cautionary findings from the study:

1. The ISO 18484:2015 standard has not been widely adopted nor embraced, as evidenced by the limited literature available on it, and the practitioner and academic viewpoints from the interviews on its implementation and adaptation.
2. The current standard could be improved and overhauled and does not seem to be fit for purpose nor a requirement of the industry.
3. It is difficult to “standardise” continuous improvement methods such as Lean and Six Sigma, so if designing a standard around these, the standard should integrate LSS.
4. Organisations successfully implementing successful Lean, Six Sigma, and LSS programs need to be dynamic in their approach in terms of what sections or parts of LSS they deploy and when they deploy them and should not be confined to a rigid or prescriptive standard. We do not feel that the current ISO 18404 standard supports this as the standard is somewhat prescriptive and states criteria to be followed.
5. The standard should have a dedicated section for SMEs with resource constraints such as budget, time, and people.
6. The standard should include the competency of LSS Yellow Belts for greater engagement of the workforce, aid inclusivity of all levels of the organisation and to help to encourage a culture of continuous improvement and respect.
7. Bloom’s taxonomy should be considered for the development of competencies from Yellow Belt to Green Belt to Black Belt and MBB levels.

There are opportunities for further exploration of case studies on the deployment of ISO 18404:2015 in an organisation. However, with the limited uptake of organisations certifying to the standard this will be difficult. Further research via more detailed interviews and surveys on the application of the standard, and the potential components and “ingredients” of the design of such a standard would be helpful. In particular, use of a wider section of stakeholders would be valuable in informing on the merit and feasibility of having a standard related to continuous improvement methodologies.

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