

Swain, Ajaya K.; Cao, Ray Qing; Gardner, William L.

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Six Sigma success: Looking through authentic leadership and behavioral integrity theoretical lenses



Ajaya K. Swain^{a,*}, Qing Ray Cao^b, William L. Gardner^c

^a Finance and Quantitative Management Department, Greehey School of Business, St. Mary's University, San Antonio, Texas 78228, United States

^b General Business, Marketing, and Supply Chain Management Department, Marilyn Davies College of Business, University of Houston-Downtown, Houston, TX, United States

^c Area of Management, Rawls College of Business, Texas Tech University, Lubbock, TX, United States

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ABSTRACT

Purpose: The purpose of this research is to broaden the current understanding of the relationship between top leadership characteristics and Six Sigma success.

Design/methodology/approach: The research used a cross-sectional survey methodology where 212 companies from six different industries were analyzed to investigate the research question.

Findings: This study provides insight into how authentic leaders and leaders with behavioral integrity can facilitate and promote the Six Sigma process in an organization. The key finding is that in order to reap the best benefits of Six Sigma, both qualities in leaders are desired. The study obtains evidence that by staying true to the values they espouse, authentic leaders with high behavioral integrity can foster elevated levels of Six Sigma performance in the workplace. The research model can be applicable in other empirical settings.

Research limitations/implications: The current study broadens the existing knowledge about leadership, trust, and performance. While many forms of leadership have been found to motivate employees to perform more effectively through mutual trust, little theory and research has examined the interrelationships among these variables within a Six Sigma context. By identifying authentic leadership and behavioral integrity of leaders as potential enhancers of the effects of top leadership in organizations, our findings represent a departure from prior approaches to understanding the impacts of top leadership on Six Sigma performance. For practitioners, the results of this study further shed light on how leader integrity relates to effective performance and highlights the fact that it is not only important for leaders to remain true to themselves, but they must also walk their talk. The limitations of this study may include the cross-sectional data, specific sample and context in which the proposed relationships were tested that may restrict the generalizability of our findings.

Originality/value: The main contribution of this work is the integration and extension of two emerging theories, authentic leadership and behavioral integrity from the leadership literature, to the field of operations management. This study is a timely response to calls from operations management scholars who strongly believe that incorporating theories from organizational behaviour can provide greater insights to practical consequences of implementing operations management practices. To the best of the authors' knowledge, this research is among the first to investigate the relationship between the authenticity and behavioral integrity of a leader and the success factors of a Six Sigma process. The study contributes to the quality management field that has been largely been considered to be lacking on strong theoretical foundations.

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* Corresponding author.

E-mail address: aswain@stmarytx.edu (A.K. Swain).

1. Introduction

Quality provides an opportunity to compete. In today's dynamic, competitive, and uncertain business environment, continuous improvement in the quality of processes and products can lead to a sustained competitive advantage [58,75,92]. Developed at Motorola Corporation in the mid-1980s, Six Sigma is fundamentally a quality improvement methodology that aims to achieve *zero defects* in a process. Six Sigma has been described as an administrative innovation [51], a business improvement strategy for greater customer satisfaction [8], better organizational performance [16,80], and also as a culture change effort that reflects a drive towards competitiveness and profitability [27,79]. Viewing the commonly used definitions found in the literature for Six Sigma as inadequate for scientific investigation, and considering the rules for constructing conceptual definitions developed by Wacker [101], Schroeder et al. [85] p. 540] proposed the following definition for Six Sigma that captures its theoretical aspects from the extant literature:

“Six Sigma is an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives.”

While anecdotal evidence supports the effectiveness of Six Sigma in a variety of organizations [46,73,97], there has been a considerable debate about the reasoning for acceptance of Six Sigma. [108] present three reasons in support of their argument that Six Sigma is not a management fad. One, usually management fads do not last long, whereas Six Sigma has been popular for over a quarter of a century. Two, management fads cannot deliver what they promise, which is not true in case of Six Sigma, as is evident from its past records. And last, the acceptance of Six Sigma follows a different pattern from that of management fads. Critics of Six Sigma (e.g. [66], p. 195) argue that “it lacks a theoretical underpinning and a basis for research other than best practice studies.” Schroeder et al. [85] observed that despite its acceptance in 1980s, attempts to build a theoretical foundation of Six Sigma is a recent development. [108] question how a mechanistic approach, such as the one Six Sigma adopts, can work well in today's dynamic business environment. They note that the mechanistic approach works well for highly repetitive and predictable tasks, but is not appropriate for an adaptive organization.

Despite such skepticism, researchers argue that it is important for the academic community to continue to study the six sigma phenomenon given its wide spread acceptance in industry [77] and insist that an in depth theoretical understanding of the underlining principles, methodology and deployment processes is missing from the quality management (QM) literature [108,30,94]. There has also been an emphasis on reflective studies critiquing the phenomena of Six Sigma from people and process perspectives in order to gain more insights to the Six Sigma process [73]. This study is a response to those calls.

Six Sigma, seen as a parallel development to earlier quality initiatives such as total quality management (TQM) and Quality Circles, draws its strength from its focus on continuous improvement and customer satisfaction, fact based decision making, employee engagement, and top management support [43]. Scholars from different fields have reported several critical success factors (CSFs) responsible for Six Sigma implementation [18,21,24,28,56,71,109]. From their pilot survey of manufacturing and service organizations in the United Kingdom, Antony and Banuelas [7] identified top leadership commitment and involvement as the most important factor contributing to a successful Six Sigma implementation. An exhaustive list of such CSFs can be found elsewhere (e.g. [33,77,96]).

While it is important to note that the founders [32], theoreticians [30], and empirical researchers [94] in the field of QM have emphasized the significance of leadership to QM practices, leadership has not been researched thoroughly in QM in particular and in the field of OM in general [59]. Moreover, not enough literature exists in this research stream that analyzes the behaviours and mechanisms through which leaders impact the Six Sigma process and its outcomes [61].

Drawing upon the emerging authentic leadership (AL; [10]) and behavioral integrity (BI; [90]) theories from the field of organizational behavior, this paper tries to address this gap in the existing OM literature while examining this broad research question: “What is the relationship between the top leadership and Six Sigma outcomes?” Specifically, the paper analyzes how authentic leaders and leaders with behavioral integrity influence important elements of the Six Sigma process that ultimately affect its outcomes. A theoretical model is developed and empirically tested to explore how specific behaviours of leaders impact Six Sigma process. Both the AL and BI constructs are new to operations management and Six Sigma research. The study contributes to the body of Six Sigma literature and leadership by linking these two well researched fields together through a fresh application of AL and BI. Moreover, the growing importance of QM and leadership to business sustainability necessitates that both academicians and practitioners develop an enhanced understanding of the relationship between top leadership and QM practices. Furthermore, there is limited research about the relationship of quality practices and leadership and their effects on quality performance [59].

The main contribution of this paper is the integration and extension of two emerging theories, AL and BI from the leadership literature, to the fields of OM and QM, and particularly Six Sigma. This research provides insight into how AL and leader BI can promote the Six Sigma process in an organization. Our results indicate that, to reap the best benefits of Six Sigma, both the authenticity and BI of leaders are important, although under different circumstances.

The following sections present relevant literature on Six Sigma and leadership, AL, and BI; the research model and hypotheses; the research method employed; a discussion of the findings; and a brief conclusion including limitations of the study and directions for further research.

2. Literature review

2.1. Six sigma and leadership

The success of Six Sigma has been attributed a lot to the top management. Transformational and visionary leadership theories have been advanced to contribute to a more realistic view of top management [23]. Schroeder et al. [85] suggest that leadership involvement through the use of improvement specialists and the strategic selection of projects in combination with a structured methodology, can lead to improved performance. Deming and other quality practitioners pointed to visionary leadership as a key requirement for an effective QM program [5,29].

A few scholars have suggested that transformational-transactional leadership is the most appropriate model of leadership in the quality management context (e.g. [30]). Although the transformational and transactional leadership styles were originally presented as two extremes of a continuum [20], more recent conceptualizations posit that a leader can be either/neither transformational, transactional, or both. Transactional leaders motivate followers mainly through contingent-reward exchanges and active management by exception [11]. Staying within an existing system, transactional leaders seek to strengthen an organization's culture, strategy, and structure. On the other hand, transformational lead-

ers tend to be charismatic, inspirational, intellectually stimulating, and individually considerate [11]. They inspire their followers through their vision, enthusiasm, and drive for innovation [13]. The relationship of transformational and transactional leadership to the implementation of quality practices is also documented in the literature [59].

Leadership theory pertains to leaders at any level in the organization and leadership research focuses on the relationship between the leaders and followers [99]. While research on trait and style approaches focus on leaders [19], researchers focus on followers for studying implicit theories of leadership (e.g. [67]). Other approaches include focusing on the nature of interactions among leaders, followers, and contexts [42,74]. All of these leadership research approaches have a predominately micro focus meaning that they study leaders and followers at the individual or dyadic levels of analysis. This study adopts this micro orientation of leadership research and focuses on the characteristics of the leaders and their relationship with their immediate followers.

2.2. Authentic leadership (AL)

A new theory of leadership, authentic leadership, has been proposed by both Avolio et al. [12] and Gardner et al. [39]. Authenticity involves being true to oneself, and relying on internal values and standards, as opposed to blindly complying with external demands and pressures. However, because all leadership is relational at its core [10], authentic leadership involves the alignment of the leader's internal standards with the empowerment of followers to likewise achieve authenticity through the creation of authentic leader–follower relationships. Indeed, the central premise of authentic leadership theory is that through increased self-awareness, self-regulation, and positive modeling, authentic leaders foster the development of authenticity in followers. The attainment of authenticity in turn contributes to followers' well-being and the attainment of sustainable and veritable performance [39].

To understand the conceptual underpinnings of authentic leadership, it is important to examine further the construct of authenticity. Authenticity can be described as both understanding and owning one's personal characteristics, such as experiences, needs, thoughts, beliefs, and emotions [48,68] and as being self-aware and behaving as one's true self. Here it is important to recognize that no individual is ever completely authentic or inauthentic ([35,36]) as the degree to which one achieves authenticity will vary across and within individuals. A comprehensive list of different definitions of authentic leaders and authentic leadership can be found in Gardner et al. [40]. These definitions include the core concepts of self-awareness, positive self-regulation, positive self-development, and/or a positive moral perspective of an authentic leader.

This work adopts the definition of authentic leadership offered by Walumbwa et al. [104], p. 94: "as a pattern of leader behavior that draws upon and promotes both positive psychological capacities and a positive ethical climate, to foster greater *self-awareness*, an *internalized moral perspective*, *balanced processing* of information, and *relational transparency* on the part of leaders working with followers, fostering positive self-development."

Self-awareness refers to the degree to which a person possesses accurate self-knowledge of his/her individual characteristics, ideals, intentions, thoughts, and behaviors [22]. Ilies et al. [50] described self-awareness as one's understanding of one's natural conflicting self-aspects and the impact of these contradictions on one's feelings, actions, and behaviors. Walumbwa et al. [104] described *self-awareness* as the degree to which leaders know and recognize their true self; hence, authentic leaders observe and analyze their own mental state through introspection during the process of self-awareness. Also, as Avolio and Gardner [10] point out, during this process, authentic leaders discover and acknowledge their funda-

mental values, thoughts, true character, and goals. To summarize, self-awareness is a process whereby authentic leaders come to recognize their true, distinct capabilities; through such understanding and self-reflection these leaders attain clarity of their fundamental values and thought processes [10,39].

Balanced processing involves a relatively impartial analysis of related information while accounting for others' opinions and feedback when making decisions [104]. Authentic leaders consider issues with an open mind and consider the merits of criticism about themselves and also their style of leadership [39]. As they go through an internal and self-reflective process to gain self-awareness, authentic leaders try not to misrepresent, overstate or disregard the relevant information required for their decision making [57].

Relational transparency pertains to the presentation of a leader's true self to others. Authentic leaders, who achieve relational transparency, exhibit openness and self-disclosure [104]. In other words, relational transparency encompasses an open sharing of information and expression of true feelings and emotions to others. Relational transparency enhances trust between a leader and followers and reduces the suppression of feelings [57]. That is, by revealing their true self in terms of goals, motives, ideals, and emotions to their followers, authentic leaders promote trust and intimacy that fosters greater teamwork, cooperation, and learning process.

Avolio and Gardner [10] point out that authentic leaders orient their ideals with their motives and actions through the process of internalized self-regulation. This process is internally motivated and involves staying true to one's values as opposed to being driven by external incentives and threats. Such self-regulation involves maintaining equivalence between one's self standards and expected outcomes [31,39]. Through this process of self-regulation or an *internalized moral perspective*, authentic leaders manage conflicts and tensions between their principles and tasks.

Having described the components of AL, it should be reiterated that no leader achieves all of these components all the time and hence AL exists on a continuum.

2.3. Behavioral integrity (BI)

Behavioral integrity (BI) has been defined by Simons [[87] p. 19] as "the perceived pattern of alignment between an actor's words and deeds." He and his colleagues describe BI as an observed pattern of behavior attributed to a manager that is clearly differentiated from common conceptualizations of trust. BI is associated with trust in leaders and organizational commitment [91]. BI is a perceived objective pattern of alignment between a manager's words and actions. The perception of an employee of the manager's BI has been shown to significantly influence work attitudes and behaviors [87]. Simply put, if an employee observes that a manager has a tendency not to be truthful or forthright, s/he is most likely to trust the manager less. So the BI of a manager impacts important characteristics in an employee, such as employee motivation towards promoting and implementing change, employee retention, and employee performance. These attitudinal and behavioral factors subsequently impact the attainment of an objective or goal of an organization. For an example, in a Six Sigma process, these factors are posited to be very critical to its success.

3. Hypotheses development and research model

Avolio and Gardner [10] describe AL as a form of leadership where one is *true to oneself*. In contrast, BI involves *being true to one's word when dealing with others* [87]. BI has been defined as the degree to which the leaders are perceived to do what they say [87]. In a broad sense, both authentic leadership and BI have been

associated with positive organizational behavior and are complementary constructs. However, as Leroy et al. [64] pointed out, they are not the same because authentic functioning is mostly inward-focused and BI is largely outward-focused and involves others' perceptions of the actor's integrity.

Deming [32] called on managers to institute leadership and explicitly stated in the recommendation of his famous 14 points that *constancy of purpose* is one of the most significant criteria for the success of a quality improvement initiative. In the case of Six Sigma, constancy means a continuous effort towards achieving Six Sigma quality by maintaining employee engagement. Waldman et al. [103] mentioned that in the absence of a devoted leadership effort towards quality improvement, employee motivation may decline over time and employees may adopt a reactive approach to the quality initiative instead of a proactive one. In the case of Six Sigma, persistent support from the top leadership is essential and top leadership that commits to this quality improvement program should continue to extend the support until the goal is achieved. This is entirely in line with Deming's recommendation for constancy of purpose.

Considering the definition provided by Yukl [107], Waldman [102] found a typical connection between leadership and implementation of a quality change initiative. He (p. 66) wrote "leadership includes influence processes involving the determination of a group's or organization's objectives, motivating task oriented behavior to accomplish these objectives, and influencing group maintenance and culture." Although he found a clear requirement of such processes for TQM practices, these may be very relevant for Six Sigma themes as well. Waldman asserts that top management that leads from the front with inspirational leadership behavior recognizes the team effort and that of an individual. Such leadership is likely to motivate followers toward an overall quality goal or in the case of Six Sigma program, "Six Sigma Quality". Again, this involves creating a quality culture across the organization where every employee starts and continues to believe in top leadership commitment and perseverance towards a quality goal. Waldman's findings are in line with BI theory which posits leaders are considered more credible when they do what they say and such credibility forms the basis for the employee loyalty and commitment that is critical to employee motivation and performance [90]. As such, it is hypothesized that a leader who persistently supports the Six Sigma cause will be judged by followers to be high in BI, which will lead to Six Sigma success. Moreover, because a leader with strong BI will have high credibility with his or her followers, high levels of employee engagement are likely, which will help to foster Six Sigma success.

H1. *Leader BI is positively related to Six Sigma Performance.*

H2. *Leader BI is positively related to employee engagement.*

Mayer et al. [72] p. 712 defined trust as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control the other party." They pointed out that a perception of another person's integrity is one of the key antecedents to trust. Simons [87] argued that for the establishment of trust between two parties, a perception of BI may be an essential condition in that it creates an expectation with the listener that the actions of the speaker will conform with his or her words. As such, research confirms that BI is closely related with trust in leaders and organizational commitment and both these factors impact customer satisfaction and organizational profitability [89]. In his research model, Simons [87] described trust as a mediating variable between BI and several outcome factors such as employee willingness to promote and implement change, employee retention, and employee

performance. All of these factors are relevant to our research because the Six Sigma process depends on employee commitment towards the quality change initiative, and also getting and staying involved throughout the process of change. The performance of individual employees in the process is linked with the overall success of this process. Thus, it is posited that trust mediates the relationship between the BI of a leader and employee engagement.

Engagement involves the "harnessing of organizational members' selves to their work roles; in engagement people employ and express themselves physically, cognitively, and emotionally during role performances" ([53] p. 694). Engagement also reflects a sense of purpose and focused energy of an individual directed toward the overall organizational goals and objectives. Employee engagement has a state and behavioral dimension [54,70]. The state of engagement precedes and leads to engagement behaviors, and engagement behaviors directly impact performance outcomes. By recognizing individual differences and complementary talents in employees, an authentic leader helps them to build on strengths that lead to greater employee engagement. Importantly, Avolio and colleagues' [12] assertion that authentic leadership promotes employee engagement has received empirical support [63]. Drawing on diverse relevant literatures, Macey and Schneider [69] provided a thorough explanation of employee engagement and offer a series of propositions about psychological state engagement, behavioral engagement, and trait engagement. Since a highly engaged employee can affect customer service positively and a disengaged employee can negatively impact the service or product quality, it is posited that employee engagement positively relates to Six Sigma performance. Also, it is posited that the exhibition of authentic leadership by top management will be related to greater employee engagement, which will in turn be associated with enhanced Six Sigma performance.

H3. *The positive relationship between Leader BI and employee engagement is mediated by trust in the leader.*

H4. *Employees' trust in their top leadership is positively related to their work engagement.*

H5. *Employee engagement positively relates to Six Sigma performance.*

The relationship emerging from a strong word-deed alignment can generate a great deal of enthusiasm and commitment within a team that truly engages members in problem solving and high levels of customer service [88]. These are two important characteristics of a Six Sigma process. AL can be related to this phenomenon by asserting that because more versus less authentic leaders stick to their commitments, followers will have greater confidence in them. It is in turn posited that this enhanced confidence of followers will be associated with greater employee engagement that facilitates a successful Six Sigma implementation.

H6. *Authentic leadership by top management is positively related to Six Sigma performance.*

H7. *The positive relationship of authentic leadership with Six Sigma success is mediated by employee engagement.*

Both AL and BI have been considered under the broader umbrella of positive organizational behavior. This positive lens on employee behavior identifies those strengths that drive effective performance in the workplace [64]. Leader authenticity and integrity are key factors that are posited to influence employee engagement and employee performance. AL and BI foster follower identification with the organization, thus driving follower affective organizational commitment. This relationship is mediated by the leader's BI. AL and BI are closely associated with followers' work role performance which is fully mediated through followers' organizational

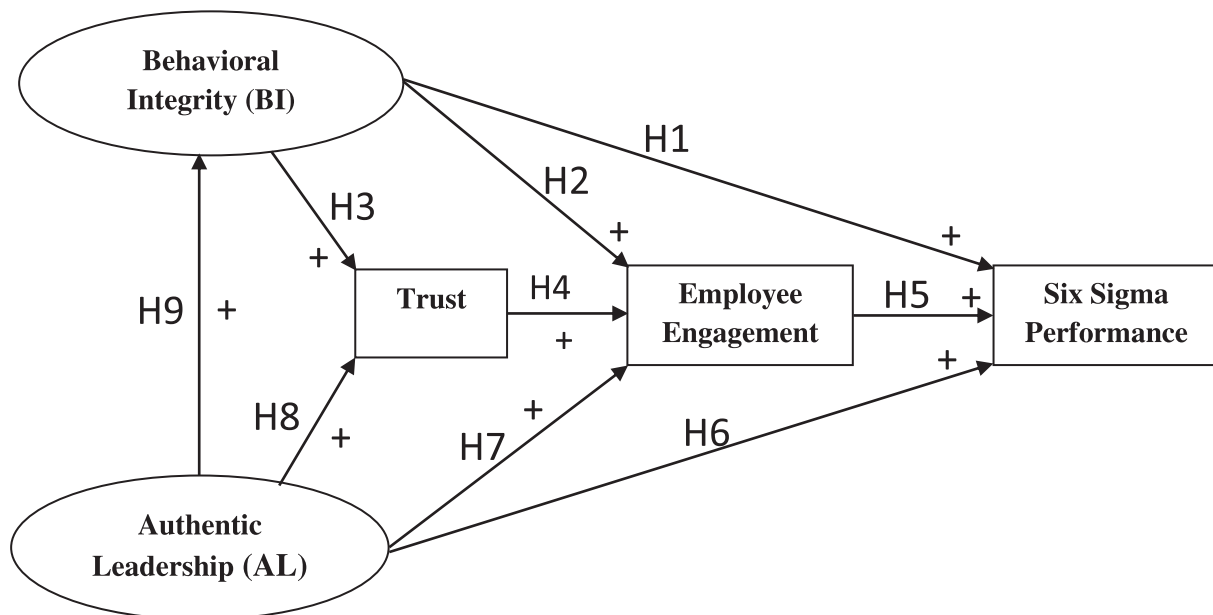


Fig. 1. Research Model.

commitment. As Leroy et al. [64] found, authentic leadership can be an antecedent to perceptions of BI. In the same vein, this paper argues that AL is positively related to employee engagement in a Six Sigma process and this relationship is mediated by trust of the employee in the leader. Furthermore, because both AL and BI are emerging fields and little literature is available regarding the relationship between AL and BI, in line with findings of Leroy et al. [64] and associated theory, this study tests the notion that authentic leadership is an antecedent for BI in the context of this study.

H8. *The positive relationship between AL and employee engagement is mediated by follower trust in the leader.*

H9. *AL is positively associated with the BI of a leader.*

A schematic diagram depicting the research model and associated hypotheses is presented in Fig. 1.

4. Research methods

4.1. Sample

The analysis of the posited relationships is based upon cross-sectional survey data drawn from a sample pool of industries that included: manufacturing, transportation, retail, healthcare, and services. To create an initial list of companies that implemented Six Sigma, a web search was done with queries of publication databases and books. Approximately 650 companies were discovered to be Six Sigma adopters. The company websites and their annual reports were examined to get an idea of when the companies actually implemented Six Sigma. To have a fairly representative list of companies and account for lower response rates typically found with mailed surveys, both public and private firms were included in the initial list. To be included in the sample, identified firms were required to have been in business for at least three years. The motive for limiting the sample to the industries mentioned above was that these industries have had a high frequency of implementation of Six Sigma in recent times [6,25,93] and therefore studying these companies was more likely to detect relationships among the focal constructs in our research model. Addresses of the companies were either drawn from their industry associations or directly from the companies' websites. Once the list of companies

was completed, companies were contacted either by phone or e-mail to identify a person within the organization responsible for Six-Sigma initiatives or process management. The main criteria for selection were: 1) the participant had to be working under the person who was ultimately responsible for Six Sigma implementation, such as a champion; and 2) the participant had to be a key member of the Six Sigma process implementation. Moreover, participants were selected based on how closely they interacted with or knew those persons responsible for the Six Sigma projects or programs. This was determined through the inclusion of a few screening questions on the survey. The unit of analysis was the plant, since it is at the plant level that QM practices are implemented and where their effect is strongest [37]. The sample respondents included: supply chain quality managers, production quality managers, inventory managers, service quality managers, information technology quality supervisors, operations quality directors, and quality improvement coordinators. Detailed demographics for the respondents are presented in Appendix A.

4.2. Measures

All constructs in our research model were measured using multi-item scales, adapted from previous studies. These scales have been reported to have high statistical validity and reliability.

Authentic leadership (AL) was measured using the 16-item AL Questionnaire (ALQ: All rights reserved in all media) which was developed and validated by Walumbwa et al. [104] and is distributed by Mind Garden, Inc. (www.mindgarden.com). The ALQ measures the four dimensions of authentic leadership identified by Walumbwa et al. [104]: self-awareness, balanced processing, relational transparency, and internalized moral perspective. The frequency of AL behaviors displayed by a leader was rated by followers on a 5-point Likert scale (0 for never and 5 for almost always). Sample items for each AL component include: "My leader seeks feedback to improve interactions with others" (*self-awareness*); "My leader solicits views that challenge his or her deeply held positions" (*balanced processing*); "My leader says exactly what he or she means" (*relational transparency*); and "My leader demonstrates beliefs that are consistent with actions" (*internalized moral perspective*). Following the precedent set by Walumbwa et al. [104] the

Table 1
Descriptive statistics.

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Authentic Leadership	1.53	4.95	3.98	0.49	−0.90	2.05
Behavioral Integrity	1.50	4.88	4.07	0.48	−0.93	2.24
Trust	1.33	5.00	3.94	0.67	−0.14	1.12
Employee Engagement	1.67	4.75	3.99	0.49	−0.83	1.83
Six Sigma Performance	1.63	4.53	3.76	0.46	−0.57	1.62

n = 212

analysis was performed using the overall ALQ score, rather than the sub-dimension scores.

Behavioral integrity (BI) was measured using an 8-item, Likert scaled (1-strongly disagree to 5-strongly agree) measure developed by Simons et al. [91]. Sample items include “My manager does what he/she says he/she will do” and “My manager conducts himself/herself by the same values he/she talks about”.

This paper uses the instrument developed by Simons et al. [91] to measure trust on a 3-item scale. A sample item is “I would be willing to let my manager have complete control over my future in this company”.

This study uses with permission the Q12 benchmark questionnaire (<https://q12.gallup.com/Public/en-us/Features>) developed by Gallup, Inc. to measure employee engagement in this study. The instrument was developed by identifying from among items Gallup employed in hundreds of surveys, focus groups, and interviews, those that were most predictive of focal outcomes. This survey includes 12 questions rated on a five-point scale. The break-down of the questions is as follows. Two questions assess the basic needs of the employee; leadership support is assessed by four questions; four questions assess teamwork; and finally growth is assessed by two questions.

The overall business performance of a firm is impacted by its quality performance [41]. Improvement in quality in the manufacturing process results in enhanced productivity, lower non-conformance rate, reductions in waste, lower total costs of production, higher returns on investment, and higher profitability [55]. Also, an improved quality product or service is associated with greater customer satisfaction, higher sales and enhanced market share [1]. Therefore, the success of any quality improvement program can be measured by any of these factors in combination. Six Sigma success was measured in terms of reduced non-conformance rate, customer satisfaction, and profitability by using the instrument developed by Zu et al. [110] for measuring Six Sigma performance (Coefficient alpha 0.91). Sample items include “The quality of our plant’s products and services has been improved over the past three years” and “Customer satisfaction with the quality of our products and services has increased over the past three years”.

4.3. Data collection

A total of 600 questionnaires were distributed in a single mailing in 2013 to the selected firms in the chosen industries from our initial list. From that mailing, 226 completed surveys were returned and 11 packets were returned as non-deliverable, which may have been due to a recent change in company addresses. Of the 226 responses, 14 were discarded for incompleteness or erroneous data, resulting in a final sample of 212 firms and a usable response rate of 35.3%. This response rate is not unusual when the unit of analysis is the firm and the questionnaire involves extensive organizational level questions [44]. Non-response bias was examined by comparing the data collected from early and late respondents and statistically significant differences were not detected for any of the constructs either at the $p < 0.01$ level or at $p < 0.05$

level [38]. Descriptive statistics for all constructs are presented in Table 1.

4.4. Model estimation

The underlying dimensions of the research constructs were ascertained using both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). In the EFA, all the constructs were introduced with their indicators and the principal components method and varimax rotation method were applied to purify the indicators. All of the indicators loaded heavily on their respective factors with all the item loadings exceeding 0.5, providing evidence of convergent validity for the measures. Additionally, each factor had an eigenvalue of more than 1.0, demonstrating acceptable discriminant validity [47]. Standardized loadings for scale items ranged from 0.78 to 0.86, which are in the moderate-to-high range. Further evidence of convergent validity is demonstrated when the relationships between the items and the construct are significant, i.e., t -values are greater than 1.96 at the level of 0.05 [3]. The t -values for between scale items ranged from 7.25 to 11.57 and all item loadings were significant on $p < 0.01$ level. As such, our study meets the requirements for convergent validity.

To test the measurement model, a CFA was conducted using LISREL 8.70. Coefficient alphas calculated for all constructs [38,100] exceeded the suggested threshold of 0.70 for assessing internal consistency in empirical research [78]. Reliability and convergent validity were further established by calculating composite reliability (CR) and average variance extracted (AVE) respectively. The CR and AVE were well above the respective cut-off values of 0.70 and 0.50, which provides evidence of reliability and convergent validity for all the scales. Convergent validity is further evidenced by the high factor loadings as shown in Table 2.

Construct validity is the degree to which a test measures what it claims, or purports, to be measuring. Stand alone indices are used to test construct validity. There is a suggestion to use Polychoric correlations instead of Pearson correlations when studying the degree of association between categorical variables in general and testing construct validity in particular as Polychoric correlations have been found to yield less biased estimates of association. The reasons cited include: if data are obtained using Likert scales, then these variables would imply ordinal scales whereas Pearson correlations assume interval measurement scales [49]. Furthermore, interpreting Pearson correlations requires assumptions about normality that distributions of affect ratings rarely meet [60]. Researchers and theorists have noted limitations of Polychoric correlations as well (e.g. [17,82]).

“Although Likert scales are widely used to obtain data, when studying the dimensionality of such data and gathering evidence about their construct validity, both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) may be conducted using Pearson correlation matrices” ([49], p. 154). As per conventional wisdom, ordinal variables with at least five categories are treated as continuous variables and analyzed with a traditional factor analysis procedure, thus ignoring the ordinal nature of the outcomes [76,83]. All scales used in this study have five or more cate-

Table 2
Summary statistics (Convergent validity and reliability).

Construct	Average variance extracted	Composite reliability	Range of factor loadings
Authentic leadership	0.813	0.82	0.73–0.87
Behavioral integrity	0.891	0.86	0.76–0.83
Trust	0.817	0.78	0.74–0.77
Employee engagement	0.873	0.85	0.75–0.85
Six sigma performance	0.836	0.83	0.76–0.82

Table 3
Fit indices for the measurement model.

	χ^2 ($p < 0.01$)	df	χ^2/df	GFI	AGFI	CFI	IFI	RMSEA	Critical N
Recommended Values			<3.0	>0.90	>0.90	>0.90	>0.90	<0.06	< N
Fit Indices Values	224.68	147	1.53	0.95	0.91	0.93	0.94	0.053	108

Table 4
Average variance extracted, correlations, and shared variances.

Construct	1	2	3	4	5
1. Authentic leadership	0.813	0.491	0.127	0.058	0.085
2. Behavioral integrity	0.701**	0.891	0.630	0.048	0.054
3. Trust	0.357**	0.794***	0.817	0.556	0.139
4. Employee engagement	0.241***	0.220***	0.746**	0.873	0.580
5. Six sigma performance	0.292**	0.291**	0.373**	0.762**	0.836

Numbers on the diagonal represent the average variance extracted; numbers below the diagonal are the inter-construct correlations and the numbers in bold above the diagonal represent the shared variances (squared correlations). ** $p < 0.05$, *** $p < 0.001$.

gories making them suitable for traditional factor analysis. “When conducting a CFA: (a) goodness of fit measured by chi-squared always shows probabilities lower than the nominal level, that is, the model is accepted regardless of the number of dimensions and asymmetric items; and (b) other global indexes of goodness of fit, such as GFI, AGFI and RMSEA, are better when we use the Polychoric correlation matrix, but values are generally good enough in both cases (Pearson and Polychoric)” ([49], p. 165). We have provided evidence for model goodness of fit in Table 3 in terms of a summary of the CFA indices for the conceptual model. The root mean square error of approximation (RMSEA) of 0.053, and χ^2/df (1.53) values meets the requirements for good fit. All goodness-of-fit (GFI), adjusted goodness-of-fit (AGFI), comparative fit index (CFI), and incremental fit index (IFI) values also exceeded the minimum cutoff value of 0.90. Critical N (108) was lower than the sample size of 212, indicating that the conceptual model achieved a good fit. All in all, these results suggest that the scales used in this study achieved adequate fit.

For adequate discriminant validity: (1) indicators should load stronger on their corresponding construct than on other constructs in the model, and (2) the square root of the average variance extracted (AVE) should be larger than the inter-construct correlations [26]. The results of the CFA show that, without exception, all indicators load more highly on their own construct than on other constructs. Furthermore, Table 4 shows that all constructs share more variance with their indicators (AVE) than with other constructs. Thus, these results point to the adequate discriminant validity of our scales.

Common method bias in self-reported studies can induce correlations arising from social desirability or other measurement effects and thereby impact statistical results. Consistent with recommendations from the literature for minimizing such potential biases [81,86], we assured anonymity and confidentiality to the respondents, kept the questions clear and concise by clarifying concepts and ambiguities, and distributed items relating to the same construct in different parts of the questionnaire.

According to Podsakoff et al. [81], among the various statistical remedies for common method biases (e.g., Harman’s single factor

test, partial correlation techniques, and latent variable approaches) the latent variable approach tends to be the most rigorous. Hence, the paper adopted this approach. First, we conducted the test recommended by Widaman [105] where two models were compared. The first model only included the theoretical factors (traits) and the second model included a methods factor [81,106]. The model comparison showed that the fit of the second model was reduced (NNFI by 0.013, CFI by 0.019, RMSEA by 0.02). The common method factor was responsible for only 3% of the variance, which is within acceptable limits [106]. Additionally, the research model was compared to alternative models, such as a single factor model, a two factor model (e.g., AL, BI, and trust loading together and employee engagement and Six Sigma performance loading together) and a three factor model (e.g., AL, BI, and trust loading together and employee engagement and Six Sigma performance loading separately) [81]. Table 5 summarizes the results of fit index comparisons between the hypothesized and three alternative models. The chi-square tests suggest that the hypothesized model achieves a significantly better fit than the three alternative models. In summary, common method variance does not appear to be a serious problem in this study.

5. Results

This paper used Structural Equation Modeling (SEM) to test all of the hypothesized relationships in the research model. The results for the six direct-effect hypotheses (H1, H2, H4, H5, H6, and H9) are summarized in Table 6 and the results of the three hypotheses for mediating effects (H3, H7, and H8) are presented in Table 7.

Table 6 presents standardized coefficient estimates of every path in our research model. Among the six hypothesized paths, four paths had statistically significant coefficients at the $p < 0.05$ level and the remaining two paths had statistically significant coefficients on $p < 0.1$ level. Specifically, the results show that all three proposed constructs were positively associated with Six Sigma performance: BI (H1), employee engagement (H5), and AL (H6). Additionally, two constructs showed direct positive links with employee engagement: BI (H2) and AL (H4). Furthermore, the results indicate that there is a direct path between AL and BI (H9).

Three sets of mediation models were tested: 1) trust mediating between BI and employee engagement; 2) employee engagement mediating between AL and Six Sigma performance; and 3) trust mediating between AL and employee engagement. The mediating results are summarized in Table 7. The key for the acronyms in Table 7 are available in Table 8.

For hypothesis 3, the total effect for BI (0.709) was the effect that would be found if the employee engagement mediator was omitted from the model. This effect was significant with a z of 13.93 with $p = 0.00$. The direct effect for BI is 0.457 which, while

Table 5
Fit indices of the hypothesized model and alternative models.

	Chi-Square/df	GFI	AGFI	CFI	IFI	RMSEA
Recommended values	<3	>0.90	>0.90	>0.90	>0.90	<0.06
Hypothesized model	2.17	0.95	0.91	0.93	0.94	0.053
Single factor model	5.46	0.49	0.43	0.42	0.39	0.215
Two factor model	4.72	0.54	0.55	0.54	0.52	0.124
Three factor model	3.38	0.62	0.59	0.65	0.57	0.103

Table 6
The path estimates and their significance.

Hypothesis	Path	Estimate	p-value	Supported
H1	Behavioral integrity (+) → Six sigma performance	0.058	0.068	yes
H2	Behavioral integrity (+) → Employee engagement	0.197	0.001	yes
H4	Trust (+) → Employee engagement	0.082	0.046	yes
H5	Employee engagement (+) → Six sigma performance	0.082	0.099	yes
H6	Authentic leadership (+) → Six sigma performance	0.722	< 0.001	yes
H9	Authentic leadership (+) → Behavioral integrity	0.786	< 0.001	yes

Table 7
SEM results for mediating effects.

Hypothesis 3				Hypothesis 7				Hypothesis 8			
Path	Coefficient	z	P > z	Path	Coefficient	z	P > z	Path	Coefficient	z	P > z
TR <-				EE <-				TR <-			
BI	0.863	11.520	0.000	AL	0.894	28.790	0.000	AL	1.142	22.66	0.000
EE <-				QP <-				EE <-			
TR	0.293	6.950	0.000	EE	0.047	1.030	0.304	TR	0.197	4.90	0.000
BI	0.457	7.790	0.000	AL	0.850	18.310	0.000	AL	1.11	20.54	0.000
Indirect effects				Direct effects							
Path	Coefficient	z	P > z 	Path	Coefficient	z	P > z 	Path	Coefficient	z	P > z
TR <-				EE <-				TR <-			
BI	0.000	no path		AL	0.000	no path		AL	0.000	no path	
EE <-				QP <-				EE <-			
TR	0.000	no path		EE <-	0.000	no path		TR	0.000	no path	
BI	0.253	5.950	0.000	AL	0.043	1.030	0.304	AL	0.224	4.790	0.000
Total effects				Total effects				Total effects			
Path	Coefficient	z	P > z 	Path	Coefficient	z	P > z 	Path	Coefficient	z	P > z
TR <-				EE <-				TR <-			
BI	0.863	11.520	0.000	AL	0.894	28.790	0.000	AL	1.141	22.660	0.000
EE <-				QP <-				EE <-			
TR	0.293	6.950	0.000	EE	0.048	1.030	0.304	TR	0.197	4.900	0.000
BI	0.709	13.930	0.000	AL	0.892	42.480	0.000	AL	0.893	28.790	0.000
Supported				Not supported				Supported			

Table 8
Key for the acronyms in Table 7.

AL	Authentic leadership
BI	Behavioral integrity
TR	Trust
EE	Employee engagement
QP	Six sigma performance

still significant ($z = 7.79$ & $p = 0.00$) was much smaller than the total effect. The indirect effect of BI on trust through employee engagement was 0.253 and was also statistically significant ($z = 5.95$ & $p = 0.00$). The proportion of the total effect that was mediated was almost 35.7% ($= 0.253/0.709$) which was statistically significant ($z = 13.930$ and $p = 0.00$). As such, hypothesis 3, which posits that the BI-employee engagement relationship will be mediated by trust, was supported.

For hypothesis 7, the total effect for AL (0.892) was the effect that would be found if there was no mediator in the model. It was significant with a z of 42.48. The direct effect for AL is 0.850 which while still significant ($z = 18.31$) was much smaller than the total effect. The indirect effect of AL through employee engagement was 0.043 and was not statistically significant ($z = 0.041$). The propor-

tion of the total effect mediated was a mere 4.8%. Thus, hypothesis 7 (“The effect of authentic leadership in Six Sigma success is mediated by employee engagement”) was not supported.

For hypothesis 8, the total effect for AL (0.893) was the effect that would be found if the employee engagement mediator was omitted from the model. This effect was significant with a z of 28.70 and a p value of 0.00. The direct effect for AL was 0.518 which, while still significant ($z = 8.69$ and $p = 0.00$) was much smaller than the total effect. The indirect effect of AL on Six Sigma performance through employee engagement was 0.224 and was also statistically significant ($z = 4.97$ and $p = 0.00$). The proportion of the total effect that was mediated was almost 25.1% ($= 0.224/0.893$) which was significant. Hence, the results also provide support for hypothesis 8, which posits that the effect of AL on employee engagement is mediated by follower trust in the leader.

6. Discussion

The aim of this study was to propose and empirically test a leadership-performance model in a Six Sigma setting. The findings provide support for the proposed research model and the majority

of the hypotheses. The study found some direct and indirect effects of AL and BI on Six Sigma performance.

The support obtained for hypothesis 1 indicates that the BI of a leader has a direct relationship with Six Sigma performance. Prior research indicates that the extent to which followers report trust in leadership and respond to leaders' actions can affect the change efforts of the organization as whole [88]. Conceiving an organizational change and effectively executing the change plans is an extremely challenging task. Considering that most change efforts in organizations do not yield the envisaged outcomes [88] leadership that displays BI by sticking with commitments to improve quality helps to elevate quality performance. This is true in case of Six Sigma, as it constitutes one of the key approaches to improving quality, and top-level leadership has consistently been identified as a key success factor [7,43]. Our results suggest that BI is a key component of leadership that accounts for Six Sigma success.

Prior research demonstrates that leader BI, particularly at upper organizational levels, has positive effects on efficiency, quality, and loyalty with the customers [88]. These effects accrue in part from the reputation for trustworthiness that organizations gain when they deliver on leader commitments. Also, an open, honest relationship between a firm's leadership and customers requires trust, and trust is built upon integrity. Hence, BI creates long-term customer relationships through branding [88]. A strong quality brand of an organization can be based on positive customer experiences, as strong brand loyalty will not prosper without a credible promise. The same can be said about relationships with other stakeholders such as suppliers. In a Six Sigma context, particularly in service industries, customer satisfaction is very important and a satisfied customer can contribute a great deal toward building a brand name for a company. Hence, a leader with strong BI can not only promote customer satisfaction, but should also help build a good reputation for the company leading to a sustained competitive advantage.

The study also found support for the hypotheses H2 (BI positively relates with employee engagement), H3 (trust mediates the relationship between BI and employee engagement), and H4 (trust positively associates with employee engagement). These results suggest that a leader who displays BI can build trusting relationships with followers. Moreover, they indicate that, when combined with the clarity in direction that BI provides, a trusting relationship between a leader and follower can enhance employee engagement on tasks. Finally, they suggest that greater employee engagement can in turn impact positively employee performance and the performance of the organization as a whole. These findings are consistent with and extend prior research.

Simons [88] argued that credibility is one of the prerequisites for clarity in direction. A credible leader at the top drives quality improvement efforts by providing direction and required support [2]. Such support could involve the allocation of resources for training, instituting a quality-based compensation policy, and other efforts to foster employee engagement [110]. The credibility of a leader also serves to foster the mutual trust and learning environment that are critical to the success of quality improvement initiatives, such as Six Sigma [4]. Leaders develop credibility among followers by keeping their word consistently and predictably; they lose credibility when they fail to follow through on promises. Simons [88] opines that a combination of a clear sense of direction and a trust-based relationship can produce effects comparable to those of charismatic leaders. Conversely, a perceived lack of BI can negatively influence other judgments that undermine trust of followers in leaders. Trust is vital to any relationship and is an important issue in organizations affecting performance. Greater employee trust in leaders can improve employee compliance with organizational rules and regulations, facilitate the implementation of organizational change, and improve employee performance [14].

Six Sigma aims to develop a learning environment. Trust is very relevant to Six Sigma, as Six Sigma implementation involves a significant change in organizational culture and building an organizational climate based on trust between the leader and employees can yield benefits for the organization in the long term.

Hypothesis 5 was also supported, indicating the importance of employee engagement in a Six Sigma process. An engaged employee can seize opportunities and take initiative to solve problems. This is extremely important in a Six Sigma context as it relies on problem solving techniques for improving quality in processes and products. If the employee can think out of the box to come up with new solutions to the existing problems besides the prescribed solutions, this can have a positive impact on the outcome of the Six Sigma process. For instance, a highly engaged employee can positively affect customer service. In contrast, a disengaged employee can negatively impact service or product quality. While an employee who is not engaged and does not trust his/her leadership can still perform adequately, they will have difficulty matching the level of excellence that can be achieved by an engaged employee [88]. Moreover, an actively disengaged employee can spread his/her disenchantment and poor work habits to other employees. In a Six Sigma process this has serious negative implications as every participant is critical to the improvement effort and the overall outcome of the Six Sigma process is linked strongly with individual efforts. Ample evidence in the literature documents that employee engagement is correlated with high levels of quality, productivity and also with higher levels of new product innovation [48,70]. Our finding of such a positive relationship in this study reinforces these earlier findings.

The study also obtained support for hypothesis 6 which suggests that AL among top leaders is positively related to Six Sigma performance. The implication of this finding is that top leaders who display self-awareness during interactions with followers, engage in balanced processing of information, display transparency regarding decisions, and stick to their deeply held values when pursuing quality initiatives, will achieve greater success when adopting Six Sigma processes.

Interestingly, the study did not find support for an indirect effect of AL on Six Sigma success through the mediating effects of employee engagement (hypothesis 7). This hypothesis was based on the assumption that in recent times leaders often find it difficult to directly manage followers' performance, and hence fostering the development of employee engagement as a driver of enhanced organizational performance is considered to be a more effective method [45]. Our null finding is also contrary to the findings of Zu et al. [110] that indicated the more top management understands and accepts the principles of Six Sigma, the more likely it is that they will support the Six Sigma process. The paper assumed that authentic leaders would be more willing to support the quality initiative and required restructuring of the organization, which would result in higher employee engagement towards adopting the change in responsibility in their job, and thereby leading to a superior Six Sigma performance. Our data did not provide adequate support for this posited relationship, suggesting that more empirical attention is warranted.

The data supported hypothesis 8, highlighting the importance of AL in building trust in the leader among followers. As described earlier, a high level of trust is significantly and positively related to employee engagement, which in turn is positively related to Six Sigma performance. Support for the hypothesis 9 was also obtained. This clearly points to the fact that AL and BI are complementary and although these are distinct constructs, an authentic leader is likely to foster a reputation for integrity among followers. Indeed, our results show that AL and BI operate together to positively influence the outcomes of Six Sigma through greater employee engagement.

7. Implications

Most of the past research in QM has focused on examining QM practices and the associated success factors [55,94]. Scholars have long emphasized the need to study the role of human factors in operations management using well accepted theories from organizational behavior (e.g. [65,66]). Particularly, as Boudreau et al. [15] pointed out, incorporating human behavior into operations management models provides more realistic insights to certain unexplained variations in organizational performance. As such, this research takes a step forward by responding to these recent calls to better understand the inter relationship between leadership and Six Sigma performance.

The current study broadens existing knowledge about leadership, trust, and performance. The bulk of prior empirical research on trust and leadership has focused on transformational leadership. Scholars (e.g. [62]) have noted a paucity of research on how other leadership styles relate to the trust of followers in their leaders. Although growing, empirical research into the authentic leadership-organizational performance relationship is limited [40]. While many forms of leadership have been found to motivate employees to perform more effectively through mutual trust, little theory and research has examined the interrelationships among these variables within a Six Sigma context. By identifying AL and BI of leaders as potential enhancers of the effects of top leadership in organizations, our findings represent a departure from prior approaches to understanding the impacts of top leadership on Six Sigma performance. The results further shed light on how leader integrity relates to effective performance and highlights the fact that it is not only important for leaders to remain true to themselves, but they must also walk their talk.

Employee engagement has long been perceived as a key to an organization's success and competitive advantage; some even consider it to be essential for organizations striving for success in the dynamic environments that face modern businesses [84]. However, employee engagement has been found to be on the decline in recent times. Indeed, it is reported that almost fifty percent of all American workers are disengaged, costing an annual loss of \$300 billion in productivity for companies [45]. Considering the criticality of employee engagement to the success or failure of an organization, the important question remains how firms can improve employee engagement, which has significant psychological and behavioral aspects [69]. As noted earlier, employee engagement plays a significant role in Six Sigma success. While there is an abundance of literature on employee engagement in many related areas, this study contributes to the Six Sigma literature by documenting the importance of engagement to desired Six Sigma outcomes. The study obtains evidence that by staying true to the values they espouse, authentic leaders with high BI can foster elevated levels of Six Sigma performance in the workplace.

Taking a project based approach, Six Sigma involves implementing a series of quality improvement projects and as such project performance is a key determinant of Six Sigma success. This study is one of a few studies (e.g. [9]) that empirically investigates the association among several key factors responsible for successful Six Sigma deployment at the organizational level. Leadership is an essential component for Six Sigma deployment, as it requires the entire Six Sigma team to display leadership across all levels, specifically the Master Black belts, Black belts and the Green belts. As Laureni and Anthony [61] note, there is a strong role for strategic and visionary leadership underpinning desired behaviors at every stage to demonstrate dedication and commitment to a successful Six Sigma implementation. Moreover, honesty, integrity and self-confidence of leaders have been identified [98] as a few key leadership traits for successful deployment of Six Sigma. This study not only reinforces those findings but also highlights the importance of

having authentic leaders and leaders with behavioral integrity in place to ensure the successful deployment of Six Sigma initiative and sustained envisaged outcome over time.

8. Limitations, future research, and conclusions

This study has several limitations that should be acknowledged. First, the focus is on exploring the relationship of AL behavior and success of a Six Sigma implementation and AL was measured through respondents' perceptions, rather than the actual behavior. This is a limitation shared by much of the AL literature, as it is difficult to ascertain leader authenticity through either other-report or self-report measures, which are potentially susceptible to social desirability biases [40]. Although the use of self-reports can potentially increase the risk of common method variance [81] some argue that common method bias is rarely strong enough to bias results [34,95]. Our analysis of potential common method effects through the inclusion of a latent methods factor in our models suggests this was the case in the current study. Second, the specific sample and context in which the proposed relationships were tested may restrict the generalizability of our findings. Third, the data were cross-sectional and collected from a single respondent of each sampled firm, which again raises concerns about common method bias. Future research should collect data from multiple sources and at multiple time periods to address this issue. More objective indicators of Six Sigma performance would be useful, particularly if they are coupled with subjective measures to facilitate triangulation [52]. Furthermore, this study tested three mediating effects, but further research is essential to have a better understanding of how trust and employee engagement change as they are influenced by the leadership overtime.

The main contribution of this work is the integration and extension of two emerging theories, AL and BI, from the leadership literature to the field of operations management. This study is a timely response to calls from operations management scholars [65,66] who strongly believe that incorporating theories from organizational behavior can provide greater insights to practical consequences of implementing operations management practices. This paper provides insight into how AL and leader BI can facilitate and promote the Six Sigma process in an organization. The key finding is that in order to reap the best benefits of Six Sigma, both qualities in leaders are desired. To the best of the authors' knowledge, this is the first paper linking AL theory and Six Sigma. The study contributes to the quality management field that has been largely been considered to be lacking on strong theoretical foundations (e.g. [66]). The same can be said about BI theory; this research is among the first to investigate the relationship between the BI of a leader and the success factors of a Six Sigma process.

There could be several future directions for this research. Past research has studied if BI is an antecedent of AL, but in different contexts (e.g. [64]). It would be interesting to explore the same relationship in our context. Additionally, this study invites scholars to explore the conditions under which the AL and BI could have negative or less significant effects on Six Sigma outcomes. Examining the moderating effects of employee engagement and trust on the relationship between AL and Six Sigma performance, and BI and Six Sigma performance could be another possible extension of our research model. The authors await future studies that explore the linkages and the relationships in this research model with a larger sample from more firms across more industries. In the meantime, the authors believe that organizations that wish to achieve competitive advantage via Six Sigma implementation will be more successful by having authentic leaders and leaders with BI at the top.

Appendix A. Demographic characteristics of the sample

Type of industry	No. of Respondents	Percentage
Machinery Manufacturing (NAICS 333)	47	22.2%
Computer and Electronic Product Manufacturing (NAICS 334)	35	17%
Electronics and Appliance Stores (NAICS 443)	36	17%
Truck Transportation (NAICS 484)	33	16%
Credit Intermediation and Related Activities (NAICS 522)	29	14%
Hospitals (NAICS 622)	32	15%
Position of respondents	No. of Respondents	Percentage
Production Quality Manager	19	9%
Quality Improvement Coordinator	24	11%
Information Technology Quality Supervisor	35	17%
Supply Chain Quality Manager	48	23%
Operations Quality Director	57	27%
Inventory Manager	29	14%
Number of employees	No. of Respondents	Percentage
Less than 200	46	22%
> 200–400	64	30%
> 400–700	52	25%
> 700–1000	39	18%
More than 1000	11	5%
Annual sales millions	No. of Respondents	Percentage
Less than 20	29	14%
> 20–100	32	15%
> 100–300	61	29%
> 300–500	54	25%
> 500–1 billion	26	12%
More than 1 billion	10	5%

Appendix B. Survey questionnaire

Authentic Leadership (ALQ Version 1 Rater)

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A few sample items are included here, rather than the full scale, to avoid copy right infringements. Researchers interested in using the full measure can request permission to do so free of charge from Mind Garden.

The following survey items refer to your leader's style, as you perceive it. Judge how frequently each statement fits his or her leadership style using the following scale:

Not at all	Once in a while	Sometimes	Fairly often
0	1	2	3
Frequently, if not always			
0	1	2	3
0	1	2	3

My leader:

1. says exactly what he or she means.
2. admits mistakes when they are made.
3. encourages everyone to speak their mind.

Behavioral Integrity

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The following items are rated on a 5-point Likert scale (5-strongly agree, 4-agree, 3-neither agree nor disagree, 2-disagree, 1-strongly disagree)

1. There is a match between my manager's words and actions.
2. My manager delivers on promises.
3. My manager practices what he/she preaches.
4. My manager does what he/she says he/she will do.
5. My manager conducts himself/herself by the same values he/she talks about.
6. My manager shows the same priorities that he/she describes.
7. When my manager promises something, I can be certain that it will happen.
8. If my manager says he/she is going to do something, he/she will.

(continued on next page)

Trust

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The following items are rated on a 5-point Likert scale (5-strongly agree, 4-agree, 3-neither agree nor disagree, 2-disagree, 1-strongly disagree)

1. I would be willing to let my manager have complete control over my future in this company.
2. I would not mind putting my well-being in my manager's hands.
3. I would feel good about letting my manager make decisions that seriously affect my life.

Employee Engagement

The Gallop Q12 Questionnaire

(1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

1. I know what's expected of me at work.
2. I have the materials and equipment I need to do my work right.
3. At work I have the opportunity to do what I do best every day.
4. In the last seven days I have received recognition or praise for doing good work.
5. My supervisor, or someone at work seems to care about me as a person.
6. There is someone at work who encourages my development.
7. At work, my opinions seem to count.
8. The mission or purpose of my company makes me feel my job is important.
9. My associates or fellow employees are committed to doing quality work.
10. I have a best friend at work.
11. In the last six months, someone at work has talked to me about my progress.
12. This past year, I have had opportunities at work to learn and grow.

Six Sigma Success

Zu, Fredendall, and Douglas [110].

Items were measured on 7-point Likert scales with end points of "strongly disagree (= 1)" and "strongly agree (= 7)."

1. The quality of our plant's products and services has been improved over the past 3 years.
2. The process variability in our plant has decreased over the past 3 years.
3. The delivery of our products and services has been improved over the past 3 years.
4. The cost of scrap and rework as a % of sales has decreased over the past 3 years.
5. The cycle time (from receipt of raw materials to shipment of finished products) has decreased over the past 3 years.
6. Customer satisfaction with the quality of our products and services has increased over the past 3 years.
7. The equipment downtime in our plants has decreased over the past 3 years.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.orp.2018.04.001.

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