Direct and Vicarious Learning and Firm Performance

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Abstract

This paper presents a conceptual model of different learning sources in the ISO9000 implementation process and their impact on the quality of implementation and firm performance. Then, structural equation modeling is used to test the model with data from 1150 ISO9000 adopters from US and Canada. Direct learning by integration of the ISO9000 quality system around existing processes is the most effective learning source. The second most effective learning source is using the knowledge of customers and suppliers in the standard implementation process. Reliance on consultants does not lead to high quality of implementation. We discuss theoretical and practical implications.

Keywords: ISO9000; direct and vicarious learning; structural equation modeling, survey

Direct and Vicarious Learning and Firm Performance

Learning begins with experience (Argote & Miron-Spektor, 2011). Learning experience can be defined along various dimensions (Argote, McEvily, & Reagans, 2003; Argote & Todorova, 2007). One of the most important dimensions of experience is whether it is acquired directly by the firm or indirectly from other units (Argote & Miron-Spektor, 2011; Levitt & March, 1988). In direct learning, a firm applies the trial and error approach and the learning is derived from firm's own experience (Cook & Brown, 1999; Nonaka, 1994; Raelin, 1997). Learning from other units is referred to as vicarious learning (Bandura, 1977) or knowledge transfer (Argote & Ingram, 2000). In vicarious learning, the firm incorporates other firms'

experience to implement an innovation (Argote, 2012; Baum & Ingram, 1998; Ingram & Baum, 1997).

Direct and vicarious learning could occur separately, consecutively, or simultaneously, but different learning experiences have higher chances of occurring under certain circumstances. For example, early ISO9000 adopters experience direct learning, as they have no one to learn from, whereas late adopters experience vicarious learning as they compare and contrast with current adopters (Naveh, Marcus, & Moon, 2004). Other researchers have also observed similar negative relationship between direct and vicarious learning (Haas & Hansen, 2005; Schwab, 2007; Wong, 2004). By contrast, Bresman (2010) has found that direct and indirect experience relate positively to each other in a complementary fashion. Understanding when different types of experience are complements or substitutes for one other (Argote & Miron-Spektor, 2011) and how their relationship affects performance is an important topic for research. This research addresses this question. In addition, most of the prior studies focus on the outcomes of implementation in terms of business results or operations performance, without considering the differences in the quality of implementation. This research focuses on this relationship.

ISO9000 certified firms differ in the kind of quality assurance systems they create and the extent to which they use them in the daily practice (Naveh et al., 2004). The ISO9000 standard ensures the existence of a quality system, but cannot guarantee its functionality within a particular firm or supply chain (Sroufe & Curkovic, 2008). Every implementation is a learning process, where firms can utilize different sources of learning. According to the contingency theory, the implementation scheme is not a predictor of the performance.

Firms have been implementing ISO9000 since 1986. While many studies explore the factors affecting the implementation process and the outcomes of the certification, theoretical and empirical evidence of the learning sources in the certification process remain sparse. This research addresses this gap by providing evidence of the different learning sources and their impact on the quality of standard implementation. Naveh et al. (2004) is the only study empirically testing the relationship between different learning sources in the ISO9000 implementation process. This study complements their research by directly investigating the impact of different learning sources on the quality of implementation.

By partially replicating the study by Naveh et al. (2004), this study verifies the current state of knowledge about different learning sources and extends the understanding with an additional investigation of the impact of different learning sources on the quality of implementation. We build on and extend Naveh et al.'s model by incorporating the business and financial results. While we use similar variables, our study focuses on the link between learning, quality of implementation, and firm results. We also use structural equations modeling, not regression, to test the theoretical framework.

We propose the following research questions: (i) What are the different learning sources in the standard implementation? (ii) Does the learning source predict performance? (iii) Do learning sources change over time and for different firms (e.g. early versus late adopters, big versus small firms, focus on getting the certificate versus focus on the process of internal improvement)?

To investigate the research questions, we use a survey of ISO9000 adopters from US and Canada. In the following section, we provide an overview of learning and the theoretical foundations of the construct quality of implementation. Based upon this review, we discuss the conceptual model and hypotheses in Section 2. In Section 3, we present the research

methodology, data collection process, and results. In Section 4, we discuss theoretical and practical implications, limitations, and future research.

Theoretical Background and Hypotheses

Direct and Vicarious Learning Impact on the Quality of Implementation

Although firms follow common prescribed requirements of the ISO9000 implementation, they may differ in the way they implement different aspects of the standard (Prajogo, Huo, & Han, 2012). The quality or depth of ISO9000 implementation has been defined in different ways. Naveh & Marcus (2004) classify ISO9000 implementation into two categories based on the standard practical uses: ISO9000 used in daily practices and ISO9000 used as a catalyst for change. Prajogo et al. (2012) and Huo, Han, & Prajogo (2014) identify three aspects of ISO9000 implementation: basic, advanced, and supportive implementation. Cooper & Zmud (1990) define basic implementation as ISO9000 standard becoming part of a firm's everyday routine. Similarly, Fichman and Kemerer (1997) emphasize the importance of a regular application of ISO9000 standard. Briscoe, Fawcett, and Todd (2005) and Naveh and Marcus (2005) define internalization of ISO9000 standard as the adoption of its underlying practices in the daily use. ISO9000 internalization ensures that the implementation fosters strategic quality management to enable continuous process improvement (Nair & Prajogo, 2009).

Learning can be categorized as direct and vicarious (Levitt & March, 1988). In direct learning, a firm discovers how to benefit from a practice in a trial and error way rethinking the daily routine and creating improvement opportunities (Cook & Brown, 1999; Nonaka, 1994; Raelin, 1997). Direct learning occurs when a firm utilizes its own resources in the ISO9000 implementation. We posit the following hypothesis:

H1a: Using internal resources to implement the ISO9000 standard has a positive effect on the quality of implementation.

Prajogo et al. (2012) define advanced ISO9000 implementation as focusing on internal integration of different management practices (e.g. JIT, TQM). Huo et al. (2014) find that advanced ISO9000 implementation is positively related to both product and process flows, which improve operational performance. Gotzamani and Tsiotras (2001) discuss the contribution of ISO9000 towards TQM and focus on firm culture ensuring goals are clearly defined so different department can effectively communicate. De Oliveira Matias and Coelho (2002) discuss the advantages and disadvantages of integration of quality, environmental, and occupational health and safety management systems and emphasize the need for standards integration. We posit the following hypothesis.

H1b: Integrating the standard within existing processes has a positive effect on the quality of implementation.

With vicarious learning, a firm relies on the experience of other firms (e.g. suppliers, customers, external consultants) to understand a practice (Argote, 2012; Baum & Ingram, 1998; Ingram & Baum, 1997). Prajogo et al. (2012) defined advanced ISO9000 implementation as focusing not only on internal, but also on external integration. External advanced implementation emphasizes the integration of upstream and downstream partners (e.g. customers and suppliers). Dowlatshahi (2011) studied the ISO9000 certification in global supply chain of maquiladoras and found that ISO-certified firms exemplified better main/core suppliers' relationships. Ebrahimpour, Withers, and Hikmet (1997) studied 500 ISO9000 registered firms and found that they expected a high degree of improvement supplier relations. Corbett (2006) analyzed 5000

firms in nine countries and found the global ISO9000 diffusion moved upstream the supply chains, e.g. ISO-certified firms required their suppliers' certification. We posit the following hypothesis:

H2a: Learning from customers and suppliers has a positive effect on the quality of implementation.

ISO9000 system works in a large infrastructure of third-party auditors, registrars, and consultants, who appraise facilities and guaranteeing their compliance. Almost all firms implementing standards are using consultants. Prior research provides evidence that not the consultant's use itself, but rather the consultant's role in the implementation process determines the quality of implementation (Iossifova & Sinha, 2006). Delegating the quality manual development to a consultant results in larger manuals (Hughes, Williams, & Ryall, 2000). Heras-Saizarbitoria and Boiral (2015) find that small and medium size companies that rely extensively on consultants in the implementation process end up with a higher level of disconnect between the discourse and practice, resulting in a superficial standard adoption. Consequently, employees do not have motivation to use the procedures. Almost 50% of the firms using consultants to develop their procedures ended up modifying the manuals to reduce the size and simplify the procedures (Hughes et al., 2000). We posit the following hypothesis:

H2b: Learning from consultants has a negative effect on the quality of implementation of the standard.

Quality of Implementation and Firm Performance

The research findings are not clear whether and when the certification affects the firm performance. For example, ISO 9001 has been found both to improve operational (Naveh & Marcus, 2004) and financial (Corbett, Montes-Sancho, & Kirsch, 2005; Chatzoglou, Chatzoudes, & Kipraios 2015) outcomes and found not to improve such outcomes (Naveh & Marcus, 2005; Terlaak & King, 2006; Yeung, Lo, & Cheng, 2011; Fatima, 2014). One reason for these inconclusive results is that most studies investigate performance measures depending on factors not directly related to the quality of implementation. For example, studies have examined dependent variables such as sales (Huarng et al., 1999), cost reduction (Yeung, Lee, & Chan, 2003), supply chain quality (Stroufe & Curkovic 2008), stock market reaction (Jacobs, Singhal, & Sumramanian, 2010), injuries (Levine & Toffel, 2010), customer satisfaction and loyalty (Yaya, Marimon, & Casadesus, 2014), and financial/business performance (Corbett et al., 2005; Terziovski, Power, & Sohal, 2003; Lo, Wiengarten, Humphreys, Yeung, & Cheng, 2013). These variables at least partially depend on factors unrelated to the quality of implementation. To control for these confounding effects, several researcher measure performance change as a result to the standards implementation and link performance to ISO9000 depth of implementation (Jang & Lin, 2008) or ISO9000 internalization (Ataseven, Prajogo, & Nair, 2014; Nair & Prajogo, 2009). Research studies have emphasized the need for internalizing ISO9000 standard to achieve performance benefits (Briscoe et al., 2005; Huarng, Horng, & Chen, 1999; Ismail & Hashmi, 1999; Lee & Palmer, 1999; Rao, Ragu-Nathan, & Solis, 1997). We posit the following hypotheses:

H4: Quality of implementation has a positive effect on business improvement after standard implementation.

H5: Quality of implementation has a positive effect on operations improvement after standard implementation.

Control Variables

The model includes three control variables: (1) Timing of adoption. Prior research had identified significant differences between early and late adopters in the motivation to adopt, implementation process, and expected outcomes. Early adopters have a higher internal motivation to adopt standard, whereas late adopters have higher external motivation for adoption. The perceptions of the benefits of the implementation are higher for early adopters, maybe due to differences in their motivation (Casedesus & Karapetrovic, 2005). Early adopters utilize more direct learning and late adopters more vicarious learning (Naveh et al., 2004). Gray, Anand, and Roth (2015) find that early ISO9000 adopters have better process compliance than matching non-certified plants and that this difference is greater for early adopters than for late adopters. (2) Motivation to adopt the standard. We expect internally motivated adopters ("quality enthusiasts" as Boiral (2003) named them) to experience direct learning and externally motivated adopters ("ceremonial integrators" and "dissidents") to experience vicarious learning. Internal motives to adopt a standard have positive impact on operational performance and implementation. Furthermore, from a strategic fit perspective, internal motives strengthened the relationship between implementation and performance. In contrast, external motives had no statistically significant relationship with performance and weaken the relationship between implementation and performance (Prajogo, 2011). (3) Size of firm. We expect larger firms to have more resources to adopt the standard and to utilize more direct learning and smaller firms to rely more on vicarious learning.

Figure 1 shows the conceptual model of the study, reflecting the relationships between different ways of learning, quality of implementation and firm performance. The following section discusses and data collection, data analysis and results.

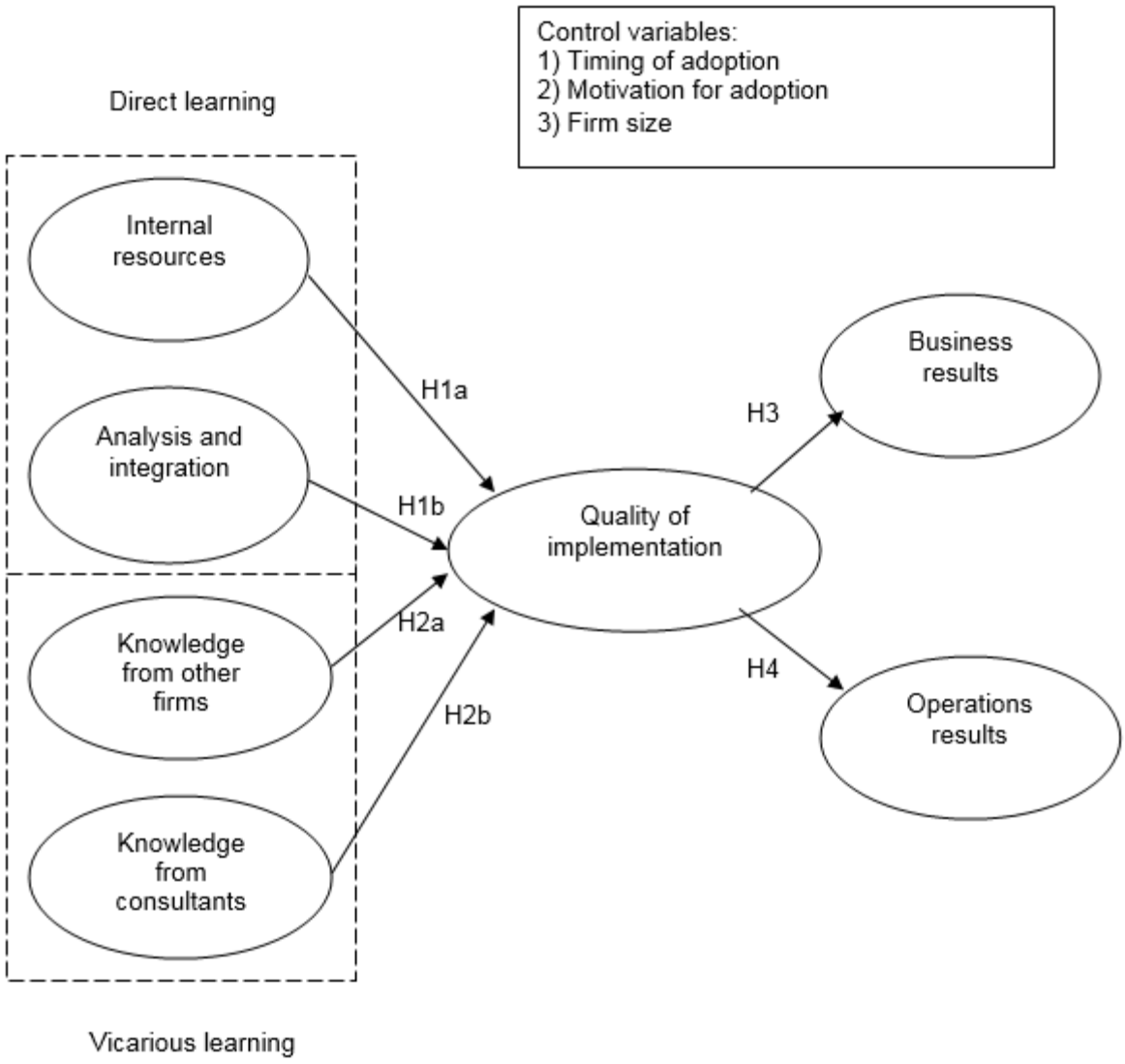

Figure 1. Conceptual Model

Methods and Results

Data Collection

We used a survey on ISO9000 adopters from USA and Canada that we sent to 5066 management representative included on the ISO9000 list of the Quality System Update newsletter published by McGraw-Hill with 1150 valid responses (22.7% response rate). This is a typical response rate for surveys of quality managers. Empirical work by Flynn, Schoerder, and Sakakibara (1994), Powell (1995), and Douglas and Judge (2001) drew conclusions from surveys with similar response rates. We checked for non-respondent bias by comparing responding firms to the total population by SIC codes, time since certification, and size. The sample closely mapped the population. Sample statistics appear in Table 1.

SIC Code and name	Percentage
Respondents by SIC Code	
SIC 1-14: agriculture, forestry, and mining	6
SIC 15-17 and >40: service, trades, and construction	20
SIC 22-26: food, tobacco, textile, and wood products	4
SIC 28-30: petrochemicals and plastics	13
SIC 32-35, 37, 39: manufacturing metals and machinery	37
SIC 36 and 38: electronics and instruments	16
Miscellaneous	4
Annual sales in million	Percentage
Firms by size	
Up to 49	21
49-100	31
Over 100	48

Table 1. Sample description (n=1227)

Measures

Appendix A presents the item list and their corresponding measures.

Direct learning consists of two constructs. The first one is the use of internal resources in the implementation process, measured by the coordination of ISO9000 design and development by employees trained and developed outside or inside the firm. The second construct is the analysis of internal processes, measured by the integration of ISO9000 design and development within existing practices.

Vicarious learning consists of two constructs. The first construct is learning from customers and suppliers, measured by the coordination of ISO9000 design and development with customers and suppliers. The second constructs is learning from consultants, measured by the coordination of ISO9000 design and development by consultants and external training providers.

Quality of implementation is defined as the standard use after the certification. We use the measures developed by Naveh and Marcus (2004) and Naveh et al. (2004) for "used in daily practice" and "regular use" respectively. The items include: a) the system is regularly ignored (reversed), b) the system is unnecessary burden (reversed), c) the system is part of the regular routine, and d) the preparations for the external audits are made in the last minute (reversed).

Performance is measured by business performance: market share, sales, and export growth and operations performance: defect rate, cost of quality, productivity, and on-time delivery. The control variables are measure as follows: a) timing of adoption (in months since registration), b) motivation for adoption (combined measure of the ranked answers to the question about the main reason for ISO9000 adoption, represented by a continuum of the extent the focus of the implementation was on the certification versus internal improvement), and c) firm size (sales volume).

We used structural equation modeling (SEM) to test the conceptual model. SEM tests all the relationships simultaneously providing a better evaluation of the importance of each factor. The two-step approach recommended by Anderson and Gerbing (1988) tests the measurement model first to ensure validity and reliability of the scales and then evaluates the structural model.

Measurement model

Convergent and discriminant validity. As a first step, we tested and purified the measurement model using confirmatory factor analysis (CFA). The initial CFA could not validate the construct of internal resources and following Prahinski and Benton (2004), we dropped it from further analysis. The reduced model, shown in Fig. 2 was tested.

We assessed c*onvergent validity* from the measurement model by checking if each indicator's estimated loadings on its posited underlying construct was significant (Anderson & Gerbing, 1988). All items load significantly on the hypothesized constructs and providing evidence of convergent validity (Appendix A).

We assessed discriminant validity by examining if the average variance extracted by the items of a construct was greater than the average shared variance (square of the correlations in the off-diagonals) between two constructs (Fornel & Larker, 1981). All constructs pass this test, supporting discriminant validity.

Reliability. The Cronbach's α composite reliability estimates (Fornell & Larker, 1981) are shown in Appendix B. The Cronbach's alpha is over the rule of thumb value of 0.7 for all constructs except for analysis of internal processes (0.648) and learning from customers and suppliers (0.662). While reliability coefficients of 0.7 or higher are desirable, coefficients below 0.7 are often considered adequate for analysis (Nunnally, 1978) and a cutoff value of 0.6 is frequently used (Chen & Paulraj, 2004). All other scale reliabilities are over 0.7 providing adequate support for reliability of the scales.

The overall measurement model fit is shown in Table 2. Although the chi-square statistic is significant, which is expected given the larger sample size, other fit indexes indicate a good fit to the measurement model as shown in the table.

Structural Model and Path Significance

Figure 2 presents the structural model with the parameter estimates and the *t*-values of the paths. The fit indexes are shown in Table 2. Overall, the structural model fit indexes provide adequate evidence of a good fit for the proposed model. Therefore, using statistical significance of the paths assessed at $p \leq 0.05$, hypotheses H1, H2a, H3, and H4 are supported, with no support for H2b. Further, with path coefficients completed standardized, we can assess their relative importance based on the magnitude of the coefficients. Substantive implications of this are discussed next.

Analysis and integration efforts of the firm prove to be the most important factors affecting quality of implementation. In support of H1, the path coefficient of 0.275 is highly significant ($p < 0.001$). Firms utilizing internal resources to implement the standard reported higher levels of quality of implementation. Thus, direct learning proved to be the strongest predictor of the quality of implementation.

In support of the hypothesized positive association between knowledge from other firms and quality of implementation, H2a, the path coefficient of 0.057 is significant ($p < 0.05$). The role of customers and suppliers is crucial for the standard implementation. Even though customers and suppliers are classified as "other firms" and learning from them is considered vicarious, many firms have stabled long-term close relationship with their customers and suppliers, collaborating and constantly sharing information on demand forecast, new product development and quality improvement. It could be argued that the knowledge from a vertically integrated supplier is not vicarious anymore, but another form of direct.

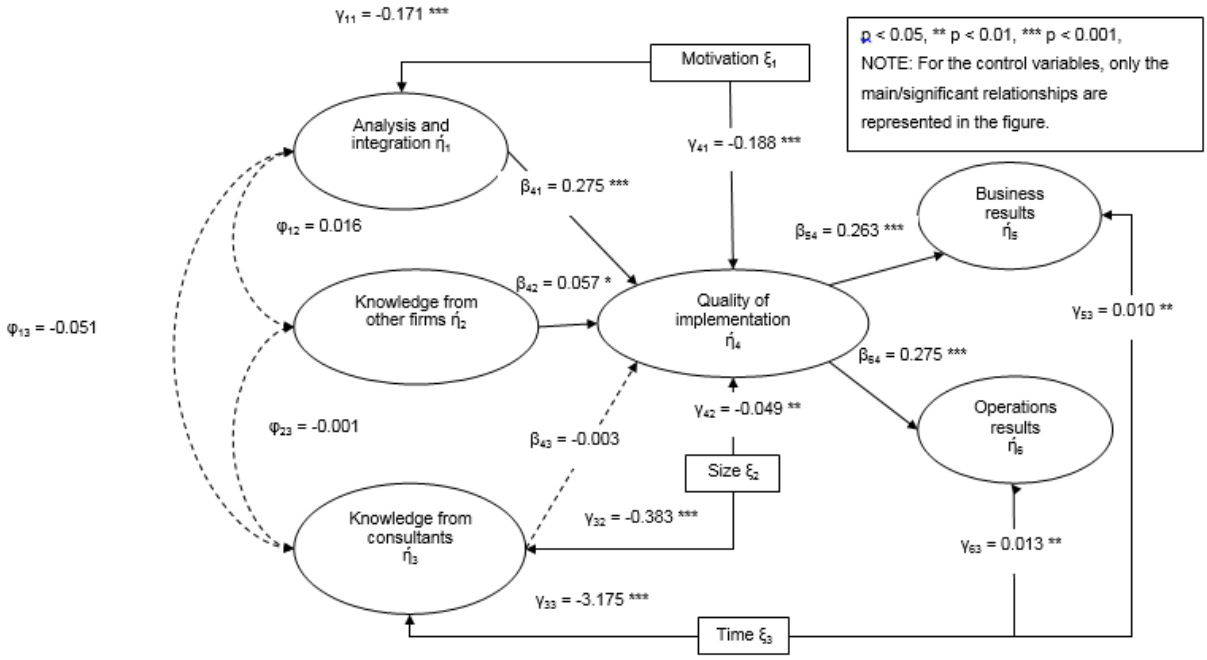

Figure 2. Structural model

The hypothesized negative relationship between knowledge from consultants and quality of implementation was not statistically significant (-0.003, $p > 0.1$). Thus, hypothesis H2b is not supported. We tested the model for different size of firms (small, medium, and large) and we found support for the hypothesis for small and large firms, but not for medium.

Evaluating the impact quality of implementation on business results, the path coefficient of 0.263 is highly significant ($p < 0.001$), providing support for hypothesis H3. Similarly, evaluating the impact of quality of implementation on operations results, the path coefficient of 0.275 is also highly significant ($p < 0.001$), in support of Hypothesis H4.

Fit statistic	Measurement model	Structural model	Recommended values
χ^2	111.994	422.108	
d.f.	38	128	
RMSEA	0.0421	0.0457	≤0.05 [a,b]
(90% CI)	(0.0332; 0.0512)	(0.0409; 0.0506)	
NFI	0.996	0.988	> 0.8 marginal fit and > 0.9 good fit [b]
CFI	0.997	0.991	
IFI	0.997	0.991	

Table 2. Measurement model and structural model fit indices with recommended values
[a] Browne and Cudek (1993), [b] Hu and Bentler (1998, 1999)

Results for Control Variables

As indicated earlier, three control variables are of interest: (i) motivation for adoption, (ii) timing of adoption, and (iii) firm size. Motivation for adoption is represented by a continuum of the implementation focus on the certification versus internal improvement. First, the higher the focus on certification (versus internal improvement), the lower the degree of analysis and integration during the implementation process. Similarly, the higher the focus on certification (versus internal improvement), the lower the quality of implementation. We recoded the motivation for adoption in a dichotomous form and ran the model separately for firms with high focus on internal improvement versus firms with high focus on certification. In the model for the firms with high focus on internal improvement the link between knowledge from customers and suppliers and quality of implementation was not significant. Most probably, these firms utilized primarily their own resources to implement the standard. Further, timing of adoption is positively associated with the knowledge from consultants, e.g. early adopters experience higher level of knowledge transfer from consultants then late adopters. Early adopters report higher level of both business and operations results than late adopters. Third, firm size is positively associated both with knowledge from consultant and quality of implementation, e.g. larger firms experience higher levels of knowledge from consultants and higher levels of quality of implementation. Interestingly, when we ran the model for small, medium, and large firms separately, the relationship between knowledge from other firms and quality of implementation is positive for small and large firms but negative for medium size firms.

Discussion

Learning and Quality of ISO9000 Implementation

Previous literature implies that learning will impact ISO9000 performance (Naveh et al., 2004). What was missing was the connection between learning and quality of implementation. Naveh et al. (2004) did measure the quality of implementation (called "regular use") as a control variable in the regression analysis; however, the construct was not included in the conceptual model. This study fills this gap by linking learning directly to the quality of implementation and testing the model using structural equations modeling.

Firms seeking to get benefits from the ISO9000 certification should focus on utilizing their internal resources to obtain high quality of implementation. Using internal resources improves employees' attitude and belief in the standard, which is directly related to the sustainable use of the standard in the post-certification period (Chee Ming, Katawala, & Sawalha, 2015). Suppliers and customers can also contribute vicariously to the implementation process. Regarding the role of consultants, we did not find enough empirical evidence to conclude the negative impact of the use of consultant, although we did find support for the negative impact for small and large size firms (but not for medium). Late adopters learn more from consultants than early adopters, consistent with Naveh et al. (2004). The impact of firm size on the relationship between knowledge from other firms and quality of implementation reveals that for medium size firms the level of customers and suppliers involvement is negatively associated with quality of implementation. These results are consistent with Molina, Lloréns Montes, and Del Mar Fuentes (2004) who tested the hypothesis that implementing the ISO9000 standards in the firm improved the knowledge transfer from customers and suppliers, but did not

find support for it. Motivation for adoption affects both direct learning and quality of implementation. High focus on certification versus internal improvement affects negatively direct learning and quality of implementation. These results are consistent with previous research (Jang & Lin, 2008).

The findings contribute to the academic literature in two ways. First, we link learning to the quality of implementation. To the best of our knowledge, this is the first study to investigate this relationship. Previous studies focus on motivation for adoption and quality of implementation, also called "internalization of ISO9000" (Jang & Lin, 2008; Nair & Prajogo, 2009; Ataseven et al., 2014). Second, we create a continuous measure for the motivation to adopt the ISO9000 standard, rather than dichotomous as used in the prior research, because firms may have both internal (process improvement) and external (marketing) drivers for standard adoption.

Practitioners also gain benefits from this study. First, small or large late adopters can benefit by trying to utilize less consultants and more internal resources as well as learning from suppliers and customers. Medium size (10-60 million dollars sales) late adopters should try to utilize more internal resources and less consultants as well as less knowledge from suppliers and customers. Possibly, medium size firms' efforts to coordinate the implementation with customers and suppliers increase the complexity and negatively impact the quality of implementation. Second, firms may not be able to impact their motivation to adopt ISO9000, but if their motivation is primarily focused on getting the certificate, they could mitigate the negative impact on quality of implementation, by trying the utilize more direct learning as well as learning from customers and suppliers.

Quality of Implementation and Firm Performance

Previous literature implies that quality of implementation or internalization of ISO9000 standard drives positive operations and business results (Jang & Lin, 2008; Nair & Prajogo, 2009; Ataseven et al., 2014). Our findings are consistent with these studies. Jang and Lin (2008) and Nair and Prajogo (2009) suggest an indirect link between quality of ISO9000 implementation and business performance through the operational performance. We did find a direct link between quality of implementation and business results. Our results also provide evidence that early adopters report higher operational and business results than late adopters, consistent with the results of Naveh et al. (2004).

These findings contribute to the academic literature by confirming the positive relationship between quality of implementation and both business and operations results. The direction of the relationship between learning and quality of implementation is not clear. From one side learning impacts quality of implementation and from the other quality of implementation drives learning. Future research could investigate further this relationship, by including other factors, such as intellectual capital and process improvement as suggested by Ataseven et al. (2014).

Practitioners also gain benefits from these results. First, quality of implementation drives business and operations results, not the certification itself. Second, even though the perceived operations and business results from ISO9000 implementation diminish over time, the timing of adoption itself does not affect the quality of implementation. Even late adopters could benefit from ISO9000 adoption if they are able to achieve high quality of implementation.

Limitations and Future Research

This research identifies how different ways of learning impact quality of implementation to achieve high results. The results show no correlation between different ways of learning, however, firms can learn by applying both direct and vicarious learning at the same time. Several studies have identified an interaction effect between direct and vicarious learning. Bresman (2010) finds evidence that vicarious learning is associated with higher levels of performance in the presence of direct learning. Similarly, Fang, Lee, and Schilling (2010) find that moderate levels of cross group linking (balance direct and vicarious learning) leads to highest performance. Posen and Chen (2013) estimate that the share of vicarious learning realized in the process of experiential learning is twice as large for entrants as for incumbents. It will be interesting to investigate the interaction effect between direct and vicarious learning and its impact on performance. Future studies may create a continuous variable for learning and investigate the impact on the quality of implementation, motivation, firm size, and timing of ISO9000 adoption. Future research may also study how prior standards, such as ISO14000, impact direct learning. Two sources of vicarious learning, consultants and other firms, do not impact quality of implementation in the same direction. Additional research is required to explore how learning is spread through the supply chain and should this type of learning be considered direct as well, as customers and suppliers become long-term partners. In this case, other factors, besides size, may determine the relationship with suppliers and customers, and the transfer of learning. The implementation of ISO9000 requires sharing of information to establish trust, commitment and collaboration (Fynes, Voss, & Burca, 2005). The nature of relationship as well as customers and suppliers' proximity (Bayo-Moriones, Bello-Pintado, & Merino-Diaz-de-Cerio, 2011) could be other factors affecting information sharing and learning.

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Appendix A. Measurement of variables

Items	Description	Mean	S.D.	Loading
Analysis of internal processes: measured by the extent to which the design and development of ISO9000 system was: (1-very low extent, 3-medium extent, 5-very high extent)				
AnaIntPro1	Integrated with practices already in use	3.74	1.05	0.78
AnaIntPro2	Customized to the needs of your firm	3.82	1.05	0.73
AnaIntPro3	Based on analysis of internal processes and performance	3.16	1.18	0.75
Learning from customers and suppliers*:* measured by the extent to which the design and development of ISO9000 system was coordinated by: (1-very low extent, 3-medium extent, 5-very high extent)				
Suppliers	Suppliers	1.78	0.87	0.85
Customers	Customers	2.15	1.11	0.86
Learning from consultants: measured by the extent to which the design and development of ISO9000 system was coordinated and led by: (1-very low extent, 3-medium extent, 5-very high extent)				
Consult1	Consultants	2.14	1.24	0.88
Consult2	External training provider	2.55	1.43	0.89
Quality of implementation: measured by the extent to which: (1-very low extent, 3-medium extent, 5-very high extent)				
QualImpl1	The system is regularly ignored (inversed)	3.91	1.03	0.84
QualImpl2	The system is unnecessary burden (inversed)	3.98	0.96	0.78
QualImpl3	The system has become part of your regular routine	3.81	0.88	0.74
QualImpl4	The preparations for external audits are made in the last minute (inversed)	3.56	1.16	0.71
Business results: *measured by a combined measure of performance change since gaining ISO9000 registration (1-getting much worse, 3-unchanged, 5-significantly improved) and extent attributed to ISO9000 registration (1-very low, 3-medium extent, 5-very high extent) [min = -8, max = 10]*				
BusRes1	Sales	2.06	2.50	0.84
BusRes2	Market share	1.82	2.40	0.83
BusRes3	Export growth	1.40	2.56	0.73
Operations results: *measured by a combined measure of performance change since gaining ISO9000 registration (1-geeting much worse, 3-unchanged, 5-significantly improved) and extent attributed to ISO9000 registration (1-very low, 3-medium extent, 5-very high extent) [min = -10, max = 10]*				
OpsRes1	Defect rate (as a percentage of production rate)	2.57	3.40	0.86
OpsRes2	Cost of quality (scrap, rework and inspection) as percentage of total sales	1.93	3.25	0.85
OpsRes3	On-time delivery to customers	2.35	2.91	0.48
OpsRes4	Productivity	2.30	2.58	0.45
Timing of adoption*, [min = 1, max = 144]*				
Time	How many months has this facility been registered?	33.45	22.87	1[b]
Motivation *to adopt measured by a combined measure of the ranked answers to the question about the main reason for ISO9000 adoption, represented by a continuum of the extent the focus of the implementation was on the certification versus internal improvement [min = -6, max = 6]*				
Motivation	What was the main reason for adopting ISO9000?	1.78	2.21	1[b]
Size of firm *[min = 0, max = 70000]*				
Size	What is your firm current annual sales volume (in million)?	726.69	4210.93	1[b]

[a] Completely standardized co-efficients all loadings are significant at $p < 0.001$.
[b] Error terms are fixed at 0 due to single item scale.

Appendix B: The diagonal in Table 3 shows the average variance expected values for the constructs. A more stringent test for discriminant validity is to test that the average variance extracted by the item of a construct versus the average standard variance (square of the correlations in the off diagonals) between two construct (Fornell and Larker, 1981). All constructs pass this test.
Inter construct correlations, average variance extracted and scales reliabilities.

	QualImpl	BusRes	OpsRes	AnaIntPro	Consult	SuplCust	Time	Motivation	Cronbach α
QualImpl	*0.326*	–	–	–	–	–	–	–	0.777
BusRes	0.000 (1.000)	*0.587*	–	–	–	–	–	–	0.780
OpsRes	0.000 (1.000)	0.000 (1.000)	*0.332*	–	–	–	–	–	0.712
AnaIntPro	0.000 (1.000)	0.000 (1.000)	0.000 (1.000)	*0.244*	–	–	–	–	0.648
Consult	0.000 (1.000)	0.000 (1.000)	0.000 (1.000)	0.000 (1.000)	*0.378*	–	–	–	0.731
SuplCust	0.000 (1.000)	0.000 (1.000)	0.000 (1.000)	0.000 (1.000)	0.000 (1.000)	*0.712*	–	–	0.662
Time	0.005 (0.869)	.120(**) (0.000)	0.064 (0.052)	0.015 (0.651)	-0.104(**) (0.002)	-0.068(*) (0.039)	–	–	–
Motivation	-.175(**) (0.000)	-0.005 (0.876)	-.119(**) (0.000)	-0.044 (0.184)	0.003 (0.927)	-0.024 (0.047)	0.064(*) (0.031)	–	–
Size	-.079(*) (0.028)	0.020 (0.569)	0.022 (0.542)	0.085(*) (0.018)	-0.088(*) (0.014)	-0.011 (0.769)	0.270(**) (0.000)	-0.020 (0.536)	–

**Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed)

