

## The Impact of TQM and information communication technology (ICT) as an enabler in the Quality Management Assessment Framework (QMAF) on business outcomes

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# **The Impact of TQM and information communication technology (ICT) as an enabler in the Quality Management Assessment Framework (QMAF) on business outcomes**

## **Abstract**

The purpose of this study is to appraise a quality management assessment framework (QMAF) model and establishes causal relationships between the various constructs in the model in order to determine optimum pathways in achieving business outcomes including information and communication technology (ICT) element as one of the constructs. We carried out an empirical study of small, medium and large manufacturing organizations in the Western Sydney Region of New South Wales, Australia.

The (SEM) recursive path analysis results of the model provide empirical evidence that establish the pathways through the various constructs considered in the model. All these pathways ultimately lead to delivering optimum business outcomes. Further, ICT as an enabler is confirmed as it is found to have direct one-to-one influence on all the constructs of the model including business outcomes.

The research findings enabled developing important and practical guidelines for managers engaged in planning and management of quality.

**Keywords:** Business outcomes; Information & communication technology; Path analysis

## Introduction

Excellence awards and management frameworks induced significant changes in the organization's performance. This made worldwide organization to imitate best quality management practices to achieve competitive advantage (Dick, 2009). This has intensified in recent times, due to increase levels of competition, globalization and collaboration with multiple levels in the supply chain (Talib *et al.*, 2011; Simchi-Levi and Fine, 2010)

Among various awards noted in the literature, the Malcolm Baldrige National Quality Award (MBQNA) has turned out to be a vital stimulus for improving the competitiveness of US companies and increasing awareness of quality improvement methods (Main, 1990; Garvin, 1991; Hart, 1993; Moore, 1995; ASQ, 1998). The Baldrige criteria offer a comprehensive framework or tool for self-assessment of quality (Garvin, 1991; Evans, 1997). In addition to various quality awards developed and discussed in the literature, other aspects associated with the quality award include (i) strength of relationships among various quality management constructs such as total quality management (TQM) practices which are measured/evaluated using levels of following key measures (leadership, strategic planning, customer focus, information and analysis, people management and process management), quality performance and innovation performance (Prajogo and Sohal, 2003); (ii) relationships between quality management and organization performance (Prajogo and Sohal, 2006), and (iii) validity of quality awards using various empirical studies. Leadership, information and analysis are identified as significant drivers of system performance while process management has an impact on customer satisfaction (Wilson and Collier, 2000). Recently, Srinivasan and Kurey (2014) identified four major attributes such as leadership emphasis, message credibility, peer involvement and employee empowerment that would enhance the competitiveness of corporate quality culture. It is emphasized that information and communication technologies (ICTs) are backbone to gain the four attributes. Furthermore, it is evident from the recent literature that ICTs play a significant role in SMEs, in particular on manufacturing processes as well as working and management practices (Ritchie and Brindley, 2005). Although the importance of ICTs on manufacturing processes and management practices are noted in various empirical studies, further investigation into its impact on overall business outcomes through a quality management framework is warranted. In addition, contemporary business systems is entwined with ICT and its influence on business outcomes needs validation. Therefore, this study extends the work of previous research on the quality management framework (QMAF), in particular the proposed framework examines ICT as an enabler (Lobo and Ramanathan, 2005; Lobo *et al.*, 2012). In this case, the study is considered to be the first empirical study on QMAF framework, investigating the direct/indirect impact of ICT as enabler on business outcomes, using data from the Western Sydney region. The holistic approach enables using QMAF for evaluation, assessment and improvement of quality constructs leadership, quality culture, information, knowledge, communication, human resources management, partnering focus, strategy/improvement methods, business processes and their collective influence towards achieving optimum business outcomes.

Furthermore, previous studies have focused on developing quality management assessment frameworks, including an analytical network process (ANP)-based framework for successful total quality management implementation. ANP has been

determined to be an effective framework for assessing readiness to adopt TQM and facilitating TQM implementation (Bayazit and Karpak (2007) and provides guidelines for self-assessment tool to be used by quality managers for continuous monitoring of quality-related performance (Quazi *et al.*, 1998) and a comprehensive framework of twelve important elements of quality, assessing quality management practices at the firm level, influenced by the role of information and communication technologies (Lobo and Ramanathan, 2005; Lobo *et al.*, 2012). In this case, the QMAF theorizes the role and impact that leadership, quality culture, information/knowledge/communication, strategy, human resources management, partnering focus, improvement methods, and business processes have on the business outcomes such as business results, customer and stakeholder value and feedback. Although the research work outlined above have proposed some sort of assessment frameworks and/or identified roles and impacts of various factors on quality management practices, including the QMAF model which provides a theoretical foundation with a holistic approach for quality management assessment, the assessment frameworks need to be supported by experimental validation. In this research, the QMAF model is modified by combining strategy and improvement methods into one element “strategy/improvement methods” in comparison to the QMAF model proposed by Lobo and Ramanathan (2005) and Lobo *et al.* (2012) where strategy and improvement methods are considered as two distinctly separate elements. It was deemed that the combined influence of “strategy/improvement methods” provided a more appropriate construct given the strong synergies in strategies and improvement methods. This is followed by experimental validation of relationships between constructs of the framework. In addition, this framework is further studied, particularly with regard to strengths of relationships between constructs of the model, using empirical data from a selected region of Australia. Overall, this research addresses the research question of how each construct of a quality management assessment framework is related with business outcomes and how direct and indirect relationships between constructs contribute to overall business outcomes, in particular with/without information/knowledge/communication (IKC) in the quality assessment framework/model.

This research, within the broader theme of experimental validation of the QMAF model, aims to (i) gain deeper insights and managerial implications from the direct and indirect effects of the categories in the QMAF and (ii) to assess the overall impact of these effects on the business outcome category, using structural equation modeling (SEM) - recursive path analysis.

The remainder of the paper is organized as follows. The literature review is presented next, followed by quality framework and research questions, the research methodology outlining the approach, data source and collection, and analysis methods. In the next section, details of data analysis and results of the study are discussed. Finally, conclusion, limitations and future research directions are presented.

## **Literature Review**

### ***Quality framework***

Among various aspects of quality in broader sense, two areas of interest in this study include quality awards and management assessment frameworks. Many frameworks to measure organizational quality have been discussed in quality management literature with different foci and purposes, including identification of eight critical factors of quality management, as the basis for producing a profile of quality practices by Saraph *et al.* (1989), a framework for evaluation of quality management programs by practitioners by Flynn *et al.* (1994), a framework to examine the effects of quality management strategies on product quality by Ahire *et al.* (1996), guidelines for self-assessment and monitoring of quality-related performance (Quazi *et al.*, 1998), and process-based framework for total quality management practices, as the basis for measuring the impact of different factors on TQM implementation in manufacturing industry (Bayazit and Karpak, 2007). Using a comprehensive study on the relationships among the Baldrige categories, Pannirselvam and Ferguson (2001) states that (i) a number of parallel measures exist between the MBNQA criteria and other frameworks; however, substantial differences exist between the measures of these frameworks, (ii) the MBNQA criteria are superior in terms of comprehensiveness with less prescriptive when compared to other instruments, and (iii) the MBNQA model places greater emphasis on continuous improvement, customer focus, and strategic quality planning.

### ***Quality practices and performance***

The greater emphasis on continuous improvement within broader performance context is evident from various research studies in the literature on the association between quality and performance by several researchers. In this context, studies have established the link between product quality, cost, market share, return on investment and profitability (Schoeffler *et al.*, 1974; Phillips *et al.*, 1983; Gale and Klavans, 1985). Roth and Miller (1989) and Rothet *et al.* (1990) studied the effect of various quality practices on quality performance. Their research evidently demonstrated that quality programs have a significant influence on manufacturing capabilities. The constructs for quality in these two studies however did not consider infrastructures, such as information management, that could influence the success of quality management practices.

Pannirselvam and Ferguson (2001) conducted a comprehensive quality award study based on the MBNQA to determine the strength of relationships between the various quality management constructs and between quality management and organization performance using path analysis, based on data from the Arizona Governor's Quality Award. Pannirselvam and Ferguson (2001) established the measurement validity of the Baldrige Criteria for Performance Excellence (CPE) by testing a confirmatory factor analysis (CFA) model using 1993 Arizona Governor's Quality Award (AGQA) applicant data. Samson and Terziovski (1999) also confirmed the measurement validity of the CPE. They analyzed data obtained from a large Australasian manufacturing sample, using a survey instrument based on the 1994 CPE. Dellana and Hauser (1999) and Dow *et al.* (1999) through their studies they arrived at similar conclusions with regard to the validity of the CPE.

### ***Relationships among categories in quality framework***

Xiang *et al.* (2010) analyzed the causal relationships among the categories in the China Quality Award (CQA) model based on the Malcolm Baldrige National Quality Award. The CQA causal model is analyzed in terms of driver (i.e. leadership), direction (i.e. strategic planning), system (i.e. human resource focus, process management, and customer and market focus), foundation (i.e. information and analysis). SEM was used to estimate the path coefficients among the CQA categories, using analysis of empirical data. The study concluded that leadership has a great influence on foundation and direction where direction affects human resources focus and customer and market focus on system but it has no influence on process management; human resource focus and customer and market focus both affect process management; and process management has a significant effect on results construct. In addition, foundation impacts direction and all the categories of the CQA causal model.

Bou-Llusar *et al.* (2005) conducted an exhaustive study of the European Excellence Award (EEA) which involved assessing the interrelationships between the enablers and result criteria in the model. The data was obtained from a sample of Spanish firms and analyzed using canonical correlation analysis. The study concluded that the set of enabler criteria is strongly related to the result criteria set. The enabler criteria contribute in a similar way to result enhancements, hence a balanced approach in the development of enablers aids correlation between enablers and results to be enhanced, this optimizes the benefits from the EEA.

Jayamaha *et al.* (2008) empirically established the validity of the Baldrige CPE, using a data set from New Zealand organizations and also determined methodological gaps as the study was based on a small sample, the study highlighted the need to meta-analyze past measurement and structural models as well as measurement instruments. They used self-assessment data from 91 New Zealand organizations and conducted the analysis with partial least squares (PLS) method of structural equation modeling. The measurement validity of the CPE was confirmed, where 11 implied causal relationships among 13 were found to be statistically significant. In addition, the results inferred some key quality management aspects: dependence on measurement, analysis and knowledge management; people involvement, and the function of leadership in setting direction.

### ***Organizational focus on improving quality culture***

Furthermore, some studies have taken a more organizational focus of quality and included organizational elements such as information management and human resources management (Anderson *et al.*, 1995; Flynn *et al.*, 1995; Chen *et al.*, 1997; Poister and Harris, 1997; Lengnick-Hall and Sanders, 1997; Li, 1997; Rungtusanatham *et al.*, 1998; Dow *et al.*, 1999), organizational culture, in particular identifying cultures that determine the successful implementation of TQM practices (Prajogo and McDermott, 2005) and need for an appropriate culture to support the scope of TQM (Irani *et al.*, 2004). Dow *et al.* (1999) surveyed a large, random sample of manufacturing sites to establish the primary dimensions of quality management and examined the relationship between quality practices and quality outcomes. The results revealed that the practices can be divided into nine categories. The workforce commitment, shared vision and customer focus categories combine to yield a positive correlation with quality outcomes. However, other categories such as benchmarking, use of teams, personnel training, advanced manufacturing systems, just-in-time

principles and co-operative supplier relations did not show any significant relationship with quality outcomes. Based on an empirical study on the relationship between TQM practices and organizational culture, Prajogo and McDermott (2005) provides further evidence of supporting the established view of different subsets of TQM practices are determined by different types of cultures, in particular a hierarchical structure is having significant relationship with certain practices of TQM.

### ***The holistic influence of TQM factors on business results***

In most cases, path analysis using structural equation modeling has been used to establish relationships between TQM factors and business results (Sila and Ebraimpour, 2005; Flynn and Saladin, 2001; Prajogo and McDermott, 2005; Jayamaha *et al.*, 2008). Sila and Ebraimpour (2005) empirically investigated the relationships among critical TQM factors and business results. Structural equation modeling was used in the study which established that TQM factors are holistic namely synergies must be created among them to achieve favorable business results e.g. leadership and information and analysis have a strong implications for a company's business results.

Using path analysis to assess the hypothesized linkages of the CPE framework, Flynn and Saladin (2001) confirmed the validity of theoretical models underlying the Baldrige criteria, through analysis of constructs and direct effects in the path model. In this case, the data was obtained from a sample of manufacturing plants in the USA and elsewhere. They also inferred that the path models that related to the 1992 and 1997 Baldrige criteria were a better fit to data, in comparison to the path model that corresponded to the 1988 criteria; concluding that the frameworks have improved upon the base established by the original 1988 framework.

It would be nice to summarize the gaps based on quality framework, quality practices and performance, relationship among categories in quality framework and organizational focus to improve quality culture. Among various studies on broader quality frameworks, some studies have considered information and knowledge in their quality frameworks using structural equation modeling to establish linkages in the constructs of their frameworks (Sila and Ebraimpour, 2005; Flynn and Saladin, 2001; Jayamaha *et al.*, 2008). This research adopts the QMAF, as the basis for explicitly establishing ICT as an enabler with information/knowledge/ communication (IKC) construct of the QMAF model. The (SEM) recursive path analysis results of the model, using a set of data collected from a region in Australia and analyzed using structural equation modelling provides empirical evidence that pathways in achieving business outcomes can be established through various elements of the QMAF model.

### **Quality Framework and Research Questions**

Based on a synthesis of the literature and quality award schema, a comprehensive framework consisting of twelve important elements of quality (Lobo and Ramanathan, 2005; Lobo *et al.*, 2012) is selected as the basis of this research and is referred to as the Quality Management Assessment Framework (QMAF). Each element of the QMAF (Figure 1) is described briefly next, before presenting research questions.

[Insert Figure 1 here]

The elements of quality framework (leadership, quality culture, information/knowledge/communication, employee empowerment, employee development, supplier focus, customer focus, strategy, benchmarking, total quality tools, continuous improvement, business processes, business results and customer and stakeholder value) are classified into eight categories. Those eight categories are subsequently arranged into five groups. The five basic groups include core drivers; quality value infrastructure; roadmaps, implementation tools and techniques; processes and performance outputs. The core drivers are leadership, quality culture and information/knowledge and communication. Leadership focuses on how top management accentuates quality at all levels and communicates this emphasis throughout the organization. Quality culture encompasses the extent to which employees work as a team accepting their responsibilities for quality with clear quality objectives and team skills to deliver to these objectives. Information, knowledge and communication management systems deliver an agile quality management system facilitating speedy and accurate data collection, analysis, reporting and decision-making tools. The quality value infrastructure is represented by human resources management and partnering focus of an organization. Human resources management consists of employee development and empowerment; partnering focus is made up of the level of customer and supplier focus that an organization possesses. The roadmaps, implementation tools and techniques of the organization are delivered by the strategy, improvement methods management system of an organization and are dependent on the level of strategy/ improvement methods used by an organization. Strategy/improvement methods consist of strategy, benchmarking, total quality tools and continuous improvement programs. The processes, identified as one group, are measured by the quality of business processes in an organization. The performance outputs are represented by business outcomes which include business results, customer and stakeholder value and the relevant feedback systems. It should be noted that the proposed model/framework is a modification of QMAF model presented by Lobo and Ramanathan (2005), which classified the elements into nine categories and subsequently into six groups. The modification is mainly merging of two categories: strategy and improvement methods into one category “strategy/improvement methods”. Two categories are merged since they are logically related, in particular strategy involves development of plans and improvement methods and subsequently enables implementation of those plans. Henceforth, the QMAF model presented here has seven constructs.

Since the model represents very closely connected groups with twelve major elements, the manner in which the twelve major elements interact and influence each other will determine the scope and extent of customer value created and the business results achieved. Organizations that aspire at being world-class focus on infusing a few core values such as good leadership, customer focus, respect for employees, and continuous improvement. The QMAF criteria are devised around such core values and are exemplified in the QMAF framework. In today’s context, where ICT plays a major role as an enabler, the elements described in the model and their interplay will be studied, with particular attention to whether relationships among those elements and subsequently overall effectiveness of QMAF is enhanced through appropriate ICT interventions.



In order to determine how major elements interact and influence each other, it is proposed that strengths of relationships between constructs of the selected QMAF model be tested. Thus, the following hypotheses are proposed and tested using data collected through a survey questionnaire.

### ***Research questions***

The following research questions are proposed to test direct and indirect relationships between combinations of constructs of the QMAF model. The exogenous constructs of the model are Leadership (L), Quality Culture (QC) and Information/Knowledge/Communication (IKC). The endogenous constructs are Human Resources Management (HRM), Partnering Focus (PF), Strategy/Improvement Methods (SIM), Business Processes (BP) and Business Outcomes (BO).

RQ1. Does Leadership positively influence business outcomes through human resources, partnering focus, strategy/improvement methods and business processes?

RQ2. Does Quality Culture positively influence business outcomes through human resources, partnering focus, strategy/improvement methods and business processes?

RQ3. Does Information/Knowledge/Communication positively influence business outcomes through human resources, partnering focus, strategy/improvement methods and business processes?

RQ4. Does Human resources management positively influence business outcomes through human resources, strategy/improvement methods and business processes?

RQ5. Does Information/Knowledge/Communication have a positive influence on leadership, quality culture, human resources management, partnering focus, strategy/improvement methods, business processes and business outcomes?

### **Research Methodology**

The research involves (i) a survey questionnaire for collecting empirical data and (ii) recursive path analysis of structural equation modelling for testing a set of hypotheses associated with broader research questions, for overall assessment of the Quality Management Assessment Framework (QMAF).

### ***Survey design***

The questionnaire adopted in this study is derived from previous studies (MBQP, 2001; Anderson and Sohal, 1999; Adam et al., 1997; Tan, 1997; Martinez Lorente *et al.*, 1999; MBQP, 1997). The QMAF questionnaire was validated by trialing it out with five organizations. The results of the assessment were discussed with the respective Quality Managers of these organizations and the feedback was very complementary. Based on the feedback from quality managers of those organizations and also considering the overall purpose of the research, the questionnaire was finalized for mailing out for required data collection. The responses to the questions were evaluated using a Likert scale of 1 to 5 with 1 representing strongly disagree and 5 corresponds to strongly agree.

## *Data collection*

Several factors were brought into consideration in determining the data collection and associated sample selection for this research.

1. The population was limited to only organizations engaged in manufacturing in the Western Sydney region. This selection was for several reasons:
  - a. It controls for heterogeneity of quality systems across New South Wales (NSW).
  - b. The Western Sydney region is the centre of industries for NSW and provides a wide variety of both industries by size and Australian and New Zealand Standard Industrial Classification (ANZSIC) category.
  - c. University of Western Sydney is based in the Western Sydney region and the researcher was familiar with the region's context, which assisted in collecting valuable information for the study.
2. The following were the conditions taken into account in identifying the sample size. First, the limitation of time and financial resources. Additionally, since it was hard to get adequate responses to the survey in the first instance, all the four lists generated from the population were used in order to generate the maximum number of responses.

The samples were selected using random sampling technique for each category, namely small, medium and large size organizations (MINITAB software).

As outlined earlier, collection of empirical data was carried out using a mail out of the survey questionnaire with telephone follow up. In this case, a comprehensive postal survey was carried out with a preliminary mail out to 300 firms in the Western Sydney Region. These firms were a combination of large, medium and small organizations. Since it was hard to achieve complete responses, from the first mail out, additional three lists of the remaining population were made in the same ratios as the first list. The complete population of 1236 was used up trying to get most of the companies to participate in the study, as the best option for increasing the sample size, as this was a major limitation to this research project.

Overall, the total responses were 73 completed survey questionnaires. This means that it is a relatively small data sample (73 responses), making one of the limitation of this research. This also restricted us from extending the analysis beyond the Path Analysis. In a similar research, Jayamaha *et al.* (2008) used 91 responses from New Zealand organizations and used PLS to empirically establish the validity of the Baldrige Criteria for Performance Excellence (CPE). Table 1 shows the total population, sample drawn for each of the four lists and response rate in each industry size (i.e. large, medium and small). Initially all data collected were coded and entered into MINITAB which was previously constructed and tested. Strict controls were imposed to guarantee integrity of the data.

[Insert Table 1 here]

In order to provide better description of data in terms of key attributes, correlations and strengths of relationships between constructs of the QMAF model, regression analysis, and path analysis of structural equation model (SEM) are used. In the case of path analysis using partial least square (PLS) of SEM, evaluation of reflective outer models is carried out using the following criteria: indicator reliability (indicator

loading), internal consistency (Cronbach's Alpha and composite reliability), convergent validity (AVE), discriminant validity cross loading (Fornell and Larcker, 1981). The inner model is validated using endogenous constructs explained variance ( $R^2$ ) and significance of path coefficients (Hair et al., 2012).

### ***Model evaluation***

QMAF model is evaluated, based on the strength of relationships between the constructs and their effects on Business Outcomes (BO), using (SEM) recursive path analysis. In this case, seven constructs of the model include Leadership (L), Quality Culture (QC), Information/Knowledge/ Communication (IKC), Human Resources Management (HRM), Strategy/Improvement Methods (SIM), Partnering Focus (PF) and Business Processes (BP). All the constructs have set of reflective items from previous studies as explained in survey design.

A recursive path analytic model determines the observed correlations among the variables to estimate the path coefficients in the model. The SEM recursive path analysis is a type of multivariate method that inspects sets of relationships in linear causal models that are unidirectional. The statistical techniques used with (SEM) path analysis is used to test the appropriateness of a causal model with the use of standardized multiple regression equations. The QMAF characterizes the causal relationships between the quality management systems and organization results, based on recursive path analysis. Therefore, this methodology is suitable for measuring such a relationship. A correlation structure model merges the factor analytic and path analytic models and simultaneously estimates the strength of the relationships between the variables.

The major limitation of this approach is that the analysis is based on the portion of the model with the largest number of predictors. This method is recommended for the minimum number of observations range from 30 to 100 cases. (Chin and Newsted, 1999).

### **Results and Analysis**

Smart PLS was used to estimate the factor loadings for each item of eight constructs of the model and strength of path coefficients. A correlation structure model was analyzed using Smart PLS 3 for each direct effect between the seven constructs and Business Outcomes (BO), and the adequacy of the whole model, together with the path coefficients for the indirect effects. In order to establish the validity of the QMAF model, three different configurations of the model's path diagrams were examined as shown in Figures 2-4.

The standardized path coefficients for the set of causal relationships are presented in Tables 3, 6 and 8. The p-values associated with each direct effects path coefficient indicate the statistical significance of the coefficient.

Figures 2-4 establish the direct effect of one construct on another by the arrow connecting the two constructs. Indirect effects of constructs can be established by following a set of forward pointing arrows. For example, though there is no direct effect of quality culture on business processes in Figures 2 and 3, an indirect effect can be established by assessing

the direct effects of quality culture on human resources management and strategy/improvement methods and the direct effects of these two constructs on business processes.

### ***Comparative analysis of the QMAF model – with and without IKC***

PLS was used given its rigorous analytical base and the relatively small sample size of this study (Chin and Newsted, 1999). Table 2 summarizes the assessment of the QMAF Model with IKC and Table 5 summarizes the assessment of the QMAF Model without IKC.

The test of the measurement model includes the estimation of convergent and discriminant validity of the instrument items. Convergent validity of the measurement models was assessed by average variance extracted (AVE) (Fornell and Larcker, 1981). Convergent validity is adequate when constructs have an AVE of at least 0.50 (Fornell and Larcker, 1981). All the constructs have an AVE score of 1.0 for the QMAF model with and without IKC. The Cronbach's alpha and composite reliability for each construct is 1.00 for both the QMAF models (with and without IKC), given we used average of all items as a single item for a construct, to reduce number of variables. A Cronbach's alpha and composite reliability value of 0.70 or more is accepted for internal consistency for established scales (Nunnally, 1967). Discriminant validity is tested, according to method suggested by Fornell and Larcker test (1981) and found that all our squared correlations are less than our AVE, for outer model all our indicator loadings are above 0.5.

The inner structural model was evaluated using the  $R^2$  for the dependent constructs and the size, t-statistics and significance level for the structural path coefficients. The t-statistics were estimated using the bootstrap resampling procedure (1000 re-samples). Furthermore,  $R^2$  values which are greater than 0.5 are very good, as suggested by Fornell and Larcker (1981), for all the constructs in both models and explains variance very well.

The global fit (GoF) for PLS path models is estimated for global validation of PLS model (Akter *et al.*, 2011). The global fit (GoF) (Wetzels *et al.*, 2009) measure for PLS model is 0.64 in the case of the QMAF model with IKC and 0.68 for the model without IKC indicating a good fit of the models to the data.

### ***Analysis of the QMAF model incorporating IKC***

The Structural Path estimates and the t-Statistics for all direct effects in the QMAF model with IKC are outlined in Table 3.

[Insert Figure 2 here]

The standardized path coefficients for the QMAF model with IKC represent set of causal relationships and are presented in Figure 2. Table 4 outlines the direct, indirect and total effects of the constructs of the QMAF when IKC is considered and included in the model. Most of the direct, indirect and total effects tested are found to be significant. It can be noted from Figure 2 that direct effect of information, knowledge and communication (IKC) on business outcome (BO) is 0.182. Similarly, indirect effect of IKC on BO as shown in Table 4 is 0.283. It should be noted that both direct and indirect effects shown in Table 4 are evaluated using smart PLS software. For example, indirect effect of IKC on BO can be evaluated manually using effects of other paths between IKC and BO and is shown below:

$$\begin{aligned}
 \text{Indirect effect of IKC on BO} &= \{(\text{Direct effect of IKC on BP} \times \text{direct effect of BP on BO}) + (\text{direct effect of IKC on SIM} \times \text{direct effect of SIM on BP} \times \text{direct effect of BP on BO}) + (\text{direct effect of IKC on SIM} \times \text{direct effect of SIM on HRM} \times \text{direct effect of HRM on BP} \times \text{direct effect of BP on BO})\} \\
 &= \{(0.182 \times 0.708) + (0.331 \times 0.613 \times 0.708) + (0.331 \times 0.585 \times 0.077 \times 0.708)\} \\
 &= 0.283
 \end{aligned}$$

In this case, Leadership has a significant direct effect on strategy/improvement methods; Strategy/improvement methods have a significant direct effect on human resources management followed by human resources management which has a direct effect on business processes; and a significant path coefficient indicating business processes have a direct effect on business outcomes. Similarly quality culture has a direct effect on strategy/improvement methods, partnering focus and human resources management. In addition, strategy/improvement methods have direct effect on business processes.

Significant path coefficients accentuate the following inferences: Quality culture has an indirect positive effect on strategy/improvement methods through partnering focus; human resources management through partnering focus followed by strategy/improvement methods; business processes through strategy/improvement methods; business processes through human resources management; and business outcomes through strategy/improvement methods followed by business processes.

Leadership indirectly has a significant positive effect on human resources management through strategy/improvement methods; business processes through strategy/improvement methods followed by human resources management; business outcomes through strategy/improvement methods followed by human resources management and business processes

Strategy/improvement methods indirectly has a significant positive effect on business processes through human resources management. Strategy/improvement methods have an indirect effect on business outcomes through business processes.

IKC has a direct significant effect on strategy/improvement methods; however IKC does not have a direct effect on business processes. A strong IKC program indirectly supports good human resources management through good strategy/improvement

methods and indirectly supports good business processes through good strategy/improvement methods followed by good human resources management. Additionally a robust IKC program indirectly supports good business outcomes through good strategy/improvement methods followed by good human resources management and good business processes.

Human resources management does not have a direct effect on business processes. Partnering focus has a direct effect on strategy in the QMAF model with IKC. Quality culture does have an indirect effect on business processes through partnering focus followed by strategy/improvement methods and human resources management; business outcomes through human resources management followed by business processes; and business outcomes through partnering focus followed by strategy/improvement methods, human resources management and business processes. Partnering focus does indirectly have a significant positive effect on human resources management through strategy/improvement methods; business processes through strategy/improvement methods followed by human resources management and business outcomes through strategy/improvement methods followed by human resources management and business processes.

Strategy/improvement methods do have a significant indirect effect on business outcomes through human resources management followed by business processes in the QMAF model with IKC. The path analysis also established that human resources management has a significant positive effect on business outcomes indirectly through business processes.

[Insert Tables 2-4 here]

### ***Analysis of the QMAF model without IKC***

The Structural Path estimates, the t-Statistics for all direct effects in the QMAF model without IKC are outlined in Table 6. The standardized path coefficients of the QMAF model without IKC for the set of causal relationships are presented in Figure 3. Table 7 outlines the direct, indirect and total effects of the constructs that were calculated for the model without IKC.

[Insert Figure 3 here]

The direct effects were found to be very significant in the QMAF model without IKC, except in the case of human resources management does not have a direct effect on business processes. Therefore Leadership has a significant direct effect on strategy/improvement methods. The significant path coefficient supports Strategy/improvement methods having a significant direct effect on human resources management. Similarly the significant path coefficient validates business processes having a direct effect on business outcomes. Quality culture has a direct effect on strategy/improvement methods, partnering focus and human resources management. The significant supporting path coefficients confirm that strategy/improvement methods have direct effect on business processes. Partnering focus has a direct effect on strategy/improvement methods, this was affirmed by significant path coefficient.

The following indirect effects were also found to be significant i.e. Quality culture has an indirect effect on strategy/improvement methods, human resources management, business processes and business outcomes; Leadership has an indirect effect on human resources management through strategy/improvement methods; Leadership also has an indirect effect on business processes and business outcomes. Significant path coefficients support partnering focus having an indirect effect on human resources management, business processes and business outcomes; Strategy/improvement methods have an indirect effect on business processes and business outcomes; strategy/improvement methods have an indirect effect on business outcomes and human resources management have an indirect effect on business outcomes

[Insert Tables 5-7 here]

### ***Analysis of the QMAF with IKC - Relationship with other QMAF categories***

[Insert Figure 4 here]

Figure 4 depicts the path diagram of the QMAF with IKC having a one to one relationship with the other QMAF categories. Table 8 summarizes the direct effects and  $R^2$  when IKC is considered to have a one to one relationship with the other QMAF categories. Simple linear regression was used to determine these direct effects. The direct effects were very significant with  $p=0.000$ . The significant path coefficients indicate that strong IKC program directly supports good strategy/improvement methods, business processes, leadership, quality culture, human resources management, partnering focus, and business outcomes respectively.

[Insert Table 8 here]

## **Discussion and Conclusions**

The causal relationships of the exogenous constructs (Leadership (L), Quality Culture (QC) and Information/Knowledge/Communication (IKC)) and the endogenous constructs (Human Resources Management (HRM), Partnering Focus (PF), Strategy/Improvement Methods (SIM) and Business Processes (BP)) on optimum Business Outcomes (BO) have been demonstrated by direct and indirect effects (relationships) and have shown in Figures 2 to 4. For example, indirect effect of IKC on BO can be represented by combination of direct effects of other paths between IKC and BO and is evaluated to be 0.283 (Table 4). These relationships have led to the development of important guidelines for managers involved in the planning and management of quality. The recursive path analysis of SEM has supported the QMAF model in Figure 1.

The research findings provide empirical evidence in answering the research questions (RQ1-RQ5). The QMAF criteria represent leadership, quality culture and information/knowledge and communication as the core drivers that influence all other elements of quality management. These results are similar to the findings of previous research which studied quality – performance relationships. Pannirselvam and Ferguson (2001) in their study of the relationships between the Baldrige categories using SEM path analysis confirmed the validity of the MBQNA framework. Additionally their results ascertain that

leadership significantly directly and indirectly impacts human resources management, product and process management, customer focus and relationship management, business results and customer satisfaction, except for strategic quality planning and information management as it was not tested in the model. Panirselvam and Ferguson have determined that human resources management has a significant indirect influence on an organization's performance through product and process management and customer focus and relationship management efforts. Their research also established that information management is vital to effectively plan and to also execute those plans. The customer focus construct in Pannirselvam and Ferguson's model had the most significant impact on business and customer satisfaction results.

Flynn et al., (1995) used (SEM) path analysis to study a quality framework which focused on both core quality management practices and on the infrastructure that creates an environment supporting their use. Flynn et al., (1995) determined that top management support has a significant effect on human resources management. Flynn also established that perceived quality market outcomes were chiefly related to statistical control/feedback and the product design process. Furthermore, Flynn also determined that the percent of product that passed final inspection without needing rework was strongly related to process flow management and to a lesser extent to statistical control/feedback. Adam et al., (1997) used factor analysis on their survey data - their results suggest that an organization's approach to quality has a stronger association with actual quality and a lesser extent to financial performance. They further determined that the major factors found to impact actual quality were the organization's knowledge of quality management, the extent of customer focus and management participation. Winn and Cameron's (1998) model, based on exploratory factor analysis, also concluded that the main effect of leadership was on the system dimensions, not on the outcome dimensions.

Therefore, validating the model provides useful guidelines to managers in deciding which pathways to choose in order to devote resources towards achieving business outcomes. Leadership has shown to have a direct impact on strategy /improvement methods and significant indirect effects on human resources management, business processes and business outcomes. Quality culture has demonstrated to have a strong influence on strategy/ improvement methods, partnering focus (customers and suppliers) and indirect effects on strategy/improvement methods, human resources management, business processes and business outcomes. Information/knowledge/communication has shown to have direct influence on all the constructs, namely leadership, quality culture, partnering focus, strategy/improvement methods, human resources management, business processes and business outcomes. Significant indirect effects of IKC were also noted on human resources management, business processes and business outcomes. Indirect effects of strategy/improvement methods on business outcomes through business processes have also been inferred.

The results of the analysis of the QMAF model without considering ICT affirm the importance of the pathways towards meeting business outcomes with the traditional TQM constructs, namely leadership, quality culture, strategy/improvement methods, partnering focus, human resources management, and business processes. This is reinforced by the increased strengths of the path coefficients and the significance with in the (SEM) path analysis most direct effects except human resources management



on business processes and indirect when IKC is not considered in the analysis. This is a further assertion of the vitality of traditional TQM constructs in the QMAF.

Leadership has shown to have a direct impact on strategy/improvement methods and significant indirect effects on human resources management, business processes and business outcomes. Quality culture has demonstrated to have a strong influence on improvement methods, partnering focus (customers and suppliers) and indirect effects on strategy/improvement methods, human resources management, business processes and business outcomes. The impact of good strategy/improvement methods on business processes and business outcomes has been validated through indirect effects. Similar links have been inferred by indirect effects of strategy/improvement methods and human resources management on business outcomes through business processes.

These findings do not in any way diminish the role that ICT plays in delivering optimum business outcomes. Instead it clarifies that fundamental traditional TQM principles must be a precursor to effectively utilize ICT as an enabler in delivering excellent business outcomes.

The one to one direct effect of IKC on the other elements of the QMAF model provides a more holistic picture of the important role ICT plays in obtaining optimum business outcomes.

### **Guidelines for Managers**

The analysis has demonstrated direct and indirect relationships between the categories of the QMAF model with pathways to achieving optimum business outcomes. The interplay with ICT and its strong significance as an enabler has also been established through the analysis. Based on a comprehensive literature review, guidelines for managers were developed and a sample of those guidelines is presented below.

#### Leadership (L)

- The organization's senior managers must communicate effectively values that their organization stands for; short and long term directions of the organization; expectations related to organizational and individual performance. The manager's must be able to translate performance review into priorities for improvement and innovation.
- The orientation of the organization must shift from managing functions to managing key business processes.
- Management in the company must understand that creating a total quality organization requires a well-trained and empowered workforce.

#### Quality Culture (QC)

- Employees individually and collectively must accept responsibility for quality.
- Teams must have the following objectives setup namely achieve specified quality standards; share work within the team on an equitable and efficient basis; work effectively with other team members; apply the next customer concept; reach production targets; perform routine maintenance; improve work area layout; look for improvement possibilities continuously.

#### Partnering Focus (PF)

- Customer needs must be determined by the following means telephone surveys, feedback from sales personnel, formal customer surveys, focus groups, competitor analysis, data mining approaches.
- Research must be conducted to project future customers and predict what their key requirements are likely to be.
- The organization must have systems which identify customer's current needs, future needs, level of satisfaction and customer's loyalty.
- The organization must be willing to share strategic information with selected suppliers.
- The organization must select suppliers based on formal evaluations and assessments.
- The organization must believe that the strategic direction, role and performance of their supply chain partners are critical to achieving success.
- The organization must facilitate a strong supply network fostering cooperation with entire chain of primary and secondary suppliers. The organization must facilitate a strong supply network fostering cooperation with entire chain of primary and secondary suppliers.

#### Human Resources Management (HRM)

- Training needs require to be identified based on: performance appraisals, business requirements and staff profiles.
- Organizations must have processes in place to foster the following in employee involvement: educating, enabling and encouraging.
- The organization must implement a number of innovative approaches to job and work design such as self-directed teams throughout all areas of the organization.
- The organization must implement a reliable performance assessment system that is linked to a reward system.
- The organization must utilize cross-functional work teams for managing day-to-day operations. The organization must link significant portion of employee performance to productivity.

#### Strategy (S)/ Improvement Methods (IM)

- The strategic planning process must address the objectives and challenges related to the following: customer and market needs/ expectations/ opportunities; competitive environment and capabilities relative to competitors; technological and other changes that might affect product/ services/ operations; strengths and weaknesses, including human and other resources; supplier/ partner strengths and weaknesses; financial societal, and other potential risks and environmental issues.
- The organization must have well established procedures to develop and deploy action plans, based on the strategic plan, to achieve key objectives.
- Benchmarks must align with the organization's strategic plans, ensure the quality of data for performance measurement is high; analysis of benchmarks must be used to determine the current competitive gap; project future performance levels; establish functional goals; implement specific actions and monitor progress; factors critical for improved performances must be identified post-analysis of benchmarks; findings of analysis must be communicated to the relevant people to plan and implement change.
- Organizations must effectively apply total quality tools. The TQ tools to be considered are flowcharts, cause and effect diagrams, multi voting, affinity diagrams, process action teams, election grids, task lists, Deming cycle (PDCA), sampling techniques, scatter diagrams, Pareto charts, run charts, control charts,

histograms, process mapping tools, FMEA (Failure Mode and Effect Analysis), QFD (Quality Function Development), Creativity tools/ Idea generation tools, display/ visualization tools, standardization tools, 5S and Taguchi methodology of experimental design.

- Continuous improvement (CI) processes must be strengthened through training of personnel, monitoring of CI process, top management support for CI programs, CI project leaders, suggestion scheme, application of PDCA, promotions through notice boards, internal media, face to face communication; use of ISO 9000, total productive maintenance regimes, formal policy deployment protocols and time studies

#### Business Processes (BP)

- Organizations require to demonstrate substantially reduced facility and operational complexity over time.
- The organization's logistical capability must be significantly more responsive (pull) as compared to predetermined (push) over time.
- The organization must actively be involved in initiatives to standardise supply chain practices and operations

#### Information, Knowledge, Communication (IKC)

Organizations can improve their Information, Knowledge and Communication systems by:

- using IT to manage its reporting systems, data collection and analysis of data and decision making process;
- ensuring logistics operating and planning databases are integrated across applications within the organization;
- ensuring the organization maintains an integrated database and access method to facilitate information sharing;
- ensuring that the organization has increased the use of integrated inventory, transportation and warehousing planning systems and EDI standards;
- ensuring the organization effectively shares operational information between departments;

#### Business Outcomes (BO)

- The organization must use 'balanced scorecard' approach to measurement.
- All key business decisions and plans must be based upon an analysis of performance data.
- The implementation of change based on gaps identified through benchmarking must lead to improvement in performance levels.

Therefore, Managers can further enhance their quality systems by developing and deploying their business strategies using these guidelines.

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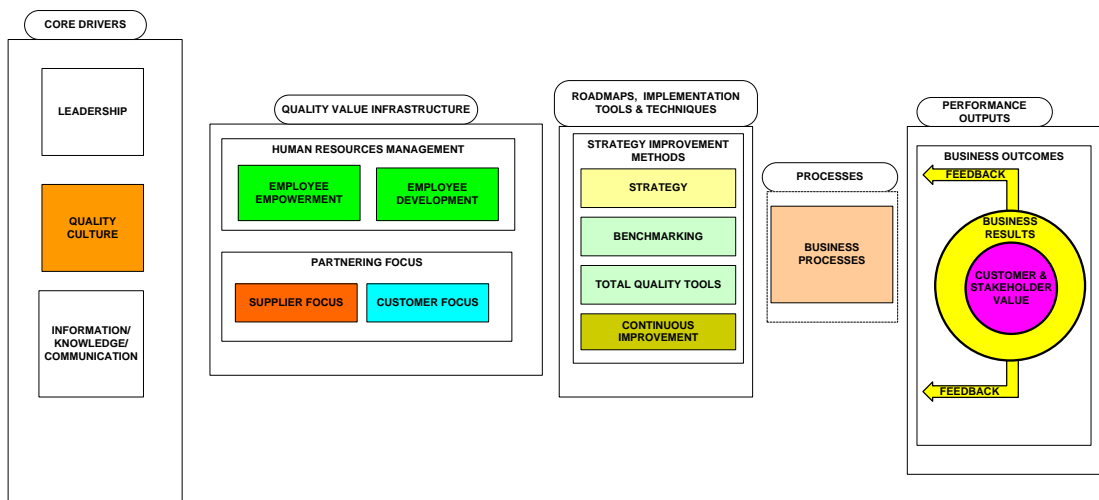


Figure 1: The Quality Management Assessment Framework (QMAF).



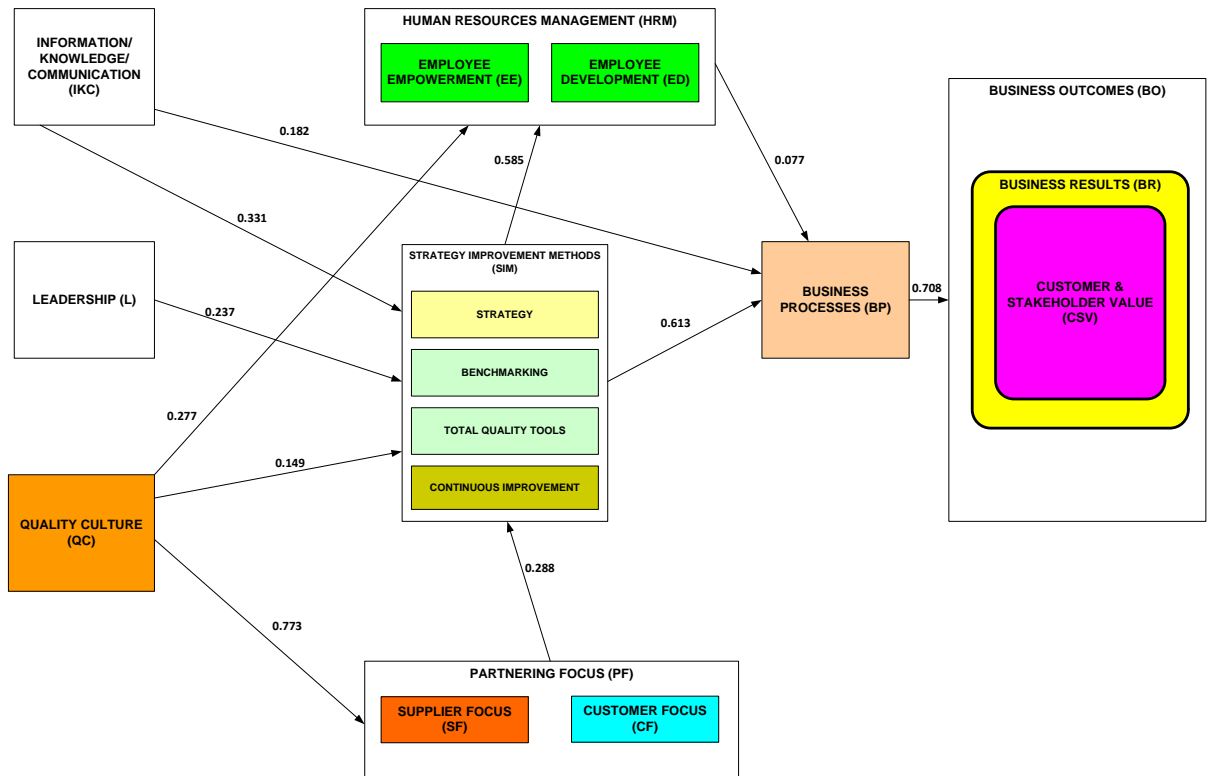


Figure 2: Path diagram of the QMAF when IKC is considered and included in the model

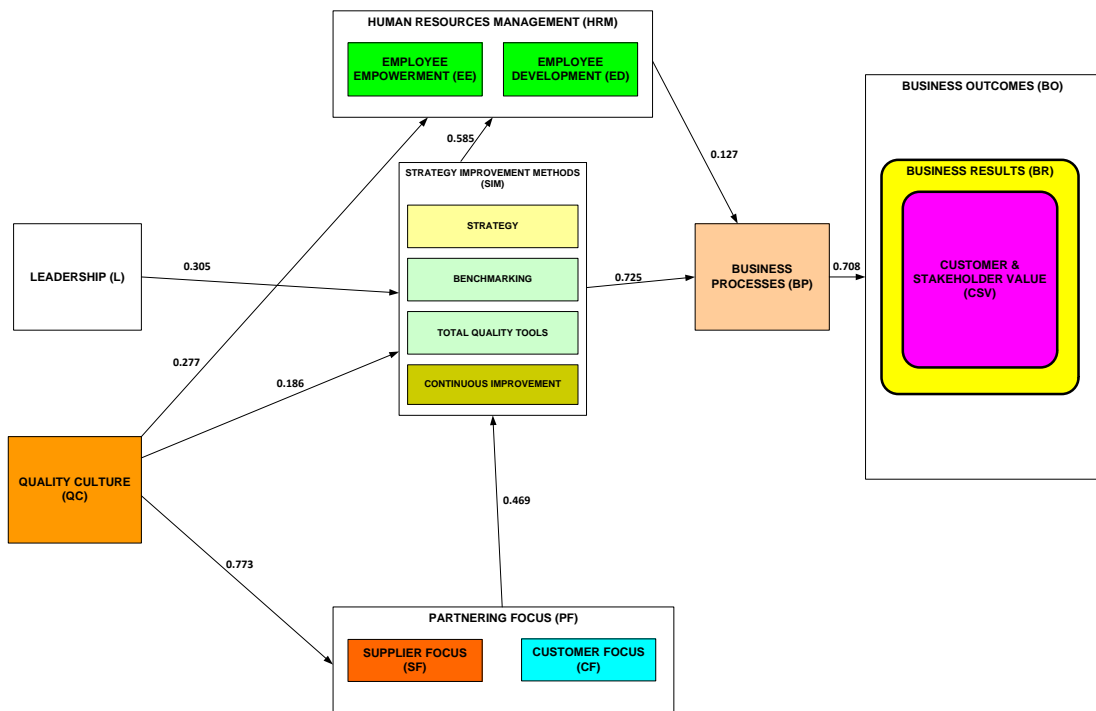


Figure 3: Path diagram of the QMAF without considering IKC

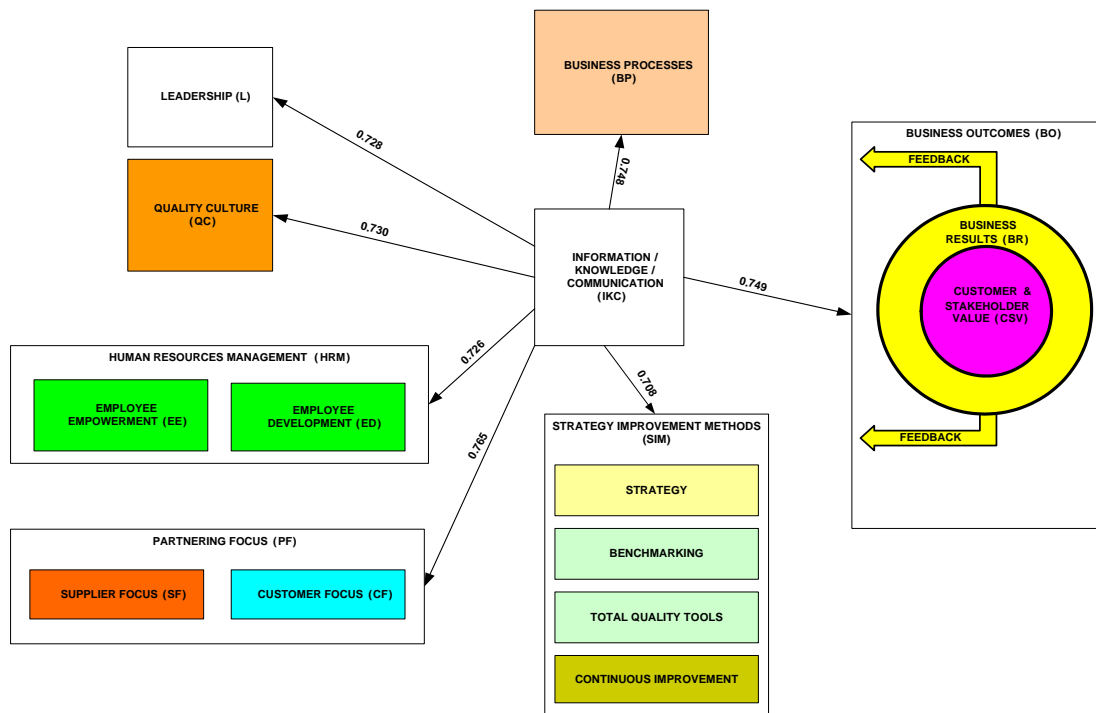


Figure 4: Path diagram of the QMAF with IKC - Relationships with other categories

**Table 1: Respondent's organization characteristics**

Size of Organization	Total Population	Sample Drawn in each of the four lists		Total Response Received
		No.	% of Total Population	
Large	126	30	2.43%	20
Medium	613	149	12.06%	33
Small	497	121	9.79%	20
Total	1236	300	24.27%	73

**Table 2: Assessment of the QMAF Model with IKC**

Category	R Square (R <sup>2</sup> )
BO	0.5008
BP	0.6977
HRM	0.6694
IKC	0.0000
SIM	0.8245
L	0.0000
PF	0.5976
QC	0.0000
Goodness of Fit (GoF) =0.64	

**Table 3: Structural Path Estimates of the QMAF with IKC**

Independent Variable	Dependent Variable	Direct Effects	p-Values
BP	BO	0.708	0.000*
HRM	BP	0.077	0.572
IKC	BP	0.182	0.183
IKC	SIM	0.331	0.000*
SIM	BP	0.613	0.000*
SIM	HRM	0.585	0.000*
L	SIM	0.237	0.013**
PF	SIM	0.288	0.007*
QC	HRM	0.277	0.015**
QC	SIM	0.149	0.102***
QC	PF	0.773	0.000*

\*p<0.001; \*\*p<0.05; p<0.1\*\*\*

**Table 4: Direct, indirect and total effects of the QMAF when IKC is considered/included.**

Path	Direct Effect	Indirect Effect	Total Effect
Leadership-strategy/improvement methods	0.237		0.237
Strategy/improvement methods-human resources management	0.585		0.585
Human resources management-business processes	0.077		0.077
Business processes-business outcomes	0.708		0.708
Quality culture- strategy/improvement methods	0.149	0.521	0.670
Strategy/improvement methods- business processes	0.613	1.271	1.884
Quality culture- partnering focus	0.773	1.546	2.319
Partnering focus- strategy/improvement methods	0.288		0.288
Quality culture- human resources management	0.277	0.773	1.050
Quality culture –business processes		0.266	0.266
Quality culture - business outcomes		0.189	0.189
Leadership - human resources management		0.138	0.138
Leadership-business processes		0.156	0.156
Leadership –business outcomes		0.110	0.110
Partnering focus - human resources management		0.169	0.169
Partnering focus – business processes		0.190	0.190
Partnering focus - business outcomes		0.134	0.134
Strategy/improvement methods –business outcomes		0.466	0.466
Human resources management – business outcomes		0.055	0.055
IKC – strategy/improvement methods	0.331		0.331
IKC - business processes	0.182		0.182

IKC-business outcomes		0.283	0.283
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**Table 5: Assessment of the QMAF model without considering IKC**

Category	R Square (R <sup>2</sup> )
BO	0.5008
BP	0.6881
HRM	0.6694
SIM	0.7865
L	0.0000
PF	0.5976
QC	0.0000
Goodness of Fit (GoF) =0.68	

**Table 6: Structural Path Estimates of the QMAF without considering IKC**

Independent Variable	Dependent Variable	Direct Effects	p-Values
BP	BO	0.708	0.000*
HRM	BP	0.127	0.286
SIM	BP	0.725	0.000*
SIM	HRM	0.585	0.000*
L	SIM	0.305	0.002*
PF	SIM	0.469	0.000*
QC	HRM	0.277	0.019**
QC	SIM	0.186	0.048**
QC	PF	0.773	0.000*

\*p<0.001; \*\*p<0.05;

**Table 7: Direct, indirect and total effects of the QMAF without considering IKC**

Path	Direct Effect	Indirect Effect	Total Effect
Leadership-strategy/ improvement methods	0.305		0.305
Strategy/improvement methods-human resources management	0.585		0.585
Human resources management-business processes	0.127		0.127
Business processes-business outcomes	0.708		0.708
Quality culture- strategy/improvement methods	0.186	0.734	0.920
Strategy/improvement methods- business processes	0.725		0.725
Quality culture- partnering focus	0.773		0.773
Partnering focus- strategy/improvement methods	0.469		0.469
Quality culture- human resources management	0.277	0.876	1.153

Path	Direct Effect	Indirect Effect	Total Effect
Quality culture –business processes		0.473	0.473
Quality culture - business outcomes		0.335	0.335
Leadership - human resources management		0.178	0.178
Leadership-business processes		0.244	0.244
Leadership –business outcomes		0.172	0.172
Partnering focus - human resources management		0.274	0.274
Partnering focus – business processes		0.375	0.375
Partnering focus - business outcomes		0.265	0.265
Strategy/improvement methods - business processes		1.523	1.523
Strategy/improvement methods - business outcomes		0.565	0.565
Human resources management – business outcomes		0.090	0.090

**Table 8: Direct effects of the QMAF with IKC - Relationships with other QMAF categories**

Path	Direct effect ( $\beta$ coefficient)	p-Value	R <sup>2</sup>
IKC - strategy/improvement methods	0.708**	0.000*	0.683
IKC - business processes	0.748**	0.000*	0.555
IKC - leadership.	0.728**	0.000*	0.496
IKC - quality culture.	0.730**	0.000*	0.460
IKC - human resources management.	0.726**	0.000*	0.573
IKC - partnering focus.	0.765**	0.000*	0.620
IKC - business outcomes.	0.749**	0.000*	0.554

\*p<0.001