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The Role of Information Technology Capability and Innovative Capability: An Empirical Analysis of Knowledge Management in Healthcare

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[Abstract] The majority of existing research studies of long-term care sectors has focused on reducing deficiencies and improving quality. The objective of this current study is to investigate how information technology capability affects innovative capability and knowledge management in the long-term healthcare sector. Our findings indicate that IT and innovative capabilities are associated with facilities’ knowledge management capability in the U.S. long-term care sector. Hence, the success of healthcare depends critically on the utilization of information technology capability and innovative capability to collect, analyze, and exchange knowledge within and across organizational boundaries.

[Keywords] Information technology capability, innovative capability, knowledge management, healthcare, healthcare information technology

Introduction

Strategic management of organizations depends on the development of distinctive competencies to improve performance over competing organizations and to serve customers. The ability to improve operations across all functions creates competency that leads to long-term survival and success. Information technology (IT) capabilities reflect the ability to support all parts of the organization while improving connectedness to the supply chain. Research seeks to determine the improvements that technology brings to various organizations. Melville et al. (2004) suggested that a broader approach was needed to conceptualize the value of IT in improving business efficiency and effectiveness. Notably, the value that IT adds to businesses continues to be the focus of upper-level managers within organizations. A broad list of approaches has specified the processes by which value is added to businesses via IT and the impact of this value on organizations. These approaches include the contributions of IT to organizational performance (Luftman et al., 2017), to internal managerial practices (Dalkir & Beaulieu, 2017), to competitive pressure (Oyemomi et al., 2016), and to supplier and customer collaboration (Liu et al., 2016).

Recently, the federal government, insurers, and employers have increased pressure for healthcare providers to be more efficient and effective in their operations. These cost pressures have led to strong competition among the various providers. Administrators and providers are looking to information technology to assist in providing better care at lower costs. New information technologies allowed healthcare providers to search for ways to improve the quality of care and operational efficiency (Bose, 2003). Thus, increased efficiency has allowed decision makers to reduce insurance premiums while finding the best utilization of resources for patient care. As service organizations, healthcare entities utilize health information technology (HIT) to improve both the quality and efficiency of decision making (Chaudhry et al., 2006). The exponential growth of available data and rapid changes in healthcare technology offer
substantial opportunities in IT. To ensure that the organization purchases the information technology which fosters the best overall value, a sustainable strategy is needed to match the organization’s needs to the IT system’s capabilities, along with a plan to maintain evaluation of the IT capability (Leung, 2012).

Therefore, top management is responsible for altering the norms and culture as a means of encouraging and influencing members to adapt to innovative technology (Chen & Prater, 2014). Earlier, García Morales and Lloréns Montes (2006) studied organizational innovation which revealed that innovative firms not only respond to the environment but also create it. Such innovative behavior is achieved by taking a proactive attitude of bringing together teams of innovative members while building on the firm’s innovative capability. The concept of firm innovativeness refers to cooperation within the firm’s environment to promote and support novel ideas. When organizations practice an innovation-based strategy to obtain specific capabilities, such behavior distinguishes these firms from their competitors via timely, appropriate reactions to variability in the environment. Therefore, innovative capabilities often lead an organization to increase performance (Ferraris et al., 2017).

The sum of the knowledge available within an organization should develop competency through IT capability and innovative capability. The integrated nature of the entire knowledge management capabilities may impact organizational performance. In fact, knowledge management capability is associated with knowledge acquisition, knowledge conversion, knowledge application, and knowledge protection (Gold et al., 2001). Typically, firms seeking to enhance their overall capabilities should first decide on necessary applications, then move to decisions about infrastructure and other required processes in support of the specific application (e.g., how knowledge will be acquired, converted and protected). Focusing on individual knowledge processes provides a more fundamental understanding of a firm’s knowledge management capability while enhancing management decision-making at the resource level (Mills & Smith, 2011). Thus, HIT cannot function well as an independent entity. Rather, it is a collaboration among physicians, nurses, administrators, and other staff members using their complementary skills to determine whether HIT can be successfully adopted by a group of healthcare organizations. For health administrators, fostering a collaborative culture among staff members is essential when adopting HIT (Leung, 2012). As such, the involvement of each stakeholder is essential for the HIT to develop its full potential, and to encourage the maximum contribution of the competitive posture of the organization.

Most of the previous research studies of long-term care sectors has focused on reducing deficiencies and improving quality (Chesteen et al., 2005). This current study provides a different view of the innovative aspect of implementing information technology in the long-term care setting. The environment of nursing home care has been defined as “low-tech” and high personal contact (Lenard & Shimshak, 2009). Therefore, assessing how nursing facilities increase their investment and implementation of information technology across facilities will be a major challenge. The objective of this current study is to investigate how information technology capability affects innovative capability and knowledge management in the long-term healthcare sector. The US healthcare industry is increasingly becoming an integrated, knowledge-based community connecting hospitals, clinics, pharmacies, insurance, and customers for sharing knowledge, reducing administrative costs and improving the quality of care. Based on the strategic objectives of an organization, knowledge management should identify, capture, structure, and share information to help nursing facilities offer better service, thereby enabling the organization to achieve competitive advantages. Hence, the success of healthcare depends critically on the utilization of information
technology capability and innovative capability to collect, analyze, and exchange knowledge within and across organizational boundaries.

**Literature Review and Hypotheses**

Figure 1 provides the research model for this present study. The literature review and research hypotheses for our current study include an evaluation of the theory based on causal relationships among IT capability, Innovative capability, along with Knowledge management in both Information & data as well as Analysis & usage.

![Figure 1. Research framework](image)

**Information Technology Capability**

Information technology capability was derived from a resource-based perspective; however, the resource-based view involves a very broad view of assets, knowledge, capabilities, and organizational processes into tangible, intangible, and personnel-based resources (Grant, 1991). Information technology capability is defined as the “ability to mobilize and deploy IT-based resources in combination or co-present with other resource and capabilities” (Bharadwaj, 2000, p. 171). Thus, IT capability can be classified into physical IT infrastructure; human IT in technical and managerial skills; and intangible IT in knowledge assets (Grant, 1991, Mill and Smith, 2011). Moreover, Lu and Ramamurthy (2011) conceptualized three different dimensions of IT capabilities: (1) IT infrastructure capability, (2) IT business spanning capability, and (3) IT proactive stance. Firstly, IT infrastructure capability is the firm’s ability to share and manage data, services, network, and applications. Second, IT business spanning capability is the firm’s ability to maintain and advance business objectives by foreseeing and exploiting IT resources. Thirdly, an IT proactive stance is the firm’s ability to develop IT innovation and seek new opportunities to enhance IT effectiveness. Lu and Ramamurthy further stated that IT capability provided a joint effect on spending resources regarding agility in operational adjustments. In other words, more IT spending or investing in operational agility tends to enhance and foster IT capabilities.
A firm’s technology may seem like a simple “make versus buy” decision; however, at a deeper level, sourcing activities reveal its preference for combining internal and external sources of new and existing knowledge. When aggregating each technology sourcing decision up to the firm level, however, upper management must decide on how to balance internal and external technology sourcing simultaneously. The critical issue lies within the managers’ decisions regarding the preferred focus on internal versus external technology sourcing, and how this balance is dynamically adjusted considering changing conditions and the resources and capabilities available during a particular time frame. The capacity to do so is captured by our understanding of ambidexterity as a firm’s ability to simultaneously balance different activities in a trade-off situation (Rothaermel & Alexandre, 2009).

Many studies have shown that IT investments have significantly improved the productivity and quality (Chen and Prater, 2013; Sher and Lee, 2004). Moreover, several studies have investigated the case for IT and quality. In fact, one major outcome of HIT on the quality of care arises in increasing observance of guidelines or protocol-based care (Chaudhry et al., 2006). Specifically, the nursing home industry reports Medicare and Medicaid financial information and quality indicators to speed up the reimbursement processes. When environmental changes are more predictable, firms tend to devote resources to technology internally. In an earlier study, Devaraj and Kohli (2000) noted that investing in technology for business process re-engineering supports the long-term performance of hospitals. Such re-engineering efforts may relate to all aspects of the organization, including human resources and patient quality improvements. Furthermore, Chaudhry et al., (2006) confirm that higher investment in technology compared to similar location and size of other competitors will improve the facilities’ performance. Conversely, Lu and Ramamurthy (2011) argue that investment in IT may hinder organizational performance and that IT capability requires support to avoid such negative effects. They maintain that significant investment in IT might not necessarily improve agility especially when such investments are not focused on fostering and increasing IT capability. However, they noted that wise IT investment successfully improves and strengthens critical IT capabilities.

Innovative Capability

The innovative capability is defined as the ability of the firm to develop new products and markets, through aligning an innovative strategic orientation with innovative behaviors and processes (Wang and Ahmed, 2007). The concept of innovative capability is multidimensional; specifically, these dimensions have been studied by numerous researchers regarding new products or services (Daneels, 2002), planning strategic marketing technology (Capon et al., 1992), and enhancing R&D of pharmaceutical firms (E’Este, 2002). Other studies (e.g., Delmas 1999; Lazonick & Prencipe 2005) also reveal that in several industries, the innovative capability is a critical factor in the firms’ evolution and survival considering external competition and change. Thus, the more innovative a firm is, the more it possesses dynamic capabilities.

As in many matters of management practice, Drucker (1954) was one of the first to call for research into the importance of innovation. The concept of innovation involves the degree to which an individual (in a social system) adopts something new (Calantone et al., 2002). While this focuses on an individual, Hurley and Hult (1998) discussed the organizational perspective of openness to new ideas as an aspect of a firm’s culture. The concept of firm innovativeness includes two areas: 1) the rate of adoption of innovation by the firm, and 2) the firm’s willingness to change. The standard classification of innovation delineates between
incremental versus radical paths (Dewar & Subramaniam & Youndt, 2005). Incremental innovation is a continuous path of improving and refining the firm’s existing products, services or technologies. Conversely, radical innovation represents a non-continuous path involving the major transformation of current products, services or technologies.

Changes in technology within product and service innovation was first studied by Comanor (1965) in the pharmaceutical industry to determine the effect of a firm’s long-term financial performance. Organizations implement useful ideas to create innovative capabilities; furthermore, firms often acquire innovation through adaptation of products or processes via external organizations. Government regulation or intervention in markets may act as an enhancer (e.g., patents for chemicals and pharmaceutical industries), or as an inhibitor of innovation in protected markets (Holloman, 1979). As a method of supporting higher long-run performance, Teece (2007) noted that invention, innovation, and manufacturing capability could enhance enterprise performance and encourage higher profits. The sourcing of technology related to organizational and technological boundaries involve two important delineations (Rothaermel & Alexandre, 2009). These delineations are (1) sourcing of known versus new technology, and (2) internal versus external sources of technology. Typically, the information technology capability within the firm assists the organization to become more innovative. Thus, we propose:

Hypothesis 1: Information technology capability is related to innovative capability.

**Knowledge Management Capability**

A model of knowledge management has been proposed by Gold et al. (2001). Gold et al. theorized knowledge management capabilities as multidimensional concepts that incorporate a process perspective focused on a set of activities. Knowledge process capabilities and an infrastructure perspective should focus on enablers (i.e., knowledge infrastructure capabilities). These, in turn, are composed of multiple dimensions: knowledge infrastructural capability comprises technology, organizational culture, and structure while knowledge process capability is made up of knowledge acquisition, knowledge conversion, knowledge application, and knowledge protection (Mills & Smith, 2011). In an earlier study, Jensen and Meckling (1995) defined specific knowledge as knowledge that is expensive to transfer among agents, whereas general knowledge is inexpensive to convey. Due to its high transfer costs, obtaining specific knowledge for decision-making involves decentralizing many decision rights. Such allocation, in turn, creates two issues: the rights assignment issue (determining who should exercise a decision right), and the control or agency issue (how to confirm that self-interested decision agents implement their rights in a way that contributes to the organizational goal).

The main distinction between information management and knowledge management is that the content of each is different; specifically, knowledge management is less structured and utilizes informal problem-solving expertise and experience rather than being limited to automated processing and data manipulation as seen in information management (Bose, 2003). Development of knowledge management includes (1) careful identification of the target user community and its needs, (2) meta information that defines the types of information to be included and how they will be categorized and summarized, and (3) administrative tools providing quality control and high availability. The commonly used terms of information and knowledge build on each other conceptually. In general, accumulation of transactional data into a
meaningful context produces information. Next, moving this information to a higher level is characterized by knowledge. Knowledge is gained through managing information effectively and efficiently through proper cataloging and structuring the data. Finally, the highest level of knowledge is gained by processing the information on a timely basis and giving access to the right decision makers (Bose, 2002).

The technology component of knowledge infrastructure is the information technology (IT) system that encourages the integration of information and knowledge in the firm, as well as the creation, transfer, storage, and security of the knowledge resources. Nevertheless, the links between information technologies and measures of organizational performance have not been found in research. The research efforts have not demonstrated whether IT is directly related to performance (Powell & Dent-Micallef, 1997); IT alone does not improve organizational performance, but once IT is combined with human and business assets, organizational performance was enhanced. Teece (2007) noted that an absence of an association between technology and performance could be due to the technology being copied by other firms, making it a short-lived competitive advantage. Although technology infrastructure is not directly related to organizational performance, it enables other knowledge resources (e.g., knowledge acquisition and knowledge application processes) to enhance organizational performance (Mills & Smith, 2011). The infrastructure of a well-designed knowledge management system facilitates creation and management of e-business knowledge that improves back-office efficiency, provides greater customer intimacy, and encourages flexible adaptation to market changes. Specifically, the volatility of the current healthcare environment forces health organizations to invest in knowledge management and establish processes and infrastructure necessary to create and manage e-health knowledge (Bose, 2002). Therefore, we propose:

Hypothesis 2: Information technology capability is related to knowledge management of information and data.

Big data may help with some of the required knowledge dissemination. As an example, physicians struggle to treat a reasonable number of patients and remain current with the latest and best evidence to guide their clinical practice. Digitization of medical literature improves access, but the sheer number of studies and their inherent differences regarding findings makes it difficult to apply the research into practice. Even if clinicians obtained all the relevant evidence and guidelines, sorting through that information is time-consuming (Leung, 2012). Certainly, treating a patient with multiple illnesses is even more complicated. The big data approach differs from traditional decision support tools in that suggestions are drawn from real-time patient data analysis, rather than solely using rule-based decision trees. For example, longitudinal diagnostic data have been shown to predict a patient’s risk of a future diagnosis of domestic abuse (Murdoch & Detsky, 2013). Moreover, data-driven analysis with clinical decision support tools could also lead to cost savings and help with appropriate standardization of care. Hence, we propose:

Hypothesis 3: Information technology capability is related to knowledge management in analysis and usage.

Organizations create value by applying knowledge of their products and services by different means. Similarly, Mill and Smith (2011, pp. 160) stated that: “knowledge application means making knowledge more active and relevant for the firm in creating value.” Knowledge creation can be accomplished by
repackaging available knowledge, training and encouraging employees to think creatively. Furthermore, employees must demonstrate an understanding of the processes, products, and services offered by the facility. Ideally, organizations support organizational learning among groups or individuals as a way of developing knowledge in new product ideas, thereby leading to improved speed to market and innovation (Daneels, 2002). Mill and Smith stated that knowledge management capabilities had been found to affect innovation and organizational effectiveness. For example, a firm’s knowledge boundary determines the general direction of the innovative process. The main consideration is whether to use incremental innovation currently within the firm or to seek radical new technology. Although the incremental approach uses existing technology, the methods or materials used can still show discernable improvements. In fact, the pharmaceutical industry’s attempts to incorporate biotechnology, a radical process innovation, into their methods of drug discovery and development serve as a good example (Rothaermel & Alexandre, 2009).

Institutionalization of the firm’s capability to preserve knowledge and the mechanisms to maintain this status quo are visible in its organizational capital. Organizational capital is exemplified by manuals, databases, patents, and licenses to solidify and preserve the knowledge bases with structures, processes, and routines that encourage repeated use of the knowledge (Subramaniam & Youndt, 2005). Moreover, when healthcare becomes more innovative by implementing its healthcare information system as a collection of firm’s information and data, the healthcare provider can potentially become a driving force in system-wide reconfiguration by encouraging reformulation of policies, reorganization of staff, etc. Through applying the data and information from the HIT, administrators may apply the knowledge to improve organizational routines and practices (Leung, 2012). Based on the organizational capital of information and data, it is believed that the firm’s prevailing knowledge reinforces prevailing knowledge and influences its incremental innovative capabilities. As such, we propose:

Hypothesis 4: Innovative capability is related to knowledge management in information and data.

Hypothesis 5: Innovative capability is related to knowledge management in analysis and usage.

Research Methodology

Data Collection and Factor Analysis

All measurement items were obtained from previous test questionnaires; therefore, no newly developed scales were used for this study. The research model and survey items were evaluated and approved by operations management faculty and other management professors. The questionnaires were also examined by seven administrators of skilled nursing facilities to ensure face validity. A few minor changes in wording were done to better align with the healthcare - nursing home sector. 1,500 surveys were sent out via US Mail to the administrators of skilled nursing facilities which receive Medicare and Medicaid reimbursement. Therefore, individual skilled nursing facilities are the unit of analysis for this study; as such, the unit of analysis is at the firm-level. The survey items reflect information technology capability, innovative capability, knowledge management in information and data, and knowledge management in analysis and usage.

We received a total of 264 surveys. Some surveys were excluded from the analysis due to one or more of the following reasons: incorrect mailing address, administrator’s unwillingness to share information, and
missing more than 20% of the survey items. Additionally, we omitted the surveys received from facilities with less than 30 beds due to staffing characteristics with low signal-to-noise ratios which should not be included in the analysis (Castle & Engberg, 2008). A total of 199 valid surveys were received from for-profit SNF administrators, and 44 valid surveys were received from not-for-profit SNFs’ administrators. Thus, 243 valid surveys were included in the final data analysis representing a response rate of approximately 16.2%.

**Non-respondent Bias**

Non-respondent bias was tested by examining the differences in organizational status (for-profit and not-for-profit status), as well as differences in the size of nursing facilities between responding and non-responding facilities. The nursing home ownership characteristic (For-Profit and Not-For-Profit) was applied and results indicated ($\chi^2 = 2.28, d.f. = 2, p = 0.32$) no significant difference between respondents and non-respondents. Moreover, the number of beds was tested with Chi-square test statistic. The output ($\chi^2 = 0.71, d.f. = 2, p = 0.701$) revealed a value that is not significant. Thus, the difference in response rate related to size (i.e., the number of beds) is not significant.

**Validity Measurements**

Cronbach’s coefficient alpha and composite reliability (CR) for four scale constructs were tested for scale reliability. The Cronbach’s alpha (CA) values for information technology capability, innovative capability, knowledge management in information and data, and knowledge management in analysis and usage are 0.833, 0.726, 0.777, and 0.742, respectively. Cronbach’s reliability test is often applied to inspect the fit of multiple items to measure for one underlying construct. The general guideline for Cronbach’s alpha is defined as a minimum of 0.6 in the lower limit for reliability (Nunnally, 1978). Factor analysis was examined to reduce item responses to a score for each of the four construct dimensions. Principle component analysis was applied to summarize the original data into a range of scores. All composite reliability values are between 0.900 and 0.845, indicating acceptable reliability as these values exceed 0.70. Please see Table 1 for Measurement scales and loadings.
Table 1
Measurement scales and loadings

**IT capability**: (AVE=0.749 /CR=0.9 /CA=0.833)

<table>
<thead>
<tr>
<th>Factor Loading</th>
<th>Source: Sher and Lee (2004)</th>
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<tr>
<td>IT is comprehensively constructed in organization</td>
<td>0.868</td>
</tr>
<tr>
<td>Members in organization apply IT to search and use current organizational knowledge</td>
<td>0.867</td>
</tr>
<tr>
<td>IT is comprehensively utilized by members in our organization</td>
<td>0.861</td>
</tr>
</tbody>
</table>

**Innovative capability**: (AVE=0.646 /CR=0.845 /CA=0.726)

| During the past five years, our company has developed much new management approaches | 0.813 |
| We are continually introducing new service offerings | 0.802 |
| We are constantly improving our business processes | 0.795 |

**Knowledge management in Information and Data**: (AVE=0.692 /CR=0.871 /CA=0.777)

| Source: Chesteen et al. (2005) |
| Our information systems are integrated across departments | 0.875 |
| Our information systems are standardized across departments (patient care, accounting, etc.) | 0.811 |
| Our information systems support front line employees | 0.809 |

**Knowledge management in Analysis and Usage**: (AVE=0.794 /CR=0.885 /CA=0.742)

| Source: Chesteen et al. (2005) |
| We use objective data to identify our competitive strengths | 0.902 |
| Organizational planning is based on objective data which we have collected and analyzed | 0.881 |

AVE=average variance extracted, CR=composite reliability, CA=Cronbach alpha

All average variance extracted (AVE) values ranged between 0.794 and 0.646 (at construct level) which is greater than 0.5. This indicates that convergent validity at the indicator and construct levels is verified. The square root of each AVE is tested for discriminant validity and should be greater than 0.7 (Chin, 1998) and exceed the related inter-construct correlations for reflective constructs. All the square roots of AVE are greater than the related inter-construct correlations, ranging from 0.891 to .803. Therefore, discriminant validity is confirmed.

The guidelines for scale measurement in the principal component analysis should be at least 40% to account for the variance proportion of each item (Carmines & Zeller, 1979). In our study, the factor loadings for each item within each construct ranged from 0.902 to 0.795, thereby providing additional evidence of scale reliability. Convergent validity was examined by running the measurement model for four latent constructs with 11 related individual items. The point estimates from individual item loading on the corresponding latent variable ranged from 0.86 to 0.68, with significant t-values greater than 9.034 (Boyer, 2012). Next, estimated model fit values were evaluated. The root means square error of approximation
(RMSEA) is a measure of model fit which does not depend on sample size (Hair et al., 1998) with a value of 0.062 (between 0.05 to 0.1) representing a reasonable model fit (Browne and Mels, 1994) for this present study. Other measurement model statistics are reported in Table 2: Measurement model fit and Structural model fit which includes all the reasonable fits. Specifically, a normed Chi-square value of 1.928 shows that the model adequately represents the data. The comparative fit index (CFI), goodness of fit index (GFI), adjusted goodness-of-fit index (AGFI), incremental fit index (IFI), and standardized root mean square residual (SRMR) are 0.803, 0.945, 0.904, 0.820, and 0.072, respectively.

Table 2
Measurement Model Fit and Structural Model Fit

<table>
<thead>
<tr>
<th>Model fit measure</th>
<th>CFA</th>
<th>SEM</th>
</tr>
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<tbody>
<tr>
<td>Degree of freedom (d.f.)</td>
<td>38.00</td>
<td>39.00</td>
</tr>
<tr>
<td>Chi-square – Test statistic</td>
<td>73.277</td>
<td>73.798</td>
</tr>
<tr>
<td>Normed Chi-square (Chi-square/d.f.)</td>
<td>1.928</td>
<td>1.892</td>
</tr>
<tr>
<td>RMSEA Point Est</td>
<td>0.062</td>
<td>0.061</td>
</tr>
<tr>
<td>Comparative fit index (CFI)</td>
<td>0.803</td>
<td>0.805</td>
</tr>
<tr>
<td>Normed fit index (NFI)</td>
<td>0.687</td>
<td>0.684</td>
</tr>
<tr>
<td>Goodness of fit index (GFI)</td>
<td>0.945</td>
<td>0.945</td>
</tr>
<tr>
<td>Incremental fit index (IFI)</td>
<td>0.820</td>
<td>0.821</td>
</tr>
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Research Results

Structural equation modeling (SEM) analysis was implemented regarding the specified causal model in Figure 1 to test the five proposed causal relationships in the long-term care industry. AMOS was used for data analysis in this present study. The input for the structural equation model estimations was based on scores of a total of four dimensions: information technology capability, innovative capability, knowledge management in information and data, and knowledge management in analysis and usage. Please see Table 2: Measurement model fit and Structural model fit for output results. The chi-square test for overall model fit with four dimensions has a value of 73.798 (p<0.01); moreover, the normed chi-square statistic of 1.892 and RMSEA (0.061) indicate that the model is not overestimated and is a reasonable model. Additionally, the comparative fit index (CFI) of 0.805, the goodness of fit index (GFI) of 0.945, the adjusted goodness-of-fit index (AGFI) of 0.906, the incremental fit index (IFI) of 0.821, and the standardized root mean square residual (SRMR) of 0.073 are reasonable outputs.

In Table 3: Path estimates for the overall structural model, the results of model estimation including path estimates, standard error, and t-tests for the path significance are provided. Hypotheses 1 considered the causal influence of information technology capability on innovative capability. The path estimates for this relationship are as follows: information technology capability to innovative capability ($\hat{\gamma}_{11} = 0.727$, p < 0.01). Thus, a significant positive relationship exists between information technology capability and innovative capability.

Hypotheses 2 and 3 proposed causal relationships of information technology capability on knowledge management in information and data, and knowledge management in analysis and usage. The path estimates for information technology capability’s significant causal relationships are as follows: knowledge
management in information and data ($\gamma_{21} = 0.491, p < 0.01$) and knowledge management in analysis and usage ($\gamma_{31} = 0.398, p < 0.01$). These results indicate a significant positive relationship between information technology capability, as well as knowledge management in information and data, and knowledge management in analysis and usage.

Hypotheses 4 predicted a causal influence of innovative capability on knowledge management in information and data. The path estimates for this relationship are as follows: the innovative capability to knowledge management in information and data ($\beta_{21} = 0.526, p < 0.01$). This indicates a significant positive relationship between innovative capability and knowledge management in information and data. Hypotheses 5 proposed a causal influence of innovative capability on knowledge management in analysis and usage. The path estimates for this relationship are as follows: the innovative capability to knowledge management in analysis and usage ($\beta_{31} = 0.587, p < 0.01$). Hence, a significant positive relationship exists between innovative capability and knowledge management in analysis and usage.

As discussed in the above analysis, significant relationships occurred for all five hypotheses. In sum, our research results offer strong empirical support for each of the five causal relationships evaluated in this study.

Table 3
Path Estimates for Overall Structural Model

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Path</th>
<th>Point estimate</th>
<th>Standard error</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>IT Cap. $\rightarrow$ Inn. Cap.</td>
<td>0.727</td>
<td>0.084</td>
<td>8.66**</td>
</tr>
<tr>
<td>H2</td>
<td>IT Cap. $\rightarrow$ Knowledge Mgmt. in Info.</td>
<td>0.491</td>
<td>0.114</td>
<td>4.30**</td>
</tr>
<tr>
<td>H3</td>
<td>IT Cap. $\rightarrow$ Knowledge Mgmt. in Analysis</td>
<td>0.398</td>
<td>0.123</td>
<td>3.24**</td>
</tr>
<tr>
<td>H4</td>
<td>Inn. Cap. $\rightarrow$ Knowledge Mgmt. in Info.</td>
<td>0.526</td>
<td>0.126</td>
<td>4.17**</td>
</tr>
<tr>
<td>H5</td>
<td>Inn. Cap. $\rightarrow$ Knowledge Mgmt. in Analysis</td>
<td>0.587</td>
<td>0.141</td>
<td>4.15**</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01

Discussion and Conclusions

This research emphasizes the effects of IT and innovation capability on knowledge management of information, data, analysis, and its usage in long-term health care in the U.S. We provide some evidence for skilled nursing facility administrators that utilization of the firm’s information technology capability may increase firm’s innovativeness to implement knowledge management in various aspects. For the final statistical outcome, H1, H2, H3, H4, and H5 were fully supported. The statistical results for Hypothesis 1 confirm that information technology capability influences the nursing facility’s innovative behavior. As IT has moved to the network era, new opportunities have arisen for diverse parts of organizations to interact while producing new products and services both within the organization and externally (Wang & Ahmed, 2007).

These new opportunities provide a rich source of innovation to satisfy the needs of customers and to improve overall organizational performance. Next, our findings indicate that information technology can organize documents and content of the transactional data for the facilities. Various information technology tools allow users to aggregate, manage, and deliver content across different functional areas. In the framework of knowledge management, knowledge is treated as a resource by exercising selectivity,
imposing order on information resources, and adding structure to enhance information systems (Ferraris et al., 2017). Furthermore, the strength of applied information technology capability and knowledge management can assist the relationships and collaboration among employees regarding the utilization and analysis of information collected from the HIT.

This knowledge management capability can further improve the facilities’ performance in quality patient care (Murdoch & Detsky, 2013). Therefore, the relationship between IT capability and knowledge management is positive for Hypothesis 2 and Hypothesis 3. Innovative capability consists of having an innovative nature within the firm, adding innovative external resources, and finally using these resources to produce goods and services which meet market demand. The greater innovative capability is associated with a facility’s efforts to improve its knowledge-building as to the organization integrating different functional departments’ information to enhance the strength and competitiveness of the facility. In other words, the nursing administrators can communicate and integrate resources to encourage and improve the effective use of HIT (Leung, 2012). Hence, the higher innovative capability can achieve a greater knowledge management capability as identified in Hypothesis 4 and Hypothesis 5.

Despite the considerable importance of information technology, innovation, and knowledge management to the nursing facilities, limitations existed for this current study. Nursing facilities are still operating in a low technology environment. The facilities typically only use information technology to report patient quality care data for reimbursement purposes only. Determining how to encourage facilities to utilize and integrate information technology in a broader aspect among different functional departments remains a great challenge.

For future studies, administrators are convinced that the best use of IT can help solve current and potential healthcare problems. Nevertheless, the process of developing this system is still not clear. Therefore, further studies may extend this current model to test whether IT capability, innovative capability, and knowledge management can reduce costs and improve quality. For example, the current model should be applied to test secondary data such as net patient revenue, operational expenses, or percentage of low-risk long-stay residents who have pressure sores to assess costs and quality indicators.

In sum, most of the research for nursing homes have emphasized patient quality and reducing deficiencies. This present study provides a different perspective on a firm’s strategic development via information technology capability, innovative capability, and knowledge management capability of information, data, analysis, and usage. The statistical outcomes of our study indicate that IT and innovative capabilities are associated with facilities’ knowledge management capability in the U.S. long-term care sector. Ideally, IT and innovative capabilities will continue to assist nursing facility administrators in improving overall facility knowledge management, eventually leading to a higher quality of care.

References


A Review and Assessment of the Existing Health Consciousness Models

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[Abstract] Despite numerous studies on the topic of health awareness there has been no uniform or accepted standard definition and measurement for health consciousness. Although the work done by researchers over the past 30 years resulted in some preliminary models, no significant work has been done in the past 10 years to develop those models further. Instead, the trend shows that the health consciousness model has been extensively used in marketing research to study effects of health consciousness on consumer behavior. An apparent focus on the application of health consciousness model on commercial research seems to have deviated scholarly attention from developing more comprehensive health consciousness models. It is time for researchers to refocus on deepening our understanding of human health consciousness so that new entry points can be created to regenerate pragmatic working strategies to develop health consciousness at an individual level. The authors have presented a review and assessment of historical and current literature related with health consciousness to indicate areas of research that have matured, and that can benefit from further research.

[Keywords] health consciousness, prediction, intervention, consumer behaviour

Introduction

Entering the 21st century, despite an improvement in lifestyle and life quality among college students, health consciousness, and health behavior are reportedly neglected (Tao, Su, & Wang, 2012). The downward trend related to health consciousness seems to be trending over a couple of decades. According to the Fourth National Youth Physique and Health Survey Report, youth morphological development indexes, such as height, body weight, and chest circumference have grown over the past 20 years, but their physical qualities are declining continuously, and the obesity rate has increased twice more than in the 1990s (The Information Times, 2008). If we take into consideration the global youth population, we find that in China, as an example, the youth’s proportion of nearsightedness is not optimistic, occurring in nearly 60% of junior high school students, 76% of high school students, and even more than 83% of college students; this means it’s difficult to find two college students with good eyesight among 10 college students (Liu, 2009).

Health consciousness and health behavior have always been the main study task of social psychology and health psychology. In the past 30 years, people’s lifestyle and life quality have increased significantly with the rapid development of high tech and new science, but their health consciousness and health behavior under its guidance had been reduced and neglected, which has then led to a decline of global human health and physique. In such a serious health crisis, the global body of social psychologists is bound to strengthen research on health consciousness and healthy behavior to discuss how to improve college students’ health consciousness efficiently. Research on understanding health consciousness through various models (such as models related to health behavior theories) may reveal practical approaches towards enhancing health
behavior and prevent disease.

**Literature Review**

It has been over 20 years since the study on health awareness became a focus of psychologists. Slater and Flora (1989) conducted research pertaining to health consciousness that can be regarded as a pioneering work. Although they approached the topic from a marketing research perspective, the focus was mainly on developing the educational intervention. Their research attempted to break down a large population into homogenous groups with distinct patterns of behaviors, so to facilitate targeted outreach of health programs. Their approach was to leverage the existing commercial marketing and advertising models and combine them with health behavior models such as the health belief model, the reasoned action theory, and attempt to create an intervention method against key public health concerns. Although the work completed by Slater and Flora (1989) was a breakthrough concept, it was limited to specific health behaviors such as the use of vitamin C, and habit of using a seatbelt while driving. This could have been an impact of the fact the body of research was funded by the Public Health Services Grant.

In a parallel effort, Gould (1988) found that there were positive correlations between a person’s health consciousness and disease prevention and health care behavior. Gould established his Health Consciousness Scale and later, championed that health consciousness simply manifested one’s psychological or inner status, and was made up of health alertness, health self-consciousness, health involvement and the self-monitoring of their health (Gould, 1988; 1990). Simply put, a person with an elevated level of health consciousness is likely to demonstrate disease prevention and health care behaviors in a more sophisticated fashion. Later, contending Gould’s opinion, Kraft and Goodell (1993) defined health consciousness as “the synthesis of a bevy of personal activities, interests and opinions”, which constituted four sub-dimensions, namely: (1) concern for hazardous environment; (2) physical fitness, or physique adaptability; (3) sense of personal responsibility; and (4) nutrition and stress. Thus, a person with health consciousness tends to be quite sensitive about health hazards, is responsible for his or her health, is concerned about his or her physique and is careful about stress and nutrition management (Kraft & Goodell, 1993). The key difference between Gould (1990) and Kraft and Goodell (1993) was, that the former viewed health consciousness as a purely psychological model, while that latter emphasized on health behaviors. Hence, between the work done between Gould (1990) and Kraft and Goodell (1993), two instruments were developed to measure health consciousness from distinct perspectives.

This body of work can be viewed as the first wave of the body of work that leveraged theories from marketing, advertising, and health psychology to first develop a health consciousness scale, and then explore further possibilities to broaden the scale. At this point, the definition of health consciousness was still open for ideas and required further discussion. Nonetheless, review of literature reflects that the introduction of two new measures moved the focus of researchers from further developing the models to the application of applying the new instruments to explore various market trends.

Almost a decade later, researchers in China put forward their interpretations of health consciousness, holding the view that health consciousness refers to one's cognition of and comments on their personal physical, psychological and social adaptabilities in their daily lives (Meng, & Wang, 2000). In a similar vein, Iversen and Kraft (2006) took an in-depth look at Gould’s opinions and defined health consciousness as a person’s tendency to be concerned with his or her health. At the same time, they stated that health consciousness was not the same as one’s anxiety about health or fear of disease or death. Moreover, other
scholars pointed out the interaction between health consciousness and health behaviors. To be more specific, health consciousness controls obvious health behavior, such as sports exercises that give people physical benefits and mental pleasure, and health behaviors, and thus, can deepen and improve a person’s health consciousness. In addition, it also proved that once one’s health consciousness was established and formed, it would remain strong stability (Li, 2006). These studies provided the groundwork for the second wave of discussions that were focused on improving the content of the health consciousness model. The theoretical discussions about what constructs health consciousness reignited the efforts to understand the phenomenon better and develop new theoretical models.

Further developing Gould’s work, Dutta-Bergman (2004b; 2006) and Dutta (2007) turned to focus on the psychological features of health consciousness and attempted to distinguish three health tendency indexes namely (1) health information orientation; (2) health belief; and (3) health activities. Some researchers also attempted to open the possibilities of exploring the phenomenon from a spiritual perspective. Li (2008) emphasized that health consciousness was a kind of spiritual phenomenon with health as its object and comprised of three factors: “knowing” – the degree of understanding about health; “passion” – the feeling and mood about health; “desire” – the degree of persistence and acceptance of health value (Li, 2008).

Despite active discussions among the scholarly circles, there was no accepted standard for the definition and measurements of health consciousness. The culmination of the second wave of development for the health consciousness model came with the development of Hong (2009) Health Consciousness Scale. Hong (2009) attempted to define the concepts of health consciousness, identified five key dimensions of health consciousness from existing literature at that time, and developed a new scale to measure and understand health consciousness at an individual’s level. The five key dimensions that he compiled were (1) engagement in health behavior; (2) psychological attention to one’s health; (3) health information seeking and usage; (4) personal responsibility; (5) health motivation. Generally, people with health consciousness would actively introduce health behaviors into their daily lives and pay continuous attention to their health status; they seek and use a variety of health information from different resources, take responsibility for their own health and maintain high health motivation all the time (Hong, 2009).

After examining the five dimensions, Hong concluded that instead of focusing on specific behaviors, the re-conceptualized view of health consciousness should focus on an individual’s orientation towards overall health and could be measured by evaluating self-health awareness, personal responsibility, and health motivation. Hong (2009) developed and validated an 11-scale instrument to measure the three dimensions.

Now the researchers had a new tool available to them. In 2011, Hong published his first study using his new 11-scale measure to study the role of health consciousness in perceiving or processing the messages conveyed through news about various health threats (Hong, 2011). This research seemed to have started the second wave of consumer behavior-centric research efforts, one more time deviating the focus away from developing the health consciousness models.

As part of our literature review, we identified 175 peer-reviewed articles published between 2010 and 2018 in academic journals, and that included health consciousness as a key term. After reviewing the content of the articles and nature of the results, we were able to divide the articles into two categories. The first, and the predominant category consisted of articles focusing on measure effect of health consciousness
on certain consumer behaviors. While the second category consisted of articles that proposed a new dimension to be researched and included in the health consciousness paradigm.

A new angle of exploring health consciousness appeared in the study presented by Teerachote et al. (2013), who explored the effect of peer leadership on health consciousness. Teerachote et al. (2013) discovered a direct correlation between the quality of peer leadership and the quality of health consciousness. In a separate study originally published in the Russian language, Goleman (2014) viewed health consciousness as a trend of shifting liability from the health services to individuals. He probed at the cultural beliefs, commercialization, and politicization of the health-related policies, and viewed health consciousness through the lens of sociological engineering. Teerachote et al. (2014) and Goleman’s (2014) theories offered a new dimension to explore an individual’s health consciousness. While the former focused on the social factors associated with an individual’s social circle, the latter probed on the sociological engineering of creating and moralizing a phenomenon.

A third study related to what constitutes health consciousness was published by McGloin, Richards, and Embacher (2016), who eliminated gender as a variable of health consciousness. The authors concluded through their research that gender had no significant relationship with the quality or magnitude of health consciousness. In relation to the other theories probing at the social factors, the normalization of gender as a variable impacting health consciousness could significantly simplify future development in this area of research.

Besides these three articles that focused on what effects health consciousness, the remaining articles explored the effects of health consciousness on certain consumer behavior, such as buying preferences of alcohol or certain health services, etc. A sample of articles falling in these categories is listed in table 1. Table 1 also shows a trend of research work that resulted in the periodic progression of developing health consciousness concepts.
Discussion

If health consciousness influences human behavior as effectively as shown by the magnitude of consumer behavior research, it is critical for social scientists to continue working on understanding the factors that develop health consciousness. The extent of research work focused on consumer behavior, and the far and few probes in between on the nature of health consciousness reflect a commercial-centric trend among researchers. Treating the health consciousness as an independent variable in research seems to be equivalent to weighing the intention to purchase of more than the well-being of an individual. The globally deteriorating health and habit trends among youth, especially college students, seek the attention of social of the social scientist to refocus on the composition of health consciousness. The subject needs to be brought
into mainstream discussions where development work can be done by exploring the phenomenon through the lens of various existing psychological, social, and health behavioral models. Such an effort is critical to discover the new entry points and pragmatic working strategies and to popularize the health education of college students as well as to improve and enhance their physical quality.

References


Expecting More Out of Expectancy Theory: History Urges Inclusion of the Social Context

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[Abstract] Investigating Vroom’s expectancy theory, with direct examination of the historical context of its three main tenants, leads to a supportable framework for inclusion of a fourth. Specific consideration is given to social context as it relates to worker motivation within the environment of multiple sectors. The literature on equity theory, organizational justice, and early modifications of expectancy theory suggest that social context necessitates consideration for effectively gauging workplace motivation. Previous research dictates a collection of individuals is not simply an aggregate of their individual motivations and abilities; rather, workplace results are a product of the group's influence on said individuals. Our endeavor is to expand the understanding of workplace motivation with a specific focus on the interaction of the social environment within the organization as well as across sectors. This examination postulates Vroom’s expectancy theory formula (motivation = instrumentality * expectancy * valence) should be modified to support management decision-making by introducing a new social variable.

[Keywords] expectancy theory, motivation, social context, group influence, management history, workplace social dynamics

Worker motivation is an important and problematic criterion for administrators to utilize effectively. As firms face increased diversity of workers in an expanding presence across sectors and the globe, managers require modernized and more applicable theories to aid in every aspect of management, including employee motivation. As firm diversity and collaboration increases, managers must utilize various criteria to motivate workers across numerous sectors and cultures continually. How are relevant factors chosen when determining processes to increase employee motivation? This is an important question in light of a firm’s desire to find factors that satisfy their employee’s motivational needs as well as the organizations’ desire to retain high-quality workers (Mak & Sockel, 2001). Having a relevant, current theory allows decision-makers confidence in selecting the appropriate criteria. As Hofstede (1980) found, there are many different motivational differences throughout the world, which can be traced back to differences in culture. The culture of organizations has been found to vary more across industries than within them (Chatman & Jehn, 1994). Hence, a need exists to determine motivation theory which accounts for the ever-increasing cultural factors involved in the workforce. Utilizing one of the most prominent theories of employee motivation, expectancy theory, this paper examines and determines the theory’s appropriateness for current cultural variation across industries and sectors.

Expectancy Theory
During the 1960’s, Victor Vroom saw a gap between the research performed by industrial psychologists
and practical models of workplace motivation that could be employed by managers (1964). In *Work and Motivation*, he postulated the theory known as “expectancy theory of motivation.” In this seminal work, he describes motivation force (MF) as a product of expectancy, instrumentality, and valence. Vroom’s theory has been widely dissected, debated and empirically tested by academicians and scholars. While acknowledging this subsequent research and building on the original writings of the social movement of the early twentieth century, this paper will re-examine the tenets of Vroom’s theory and suggest a new variable, the social context, which needs to be included in the theory of motivation.

Expectancy theory was postulated during the golden age of motivation theories during the 1960’s. However, what separates expectancy theory from the other seminal works on motivation is that expectancy theory focused on the cognitive antecedents that contribute or detract from personal motivation (Lunenburg, 2011). Albeit the theory heavily influences modern thinking on motivation, much debate exists whether the model can reasonably predict workplace motivation and behavior.

In the decades following the Vroom’s publishing, several need theories of motivation were developed which tried to explain specific physical and psychological forces (i.e., food, security, esteem) that drive workplace behavior. These include Maslow’s hierarchy of needs, McClelland’s human motivation theory, Herzberg’s two-factor theory, and Alderfer’s ERG theory (Lunenburg, 2011). Vroom defines motivation as “a process governing choices made by persons or lower organisms among alternative forms of voluntary activity” (1964). Expectancy theory is based on the postulation that individuals have choices, and they make decisions based on which choice they perceive will lead to the best personal outcome. This supposition is composed of three premises which Vroom’s uses to construct his theory – expectancy, instrumentality, and valence. According to Vroom, the motivational force that drives behavior is a product of these three variables and can be represented by the equation:

$$Motivation = Expectancy \times Instrumentality \times Valence$$

Each premise has an assigned value – expectancy 0 to 1, instrumentality 0 to 1, and valence -1 to 1. Therefore, if any of the variables are equal to 0, the motivational force will be absent. If valence is less than 0, the motivational force will be directed towards avoidance of the reward.

**Expectancy**

Expectancy is the worker’s anticipation that a certain effort on their part will lead to a specific performance. It is the degree to which an individual believes their abilities will lead them to goal achievement. Vroom describes expectancy as “an action-outcome association,” and “takes values ranging from 0 to 1.” In summary, a person’s motivation will range from 0 (no expectation) and 1 (full expectation) as it relates to whether they believe their efforts will achieve a certain outcome.

**Instrumentality**

Instrumentality is the perception that a given outcome of performance on their part will lead to them receiving an anticipated reward. Vroom describes this as an “outcome-outcome association” (1964) and also ranges on a scale of 0, where there is no expectation of desired outcome delivery to 1, where a reasonable probability of the delivery of rewards is perceived. It is an “estimate of the probability that a given level of achieved task performance will lead to various work outcomes” (Lunenburg, 2011).
Valence

Valence is the degree to which an individual has a preference for a given outcome. Vroom describes valence as “effective orientations toward particular outcomes” (1964). Valence can be positive, whereby the attainment of the reward is desired, or negative whereby the attainment of the reward is something an individual wishes to avoid. As such, valence can have a value ranging from -1 to 1. Vroom clarifies the difference between valence and value in that valence is the perception of anticipated satisfaction while the value is the actual satisfaction or utility received after attaining the reward.

Expectancy Theory Model

Motivational force as described by the expectancy theory is based on an individual’s belief that a certain effort will lead to a given performance (expectancy) and that performance will lead to attainment (instrumentality) of a desirable or undesirable (valence) reward. An individual’s perception of each variable is essential to determining behavior and can be illustrated with the following figure.

Following publication in 1964, Vroom’s expectancy sparked substantial debate on the subject in the proceeding decade. Updates to the model were suggested, most notably by Lawler and Porter (1967), Porter and Lawler (1968), Graen (1969), and Lawler (1971). For a summary of these early modifications to the model see Lawler and Suttle (1973). The major criticisms of expectancy theory focused on the simplicity of the model. Factors were added for both intrinsic and extrinsic motivations: valence, task requirement and perception of fairness of given rewards. Lawler (1971) defined the difference between expectancy that actions would lead to successful performance and the expectancy that actions will produce outcomes. Expectancy theory was expanded by Porter and Lawler (1968) to account for the role of personal abilities and skills, to include the relationship between satisfaction and performance, and to recognize the influence that past relationships have on expectancy.

Research on Vroom’s expectancy theory following these early modifications is substantial and ranges from an analysis of the theory’s underlying assumptions (Behling & Starke, 1973 & Liddell & Solomon, 1977) and empirical testing of its validity (House & Wahba, 1974) to several applications in specific industries to better understand employee motivation which include pursuit of entrepreneurial ideas (Hayton & Cholakova, 2012), nursing education and career progression (Candela, Gutierrez, & Keating, 2015), federal employee workforce (Park, & Kim, 2017), civil service, (Leonina, 2017), energy markets, (Baumhof,
Despite 50 years of research on motivation, recent literature calls for a renewed focus on the subject (Leonard, Beauvais, & Scholl, 1999; Selden & Brewer, 2000; Kim, 2006). Motivation continues to be a principal concern of employers and organizations, yet motivational theories still fall short of explaining human behavior at work. Most theories focus on solitary factors as contributors to motivation, leaving a need for more expansive and comprehensive models (Humphreys & Einstein, 2004). Some scholars concluded that expectancy theory could be combined with other motivational theories to gain a deeper understanding of workplace motivation (Kanfer, 1987; Kernan & Lord, 1990). However, a meta-analysis conducted by Eerde and Thierry (1996) demonstrated that the extensions of expectancy theory and manifold context-specific analyses were scattershot, and no consistency existed in the line of research that explored its tenets. They specifically called for an integrative theory or research agenda that could accomplish what the previous thirty years of research on expectancy theory did not achieve. Despite a waning of scholarly interest on the subject since their call for an integrated theory, some research projects have focused on trying to integrate the social elements of expectancy theory.

For example, Adler and Kwon (2002) first explored the relationship between social context and motivation when they developed intra-organizational social capital (IOSC), which explains the impact of collective action and social influences on organizational readiness and performance. Mahajan and Benson (2013) extended this theory by determining the positive impact that IOSC has on individual employee motivation. This research explains the motivational context of the social environment, but does not specifically address the elements contained within expectancy theory. Gyrko (2010) postulated that expectancy theory creates workplace momentum as a result of social cognition, but results of empirically testing this nexus were marginal. The lack of a foundational theory that fully assimilates socialization and its influence on workplace represents an ongoing gap in the extant research on expectancy theory.

The limited discussion that exists on social context and the motivating factors of expectancy theory are the basis for this scholarly work. The historical context of expectancy theory is provided so that an explicit connection can be drawn between the constructs being explored. While Lunenburg (2011) draws a connection between the two, stating the influence of group norms would determine the positive or negative perception of the valence of rewards, he does not identify the impact as a completely separate variable. The theory has been examined in light of inexorable influence that cultural characteristics can have on workplace motivation (Bhagat & McQuaid, 1982). Humphreys & Einstein (2004) identified the importance of personalities of both leaders and followers on motivation as it relates to temperament congruence. Impression management is a moderating factor in organizational politics which heavily influence the variables within expectancy theory (Chen & Fang, 2008). Locus of control plays an important role in workplace motivation, whereby fair pay, job content, work conditions and relationships are weighty influencers of motivation (Kandrom, 2015).
The existence of informal group influence and social impact on workers' performance has been widely discussed in the literature. Empirical analysis conducted by Hongseok, Myung-Ho, and Labianca (2004) reviews the concept of group social capital, which denotes the social relationships among group members and their impact on group efficacy. Researchers focused considerable effort on organizational justice in the 1960s, and discovered motivation can be derived from perceptions of fairness. Van Avermaet, McClintock, and Moskotwitz (1978) established the reactive-proactive principle of organizational justice whereby individuals will either seek to correct an injustice or strive to attain and promote justice. A further distinction of organizational justice is between the process and the content approaches. Process approaches address fairness in how various outcomes are determined while content approaches address the fairness in the distribution of those outcomes (Walker, Lind, & Thibaut, 1979). These two dimensions (reactive-proactive and process-content) serve as the context for how individuals perceive fairness within an organization. For a summary of the literature on organization justice, see Greenburg (1987). Motivation in terms of organizational justice theories are not relegated to individual understandings of fairness, but contingent upon the individuals' perceptions of fairness within their social environment.

Several prominent theories emerged from this early research on the categorization of organizational justice. Distributive justice was defined by Folger and Cropanzano (1998) as “perceived fairness of the outcomes or allocations that an individual receives” (p. xxi). When an individual perceives a violation of distributive justice, job performance, cooperation with co-workers, and quality of work decrease (Greenburg, 1988; Pfeffer & Langton, 1993; Cowherd & Levine, 1992), while theft and stress go up (Zohar, 1995; Greenberg, 1990).

Procedural justice was identified as “fairness issues concerning the methods, mechanisms, and processes used to determine outcomes” (Folger & Cropanzano, 1998). Interactional justice is derived from “the quality of the interpersonal treatment . . . received during the enactment of organizational procedures” (Bies & Moag, 1986). Referent cognitions theory describes an individual’s construction of alternative outcomes and their understanding of the ostensible instrumentality of those outcomes (Folger, 1993).

Equity theory arose from the same era that produced other seminal motivational theories; Adams (1963, 1965) established equity theory as a new approach to understanding motivation. Essential to equity theory was the notion that an individual compares the ratio of their output to input to their perceptions of the ratio of others within the organization. If the ratios are not balanced, the individual will experience a level of distress commensurate with the imbalance of equity. Most importantly, the degree of this imbalance determines the degree of motivation an individual generates for correction. Interestingly, Adams (1963) found that inequity of outputs in favor of the individual could have a negative impact on motivation in the same way that perceived inequity is not in their favor. Huseman, Hatfield, and Miles (1987) extended the research further by claiming individuals have various tolerances for inequity, known as equity sensitivity.

Literature abounds in comparison of equity theory and expectancy theory, most notably by Campbell and Pritchard (1976) and Lawler (1968, 1973). These authors juxtaposed the two theories not as antitheses, but as each containing elements of the other. For example, equity theory could inform the understanding of valence outcomes and therefore motivation. Vroom (1964) acknowledged that an understanding of the fair distribution of outcomes as proposed by equity theory would require a moral system from which to base that perception. We refer to a social factor that exists (inclusive of informal group influence and social
impact on workers performance) such that its inclusion in expectancy theory will alter the motivation outcome when determining overall worker motivation. Thus, we offer the following hypotheses:

Hypothesis 1: A Social Context exists for individuals such that as the positivity of a social context factor increases, as all other factors remain the same, worker motivation increases.

Hypothesis 2: A Social Context exists for individuals such that as the negativity of a social context factor increases, as all other factors remain the same, worker motivation decreases.

Hypothesis 3: A Social Context exists for individuals such that as the value of a social context factor equals zero, worker motivation is eliminated.

**Historical Support for the Inclusion of A New Variable**

Two major events promulgated the advent of the industrial revolution - the invention of the steam engine and the publication of Adam Smith’s economic treatise *The Wealth of Nations* (Ashton, 1948). Conditions in Great Britain had primed for such industry growth, and the result was an immense augmentation in manufacturing output and an increase in worker migration from farms to factories. A focus on processes, efficiency, and cost-reduction ensued, which relegated labor to another “factor of production.” Labor was viewed as another element to be managed. During this timeframe, workers were required to labor long hours in poor and often unsafe conditions. The formation of labor unions attempted to address the needs of the workers (Ashton, 1948).

During the eighteenth and nineteenth centuries, the ontological meaning of work came into the debate. Adam Smith argued that work was a means by which man could achieve other ends that coincided with rational self-interest (Volf, 1991). Karl Marx, on the other hand, postulated that work was itself an end. Work carried specific individual meaning toward dignity and had lasting social implications. “What differentiates human beings from animals is not only that they work freely and purposefully but also that they work consciously for one another. They relate to one another as human beings” (Marx, 1973).

A new concept emerged around the same time Frederick Taylor was initiating the movement towards scientific management. Christian von Ehrenfels articulated the unique concept of *gestalt* in his monograph *Über Gestaltqualitäten* (1890). In summary, he claimed that the “whole” is more than simply the sum of its parts - context and interrelation between variables was relevant and needed consideration (Smith, 1988). This concept of gestalt had significant implications on the life of a laborer – making each more than a wage-earning producer of goods that needed to be managed, but rather a part of a larger internal context with fellow laborers and external context with family and society.

The preponderance of Marx’s writings on the social relevance of work and Ehrenfels’ definition of gestalt as the inclusion of a larger context of work became the underpinnings of what would become the social movement, where the laborer would be seen as a social being. The writings of Paul Göehre, Whiting Williams, Mary P. Follet, Elton Mayo, Fritz Roethlisberger and William Dickens later articulated the notion that interaction between a worker’s internal and external social environment had an impact on workplace motivation.

The first major contribution to the research on social context came from the work of Paul Göehre as he spent three months working alongside laborers at a machine-making factory in Germany. He endeavored
to understand the reasons workers subscribed to the political platform of Social Democracy and the effects it had on internal group dynamics. What he found was workers’ “experiences, personal desires, and early [life] influences were often exceedingly intense and powerful, [yet] strangely bound up in connection with social-democratic ideals and teachings” (1895). In short, he found that productivity increased when members felt interdependence within the group and that the informal group, which was heavily influenced by political affiliation, created social pressure on individual members. Isolation of group members had a direct relationship with lower morale and productivity (1895). Published in 1891, this was one of the earliest academic publications that connected internal social dynamics and worker productivity.

In similar fashion, Whiting Williams spent several years working alongside various manual laborers in the U.S., after which he published findings on his experiences in *What’s on the Worker’s Mind? By One Who Put on Overalls to Find Out* (1920). The key takeaway from his research was that a worker’s job was inexorably connected to social status outside of work. Williams found that for the laborer, work was “the most important means of establishing his status and standing as a man and a citizen – and the status and standing of his wife and children” (1920). In essence, social identity came from job status because wages and position provided access to the worker’s material needs and social desires. As such, the actual wages an individual received were not as important as the comparison the worker made to what others received.

Williams also found that workers engaged in a behavior known as “soldiering,” whereby they deliberately restricted output when they perceived a shortage of labor opportunities. Moreover, unions arose because employers were not addressing the long-term security needs of the worker (1920). On occasion, workers would strike as part of a union’s effort to improve conditions. Both of these observations reinforced the idea that a worker’s primary concern was for maintaining their social status, which was made possible by job security.

Mary Parker Follett further promulgated the social context of work. She was heavily influenced by the work of Anna Boynton Thompson who was a proponent of fully developing the individual in the context of the “many” and the “universal” (Thompson, 1895). Thompson claimed that “duty to a neighbor was to introduce into his knowledge the concept of the highest possible development of existence” (1895). Man was not called into isolation through work, but through contribution to a collective ego.

Another significant influence on Follett was that of the gestalt writers such as Von Ehrenfels. She iterates the concept that the “meaning of a social situation is to be found not in its elements viewed separately, but only in the total situation” (1924). Moreover, she states that it is imperative to “study [the] whole and parts in their active and continuous relation to each other” (1924). These two influences laid the groundwork for her thoughts on group dynamics. In *Creative Experience* (1924) she claims that group experiences can have a positive effect on helping individual members find new creativity in developing integrative solutions to conflict. By contrast, if each individual acted independently, an ideal solution would not be possible. A focus on integrative resolutions necessarily meant unifying group effort and avoiding compromises whereby one party must settle for a sub-standard solution (1924). In *Dynamic Administration* (1940) Follett furthers the notion that by searching for integrative solutions “people identify themselves with the group interest, feeling consciously that it will be their own interest in the end.”

In 1923, General Electric commissioned and funded a series of “industrial illumination tests” that were carried out by the Council on Industrial Lighting in late 1924 – a study that became known as the Hawthorne Illumination Tests (Wrege, 1976). The results of these initial tests did not prove a correlation between
illumination levels and worker output. However, Charles Snow, the lead researcher, found telling insights into other factors that affected workplace motivation, which included “(1) social pressures used by the foreman to increase production, (2) physiological and psychological factors, and (3) influence of home environment” (Wrege, 1976). The Hawthorne Studies unwittingly discovered the social context as a predominant factor in workplace motivation and created a new focus for researchers during the next two decades.

Elton Mayo joined the Hawthorne Studies researchers in 1928. From his experiences at Hawthorne and subsequent research in the decades that followed, he developed three salient points in the social context of the workplace. The first of these conclusions was a gestalt-influenced theory on understanding the “total situation” (1923). To him, the worker was a social human being and required attention towards social needs. Individuals, therefore, must be perceived not as singular and independent variables within the workplace, but rather as a part of a group. “It is with a man as a totality, the individual in his social relations that we are dealing with business” (1923). Mayo further stated that “man’s desire to be continuously associated in work with his fellows is a strong, if not the strongest, human characteristic” (1945).

A second conclusion that Mayo readily reported in his research was that financial incentives were subordinate to the worker’s desire to belong to the informal organization. “Morale [is] derived not primarily from incentive plans devised by industrial engineers, but from a sense of solidarity with the community and service to it” (1932). His research found that “in many industries . . . the majority of workers refuse to earn more than a certain income” (1923). Pecuniary interest yielded to a deeper need for social inclusion.

The third, and perhaps most telling conclusion drawn by Mayo as it relates to worker motivation, is that informal groups had the power to influence the behaviors of individual members. He references “the inner compulsion to think and act in a way that is socially acceptable, which is imposed upon an ordered community by social tradition” (1933). This compulsion manifests itself through “a discipline that enhances the certainty of unity in work” (1945).

Following the completion of the Hawthorne Studies, Fritz Roethlisberger and William Dickson published the complete findings in their book Management and the Worker (1939). One of the key takeaways in this work included discussion on the “social control of work behavior.” Observation of the informal groups provided commentary on how individuals were positioned within the group (1939). Social status was a function of both conforming to “group expectations on output” and to an individual’s adherence to “group sentiments on personal conduct” (1939). Some workers excelled at the output, but held lower social positions because of abrasive attitudes. Other workers lacked in conformance to output standards, yet were still accepted into what the authors describe as the “clique” because their personal conduct was deemed acceptable. The dual expectation by the informal organization provides insights as to the dual nature of workplace motivation – towards wage incentives as well as group norms (1939).

A better understanding of wage incentives arose clearly from the research. They found that wage incentives could not be considered a completely independent factor in fueling a desire to increase output, but “only in connection with the interpersonal relations at work and the personal situations outside of work could its effect on output be determined” (1939). In essence, a worker’s ostensible motivation to increase output was not solely determined by the financial incentives to do so.
Summary of the Social Context

The published works of Mayo, Roethlisberger, and Dickson following the Hawthorne Studies created a new focus for workers as social human beings. Several key learnings were gleaned from their findings as it relates to workplace motivation. Individuals could only be studied in the bigger picture of their role in a group and relationships within the same. The informal groups of an organization could wield resilient influence on the behavior of individual members, both on output effort and conformance to group norms. The monetary incentives provided by the organization to increase output were secondary to the individual’s need to be included and accepted into the informal group to which they belonged.

Vroom acknowledges in the introduction of Work and Motivation the previous research on the social environment’s effect on workplace motivation but did not describe its inclusion into his theory of individual motivation. In the spirit of gestalt thinking, the theory needs to consider the impact social factors play on each of the premises in the expectancy theory. The following discussion addresses this consideration. In short, individuals do not work in a vacuum. They are, as both Mayo and Williams described, a “social man” and the life of a worker outside of the factory cannot be separated from the daily output on the factory floor. Roethlisberger, Dickson, and Göehre described the relationships within the workplace as having a substantial influence on workplace behavior through the pressures of informal group expectations. Individual motivation must, therefore, be considered utilizing both these external and internal relationships – hence the “total situation,” and a new gestalt for Vroom’s theory.

Effect of Social Context on Effort, Performance, And Reward

Whiting Williams witnessed both “soldiering” (stringing out the job) and union strikes during his observations in the field. On these occasions, the individual interests were subjugated by group influence. In many cases, soldiering and striking happened despite financial incentives being in place for increased output. Let us apply the premises of the original expectancy theory in an attempt to explain a singular worker’s motivation at one of these moments in time.

1) Effort – Workers needed the job because it provided material goods for their family and allowed them to maintain social status. Therefore, they should have been willing to show up to work and give the required effort.

2) Performance – The nature of each job (coal, oil, shipyards) was repetitive. The previous experience gave the worker reasonable confidence that they could perform at a level to attain output goals, and they had no reason to believe that management would not pay out promised incentives.

3) Reward – Increased monetary payouts should have had intrinsic value for the worker. More pay meant security and stability in social status. Each of these factors was positive and should have led to increased motivational force.

\[ MF = \text{Expectancy} (+1) \times \text{Instrumentality} (+1) \times \text{Valence} (+1) \]  However, on occasion workers did strike and did string out jobs. Expectancy theory falls short in explaining the complete picture. These workers, who otherwise would have had a positive motivation, chose to engage in behaviors that conformed to group expectations.

Including A New Variable

Vroom’s research indicates that motivational force (MF) is a product of his three premises (expectancy,
instrumentality, and valence). Each worker carries these predispositions of motivation each day at work, represented by the formula \( MF = e \times i \times v \). However, these workers interact and affect the predispositions of other workers in the workplace. These other workers can be in different industries, sectors, and geographic locations. These factors increase the variability of cultures involved, which complicates efforts to determine effective motivation criteria. Worker A’s choices regarding motivation are influenced by a relationship with Worker B and a relationship with Worker C. Additionally, Worker A is influenced by his personal perception of the relationship between Worker B and Worker C. As described by Whiting and Mayo, these internal relationships are also heavily influenced by the social environment.

![Inter-relationships and the External Environment](image)

This social interaction is the link between each worker’s personal motivational force. As a result, expectancy theory should account for this connection with the inclusion of the social variable into the equation. The inter-relation of the workers should be represented as a valid premise in determining workplace motivation as the full context of motivation could not be understood or explained without its inclusion (as demonstrated with Williams’ soldiering and striking example). The workplace then becomes not simply an aggregate of the individual motivational forces, but something completely new (a gestalt), where the individual motivational forces are inter-dependent. The new variable representing the social context would be an algebraic summation of all internal relationships (and the individual’s perceptions thereof) plus the impact of the external social environment.

![The Social Impact](image)

\[
s = \sum_{i=1}^{x} i + e
\]

- \( i = \) the internal relationships
- \( x = \) number of internal relationships
- \( e = \) impact of external environment
- \( s = \) overall social impact
Just as Vroom assigned numeric value to the first three variables of the theory, the result of the summation of social context would range from -1 to 1. A value less than zero would indicate the social environment has a negative effect on motivation. In one example from the Hawthorne Studies, “an operator’s output declined when her father threw her out of the house, and she was forced to sleep in the park” (Wreg, 1976). A value above zero would indicate the social environment had a positive impact on workplace motivation. During the Hawthorne Studies, the researchers observed increased output when the workers were given a higher number of rest periods, not as a result of reduced fatigue, but because the more social interaction was possible (Roethlisberger & Dickson, 1939). The inclusion of the social variable would result in a new formula for the expectancy theory where: 

\[
\text{motivational force} = \text{expectancy} \times \text{instrumentality} \times \text{valence} \times \text{social impact}
\]

The historical support for the inclusion of this new variable started with von Ehrenfels idea of gestalt, Uber Gestaltqualitäten in 1890, the whole is simply more than the sum of the parts. The focus was that though there is a need to analyze and fully understand each part of a model, it is just as important to understand the complexity of the complete idea. To better understand and utilize motivation, Vroom’s expectancy theory needs to better explain the ‘big picture’. Adding a social context has been suggested over the previous 130+ years. Paul Göehre connected internal social dynamics and worker productivity in his 1891 publication. Whiting Williams also discussed social standing in 1920, and supported the notion of ‘soldiering’, where a worker’s primary concern was social status and not wages. Elton Mayo, from his work with the Hawthorne Studies, further promotes a social context with his three points regarding ‘total situation’-that social inclusion may be a worker’s strongest motivator, financial incentives being secondary to worker’s belonging, and the power of informal groups to influence individual worker behaviors.

Including the social context in expectancy theory should help satisfy the more recent research asking for more comprehensive models in motivation, such as Kanfer, 1987, Kernan & Lord, 1990, and Humphreys & Einstein, 2004. The relative simplicity of the social context variable should satisfy Eerde and Thierry’s (1996) finding of inconsistent, scattershot extensions of motivation theories. The addition of a social context variable to Expectancy Theory is parsimonious and preferable to attempts to add more micro-constructs, (i.e. intra-organizational social capital (IOSC)) external to Expectancy Theory.

Practical Implications and Future Directions

In addition to the contribution this investigation presents for the development of management theory, there are a number of implications for practice that emerge from the creation of an updated theory. Managers who seek to increase motivation and worker output utilizing Vroom’s expectancy theory may have previously been able to ignore the social context in their policy creation and application. However, it is apparent in the current business environment, with the three factors of expectancy theory calculating positive or negative results, outcomes could easily be altered by a fourth criterion, social context. We will discuss several implications can be drawn from this discussion.

First, practitioners can better understand the complexity of motivating workers, and the need to include the social context of their worker’s in their decision-making. As these concepts have been separate, it is likely the management has spent more time, money, and effort to motivate workers- with lesser results. The updated model from this paper will allow manager’s to better understand how their workers are motivated and thus managers are better able to utilize the tools at their disposal to better worker motivation.
Regarding businesses which continue to further engage across industries, sectors, and geographies, the theory needs to evolve to account for differences in motivation based on cultural and social context. As worker motivation is affected by stronger intra-industry and geographical coworker relationships and societal expectations, corporate policy needs to be grounded in all four criteria in order to motivate effectively. Furthering Vroom’s expectancy theory as detailed and supported in this article satisfies this need. Second, matching the evolution and expansion of the managers’ business environment with their needs to motivate workers effectively across changing criteria which become more evident as their employees work across industries, sectors, and cultures. As globalization increases and businesses operate further across various industries and sectors, managers need theory to corroborate the changes they encounter. Adding fourth criteria to a very popular motivation theory modifies and modernizes the theory with real-world changes.

Third, employers must be aware of the potential impact of social context on employee motivation (and thus output) when designing jobs and incentive structures. If entrepreneurs and owners fail to learn or comprehend the need for a social context in their motivation calculations, the effects could be costly. As discussed previously, it may be inconsequential how strong the positive calculation of effort, performance, and reward; however, failure to include and manage for the social context with a strongly negative social context variable, could result in eliminating any positive effects. Deprived of this updated motivation theory when designing jobs and incentive structures, the resulting employee motivation could destructively work against the firm.

Fourth, as every competitive marketplace further develops globally, the diverse social interaction of employees becomes more necessary and frequent. As employees interact more frequently with other workers in different departments, sectors, and geographic locations, increasing the variance of interacting social systems, the effect of these interactions needs to be managed further. If employees and managers are educated regarding the impact on motivation from increasingly variable social contexts, they can develop methods to use this knowledge to their advantage.

This is the initial step validating a fourth social factor in expectancy theory. Subsequently, the authors propose to apply the established, updated model in an experiment which monitors, evaluates and controls the social context of subjects, while measuring the predicted and summative motivation of each person. It should be very interesting to determine whether a social context is present and if so, its effect, if any, on the overall motivation of workers.

The authors’ intent is to follow this effort with empirical testing of the social context’s validity. Though the adoption of a social context is supported through over a century of previous findings, a direct, controlled, empirical analysis is the appropriate second step to solidifying the improved theory.

Further study in this area would include continuing the previous discussion of parsimony, and begin the addition of previous findings of factors influencing worker motivation and discover how these criteria can be explained via Expectancy Theory. There would need to be efforts to reevaluate previously tested contextualization, such as employee turnover and absenteeism (Porter & Steers, and Mowday, Porter & Steers, 1982), organizational citizenship (Organ, 1988), etc. The long-term goal is to fully develop expectancy to better explain motivation as a complete theory. To do this, expectancy theory would need to incorporate applicable, major motivation theories such as Hygiene, Equity, and Goal Setting Theory.

There is also need of researching the different social contexts sectors or geographic locations. As
cultures obviously are different globally, it is important to understand whether different levels of social context are present and thus have altering effects on worker motivation. If so, managers would require training on methods for adequately accounting for social context in determining employee motivation. The argument also appears sound for asserting that different sectors would employ workers of similar social skills and/needs. Hence, managers may have to account for not only global social context, but also for the varying social contexts across sectors.

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Analysis of Effectiveness of Optional Versus Mandatory Quizzes on Final Comprehensive Examinations Performance

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[Abstract] The main objective of this investigation is to analyze the effectiveness of two distinct methods of quiz offerings (optional and mandatory) on learning specific concepts in college courses, specifically analyzing how each method contributes to the final comprehensive examination performance. Quiz and examination scores were collected from several courses. Unexpectedly, analysis of the data demonstrated that both optional and mandatory quiz methods had a similar, weak correlation with the performance level of final comprehensive examinations.

[Keywords] quizzes, examinations, online courses

Introduction
Common sense indicates that quizzes naturally should improve examination performance and, eventually, learners’ overall performance. Many educators believe that quizzes have beneficial effect on examination performance (Tapaswi et al., 2016; Kovacs, 2016; Freitas et al, 2016; Murai, 2016; Ramazanzadeh, Khodabandehloo & Noushak, 2013; Bontchev & Vassileva, 2010; Shirvani, 2009; Daniel & Broida, 2004; Brothen & Wambach, 2004; Anderson, 1984; Bangert-Drowns, Kulik & Kulik, 1991; Wilkins, 1979; Mawhinney et al., 1971). On the contrary, as early as 1984, Anderson revealed that announced quizzes had no positive effect on learners’ examination performance using a limited and small sample. However, based on a broad literature search, there are different theories and inferences about the impact of quiz methods on performance.

Considering the optional method of quizzing, Grimstad and Grabe (2004) showed that learners who completed voluntary concept quizzes significantly improved their examination performances. They asserted that when learners received no credit for answering practice questions and were not obligated to perform the quizzes, students scored higher on course examinations when compared with students who had completed mandatory quizzes. On the other hand, Brothen and Wambach (2001) stated that required quizzes might only improve examination performance if learners use an efficient strategy of using the quizzes to assess their knowledge of the material.

In this brief article, authors investigated and analyzed the effect of optional and mandatory quizzes on learners’ final examination performance. Quiz and examination data were collected and analyzed from a broader selection of learners and courses over several years to determine any statistical correlation between them.
Method

Hypothesis and Objectives

The primary hypothesis (Alternative Hypothesis - H1-1) of this investigation is that learners’ performance on either optional or mandatory quizzes positively correlates with learners’ performance on final comprehensive examinations. The secondary hypothesis (Alternative Hypothesis - H1-2) is that learners who take mandatory quizzes will perform higher than learners who take optional quizzes on final comprehensive examinations. The main objective is to perform an analysis of the effectiveness of optional versus required quizzes on final comprehensive examinations performance.

Participants

Learners’ quizzes and final comprehensive examinations data were collected for two junior courses spanning over semesters of five years period. The sample did not include any identifiable data about the learners. Also, for simplicity, the sample did not focus on any other variables, such as gender, age, majors, classifications, or Grade Point Average.

Apparatus

There were ten quizzes in each course with ten points each. Each quiz consisted of ten multiple-choice and true-or-false questions. Quizzes were related to chapters covered in the learning modules within the course. Final comprehensive examinations had one hundred points covering all of the chapters that were covered in the quizzes. Similar to the quizzes, examinations consisted of one hundred multiple-choice and true-or-false questions. All questions for quizzes and examinations were extracted from the same question bank.

Design and Procedure

Two junior-level courses that were taught for a five-year period (consisting of three semesters per year with multiple section offerings) were identified for this investigation. One of the courses contained ten optional quizzes with the same number of questions. Learners were allowed to take the quizzes twice, and the systems kept the highest scores. However, scores were only displayed for learners’ information and were not computed in their overall grade (that is, they were “no credit” quizzes). The other course had exactly ten quizzes with ten questions, and as before, learners were allowed to take each quiz twice, retaining the highest score. However, all quizzes were required, and their scores were computed in learners’ final grades. Both courses under investigation had one hundred multiple-choice and true-or-false for the final comprehensive examinations. Quizzes and final comprehensive examinations offered in both courses had the same structure, meaning that a number of questions and time to complete (20 minutes for quizzes and 200 minutes for examinations) were the same. It is important to reiterate that all the questions were extracted from the same question banks for each category. Collected data were subjected to a variety of statistical procedures, such as correlation coefficient procedures, followed by presenting conclusions and recommendations.

Results

Optional Quiz Method: The value of $r$ is -0.1811 (n=440). Although technically a negative correlation, the relationship between the variables (Optional Quizzes and Final Comprehensive Examinations) is weak.
(the nearer the value is to zero, the weaker the relationship). The value of \( r^2 \), the coefficient of determination, is 0.0598. Both primary and secondary hypotheses (H1-1 and H1-2) were rejected. Figure 1 depicts the graph of the correlation between Optional Quizzes and Final Comprehensive Examinations. Furthermore, Table 1 shows details of the statistical analysis of the two categories.

Table 1

*Detailed statistical analysis of Optional and Mandatory Quizzes versus Final comprehensive Examinations*

<table>
<thead>
<tr>
<th>Category of the Correlation</th>
<th>n</th>
<th>Mean</th>
<th>r</th>
<th>Analysis/Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional Quizzes</td>
<td>440</td>
<td>63.681</td>
<td>-0.1811</td>
<td>A weak relationship* Reject H1-1 and H1-2</td>
</tr>
<tr>
<td>Final Comprehensives Examinations</td>
<td>440</td>
<td>89.762</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandatory Quizzes</td>
<td>369</td>
<td>77.366</td>
<td>0.2866</td>
<td>A weak relationship* Reject H1-1 and H1-2</td>
</tr>
<tr>
<td>Final Comprehensives Examinations</td>
<td>369</td>
<td>77.542</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The nearer the r value is to zero, the weaker the relationship.*

In all likelihood, students performing poorly in the course were more likely to have taken the optional quizzes, both to increase their understanding of the material and to improve their exam performance. As such, it makes sense that there is a negative correlation between the quiz scores and exam performance.

*Figure 1. Graph of correlation between Optional Quizzes (X-Axis) and Final Comprehensive Examinations (Y-Axis)*
**Required Quiz Method:** The value of $r$ is 0.2866 ($n=369$). Although technically a positive correlation, the relationship between the variables (Required Quizzes and Final Comprehensive Examinations) is weak (the nearer the value is to zero, the weaker the relationship). The value of $r^2$, the coefficient of determination, is 0.0821. Both primary and secondary hypotheses ($H_1-1$ and $H_1-2$) were rejected. Figure 2 depicts a graph of the correlation between Optional Quizzes and Final Comprehensive Examinations. As an iterative note, Table 1 illustrates details of the statistical analysis of two categories.

![Figure 2. Graph of correlation between Mandatory Quizzes (X-Axis) and Final Comprehensive Examinations (Y-Axis)](image)

**Conclusions and Recommendations**

In this article, authors investigated and analyzed the effect of two types of quizzes (optional versus mandatory) on the learners’ performance. Quizzes and examinations data were collected and analyzed from a broader selection of learners and courses over several years, and statistical correlation method was applied to the data. Results showed weak relationships between quizzes and final comprehensive examination for both quiz methods. These results are in line with Anderson’s research, as early as 1984, that revealed quizzes had no positive effect on the learners’ examination performance. Since then, many more researchers have attested to Anderson’s conclusions (please see Introduction section for a detailed list of researchers).

For the courses under investigation, neither requiring quizzes nor making them optional had much of an impact on final examination performance at all. This is especially surprising given that most educators believe that quizzes reinforce learning and therefore should significantly improve performance. The courses under study did not consider the quantitative content related to the performance. More research is required to see whether quizzes improve students’ performance in quantitative components of the courses. Furthermore, in general, quizzes might have been good practice tools to improve psychological aspects (such as test-taking familiarity and confidence), rather than improving the content knowledge. Finally, authors strongly recommend that educators to review their courses to verify that quizzes are accomplishing their purpose in their courses.
References


Establishing and Analyzing Commercial Banks’ Carbon Finance Business Revenue Model

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[Abstract] We developed this study based on a summary of current studies on development of the carbon finance business by commercial banks. To determine the amount of carbon emissions and production cost incurred by enterprises, we analyzed emission reduction equipment and carbon emission rights purchased by emission reduction enterprises. Next, to establish a revenue model for commercial banks’ carbon finance business, we analyzed and compared the revenue and the revenue impacting factors and identified theoretical conditions under which commercial banks may develop carbon finance business.

[Keywords] commercial banks, carbon finance, carbon emission, revenue model

Introduction

Global warming has become one of the key issues of interest in countries around the world. Based on the pressure to reduce carbon emissions and characteristics of its development, the use of financial market tools to achieve the goal of reducing carbon emission has both theoretical implications and practical value. Internationally, carbon emission resources, carbon trading, and carbon derivatives trading have great development potential and create commercial opportunities. The “carbon finance” derived from the above situation is an important method not only for realizing energy savings and emission reduction but also for achieving low-carbon development in the environmental finance area, which is a “hot” research topic. As primary financial institutions, commercial banks actively participating in carbon emission innovation should have two objectives: realizing carbon emission reduction and increasing enterprises’ operating revenue.

“Carbon finance” remains at the theoretical forefront and exploration stage of international finance. Scholars and research institutions in various countries are actively involved in relevant research and practices. The only global environmental finance magazine defines carbon finance as follows: “finance problems related to global climate change.” Carbon finance primarily includes renewable energy sources certification, “green” investment, weather risk management, and the carbon emissions market. Carbon finance, including elements such as markets, institutions, products, and services, should be the solution to climate change. Carbon finance establishes an important segment to manage climate change and a low-cost method to achieve sustainable development, to reduce and adapt to climate change, and to manage the disaster. It is also the core economic method of low-carbon development. The international carbon finance system includes three primary parts: the carbon finance market system, the carbon finance organization service system, and the carbon finance policy support system (Wang, Y. 2010). The function of carbon finance is to shift environmental risks, improving the environment, reduce finance risks, and increase social
benefits. These objectives are obtained by taking advantage of various financial institutional arrangements and trading activities aimed at greenhouse gas emission reduction. Finance market tools and finance services such as carbon emission rights and derivatives trading, investment in and capital raising for low-carbon project development, carbon insurance, carbon funds, and relevant financial consulting services are utilized (Du & Li 2012). This article defines “carbon finance” as all finance activities that benefit carbon dioxide reduction, including capital-raising activities for low-carbon projects, carbon derivatives trading, and relevant consulting and guarantee activities. Thus, combining the business characteristics of commercial banks and based on the reduction of enterprise actual production and operations, this article proposes a revenue model for commercial banks to develop their carbon finance businesses and comparatively analyzes the revenue conditions and primary elements of commercial banks’ carbon finance businesses.

Literature Review

With the expansion of the carbon trading market carbon emission rights have become financial assets with investment value and liquidity. The phenomenon has generated a carbon trading currency and a carbon finance system supported by a series of financial derivatives such as direct investment, capital raising, bank loans, carbon index trading, and carbon options and futures (Ge 2012, Wang & Wang 2015). The international carbon trading market has great potential: carbon finance has become a new area of competition for global financial institutions, and the development of the carbon finance business by domestic commercial banks is an inevitable trend. One of the hot and difficult problems in the future research on carbon finance theory is that the financial institutions should study the operation mode and innovation of the carbon finance business on the one hand. On the other hand, the carbon financial institutions need to actively study the carbon finance business Its risk management in the carbon business (Xu & Li 2015).

In the field of theoretical research, international studies on carbon finance primarily focus on the carbon finance concept, choosing the carbon finance development approach, the trading price of carbon emission rights, product innovation in the area of carbon derivatives, and risk management and policy arrangements related to the carbon market. Studies on the carbon finance businesses of Chinese commercial banks remain rare, and future carbon finance systems and operational arrangements of commercial banks are the primary manifestations of financial institutions’ participation in carbon finance. Recent years, scholars began to pay attention to the role of commercial banks in carbon finance, and the number of studies on such topic began to increase dramatically. The effective development of carbon finance became a topic that needed extensive discussions and is scholars’ current focus (Liu & Liu 2016). Current studies show that domestic and international research in the area of “carbon finance” primarily focuses on macro policy, the carbon finance model, and the establishment of a carbon market institutional system.

Most studies merely focus on the macro aspect, whereas specific model research and empirical and case studies remain rare. In particular, China’s carbon finance policy is relatively scattered and lies behind the development of carbon finance; also, a policy support system for such area has yet to be established. Regarding practice, China’s carbon finance business is at the gradual-development stage, and the environment for developing carbon finance has essentially been created.

Studies show that commercial banks are monetary operation enterprises with the primary business of
making deposits in and loaning money to industrial and commercial businesses with the objective of profit. These commercial banks’ operating revenue and risk control have become key issues. The theoretical research on the carbon business of domestic commercial banks remains at the explorative stage, and most of the data are from international statistical materials. Thus, domestic empirical studies are rare. Research on empirical models can be divided into two categories: the first is the carbon finance business model, and the second is the commercial bank revenue model. In research on the carbon finance business model, Blyth et al. (2009) conduct a stochastic model analysis of carbon credit price dynamics, expand the often-used analytical framework of static marginal emission reduction costs, include policy effects and technology cost dynamics, and analyze carbon market dynamics and risk factors.

By establishing the game model of local government and commercial banks, Zhang & Li (2009) analyze not only government behavior according to different development views and institutional arrangements when the utility function changes but also the external conditions for green lending affected by such behavior. Using the closing price of carbon finance spots published daily by the BlueNext Exchange, Chun & Wang (2012) applied the extreme value theory (EVT) to establish models and analyzed the left and right 10% tails of revenue rates. Most studies on commercial bank revenue models adopt the concept of “residual income” to evaluate enterprise value and apply the complete residual income theory as the basic theoretical model for evaluating enterprise value. Zhang, Yang & Zhang (2015) studied the copula function method of dealing with the nonlinear correlation between risk factors, constructed the Copula-ARMA-GARCH model and calculated Monte Carlo simulation of the integrated VAR of carbon market multi-source risk. Gao & Yu (2007) propose the asset volatility method and the income volatility method.

They apply the income volatility method and use the stock acquisition of Shenzhen Development Bank by Newbridge Capital as a case study to conduct a Monte-Carlo simulation by applying the matrix laboratory (MATLAB) procedure. Xu., Deng & Thomas (2016) develop a stylized model to investigate the impact of financial options on reducing carbon permit price volatility under a cap-and-trade system. Rogers et al. (2015) takes an integrated analysis approach to explore the options available for a UK homeowner to reduce their domestic emissions to the level advised by the UK governments Committee on Climate Change of 20% of those associated with a typical house in 1990.

At present, there is a lack of empirical model construction and analysis in the research of commercial banks' carbon finance business, especially the core and foundation of theoretical research. Therefore, this paper creatively constructs the carbon emission benefit model of commercial banks and reveals the income of China's commercial banks to carry out carbon finance business through hypothesis analysis.

**The Revenue Model of Commercial Banks’ Carbon Finance Businesses**

This part first analyzed the introduction of emission-reduction equipment and the purchase of carbon emission rights by emission-reduction enterprises to determine their carbon emission amount and to further determine product cost. Next, based on enterprise financing, this part established a carbon finance revenue model by comparing the revenue of commercial banks that have carbon finance businesses. Last, this part discussed the theoretical conditions for commercial banks to develop carbon finance businesses.

**The Amount of Carbon Emissions Reduced by Emission Reduction Enterprises**

First, we determine the amount of enterprises’ carbon emission. We consider a representative enterprise and assume that without any emission reduction measure, the enterprise’s normal carbon emission is $x$ ton.
and the enterprise’s restriction of its carbon emission is \(x_0\) ton. Because \(x_0 < x\), the enterprises must reduce their carbon emission to the standard \(x_0\) ton. Here, we assume that the enterprise can reach the reduction standard by only two methods, with one method being the introduction of reduction equipment. Assuming the enterprise introduced \(n\) emission reduction equipment, the carbon reduction amount of each equipment is \(x_1\) ton, but such equipment requires a huge amount of fixed assets investment. The other method is to purchase carbon emission trading rights from the carbon-trading market. Assuming the price of carbon emission rights is \(p\) yuan per unit and the carbon emission amount purchased by the enterprise is \(x_2\) unit, the functional relation can be derived:

\[
x = x_0 + nx_1 + x_2 \quad (1)
\]

In the formula, \(x\) represents the amount of carbon emission of the enterprise without any reduction measure, \(x_0\) is the enterprise’s standard carbon emission, \(n\) is the number of pieces of reduction equipment, \(x_1\) is the emission amount that each piece of equipment can reduce, and \(x_2\) is the amount of carbon emission purchased from the carbon trading market.

**The Production Costs of Emission Reduction Enterprises**

Assume that the costs being considered here include only carbon-emission-related costs and the effects of output. In other words, if the output of the enterprise is constant, then:

\[
c(x) = c(x_0 + nx_1 + x_2) \quad (2)
\]

In the formula, \(c(x)\) is the enterprise’s production cost. Because \(c(x)\) only represents carbon-emission-related costs, the more carbon emissions, the more cost savings. Thus, the production cost is negatively correlated to the carbon emission amount, and then:

\[
\frac{dc(x)}{dx} < 0 \quad (3)
\]

In the formula, \(x\) represents the carbon emission amount without any reduction measure by the enterprise, and \(c(x)\) is the production cost of the enterprise. The actual amount of carbon emission after the enterprise’s emission reduction is the sum of its carbon emission rights and the rights that the enterprise has already purchased from the market. Accordingly,

\[
x' = x_0 + x_2 \quad (4)
\]

In the formula, \(x'\) is the actual amount of the enterprise’s carbon emission, \(x_0\) is the enterprise’s carbon emission standard, and \(x_2\) is the amount of carbon emissions purchased from the carbon trading market. Thus, the revenue obtained by the enterprise due to social and government recognition of its carbon emissions can be illustrated as:

\[
R(x') = R(x_0 + x_2) \quad (5)
\]

In the formula, \(R(x')\) is the revenue obtained by the enterprise due to social and government recognition of its carbon emission. The more carbon emissions the enterprise has, the less revenue it can obtain from social and government recognition. Accordingly, revenue is negatively correlated to the actual amount of carbon emission. Therefore,

\[
\frac{dR(x')}{dx'} < 0 \quad (6)
\]

In the formula, \(x'\) is the actual amount of the enterprise’s carbon emission, and \(R(x')\) is revenue from the social and government recognition obtained by the enterprise.
Revenue Analysis of Commercial Banks’ Carbon Finance Businesses

Enterprises’ financing activities: Assuming the capital of the representative enterprise is all from bank loans, financing activities can be divided into two phases: the first phase is borrowing from commercial banks, and the second phase is repayment. The amount of money that the enterprise needs to borrow in the first phase is as follows. First is the production cost \( c(x) \), which is borrowed based on the market interest rate \( r_0 \). Second is the carbon emission rights purchased from the carbon trading market; the fee is \( px_2 \), which is also borrowed at the market interest rate \( r_0 \). Finally, the cost of purchasing \( n \) emission reduction equipment is \( nF \), which is borrowed at the interest rate \( r_1 \). Because the government and banks encourage enterprises to actively conduct emission reductions, interest rate \( r_1 < r_0 \). In the second phase, an enterprise’s repayment amount can be illustrated as:

\[
L = (1 + r_0)[c(x_0 + nx_1 + x_2) + px_2] + (1 + r_2)nF \tag{7}
\]

In the formula, \( L \) is the enterprise’s total repayment amount, \( r_0 \) is the market interest, and \( r_1 \) is the favorable interest rate. Because the enterprise reducing carbon emission can obtain social and government recognition and obtain revenue, the enterprise net repayment amount is as follows:

\[
NL = (1 + r_0)[c(x_0 + nx_1 + x_2) + px_2] + (1 + r_1)nF - R(x_0 + x_2) \tag{8}
\]

In the formula, \( NL \) is the enterprise net repayment amount, and \( R(x_0 + x_2) \) is the revenue obtained by the enterprise from carbon emission reduction. The problem then becomes to seek the minimum of \( NL \) under independent variables \( n \) and \( x_2 \). The first-order conditions are as follows:

\[
\frac{dNL}{dn} = (1 + r_0)c'(x_0 + nx_1 + x_2)x_1 + (1 + r_1)F = 0 \tag{9}
\]

\[
\frac{dNL}{dx_2} = (1 + r_0)c'(x_0 + nx_1 + x_2)n - R'(x_0 + x_2) = 0 \tag{10}
\]

Once the minimum net repayment amount has been determined, commercial banks’ revenue from providing financing for enterprises that reduce their carbon emission can be determined. Because commercial banks provide loans at favorable rates to assist enterprises in reducing carbon emission and environmental pollution caused by production, enterprises will obtain social benefits (such as government rewards, social honors, good will, and image improvement), which can be illustrated by the following formula:

\[
W_1 = r_1nF + r_0[c(x_0 + nx_1 + x_2) + px_2] + R(r_1) \tag{11}
\]

In the formula, \( W_1 \) is the revenue of commercial banks that provide financing for carbon finance projects, and \( R(r_1) \) is the social benefit commercial banks will obtain. Commercial banks’ revenue from regular loans is as follows:

\[
W_2 = r_0nF + r_0[c(x_0 + nx_1 + x_2) + px_2] \tag{12}
\]

In the formula, \( W_2 \) is commercial banks’ revenue from regular loans. The revenue difference under these two conditions is as follows:
In the formula, $W'$ is the difference between commercial banks’ revenue from carbon finance projects and regular loans, which is $W_1' - W_2$.

Based on the preceding, realistically speaking, to encourage commercial banks to participate in carbon finance projects, it is necessary to ensure that they can obtain more revenue and higher profits from carbon finance projects. According to formula (13), $r_1 < r_0$ and thus, $(r_1 - r_0)nF < 0$. Represents the social benefit obtained by commercial banks from carbon finance project financing; $R(r_1) > 0$. Thus, the condition for $W' > 0$ is $R(r_1) > (r_0 - r_1)nF$. In other words, the social benefits obtained by commercial banks from carbon finance project financing outweigh the revenue decrease resulting from the favorable rate.

Therefore, based on the preceding analysis and comparison, it can be concluded that commercial banks’ carbon finance businesses are affected by various factors such as financing revenue, social benefit, reduction in enterprise’s financing activities, and government interest rates. Also, it is worth noting that the risks of commercial banks’ carbon finance businesses are unavoidable. Therefore, the measurement of operational risks is the core and foundation of commercial bank risk management. The EVT and the Loss Distribution Approach (LDA) can be used to measure commercial banks’ operational risks. Feng et al. (2011) analysis of Chinese commercial banks’ operational risks and loss data indicates that the results of the two measurement methods have a relatively high degree of consistency, whereas the difference in the results from two types of distributions using the LDA is larger than the difference in the two methods. From a policy perspective, the risks of EVT and LDA arise out of the application process rather than the model selection. Thus, what is important is how banks apply the selected models.

Conclusion

By analyzing the production and operation of representative emission reduction enterprises, this article creatively established the theoretical model for commercial banks’ development of carbon finance businesses and subsequently studied their revenue. The study finds that commercial banks’ carbon finance businesses are affected by various factors such as financing revenue, social benefit, and reduction in enterprise’s financing activities, and the government interest rate. When the social benefits obtained by commercial banks from carbon finance project financing outweigh the revenue decrease resulting from the favorable rate, the revenue of commercial banks from carbon finance projects outweighs that from regular loans. This article theoretically confirmed that commercial banks’ carbon finance businesses could increase their operating revenue and can facilitate the achievement of the win-win objective of emission reduction enterprises and commercial banks.

References


Construction of Performance Evaluation System for Public Projects Based on Public Satisfaction

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[Abstract] Bing founded on public satisfaction; this paper analyzes the necessity of the construction of performance evaluation index for public projects. After discussing the principles and priorities of index construction, the initial indicators are proposed, and the feasible and reasonable methods to establish the evaluation system are penetrated as well. As a conceptual and theoretical study, it is concluded that public satisfaction should be integrated into the performance evaluation of public projects, not only because of the dominated goals but also the requirements of continuous improvement for public projects.

[Keywords] public projects; public satisfaction; performance; an evaluation system

Introduction
With the developing economy, Chinese governments increasingly pour lots of funds in public works. From 2006 to 2015, annual fixed assets in municipal public utility construction roared from 576.51 billion yuan to 16204.4 billion yuan (MOHURD 2016). Due to the large scale of investment in public works, there are inevitably accumulated problems, such as projects of low quality, and then casualties damaged by these defective public works, high pollution, resource wasting, and even corruption, etc. The performance evaluation of public works, refers to using scientific and normative evaluation methods to compare anticipated target, process and results of economy of public investment behavior, efficiency, and comprehensive evaluation (Zhu et al. 2009). Therefore, performance evaluation is now transparent to public and is taken seriously. However, the performance evaluation system of public projects in China is still in its infancy and needs to be perfect. Moreover, the goal of public projects is to maximize public interest so that public satisfaction will be an important indicator of public project performance evaluation. After consideration of the above issues, this article provides certain guiding role for the government to improve the performance evaluation of public project.

Literature Review
Reviews on the Performance Evaluation of Public Project
The United States is the world's earliest countries taking account of examination and assessment of public projects. In the 1960s, American accounting agency firstly established the rules, e.g., Economy, Efficiency, and Effectiveness, recognized as "3E" government performance of typical structure paradigm, and later joined Equity, building the structure factors of "4E". Also in January 1993, the United States Congress passed the Act of Government Performance & Results, as an important legal basis for performance evaluation of public projects used by the science and technology departments.
Project output should not only contain economic profits, but also include social benefits. This definition provides a measure of social benefits and foundation for the national economic evaluation (Depuit, 1884). After social benefits are presented, the performance evaluation gradually goes into the public view; organizations can get citizen trust through performance evaluation, the public will think the corresponding reasonable after the tax return (Ammons 1995). Advocated by the public, the emphases should be laid on the questions such as effective administration, accountability fulfilling, meeting stakeholders’ expectation, result-oriented (Flynn, 1997).

Since the 21st century, regarding public project performance evaluation in China, great progress has been made. In 2006, Methods and Parameters of Economic Evaluation for Construction Projects was authoritatively issued by departments of central governments. Building a set of the reasonable and feasible index to scientifically evaluate public projects is necessary (Jia et al., 2003), to improve management and performance (Zhang, 2006). Only by this comprehensive and effective evaluation index, performance evaluation can be exactly implemented, in-depth analysis can be reached, and finally performance improvement can be targeted (Du et al., 2008). Chinese scholars have made some penetrations. Evaluation methods, indicators, standards, and procedures are analyzed for different types of public projects, for example, science and technology projects (Li et al., 2004), fiscal expenditure projects (Zhang et al. 2007), and environmental protection projects (Zhai et al., 2009).

Reviews on Public Satisfaction

As a result of increased focus on performance evaluation by governments, public satisfaction, which centers around the public and set public perception as the criterion, moves into the public view. Once OECD proposed the idea of an analogy between the public and the client, which indicates that public administration is a kind of service, and the public is the same as clients. Hence clients’ roles among public and private sectors converge (Hughes, 2001). The public satisfaction index (PSI) evolves from the Customer Satisfaction Index (CSI) and stands for a perspective of the beneficiaries’ satisfaction evaluation (Chen et al., 2006). When using PSI to evaluate the governments’ performance, it shows the urgency and necessity of application of administration philosophy in public satisfaction (You et al., 2004), for instance, to analyze the key factors of satisfaction for rural public service (Li et al., 2010).

In aware of the importance of public satisfaction on Chinese project performance evaluation, the study of the public satisfaction index system for public service, the discussion of factors influencing public satisfaction among the government service, and the ways to improve the public satisfaction have already become the important fields in current research scholars.

Reviews on Project Performance Evaluation Based On Public Satisfaction

Along with the advancement of democracy in our country, public satisfaction will be the fundamental orientation of government re-engineering and ultimate goal. Government performance is no longer a simple set of synthetic statistical indicators. Government performance must reflect the people's satisfaction (Zheng et al., 2007), and establish a scientific performance evaluation mechanism to meet the inherent requirement of high performance in the definition of public satisfaction government (Zhu et al., 2009), which is the foundation of satisfaction orientation for government projects performance evaluation (Zhu et al., 2008). Here citizens’ satisfaction is a primary measure of public service and government performance (Hu et al., 2014). The measure indicators should be proved as holding the nature of operability (Liu et al., 2006) as well as effectiveness and science (Hu et al., 2009).

In summary, in China, there is some exploratory research on the operable attribute, scientific analysis and rational nature for evaluation system of public service, yet little study on the index
construction for performance evaluation of public projects based on public satisfaction. Public satisfaction should be one key factor in public project evaluation criteria to improve performance. Under this recognition, this article attempts to construct a performance evaluation system to effectively evaluate the performance of public projects and finally improve projects’ management.

Build the Initial Index System

The Principles of Index System Building

Based on public satisfaction of performance evaluation for public projects, the performance evaluation index should be effective, applicable and rational. Therefore, the selection of evaluation index should follow certain principles, and start from the overall welfare to meet the needs of stakeholders. These principles are:

Macro nature. Selecting the public project performance evaluation index should proceed from the overall situation of national development to promote the social and economic benefits and welfare, rather than being confined to the project evaluation of their own interests, but should.

Comprehensive nature. Public projects own the characteristics of a large investment, long construction period, affecting a wide range. Besides the projecting area, it will exert negative or positive impacts on a much wider region. Therefore, it should care about all factors and stakeholders.

The orientation of public value. The public is beneficiaries as well as evaluators of public projects; the public project is closely related to the interests of the public. Therefore, when conducting a performance evaluation, we need to start from the public interests and value, then fit well maximizing public interests in with optimal social welfare.

Response to the real public demand. Since public projects serve the public, then before making the public project performance evaluation index, it should start from the actual demand of the public and consider the opinions of the citizens, ensuring full compliance with the interests of the citizens as well as democracy.

Convenience of operation. The selected index should be operable, representative, logical and independent of variables; it also should consider the design of index data which can be collected easily.

Public equity. Unlike private projects, public projects are funded by the public whose values and preferences are diversified, so in the selection of public project performance evaluation index, we should take account of the fairness of interest distribution between different stakeholders.

Dynamics. Indicator selection for performance evaluation of public projects will vary over time because of the nature of changes on the environment, time and other external conditions. So, at a time we should improve our decision according to the actual project performance and the changing external conditions and internal factors.

The Construction of Initial Indicators

Considering the above principles, we propose a model as an initial index from six aspects, e.g., evaluation of project reputation, project cognition, project significance, project process, project management, and project solution. The model will emphasize the importance of performance evaluation and originate from the Public Satisfaction Model (Zhu et al., 2009), as shown in figure 1.
Public Satisfaction

Figure 1. The framework of initial indicators for public-satisfaction-based project performance evaluation

**Project reputation.** Project reputation refers to the formation of recognition and the degree of satisfaction by the public, according to their value judgment after comprehensive evaluation of a public project and its related factors. Hypothetically, the project reputation is positively related to public satisfaction.

**Project cognition.** Project cognition refers to the extent to which the public project is known by the public, including the depth of understanding and span of recognition, which will respectively be defined the details of relevant information and levels above a certain area known by the public (Zhang et al., 2006). The higher project cognition, the easier and more accurate the project performance evaluation.

**Project significance.** Project significance to the society will be assessed via a post-evaluation which will be examined from economic, social, environmental, and sustainable factors. The public will push up their satisfaction when public projects show the importance to enhance the above factors.

**Project process.** A project will process some stages, e.g., conceptual design, early development, detailed design, production, closure, and operation (Shtub et al., 2007). Process evaluation includes the indicators of project completion and its quality.

**Project management.** Project management is divided into areas as time management, cost management, quality management, risk management, contract management and so on. Public evaluation for each project management area emphasizes on management capability and goal achievability (Jiang, 2013). Excellent management will promote public satisfaction.

**Project solution.** During any stage of a project, there will be some unexpected problems. How to resolve these problems, including methods, results, and consequences, will be appraised by the public, which will inversely interfere with public satisfaction.

**Construction Methods of Evaluation Index for Public Project Performance**

The construction of the comprehensive evaluation index can be used via the expert survey method, the minimum mean-variance method and the minimax difference method (Hu et al., 2000). Above proposed methods are based on the initial indicators of public satisfaction index for public project
performance evaluation, namely the first-level indicators. From the entire index system building, these indicators need to adopt further scientific and reasonable refined subsystems according to the specific situation of the public project, such as secondary and tertiary indicators, and in nature, they can be divided into the quantitative index and qualitative index. Some of which can index for direct quantitative indicators. Jiang (2013) discovered that for other indicators which cannot be quantified directly, required methods should firstly be characterized by fuzzy language, and then ways used via consulting the expert opinion and questionnaire to obtain data, which specifically set up the evaluation system. After the completion of the evaluation system, we can compare and select appropriate methods of performance evaluation.

Main methods include the Analytic Hierarchy Process (AHP), fuzzy comprehensive evaluation method, artificial neural network method, grey cluster evaluation method, etc. For example, when adopting AHP, we need to experience five steps: identify the goals of the evaluation; establish the hierarchical model structure; set up comparison matrix; conduct single level sequencing; test consistency; classify the sort of level (Meng, 2008). In selecting the performance evaluation methods, according to the nature of public projects, we can flexibly choose various evaluation methods proposed above and combine a variety of evaluation methods when necessary. When index weights are determined, by using linear weighted model, combined with weights of the index and the values of parameters, we can calculate composite scores of the whole model (Chen et al., 2008). Then, according to the above scores, finally, we can evaluate the performance of public projects.

Conclusions

Public projects are critical to the development of a country and society. Since they set the goal to serve the public, the real needs of the public should be taken into account. Thus, the performance evaluation of public projects must start from the vital interests of the masses and be on account of public satisfaction. With fair certainty, it is time to establish a set of scientific and reasonable performance evaluation system for public projects in China. This conceptual and theoretical paper presents the principles of construction based upon public satisfaction with public project performance evaluation system; and after examining basic principles, the performance evaluation system of public satisfaction and public projects are combined to determine the initial indicators of performance evaluation for public projects. Thereby we also put forward the evaluation method and procedure, construct the initial performance evaluation index. Due to dynamics of the establishment of performance evaluation system for public projects, the established index in this paper should be changed according to shifts of external and internal factors among different projects. Continuous should be founded on public satisfaction to increase the effectiveness of performance evaluation.

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Chapter 14: The Philosopher: Feasible or Desirable

Science accumulates knowledge faster than society accumulates wisdom.

------ Isaac Asimov

My God, what have we done?

Robert A. Lewis
Co-pilot of the Enola Gay

The Enola Gay was the infamous American B-25 bomber from which the first atomic bomb was dropped on Hiroshima, Japan on August 6, 1945. Robert Lewis had a terrifying first-hand look at the massive destruction that the bomb wrought, and he immediately grasped its terrible meaning.

On the ground the experience was much more terrifying. 60,000 to 80,000 people died instantly, and 100,000 more died in the following days and years. Most of the survivors never recovered their trust, their faith, or their health.321

But of course the bomb affected not only those who were there, but all humanity. The explosion of the atomic bomb that decimated Hiroshima fundamentally altered humanity’s collective understanding of reality, as at that moment the world learned something profoundly new and also deeply troubling about the enormous destructive power inherent in nature, about the dreadful capacity of science to decode that power and apply it to human purposes, and simultaneously about the willingness of humans to vaporize one another, whether justly or not, in service to war. Science in that instant became the indispensable tool of statecraft, the vital strategic asset that every nation has since pursued relentlessly. Henry Kissinger explains the shift this way:

The traditional balance of power emphasized military and industrial capacity. A change in it could be achieved only gradually or by conquest. The modern balance of power reflects the level of a society’s scientific development and can be threatened dramatically by developments entirely within the territory of a state.322

Those “developments” being, of course, the atomic bomb. And so the very notion of the nation-state itself was transformed from one of primary importance in the global system to secondary because now it was any individual who had a bomb who also had the power, state or no state.

The Philosophers

The bomb is the ultimate example of humanity’s proclivity to do what is feasible regardless of how undesirable it might be. Philosophers have always been concerned with such topics, with difference between what we can do and what we ought to.
And it seems that philosophy has been with us since long before anything was written down, and once we did start writing it was to define or decree the differences between right and wrong. The Code of Hammurabi, a set of codified laws that defined 282 specific rules for conduct and transactions, covering everything from contract law to divorce, was written down more than three and half millennia ago. It was based on even older sets of laws, which we infer were themselves based on oral traditions in societies that existed before writing.

In the West it was the Greeks who embraced philosophy as a core of their civilization and passed down to us the foundations of many of our beliefs about ethics and community. In China the great philosophers such as Lao Tze and Confucius explained the workings of the cosmos and defined the proper and harmonious roles for the emperor, the parent, and the child, and these notions are still highly influential in China. In India the great Buddhist and Hindu philosophers described the universe as the Great Wheel of 84, the 8,400,000 living species through which all souls migrated one after the next throughout the great cosmic cycles of creation and destruction.

The question that all of them engaged in answering was the definition of what is right. What is the right thing to do, and to not do? As each society has come to these definitions and decisions for itself it set itself therefore on a path that largely defined not only what could and could not be achieved, but what should be achieved.

In our times we know that rapid change is an inescapable aspect of society and that we will be compelled to make choices, significant ones, as events unfold. And we are confronted, as we saw in the last chapter, not only with a potential cascade of practical problems that could result from our past choices and the ones yet made, but also with a set of philosophical ones related to our self-definition.

For self-definitions do frame our choices as much as they also express our values, and in this way philosophy becomes not just a matter for philosophers to consider in the abstract, but like Hammurabi, a very practical set of issues that we will inevitably confront. What choices will we be presented with as a result of the choices we made previously? And which are the best options for the future? Are we willing to define what is “best” based on a set of enduring principles, or will be compelled by events or by our own short-sightedness to choose short term expedience?

Turning Point

August 6, 1945 marked a turning point in human destructiveness and thus in human inhumanity, and now 70 years later we are fully aware that humanity is engaged in a race between human culture and human evolution. Culture is moving ahead much more quickly that our genes can adapt, so the limits that we face are no longer the ones defined by nature and evolution through the millions of years process that took us from single cells to brains of 100 billion cells and 1000 trillion connection between them, but our standards and rules and values. The scale of our abilities is far greater than it’s ever been, and thus our capacity to make change has raced far ahead of our capacity to comprehend and manage it.

Further, due to the continuing expansion of our scientific and technological knowledge we are no longer tinkering only at the fringes of fundamental forces of nature, but closer and closer to their very core. As Dr. Kissinger notes in the quote above, it is no longer society or the nation that holds the all power; it is the one who holds the bomb. Or the deadly virus, or the malware code, or the cruise missile, or even the controls of the combat-ready drone that is circling about, but 5000 miles away.

The gene and the protein and the cell, the atom, the electron, and the photon, these are our media at the micro scale, while the oceans and the ice sheets and the climate and the forests are our media at the macro scale.
Physics, biology, chemistry, climatology and a thousand specialties and subspecialties define the realms of science, and through the tools they have given us we are acting directly on the essential and formative elements of these systems on a scale that affects all life. Unprecedented power lies at our fingertips. But not, unfortunately, unprecedented wisdom.

We are confronted, then, with a potential mismatch between what we could do, the feasibility of our means, and our ability to decide and agree on what we ought to do, the desirability of our ends.

This is occurring not because any individual chose it to be this way, but because of how evolution structured us, and how we in turn have structured our society and our economy. Evolution gave us powerful penchants for experimentation and for competition and especially for collective learning widely shared and then augmented and passed down from generation to generation, and we’ve put these impulses at the forefront of our social and economic systems.

We readily fund new scientific and technological endeavors that could provide military advantage or commercial profits, for these are the inherent dynamics of a competitive multi-state planet that is immersed in capitalism. And then we sort out the consequences later on, and as a result, we have gotten ourselves into the situation so eloquently and concisely described above by Isaac Asimov and by Robert Lewis.

The point, of course, is that given the five revolutions, the antirevolution, and our geopolitical realities, the gap between the feasible and the desirable is only going to get wider. We must expect in the next few decades to see massive increases in the extent and consequences of newly gained knowledge, and thus in the power and impact of new technologies, as progress across all fields of study leads to massive breakthroughs at the micro, macro, and intermediate scales. All of which will massively affect our daily lives, our social systems and structures, and our future prospects. As we continue in the acceleration in the process of change, life will inevitably present us with a great many important decisions to make.

Further, we will frequently be making these decisions after the fact, but we will nevertheless be obliged, as nations and as a global society, to decide between the merely feasible and the legitimately desirable. Many of these will not be easy to make, and while some competing interests will surely be vehemently in favor, others will violently oppose. It will be our challenge to sort it all out, and to do so in relatively short order.

This is how societies develop now, thrust forward by events not of their own choosing, but from which they cannot escape. And as we study the history of civilizations it seems that it has been this way for millennia. Archaeologist Joseph Tainter examined the underlying dynamics by studying 18 pre-modern societies and he identified a pattern that explains a great deal about how societies have evolved to higher levels of complexity, and the unique challenges and situations they face as they do so.

As societies increase in complexity, more networks are created among individuals, more hierarchical controls are created to regulate these networks, more information is processed, there is more centralization of information flow, there is increasing need to support specialists not directly involved in resources production, and the like. The result is that as a society evolves to greater complexity, the support costs will also rise. … In many crucial spheres, continued investment in sociopolitical complexity reaches a point where the benefits for such investment begin to decline, at first gradually, then with accelerated force.323
What Tainter describes here is now considered a law of economics, the law of marginal returns. In essence, there comes a point at which it costs more and more to produce just a little more. As this “overhead” creeps upward and the continuing efforts to produce and succeed become more costly individuals and institutions begin to lose confidence. Tainter’s studies of far history show that societies reach a point at which the investment is no longer supported, and they collapse.

**Culture and Evolution**

As of today, sadly, the world’s inventory of nuclear weapons has ballooned to about 15,000, a welcome reduction from the 65,000 bombs that were deployed at the height of the Cold War, but still more than enough to terminate civilization hundreds of times over. Most of them are far more powerful than the one dropped over Hiroshima because our skill at bomb-making is considerably improved. This is our creativity run amok.

And whether the number of bombs is 65,000 or 15,000, both are insane and ridiculous. More broadly, they reflect the cultural norm that we are living in a society that is obsessed with doing whatever is feasible but which gives far less attention to what is desirable or sensible. And as a result, whether it is through negligence or malice or naiveté, our intended solutions frequently become the bases of our subsequent problems. Asimov was quite right that our capacity has far outrun our wisdom.

What, then, shall we do about this imbalance?

Sometimes we agree about what is right and not right, and when that happens change can occur stunningly fast. When a nation or a culture suddenly comes into widespread alignment that it’s time for change then the will of a people can be overwhelming. Hence, the astonishing power of the Tunisian and Egyptian Arab Spring protests was not only due to the massive number of people who turned out in the marches, more than a million in Cairo, but also the depth of commitment and apparently the extent of the agreement that they felt. When millions of people feel compelled to take to the street change may arrive very quickly. Mubarek’s regime was toppled in days.

In other situations, however, change emerges much more slowly, and it takes extended periods of years or even decades for society to adopt new standards, new rules, or new behaviors. This is particularly true in democracies since they are founded on collaborative social process and in which slowness is actually built into the system. The structure of the American system of government is specifically and consciously designed to slow change down by utilizing the principle of so-called checks and balances. That is, when there is widespread agreement about what needs to change, then change can be instituted almost immediately. But when there is disagreement, and thus other than in immediate crisis situations such as war or epidemic, then each of the three branches of government can effectively stop the other two from pushing through something new. Consequently, most major decisions are made slowly and deliberately, often agonizingly so. Significant issues can be debated for years or even decades before change is brought forth, and the system provides great powers to those who oppose impending change that they can use to completely block change from occurring.

Hence, during the last two centuries, social change in American has advanced mostly step by agonizing step even in fulfilling an important core principle of the American system, the idea that all “men” are created equal. It took decades after the Revolutionary War to eradicate slavery, and only then because of a bitterly destructive war. Even now, another 150 years later, visible symbols of that war are still present and bitterly debated, and the lingering remnants of racism are felt every day in communities across the country.324 A recent study revealed that President Obama’s skin color had been noticeably darkened in opposition campaign advertisements, a regressive return to an old racial stereotype.
Similarly, the extension of voting rights from American men to women also required more than a century, and now there is a strident debate about many issues, as we discussed in Chapter 12; about whether Americans have a right to health care, about which Obamacare says yes and the opposition Republicans say no, about whether LGBT citizens have equal rights, about the extent of America’s international responsibilities, about environmental protection and education, and about the right or nonright of society to restrict ownership of guns. Americans are also arguing about the extent to which government policies should be shaped to address the threat of climate change, and there is wide disagreement from state to state about the extent of the risk, and about the appropriate responses to take or not take.

In Europe many of the issues are similar, and now Europe’s grand experiment is with continental unification, which means grappling with the realities of a common currency but national indebtedness, and with common borders but quite different attitudes toward immigrant refugees, and thus with difficult issues of social costs and cultural assimilation and diversity.

And while Americans and Europeans struggle to agree on the extent of inclusion and rights, the Russians transitioned from a totalitarian monarchist empire to a totalitarian Communism one, and now perhaps to democracy in name but what appears in practice to be a totalitarian autocracy. In China, meanwhile, a totalitarian empire for millennia was briefly a quasi-democracy before becoming the Communist autocracy that functions today, but it is certainly not a nation without dissent.

By some counts there are dozens or even as many as 500 hundred protests each day across China, as citizens express their discontent about local development policies, land seizures, corruption, environmental pollution, and even democracy itself.326 And while the senior leaders in Russia and China certainly have more latitude to take action on a strategy or a whim, still the social and economic issues that they will be grappling with in the coming decades will be no easier to solve than those in Europe and the US, or in India, Brazil, and South America and across Africa and Oceana. Change is coming to all of us, and decisions will be required of all of us.

From Data to Wisdom 327

We know intuitively that there’s an excess of data in the world and an absence of wisdom, and the great systems thinker Russell Ackoff has given us a way to understand the connection between them.

In the industrial economy, he points, out, those who knew what to do with machines were successful. Today, however, there is a digital economy precisely because knowing how to use digital information is the key distinction between those who are successful and those who are not. Information has not replaced industrialism, but it has changed everything about how industrialism is carried out. Data, and data filtered into information are the raw materials of this economy.

In addition to collecting data and information, another important aspect of this technological pattern has to do with sending it from one place to another. When long distance communication required the writing and posting of a letter it could take weeks or even months to reach its destination, and the same for the reply to arrive. The cost of coordinating large and widely disbursed government and business enterprises was high, and response times were long. Because of computer chips, the cost of sending messages has, for us, reached unprecedented lows; it costs nothing. Numerous technologies, including satellite communications, fiber optics, cable TV, cell phones, email, networking, and video conferencing are all essentially instantaneous and free.

The underlying marketplace phenomenon that drives this entire process is, of course, the fact that information is economically useful. Each subsequent information technology increases society's
reliance on information, and thereby our reliance on information technology. An ever growing proportion of humanity's resources are directed into the development and deployment of computers and databases, and now robots and self-driving cars.

Figure 105. Data Must Be Filtered to Become Useful as Information

Today's paper money, which is itself entirely symbolic, is being replaced by an even more ephemeral form of information, electrons and bits of worthless computer code that represent the ownership of tangible assets all around the globe. Electrons thus represents money, which itself just represents buying power; they zip around the globe from continent to continent in a process so abstract that no one ever sees it or touches it.

Available in such abundance and transmitted so cheaply, information has become a commodity. It is bought and sold, mined, refined, and traded, just like physical commodities such as oil and iron ore. But information has different properties than material commodities, for although it has no mass and no size, its consequences are economically decisive. Information is purely potential, a unique energy that motivates every aspect of human culture.

Another reason that information is unlike other commodities is that it isn't necessarily used up when it's used. More than one person can use the same information, and each can receive unique value. Sharing information may actually increase its value, as the purpose of collaboration is to make information more useful by combining the informed intelligence of many individuals into ... new information.

Some information is most valuable when it is a secret - that's why every nation has its army of spies. Companies are also intent on protecting their secrets, mostly consisting of technical information that has been accumulated at great cost and which may be used to create new distinctions, and thus advantage in the marketplace. Sometimes, however, a secret that was valuable yesterday isn't worth anything today, for as the rate of change increases the likelihood also increases that a particular piece of information will quickly become irrelevant. New technical information replaces older technical information over night, particularly in the most rapidly changing marketplaces such as computers. Thus, last month's breakthroughs may not be unique or interesting for very long.

The root of the word information is 'inform,' from Latin meaning 'to give form to.' Information is that which provides shape or character, as a potter gives shape to the clay or a sculptor to stone. But information gives form in a deeper way, for it is not so much an external shape that information affects, it is its subtle internal essence. This essence is most of all the meaning of words and phrases, for in their
meanings lie the greatest interest and the most importance. ‘Meaning’ has to do with the deep and fundamental issues of existence, with the source of commitment, of caring, and of the capacity to affect the future. It is the source of motive, the energy to pursue visions, to change the world and so to make it more like we think it ought to be. Information has tremendous power and profound impact on our lives and our journey through the world. We receive new information and we ask, “What does this mean?”

“Information is that which changes us,” suggests Stafford Beer, a subtle but quite powerful concept. Simply by knowing some piece of information, our actions are shaped; we choose to do, or to not do something, based on the information we receive. Likewise, a lack of information also shapes our actions, although we discover the lack only in hindsight: “If only I had known!”

Anthropologist Gregory Bateson proposed a definition of information that expresses the same sensibility, but with a different and very illuminating choice of words. He wrote that, “Information consists of differences that make a difference.” When its existence has been recognized, information has already made things different, precisely because having information causes us to perceive the world differently than before. Without being recognized or acknowledged, of course, it isn’t information – yet. But once it is seen or heard or read or felt, information is the ‘difference’ whose meaning has already resulted in changes in our perception. How we perceive the world has everything to do with how we behave in the world, so a change in our perception is utterly decisive.

Both definitions express the powerful relationship between information and action. The recognition that information exists leads immediately to action: information “changes” and information “makes.” Inasmuch as ‘making’ is the essence of exchange in our technological society, and inasmuch as ‘change,’ accelerating change in particular, now dominates every aspect of society, the power of information is literally compelling us into the future. And it is precisely this power that the corporation must master if it is to survive.

Knowledge and Wisdom

The ultimate payoff that justifies any investment in data collection comes when it is filtered into information that is useful. Information, in turn, can then be applied to the accomplishment of useful work as that immensely valuable phenomenon of the information economy: the knowledge of how to actually accomplish something. But knowledge comes about only under specific conditions, only when information is integrated with theory and with experience.

W. Edwards Deming observes, “Theory is a window into the world. Without theory, experience has no meaning. Without theory, one has no questions to ask. Hence without theory there is no learning. ... To put it another way, information, no matter how complete and speedy, is not knowledge. Knowledge has temporal spread. Knowledge comes from theory. Without theory, there is no way to use the information that comes to us on the instant.”
And in the words of Peter Drucker, “Only when a [person] applies information to doing something does it become knowledge. Knowledge, like electricity or money, is a form of energy that exists only when doing work. The emergence of the knowledge economy is not, in other words, part of ‘intellectual history’ as it is normally conceived. It is part of the ‘history of technology,’ which recounts how man puts tools to work.”

How closely this is aligned with the concept that’s embedded in the titles of each chapter here; the uniquely human capabilities that, together, make us human and define civilization.

The integration of theory, information, and experience creates knowledge, and it is the process of learning. From these distinctions we can see more clearly the difference between education and learning. As education comes from without, ostensibly from a “teacher,” it can be sure to convey only information, which may be delivered in the form of descriptions that are encoded and expressed through numerous media, including speaking, writing, drawing, and computer code. Learning, though, is entirely different. It is the very personal process of integrating theory, information, and experience into knowledge, and it can occur only within the individual. Such an integration cannot be forced to happen, which makes it apparent that learning leads to competence that is far beyond what education can hope to accomplish.

When someone questions us we and we respond, “I know what I’m doing,” it is intended to convey that we’ve done that integration on a very personal level. Such knowledge always and necessarily concerns the past, for as experience is one of its integral components, knowledge exists only as a consequence of what has already been done. Those who accept things as they are may have the knowledge to maintain the status quo, but their knowledge may not be sufficient to deal with the constant novelty of a rapidly changing environment. Thus, as important as knowledge is, it does not advance unless it is accompanied by the vision that looks toward the future and defines how things ought to be. More often than not, the view forward is stimulated by the asking of questions.

Russell Ackoff points out that beyond knowledge is where we find understanding and wisdom, which are even more fundamental to the responsibilities of management.
Whereas information, knowledge and understanding are concerned with doing things right, wisdom concerns doing the right things, and so it is only from wisdom that compelling visions can come. Here, but not before, do we have the means to distinguish between desirable and feasible.

Interestingly, when knowledge, understanding or wisdom are shared, they can be shared only as information. One person's knowledge reverts to information for those with which it is shared, until they reintegrate it in the context of their own experiences and their own theories, and thereby make it knowledge, understanding or wisdom once again. As I mentioned above, you cannot learn for someone else (although intriguingly, robots may be able to just that).

It was the ability to encode information in the form of computerized messages that propelled society from the industrial economy to the digital economy as it enabled people to share information with each other at an unprecedented scale and speed, leading to the creation of new knowledge also at an unprecedented scale.

Now that we are drowning in information, we are forced by our own economy to distinguish information from knowledge, understanding, and wisdom. We will become adept at distinguishing ‘doing things right’ from ‘doing the right things’ as we become more proficient at recognizing the important patterns, and at using models to understand the long-term consequences of our present-day choices.

![Figure 107](image)

*Figure 107. The series of transformations necessary to get from Data to Wisdom.*

**Patterns and Models**

Hence, the problem with all this data is that there’s too much it. Filtering is thus an essential issue for all organizations to grapple with, and it’s also fundamental to all organisms, including us. In fact, data filtering is an issue that is encountered by all systems, living and non-living. Systems exist in the context of environments to which they must adapt, and the precise nature of their efforts to adapt depend on the data that they gather about their environments, how they interpret the data, and how they then respond.
Our very existence is evidence that evolution has indeed solved the filtering problem. Our senses receive enormous quantities of data, billions of bits each minute especially through our eyes, and also our ears and noses and skin and taste buds. Transmitted as electrical impulses, the brain is able to make sense out of it all without being overwhelmed, enabling us to walk down a busy street without running into every person we pass, or every signpost, and all the while our conscious mind is thinking about some abstract problem in physics or philosophy, or about what’s for dinner.

The brain uses patterns to filter the stream of data it receives, to assemble it into coherent models of us-in-the-environment. Many of these patterns are developed through conscious learning: we learn to read, write, walk, and sing. Learning and creating the patterns of conscious behavior occupies a large portion of our awareness, beginning at birth and continuing throughout our lives.

At the same time that we are looking forward to the next good meal and some relaxing conversation, the brain is also actively engaged in filtering data that are sent from receptors located throughout the body. These receptors constantly measure the quantities of dozens of chemicals that perform metabolic functions. Oxygen and carbon dioxide in the lungs and blood must be calibrated with the heart rate, while digestion proceeds on that big lunch we had hours ago, and numerous hormones circulate throughout the body delivering messages to cells of various organs. We don't have to learn these patterns consciously (which would be impossible) because we receive them as part of our pre-programmed genetic heritage.

All metabolic data must be assimilated and interpreted immediately, because if any aspect of our metabolic functioning goes out of control we are likely to die. Three to five minutes without oxygen, for example, is about all the brain can tolerate. When all metabolic variables thus operate within the parameters that constitute ‘health,’ we are healthy. When they deviate from those parameters, un-health results, which often threatens the survival of the system. How does the body know exactly how much of which chemical is the right amount? For this it must refer to a pattern, a model value that is already established.

As we have discussed already, systems science has discovered that it’s not possible to regulate any system without using a model of that system, because regulation is fundamentally about comparisons between what ‘is’ and what ‘needs to be.’ Whether it is a human body or a business or the economy of a nation, regulation can only occur when regulatory parameters have been defined in a model that is outside of the system that is being regulated. This invariant reality pertains to all systems: “A regulator [of a system] contains a model of that which it regulates.”

If there is no model then there can be no regulation, for lacking a frame of reference through which the collected data can be interpreted, there can be no way to discern if events are happening as they should, or as they shouldn’t. And thus no possibility of taking precise and appropriate corrective action (other than by guesswork), and thus no way to assure that the system will continue to be viable.

Such a model can exist only at a different logical level than the system itself, for the model is a description of the system that is necessarily a different logical type. The model must include reference to the purposes of a system as well as the modes of its operation, purposes that are the expression of doing the right thing.

Models

The distinction of logical types between a system and its model underlies Einstein’s comment that, “We can never solve our problems at the same level at which we created them.”
These distinctions define the pathway from data to wisdom, and also frames the essence of our management task: we are obliged to create a model of our world and to choose based on our understanding of it. If we have, therefore, a poor model, we are likely to make poor decisions and to achieve poor results. This is precisely what happened with the Schleiffen Plan and Plan 17; as they drastically overestimated their own respective capabilities and underestimated the capabilities and determination of their adversaries, the stalemate resulted, which fully revealed the shortcomings in the models and also decimated both nations. An entire generation of young men was wiped out and Europe remained traumatized for the twenty years between the wars, and then the brutal duration of the second go round, and then the decade after that too. This was largely, although not entirely, the result of bad models.

In this book, I’ve described a lot of models, and it’s up to you as the reader to assess whether they’re good ones or not, although time will also make that assessment in due course. The concept of the five revolutions and the anti-revolution is a model, and so are all the various scenarios. Climate science is based on the powerful combination of data, modeling, and interpretation, and if any of the three are erroneous then the results will be too. But the much greater error could turn out to be the ideological model which says that it cannot be happening. If it is in fact an error, then at some point the evidence will overwhelm the ideology, but not before massive damage is already done, damage that could easily have been avoided.

The concept that a well-designed city is an instrument of a healthy society, and poorly designed ones promote ill health is likewise a model, and so is all of discussion about the economy and what makes it work or dysfunction. Greenspan’s model and Taleb’s, Randers’ and Zeihan’s they’re all models, all more or less useful depending on the context, but in any case the act of modeling is an essential part of how humans relate to the world, and a profoundly useful explanation for why we’ve been so excessively successful in altering the world to suit our desires and preferences. In Chapter 9 we discovered that we interact with the world through and largely because of our models of it, and of ourselves, and of the relationship between them. Our experiences are largely conditioned by our expectations and ideologies – we see what we believe, not vice versa. And what we believe is, in effect, a model.

**Problem Creation and Problem Solving: Fix the Models**

At the roots of this challenge are really two different problems. The first is a problem of mindset that arises if there is a mismatch between the problems – accelerating change and increasing complexity – and the mental concepts and tools that people are using to recognize and address them. If we cannot or do not recognize our problems and challenges for what they are and instead we try to ignore them or make them fit our preconceived notions of what they might be or we wish them to be, then there will be an enduring misfit between our models of the world and the world in which we actually live. This will lead us to make the wrong choices nearly every time. We will continually make incorrect diagnoses of our problems, and initiate counter-productive actions to correct them.

In effect, we will therefore find ourselves addressing the wrong problem. This situation is pervasive, and many of the visionaries that we’ve met in prior pages were particularly attuned to this, and particularly adamant about calling it to our attention. Hence, Jay Forrester’s paper on Counter-Intuitive Behavior of Social Systems was derived from his testimony to a committee of the US Congress, and he obviously wanted the Congressmen and Women to understand what they were getting themselves into;
that is, he wanted to give them a better model of policy and social change than the obviously less effective model they were at the time working with. Stafford Beer, similarly, addressed many global leaders and often worked closely with them to help them implement the thinking tools and management tools that he had devised.

So what is the right problem?

First, if you are a leader and decision maker then the quality of your models, both spoken and unspoken, mental and explicit, matter a great deal.

The connection between bad models, bad decisions, and bad outcomes is irrefutable. Hence, the problem is the model; as a strategic leader you must therefore engage in a very rigorous effort to improve your models. This is an unending process, as the external environment will be changing perniciously and your models, even if they’re outstanding today, will need constant attention to keep up.

And of course it’s not just you personally. Executive teams, collaborators, clients, we’re all using models, and we need to be attentive to those of our partners and team members as to our own, and to the organization’s “official” models.

What models are we talking about? Strategic plans, competitive landscapes, geopolitical assessments, technology roadmaps, even organizational charts, product designs, recruiting plans, education and training ….

Second, there will never be enough time to make decisions, nor as much information as you would like to have when decisions must be made. This is a fact of a leader’s life so you must prepare wisely. And make sure to prepare for the challenges to come, not the ones passed.

Third, the actions you take to reform your organization and adapt, when the changes you are anticipating or responding to are more than superficial, will inevitably provoke counter proposals and even counterreformations.

You do well to anticipate these reactive cycles, and in many cases to preempt them proactively.

We will return to these questions about leadership in Chapter 16, but in the meantime a few words about strategy as well.

**Strategic Initiatives**

In addition to the modeling and decision making issues that, done well, will clarify the supremely important differences between what is merely feasible and what is immanently desirable, there’s also the issue of strategy itself, and there are a few key points about strategy to be made here.

First, in our environment of accelerating change there is no substitute for innovation; it has become an utter imperative whose importance cannot be underestimated as a strategic competence. This applies whether your organization is a government or a company, or a small business, or really any size or purpose. If you’re not innovating then the world is passing you by. This is the subject of the next chapter.

Further, your capacity to learn quickly and thus to adapt, which I call super-learning, is, among all of the uniquely human skills and attributes that we’ve discussed throughout the book, also essential. It’s the subject of the Conclusion. 515

**The Momentum of the Market**

Because of the competitive nature of the marketplace and the powerful incentive that all market participants have to find competitive advantage, we continue to speed forward. We are compelled to do this by our social and economic systems, but not because whatever we’re doing is necessarily the right
thing to do. We have only to look at the dark history of the 20th century’s global scale violence to see abundant reminders of this, from the millions of casualties during the World Wars to the development of nuclear weapons to culturally-induced famines with further millions of casualties, to sexual slavery and repression of anyone who might be considered a minority, to large scale environmental destruction, to tobacco and addictive drugs. All of these errors and horrors also came about because of business or ideological decisions made by someone, somewhere.

These are just a few among countless examples that demonstrate our troubling proclivity for making unethical and immoral choices based on expedience and the desire for temporary advantage.

Interestingly, this is true not just in business, as even science itself sometimes operates according to the same dynamic. The acclaim, wealth, and power that accrues to the scientists who make the big breakthroughs is orders of magnitude greater than the rewards of second place, and so science is subject to intense competition that sometimes leads to ethical shortcomings. They are, in fact, a human problem.

When new technologies are in development, which is now occurring constantly, we don’t know if they’re going to work. Robots, nanotechnology, alternative energy systems, and biotechnology could have major impacts on our future, but as of now we simply cannot know for sure if they’ll actually arrive, and if they do arrive in what state of usefulness or destructiveness they will be. Their impact could be immense, either positively or negatively, or negligible.

And behind these four examples are a hundred more from fields of science that you may not have ever heard of, and still more in domains and specialties that haven’t even been invented yet, but they will be soon.

We know that scientists, technologists, and business leaders often have powerful incentives to continue their work. In many cases they are motivated by the pursuit of knowledge and also of fame, as well as by the lure of fortune. Technological progress, enabled by science, is the essence of the capitalist process that the Austrian economist Schumpeter recognized as creative destruction. This is the essential dynamic of marketplace innovation that we will examine in the next chapter.

But that does not mean that it’s particularly ethical, moral, or sustainable (sustainable in the sense that it promotes the long term health and viability of civilization). Nevertheless, as a society we revere the great ones who have made the big breakthroughs, and who would not want to be part of that esteemed club of heroes?

As a society we are therefore constantly faced with the challenge of what to do with the new stuff. How should we and will we use it? How should we and will we regulate it?

The cynic, the skeptic, and probably many of the realists would tell us that yes, society and ethics will always be chasing behind science and technology. The philosophers tell us, quite correctly, that the moral basis of any community, of any civilization, is an essential and utterly practical aspect of its existence. Faced with an infinitude of choices, the ones that lead to good outcomes will unequivocally align with the desirable, but rarely with the merely feasible. This inevitably raises difficult choices; the decisions that we make when confronted with this choice will ultimately tell us, and history, of our worthiness. In this way, philosophy becomes not merely an abstract subject, but an eminently practical one as well.
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