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Quality Management, Customer Inputs and Operational Complexity in Knowledge-Based Service Operations

Nanyama Inyo, Wainaina Githii

Department of Management Science and Project Planning, University of Nairobi, Kenya
Email: nanyama@uonbi.ac.ke, wainaina.githii@uonbi.ac.ke

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Abstract

Managing complex service operations requires a comprehensive understanding of the fundamental dynamics and intricacies that affect the performance of service firms. This study is a review of the critical literature on how quality management, customer inputs, and operational complexity are interrelated and their respective influence on the delivery of knowledge-based service operations. Research propositions are developed to illustrate the key relationships among concepts and basic components of service quality, indispensable customer inputs, and prime sources of operational complexity. The study identifies two dimensions of quality; process quality and output quality and four categories of customer inputs; physical presence, task performance, material belongings, and information and knowledge. The study pinpoints four sources of operational complexity; complicatedness, uncertainty, interrelatedness, and multiplicity. A conceptual model is developed as a foundation for future research, particularly in service delivery systems, customer evaluation tools, and complex systems. The study extends knowledge of how knowledge-based service operations can enhance productivity by managing quality, customer inputs, and operational complexity.

Keywords

Customer Inputs, Operational Complexity, Quality Management, Knowledge-Based Service Operations

1. Introduction

Knowledge-based service (KBS) operations are one of the fast-growing subsectors of the service industry driven by rapid technological innovations and com-

plexities of the global business environment (Lafuente et al., 2019; Mustak, 2019). The distinctive characteristics of KBS operations such as high customer contact, service customization, and knowledge intensity make it difficult to control the quality of services and standardize service processes (Balthu & Clegg, 2021; Javalgi et al., 2009; Lewis & Brown, 2011; Ponsignon et al., 2011). For instance, the core capabilities of KBS operations are the tacit knowledge and expertise talents of professional employees, which may not be accessible by customers when assessing the quality of outcomes (Edvardsson et al., 2020; Jayaram & Xu, 2016). According to Sampson & Froehle (2006), a service process depends on customer inputs (CI) such as customer-self, tangible belongings, and information as preconditions for service production. However, the integration of CI in the service delivery process makes managing quality challenging due to the variability predisposed by the customer (Brandon-Jones et al., 2016; Sampson, 2012). Similarly, reliance on customers as suppliers of essential inputs is another source of operational complexity (OC) in service operations. For instance, customers may occasionally produce incomplete inputs, appear unprepared, or have unrealistic expectations, which escalate role conflicts between service providers and customers, thus affecting the quality of service outcomes (Blut et al., 2020; Fitzsimmons & Fitzsimmons, 2011; Hurtak et al., 2022).

With the increasing value of the service sector globally, managing the quality of service experiences and outcomes has become strategic. For decades, numerous studies have been conducted to improve the understanding of the concept of quality management (QM) and how firms effectively manage quality. Though QM has become a strategic weapon for organizations, especially in the global marketplace, its guiding principles are deeply rooted in the non-service approaches with stable standardized processes that are managed by factual evidence (Lillrank, 2003). However, the application of similar QM principles in KBS operations such as healthcare, legal, or engineering consultancy services may become problematic and complex. Generally, the KBSs operate in volatile business environments with non-routine processes and undefined customer expectations that demand custom-made services (Prashar, 2020). Hence, the approach to quality decisions in KBSs involves understanding customer needs and managing service delivery processes while considering the efficiency of operations. Similarly, the quality decisions in KBS should be operations-driven with a focus on conformance to specifications rather than concentrating only on the customer's point of contact during the service encounter (Johnston & Clark, 2005). Therefore, an organization should adopt a total approach to QM by considering decisions such as why quality is significant and how to improve it (Slack & Brandon-Jones, 2018).

The speedy growth of technologies has increased the complexity of doing business with challenges ranging from planning, strategy implementation, evaluations, and quality issues (Ferdowsian, 2016; Kreye, 2019; Peng & Zhang, 2020; Sayed et al., 2017). Nilsson (2019) asserts that complexity in business operations is rising due to the interconnectivity nature of operations, the increasing cus-

tomer demands, and the intensified concerns about the sustainable development of organizations. Indeed, Abdullah et al. (2012) found out that OC is a contextual element that impacts QM practices and firm productivity. Hence, it is necessary to relook into ways organizations manage and improve operations given the increasing complexity and uncertainties of service operations (Ferdows, 2018). The main goal of any operations unit of an organization is to control resources by minimizing costs to increase the efficiency of the daily activities (Sharma & Modgil, 2019). However, in most KBS operations, the critical resource is proficient knowledge, which is possessed and controlled by professional employees (Beltagui et al., 2017; Fuller, 2021). Hence this becomes problematic for KBS firms to control the key resources for competitiveness. Generally, assessing the quality of service is difficult especially before the customer experiences it (Ayswarya et al., 2019; Harvey, 1998). However, unlike in most service operations such as restaurants or dry cleaning services, the KBS customers are typically unaware of what to expect during the service encounter (Nordenflycht, 2010). Mostly, customers assess the KBS by searching for tangible cues such as the physical appearance, interior designs of buildings, and attitude and behaviour of service providers, to evaluate the quality of the service outcome. As a result, this leads to operational challenges between the customer and the firm.

Most of the quality aspects of KBSs focus on the customer's expectation-perception gap (Nakhai & Neves, 2009; Parasuraman et al., 1988; Sohail, 2003). With the unique features of KBS, operations managers must identify the essential components of QM that enhance service delivery. Though plenty of literature on the significance of customer participation in service operations exists, there is fragmented information on the significance of CI and especially how KBS firms can manage them to enhance efficiency. Similarly, the uncertainty and interrelatedness of the service provisions, influenced by globalization and rapid technological development have contributed to indefinite OC. As a result, service firms require solid information on the main causes of OC and how to control its adverse effects. However, there is limited literature on how KBS firms make concrete decisions on quality, customer inputs, and operational complexity for efficiency, productivity, and competitiveness.

Therefore, this study explores the critical literature on the influence of QM, CI, and OC in KBS operations. The review is aimed to establish the relevant theories, relationships, and knowledge gaps in the previous studies. As a result, the findings will contribute new knowledge on how service firms can improve productivity by improving QM, CI, and OC.

The paper is organized as follows: first, section one describes the critical features and considerable insights of the three constructs. Section two outlines the methodology and approach used to derive the research findings. Section three highlights the key relationships among the constructs culminating in four strategic propositions and a service conceptual framework. Section four discusses the key findings and their contribution of knowledge to the KBS. Finally, section five and six gives a conclusion and recommendations for further studies.

1.1. Quality Management

Managing quality requires organizations to define quality in operational terms, understand quality benefits, costs and their consequences, and recognize the significance of ethical values (Jacobs & Chase, 2018; Stevenson, 2018). For decades, organizations have recognized that QM is more than just dealing with defects, rather, it is one of the main drivers for sustainable competitiveness. Slack and Brandon-Jones (2018) define QM as the consistent conformance to customers' expectations. This implies the constant specification of what the product or service can do and ensuring the process conforms to specifications. Similarly, defining the quality features of a product or service such as functionality, reliability, appearance, and physical contact is essential to appreciate the influence of quality on the perceptions and expectations of the customer (Slack et al., 2016; Sousa & Voss, 2002). The customer expectation of quality service is shaped by past experiences, customer knowledge, and history. In addition, Hensley and Utley (2019) proposed a methodology that assists operations managers to utilize reliability and other service features to minimize customer dissatisfaction.

The dynamism of the global business environment requires firms to consider QM programs as significant for sustainable performance (Bouranta et al., 2019; Lasrado & Nyadzayo, 2020). However, to achieve quality in business operations, organizations must explicitly understand the critical QM components that necessitate operational performance. Thus, one of the critical areas for quality decisions is the effective application of QM practices. For instance, total quality management (TQM) highlights eight elements, which are; leadership, customer focus, people involvement, continuous improvement, system approach, process management, fact-based decision making, and supplier relationship. The TQM constructs are similar to the principles found commonly in QM frameworks, that is, the Malcolm Baldrige National Quality Award (MBNQA), the European Quality Award (EQA) and ISO 9000.

Previous studies postulate that quality is a dynamic concept that highly depends on the prevailing context and situations hence requiring frequent re-definition. The earlier QM gurus approached the concept of quality differently (Polese et al., 2019; Van Kemenade & Hardjono, 2019; Weihrich et al., 2008). For instance, Deming defines quality as providing products and services that delight customers while focusing on continuous improvement. Juran describes quality as fitness for purpose whilst Crosby delineates quality as conformance to specifications. Contrariwise, the QM philosophy has received a share of criticism in the literature. For instance, Backström, (2017) postulates that the application of QM principles focuses on short-term outcomes and financial viability of a firm, such as; standardization, process efficiency, and waste reduction, which henceforth inhibit the innovative ideas. Therefore, organizations should upgrade the QM standards and programs such as ISO 9001 to match the changing business trends (Lilja et al., 2017). Also, firms must relook into the QM principles to suit the needs of the emerging business models to increase the productivity of

firms.

Though there are numerous approaches to QM and improvement programs such as TQM, BPM, benchmarking, lean six sigma, JIT and others, organizations continue to experience costly quality problems (Palm & Lilja, 2017). The reason for this problem is that many organizations apply an incomplete or loosely defined quality improvement program for compliance and protection from ethical violations rather than focus on value-based goals (Ferdowsian, 2016). However, with the current complex global business environment, the demand for quality products and services cannot be over-emphasized (Bashan & Notea, 2018; Bashan & Armon, 2019).

1.2. Customer Inputs

In service processes, customers play a major role to determine the service outcomes hence contributing to their satisfaction (Bitner et al., 1997; Wirtz & Lovelock, 2016). Customers engage in service delivery by physically presenting themselves, availing of their tangible possessions or giving critical information (Sampson & Froehle, 2006). Furthermore, in KBSs such as management consulting, education, and legal services, a customer is a co-creator of the service outcome. The degree of customer contact in KBSs is ultimately unavoidable and may involve a high level of physical contact between the consumer and the service provider (Sampson & Chase, 2020). In such cases, the customer's role in the production of the service is not only necessary but critical and unless the customer willingly participates in co-production, the quality of the outcome could be blurred.

The effectiveness of the CI, therefore, impacts customer satisfaction and the overall productivity of the firm. To enhance the service experience, a customer participates in the service process in three ways; as a productive resource, as a contributor to the quality and ultimate satisfaction, and as a competitor to the organization (Nicolajsen & Scupola, 2011). Customers are engaged in the production of services by undertaking a particular task on their own and accessing special facilities or systems of the service provider (Chen & Chen, 2017). In this case, a customer becomes a "partial" employee substituting the time and effort of a service provider.

However, CIs in the service process are one of the major sources of service failures facing organizations. For instance, Oertzen et al. (2018) establish that customers contribute to about one-third of service operations problems. Also, customer interaction with the firm transmits uncertainty into the service processes. Hence organizations must develop systems that allow customers and service providers to actively play their roles well while preventing service failures. Therefore, minimizing the probability of service failure in service operations is the ultimate requirement for competitiveness. In the recent past, due to advances in technological innovations and internet services, one of the effective ways to safely engage customers in co-production is through the application of

self-service technologies (Buell et al., 2010; Campbell & Frei, 2010). Technology allows customers to contribute to the quality of service delivery and outcomes, through self-service technologies such as ATMs, vendor machines, e-ticketing and others. However, variations in customers' prior knowledge, experience, and attitudes may lead to customer participation anxiety and dissatisfaction (Blut et al., 2020).

1.3. Operational Complexity

The main source of operational problems and challenges facing business firms today is complexity (Johnston & Clark, 2005; Suárez-Barraza & Rodríguez-González, 2019). The effects of globalization and technological innovations require businesses to engage in an array of uncertainties and complex decisions (Wu et al., 2007). However, despite the large amounts of information and awareness of the urgent need for solutions to the growing complexity of business operations, there seems to be little evidence of the progress (Ferdows, 2018).

Complexity is defined based on the factors that determine the degree or level of complexity in the system. Skaggs and Huffman (2003) defined OC as the level of coordination in the service delivery process. A service delivery process involves the interrelated sub-processes that work together as a whole. Similarly, OC refers to the uncertainties brought by the interconnectivity of managing supplier-customer systems (Efstathiou et al., 2002; Sivadasan et al., 2010). Additionally, complexity emanates from the diversity and multiplicity of product and service elements as well as the unpredictable nature of interconnected operational activities (Kreye, 2017, 2018; Wu et al., 2007).

Furthermore, OC is influenced by the strategic position of a firm. Generally, a firm takes a specific strategic position or direction in the market to differentiate itself from the competition. According to Wiengarten et al., (2017), OC is sometimes inevitable and necessitates creativity and innovation that contributes to the competitiveness of a firm. Henceforth, a firm needs to understand how to cope with and manage OC to reduce its negative impacts on productivity.

1.4. Knowledge-Based Service Operations

The contribution of the service sector has continued to dominate the global economy in terms of the growth of gross domestic product (GDP) and employment opportunities (Sampson, 2020; Wirtz & Lovelock, 2016). The knowledge-based service (KBS) sector is considered one of the innovative industries in the service economy (Miles et al., 2019). According to Javalgi et al. (2009), KBSs are services that are highly focused on human capital as inputs, that is, people skills and technological know-how. The core competency of KBS firms is the tacit knowledge of the workforce (Edvardsson et al., 2020). Also known as professional, information-based, advisory and assistance services, the KBSs provide vital services. For instance, KBS firms create, accumulate, and convert technical knowledge into customized services using professional orientation (Horváth &

Rabetino, 2018).

The nature of KBS businesses is varied and innovative with examples spanning from customized accounting, management and engineering consultancy, information technology services, architectural services, education and training services, medical, program management, legal, logistics, professional management, administrative support, and consultation services (Harte & Dale, 1995; Lafuente et al., 2018, 2019). The KBS offerings exist in various forms including, information, data analysis, monitoring and evaluations, training, recommendations, and daily support of the workforce. In addition to the distinct characteristics of services, KBS has additional unique features such as complexity, risk, uncertainty, high customer contact, and customization (Mustak, 2019; Prashar, 2020). In the last decade, KBS businesses have attracted the attention of scholarly research due to the growth of the service economy and a value-adding component of the KBSs (Horváth & Rabetino, 2018; Sampson, 2018). However, for KBS firms to improve operational performance, making concrete quality decisions is critical.

Similarly, most KBSs are value-addition potential integrated into non-service operations, a concept known as servitisation (Kreye, 2018). According to Lafuente et al. (2019), KBSs are critical economic agents or carriers of knowledge that influence the diffusion of innovation in the global economy. Also, KBS firms facilitate the transfer of critical knowledge and technologies to other business firms (Bustinza et al., 2019). Since KBSs operations are highly complex and uncertain, the literature shows that QM is more complex in KBS operations compared to other services (Nullmeier et al., 2016; Zou et al., 2019).

2. Methodology

This study adopts a critical literature review approach, conducted as per Baumeister and Mark's (1997) guidelines. The review focuses on how quality management, customer inputs, and operational complexity are interrelated and their respective influence on the delivery of KBS. A critical review is useful especially since the state of research in the field of KBS is fragmented and incoherent. The following five steps were undertaken to determine the relationships among the constructs and contribute to the enrichment of the body of knowledge in the field of KBS.

The first step entailed a thorough search of appropriate databases to establish the scope of the review. These include Google Scholar, JSTOR, EBSCOHOST, Science Direct, and Emerald Insight. In addition, hand searching, cross-referencing and consultation with experts allowed the researchers to highlight other related publications. The second step was to identify the relevant research keywords and concepts. To establish the key concepts, themes, relationships, and gaps in the literature that require further study, a quality check was conducted to filter out the non-scholarly publications. Further, the inclusion and exclusion criteria of research keywords were used based on the objectives of the study. These include

the "quality management", "customer inputs", "operational complexity" and "knowledge-based service operations" and their potential variations, using the Boolean operators [AND] and wildcards [*]. The sources of data comprised the peer-reviewed journal articles, special industry-based reports, government reports and statistical information.

The third step involved the review of abstracts of the selected articles to establish the theoretical and the current position of the information on the constructs of the study. This led to the fourth step, which was to analyze, synthesize and evaluate the studies and document the findings from the selected articles. The essence is to demonstrate the knowledge and understanding of the research problem in the scholarly context. The fifth step involved establishing the interrelationships among the constructs: quality management, customer inputs and operational complexity to develop the propositions and conceptual framework.

3. Literature Review

3.1. Quality Management and Customer Inputs

The relationships between QM and CI in service delivery processes have been studied for decades. The existent literature confirms that CI in the service delivery process improves quality as customers become responsible for their satisfaction (Bitner et al., 1997; Chakraborty & Kaynak, 2014; Dong et al., 2014; Liang et al., 2020). However, other studies contend that CI in the delivery process significantly impacts negatively the quality of the service outcome (Amorim et al., 2015; Chandon et al., 1997; Hwang et al., 2015; Mersha, 1990; Najafi-Tavani et al., 2022; Soteriou & Chase, 1998). Hence there is a bidirectional relationship between QM and CI.

Proposition 1. Customer contribution of essential inputs in the service delivery process improves quality as customers willingly become responsible for their satisfaction. Contrarily, customer contact in service production is a major source of poor quality services.

From the service operations perspective, a service is a provider-consumer interaction wherein the customer provides essential inputs and/or is involved in the actual delivery process (Sampson, 2012). The CI in the production process has numerous operational implications for service operations. The earlier version of the customer contact approach (Chase, 1981; Chase & Tansik, 1983) suggests the physical presence of the customer in the service delivery system. Grounded on the notion of customer contact, many service operations scholars have studied various categories of CI in the delivery process. For instance, the Unified Service Theory identifies three forms of customer inputs; customer-self, tangible belongings, and information (Sampson & Froehle, 2006).

Further, recent studies consent that the degree of customer contact with the service delivery process affects service operations decisions including QM. Sampson (2019) investigated customer-interactive service operations based on the earlier developed process chain network (PCN) analysis (Sampson, 2012)

and classified provider-customer inputs into three categories; direct interaction (suppliers and customers), surrogate interaction (non-human resources e.g. belongings, information, technologies), and independent processing (non-service production and do-it-yourself services). Liang et al. (2020) established that collaborative engagement of service providers and customers has numerous service outcomes such as improved quality, customer satisfaction, and loyalty. They described the different contributions of provider-customer engagement behaviours to the production process. The employee engagement behaviours comprise of investing effort, making extra contributions, and stretching beyond normal activities, while customer engagement behaviours include; service explorations and service coordination behaviours. A similar study by Kellogg (2000) identifies four sets of CI; physical presence, indirect involvement, surrogate interface, or no contact. Hence service operations are viewed as customer-interactive delivery processes in which CI influence the quality and other operations decisions. Besides, aligning the service delivery process with service concept (what is being offered) enhances the ability of the firm to achieve its operational goals, which include quality, flexibility, cost, and speed (Mustak et al., 2013; Ponsignon et al., 2011; Smith et al., 2017; Xu et al., 2006).

Managing quality is one of the key components for sustainable KBS operations since the customer evaluates quality based on the outcome and service experience. Alzaydi et al. (2018) define quality as the customer's comparison between service expectations and customer perceptions of the actual service. To understand the concept of QM, many scholars have proposed various service dimensions' models to evaluate and conceptualize quality in service operations. For instance, industry experts have studied the relevance of quality attributes such as the SERVQUAL model (Jadayil et al., 2020; Parasuraman et al., 1988, 1994; Roy & Mukherjee, 2018) and Gronroos service quality model (Grönroos, 1988; Grönroos, 2001; Salim et al., 2019), which proposes that a firm can achieve operational performance by enhancing technical quality, functional quality, and corporate image.

Recently, Prashar (2020) disclosed three distinct quality dimensions critical in KBSs; corporate quality, interactive quality, and physical quality. Similarly, Brady and Cronin (2001) proposed three quality dimensions; physical environment quality, outcome quality, and interaction quality. Gaudenzi et al. (2020) described quality as a multidimensional construct that takes a combination of technical, functional, and corporate image attributes.

The diverse QM literature affirms that CI are critical in KBS operations thus QM decisions should focus on improving both the process and the outcome quality. Hence a customer assesses the quality of services by evaluating the quality of the service delivery process and outcomes. Lehtinen and Lehtinen (1991) proposed two approaches to service quality. First, quality is described as physical, interactive and corporate and second, as process quality and output quality. This study adopts the second perspective; managing process quality and out-

come quality in KBS operations.

Process quality, also known as functional quality or quality of service delivery process, is determined by the fit between the customer's involvement style and the service provider's service style (Lehtinen & Lehtinen, 1991). Customers can also influence or are influenced by the styles of other customers participating in the service delivery thus instigating a misfit of service outcomes. Recent studies describe process quality as tangible cues or physical environment of the service including the tangible service attributes such as facility design, simplicity of functions, accessibility, and security (Foroughi et al., 2019). Other scholars contend that process quality involves observable employee attributes such as capabilities, attitude, communication, commitment, and behaviour (Stock & McFadden, 2017). By interacting with the production process, the customer forms mental pictures of the service experience. Hence process quality is critical in enhancing customer satisfaction. Kumar et al. (2008) argued that quality is not only evaluated based on the outcome quality or technical quality alone but also on the process quality. The philosophies behind quality models and frameworks such as MBNQA and ISO 9001 originated from the quality aspects of process quality (Gaudenzi et al., 2020).

Outcome quality, also known as technical quality is the extent to which customer expectations are met (Beltagui & Candi, 2018). Similarly, Um and Lau (2018) define outcome quality as what the customer receives after interacting with the service firm. Unlike the process quality that is evaluated by the customer only, outcome quality is assessed by not only the customer but other persons not directly involved in the service production (Lehtinen & Lehtinen, 1991). While many previous studies have emphasized process quality rather than outcome quality, other findings indicate that outcome quality is most crucial since the customers' interest is to get what they expect of the service (Maddern et al., 2007). Nevertheless, process quality and outcome quality remain critical in KBS operations due to the necessity of CI.

3.2. Quality Management and Operational Complexity

Managing quality has been acknowledged as one of the most effective mechanisms to reduce complexity in service operations (Chen & Weng, 2002; Dervitsiotis, 2015; Ferdows, 2018; Funk, 1995). The impact of complexity and the need to eliminate defects associated with reworks, queues, and process variability remain critical in business operations (Martínez-Tur et al., 2001; Turner et al., 2018).

From the extant literature, the interactions between people, processes, and systems are increasingly being considered complex systems (Alexander et al., 2018; Amaral & Uzzi, 2007; Baldwin et al., 2010; Fast-Berglund et al., 2013; Nilsson & Darley, 2006). As Calinescu et al. (1998) observe, uncontrolled complexity causes a set of operational challenges such as poor quality control, inconsistency, process instability, ineffectual decision-making process, and high production costs. The authors identified six elements of complexity: product struc-

ture, layout structure of processes, planning and scheduling activities, information flow, dynamism, and uncertainty. Also, they concluded that elements are interdependent as each element depends on or is influenced by others. Hence the degree and level of complexity in the production process are influenced by the number of interconnectivity of systems.

Proposition 2. Managing quality reduces operational complexity in service operations.

Fuller (1985) contends that focusing on QM eliminates the need for complex production processes. The author defines OC as internal errors (mistakes in steps of process and problems with tools, supplies, and equipment) in the production process and range from high to low. High complexity entails high work-in-progress materials; people's movements, in queues or standing idle; disorganized workstations; vague explanations of work outputs; piles of processed and unprocessed documents in workstations; and blame games. Low complexity comprises few work-in-progress materials; few people movements, no waiting lines or idleness; neat workstations; clean in-trays, and no blame games among staff. Similarly, Abdullah et al. (2013) posit that high OC impacts negatively on the QM practices of the firm. They identified two dimensions of OC; complicatedness (number and heterogeneity of interactions in the system) and uncertainty (reliability and accuracy of the system). To build appropriate QM approaches, a deeper understanding of complexity in terms of its characteristics, causes, and volatility is indispensable. For instance, based on Dervitsiotis (2015), there are three key drivers of OC; materials (production inputs such as labour, energy, and facilities), information (data inputs), and human communication (relationships, attitudes, mindsets, conversations) processes. Jacobs and Swink (2011) established three aspects of OC; interrelatedness, multiplicity, and diversity. Also, a study by Wu et al. (2007) identifies three characteristics of OC; uncertainty, product variety, and connectivity.

Recently, Kuhn et al. (2018) developed a process complexity model (PCM), which incorporates process quality aspects and complexity theory to enhance the understanding of how OC can be managed to improve QM. They identified four characteristics of complexity structural, interconnectivity, dynamism and uncertainty. Comparatively, Saurin et al. (2013) establish that though QM approaches such as lean production are progressively being adopted in complex systems, the compatibility with the distinctive characteristics of those systems is questionable.

Although no formal literature on OC exists that addresses complexity relationships in KBS operations, the extant studies have examined complexity as an array of diverse operational problems that professionals endeavour to resolve by use of proficiency and abilities. Just like most fields of management, KBS firms are managed by professional associations with distinct bodies of knowledge that dictate organizational general practices, practitioner-level certifications, and knowledge proficiency (Geraldi et al., 2011). Benedettini and Neely (2012) high-

light two sources of complexity in services; general complexity (complexity level generalized to all firms offering similar services) and individual complexity (complexity faced by different firms offering similar services). They also identified two causes of complexity in services; complicatedness (multiplicity of service components or level of interactivity) and difficulty (variability of resource input into the delivery process).

Recently, Bai and Sarkis (2018) investigated the existing complexities in operations and identified numerousness (expansive sets of entities involved), interconnectivity (interactions between key players), unpredictability (uncertainty of information required), and trade-offs (balance between efficiency and customer value) of systems as main complexity aspects.

3.3. Customer Inputs and Operational Complexity

The contribution of CI is fundamental to any service delivery process (Mustak et al., 2016; Sampson & Froehle, 2006). However, OC increases when CIs are introduced into the service production process (Kreye, 2019; Mikolon et al., 2015; Scerri & Agarwal, 2018). Since most service operations require CI, the notion of OC has become an essential focus of analysis. The role of the customer has escalated from just being the evaluators of the service experiences to also being the partners in the service delivery (Rew et al., 2018).

Bellos and Kavadias (2018) established how customers should be assigned control of various tasks of service production. This means customers perform tasks for increased customer experience while ensuring operational efficiency. Nevertheless, increased customer contact in the service delivery process prolongs the intensity of OC and service design issues in operations (Sampson & Chase, 2020).

The service delivery process or production process is defined as the process that transforms inputs into outputs by a producer using production components such as labour, capital, infrastructure, and knowledge for the customer (Pinhanez, 2008). Similarly, a customer is a person or entity that determines whether the service produced is worth compensation (Sampson, 2000). Danaher & Mattsson (1998) define OC as the degree of interactions and interrelations between the service provider and the customer during the service encounter. From an operations management perspective, a customer participates in the service delivery process by contributing versatile inputs such as physical labour, task performance, time, effort, belongings, behaviours, information, and knowledge (Damali et al., 2020; Dong & Sivakumar, 2015; Mustak et al., 2016; Sampson, 2018).

Previous literature reveals that OC hinders operations managers from making effective decisions and developing noble policies (Baldwin et al., 2010). Conversely, the main cause of OC is the unpredictable variations of information and material flow into the production process due to misaligned supplier-customer interfaces (Mattsson et al., 2016; Sivadasan et al., 2002, 2006, 2010). According to Leeuw et al. (2013), OC is influenced by several dimensions; uncertainty, diver-

sity, size, variability, lack of cooperation (between partners in the production process), and lack of coordination and control of required information and resources. Similarly, the heterogeneity of CI in the service process causes the variability of service experience and outcome (Hernandez & Kreye, 2020; Melton & Hartline, 2015). Basole & Rouse (2008) argued that service outcome and customer value are a complex array of relationships of multiple actors where the customer play a major role.

Proposition 3. Customer inputs in the service delivery process intensify the operational complexity of service operations due to customer heterogeneity and service customization.

According to Gerschberger et al., (2012), complexity is determined by five factors; number and heterogeneity of elements, interrelations, uncertainty, customer-driven requirements, and geographic components. Größler et al. (2006) established a bi-directional relationship between the internal and external drivers of complexity, which require both implicit and explicit adaptation mechanisms. Internal complexity is influenced by process structure (layout, number, and types of processes) while external complexity is determined by the type of services (breadth, life cycle, and specifications), and customers (number, heterogeneity of customer base, and customer bargaining power). However, Roehrich and Lewis (2014) observed that firms should avoid trying to reduce complexity in their operations but instead, respond by conceptualizing complex decisions, strategies, and structures to address complex systems.

The extant studies consent that CI is required in multiple forms in KBS than in other services. For instance, Mustak (2019) recognizes a customer as; a supplier of intangible resources, a decision-maker, a contributor of helpful feedback, and a quality controller. By contributing essential labour inputs, Chen and Chen (2017) observed that customers play the role of "partial employee". Equally, Mustak et al. (2016) identified six categories of CI; labour or self, self-service, information sharing, knowledge sharing, benevolent behaviour, and cooperative behaviour.

Sampson and Money (2015) describe a customer as; a provider of service specifications, service designer, performer of service functions, and an object for transformation. Likewise, Dong and Sivakumar (2015) establish that customers bring both tangibles (themselves and physical objects) and intangibles (effort, information, knowledge, and nominal goods) resources for the service delivery process. A similar study by Sampson and Spring (2012) identified eight distinctive customer roles as; component supplier (inputs), labourer (co-producer), design engineer (customer expertise), production manager (directing and influencing others), actual product (education and healthcare services), quality assurance (provide quality specifications and judgement), inventory (psychology of waiting) and competitor (clients solving their problems).

Nicolajsen and Scupola (2011) classified a customer as a resource, co-creator, and user. Bitner et al. (1997) identify a customer as a productive resource, con-

tributor to quality, satisfaction and value, and a competitor. These classifications imply that the customer role in the service delivery process is multifaceted and fundamental. Therefore, CI in service production is critical and may affect their satisfaction, that of other customers, and firm performance.

3.4. Quality Management, Customer Inputs and Operational Complexity

The KBS operations are characterized as highly complex, knowledge-intensive, customized, flexible, as well a high degree of customer contact (Brandon-Jones et al., 2016; Lewis & Brown, 2011; Nordenflycht, 2010; Sampson & Chase, 2020; Zou et al., 2019).

The high customer contact is allied to the fact that customers contribute essential inputs to the service delivery process, hence making the fate of service outcome solely dependent on CI (Johnston & Kong, 2011). Also, CI influence the service delivery process and its outcome, as well as the impact on other customers' perceived quality of service (Parasuraman, 2002; Sampson & Froehle, 2006; Smedlund, 2008). Though extant literature delineates services along with the four common characteristics; intangible, inseparable, perishable, and heterogeneous; several scholars have posited their criticism terming it as ambiguous and limited thinking. Instead, they advocate the classification of services based on CI (Sampson, 2012, 2018; Vargo & Lusch, 2004).

Mills and Moshavi (1999) establish that managing CI in complex operations enhances the quality of service outcomes. They developed a framework with four dimensions of professional concerns on how to manage KBS relationships to deliver quality products. The dimensions include; provider authority, social affiliation, client role, accountability, and objective attitude. They also identified three customer control mechanisms; social distance, psychological attachment, and professional distance that firms use to control the behaviour of customers.

Service operations struggle to maintain efficiency since customers interfere with their day-to-day operations, which require firms to relentlessly deal with CI. For instance, Frei (2006) argues that customers interfere with service operations by exhibiting customer-imposed variabilities; arrival, request, capability, effort, and preference variability, which affects the firm's capability to deliver quality service outcomes. Since customers are key inputs into the service delivery process, maintaining efficiency and quality control is uncertain (Roels, 2014). Also, customers who are incompatible with the service operating model are a source of OC (Buell & Choi, 2019; Campbell & Frei, 2010).

Buell et al. (2020) establish that a fit between customer needs and the firm's operational capabilities is necessary, which has a greater impact on firm performance. They argued that since CI are essential to the service delivery process, aligning customer needs to the firm's operating model reduces OC. Similarly, Beltagui et al., (2016) argue that customer variability affects the quality of service and suggested two resolutions; customer accommodation and customer empowerment.

In the literature, there is a consensus that managing KBS operations is more complex than other service operations. For instance, Froehle and White (2013) posit that interruptions and forgetting are common obstacles to productivity in KBS since they lead to re-work or re-learning thus additional time and effort of employees to complete a task. While managing OC is vital to most service operations, the KBS operations are more susceptible to the occurrence due to unpredictable variations of daily operations such as ad hoc orders, unreliable deliveries, alterations to specifications and variations in CI (Kreye, 2017; Ruiz-Alba et al., 2019; Sivadasan et al., 2006, 2010).

There are numerous benefits of customer contribution of essential inputs in service operations. For instance, Damali et al. (2020) established quality improvement, productivity, and competitiveness as noble returns on CI. They underlined slow service, long waiting lines, negative publicity (caused by difficult-to-use technologies, and lack of clear instructions) as some of the jeopardies that frustrate customers' performance in service production. Similarly, CI is acknowledged as a source of value creation (Anning-Dorson, 2018).

Therefore, by participating in service delivery, customers contribute exclusive solutions to improve the quality of process and outcome. Sampson and Spring (2012) observe that since the customer plays the role of supplier and consumer, they contribute to quality improvement, service customization, and customer satisfaction. Correspondingly, other studies disclose that CI enhance efficiency and productivity, quality of services, cost reduction, high control and authority and customer satisfaction (Mustak, 2019; Mustak et al., 2013; Sampson & Froehle, 2006).

Conversely, some studies advocate that there are operational risks associated with CI. For instance, the varying degree and quality of inputs (Damali et al., 2020), are the root cause of uncertainty and complexities (Alzaydi et al., 2018; Chen & Chen, 2017), and negative effects on quality, operational efficiency and service performance (Dong & Sivakumar, 2015; Oertzen et al., 2018). Also, the variability of human inputs from supplier-customer interactions heightens complexity in operations (Beltagui et al., 2017; Field et al., 2018; Ponsignon et al., 2011).

Proposition 4. The degree of customer contact in service production affects quality management decisions and increases the operational complexity of services. Conversely, a service process depends solely on customer inputs.

Though several studies have examined CI in service operations, there is still scarce information on how KBS firms manage CI for productivity. Besides, the literature on QM and OC in KBS operations is still infrequent and anecdotal. The Unified Services Theory asserts that the most distinctive managerial concerns in service operations including QM and OC are deeply rooted in the customer as being the key supplier of inputs. Hence since KBS operations depend on essential CI, the concept of QM and OC is indispensable. The scope of this study focuses on the customer as an individual and not as an entity. However,

KBS firms often have other interested parties such as regulators, industry players, special groups and the society at large who are concerned with the quality and reliability of the firm's delivery system.

Although there is a close relationship between CI, QM and OC, to the best knowledge of the researchers, this may be a pioneer study to combine the three constructs in one study. Also, this study is the first to highlight the research gaps in KBSs literature on the three constructs. Table 1 shows a summary of the literature on the relationships among the three constructs, QM, OC, and CI.

Since the customer contributes essential inputs to the service delivery, they are regarded as agents of quality for most services. However, this becomes a challenge for service providers to improve quality as the customer is part of the service performance. A bidirectional relationship between QM and CI should be considered when making decisions on QM and CI, especially in the KBS.

Similarly, for service firms to thrive in their performance, the emphasis on the elements of QM is essential due to the internal relationships between QM and OC. The service providers should establish their key OC elements to guide them on QM improvement. Further scrutiny of the literature reveals that OC increases

Table 1. Summary of knowledge gaps among QM, CI and QM constructs.

Studies	Constructs	Key Focus and Findings	Gaps	Contribution to Current Study
Buell et al. (2020)	Customer compatibility, CI	Describes the fit between customer needs and operational capabilities of the firm. Key findings: customers make sound decisions based on the transparency of the firm's capabilities and tradeoffs	The link between CI, QM and OC needs more clarifications	Customer roles and service processes and outcomes
Damali et al. (2020)	Customer participation, Risks, Service design	Highlights benefits and risks associated with CI in service operations. Developed a CI risk assessment tool. Key findings: OC increases when customers are involved in service production	The focus is on evaluating risks hence more information is needed to clarify on forms of CI	The link between CI, OC, and QM
Mustak et al. (2016)	Customer participation, CI, QM	Identifies three categories of CI: labour/task performance, information/knowledge, and behaviours. Key findings: CI increases OC and QM based on the management capabilities	Fragmented information on the relationships between CI, OC, and QM	Role and types of CI
Frei (2006)	CI, QM, OC	Identifies five types of CI variabilities: arrival, request, capability, effort and subjective preference. Key findings: customer interference causes OC	More information is required on forms of CI	The link between CI, OC, and QM
Mills & Moshavi (1999)	KBS, CI, QM, OC	Focuses on knowledge of service providers and customers and prevailing quality concerns of services. Key findings: CI affects QM	More clarity on the role of CI in KBS is required	The link between CI and QM in KBS

when CIs are introduced into the service delivery system. This requires KBS firms to identify and manage their CI to control OC. As a result, the extant literature on the three constructs reveals that QM, CI and OC influence each other hence KBS firms should identify and manage their key components to improve performance.

4. Discussion

Based on the extensive literature, CI improves the quality of service outcomes. However, in some incidences, the presence of CI in the production process impacts negatively on QM practices. Hence a bidirectional relationship is observed. Process quality and outcome quality should be improved since the customer evaluates quality when directly involved in the service delivery process.

Also, QM reduces OC. However, it has been observed that uncontrolled OC leads to poor quality of service outcomes. Therefore, focusing on improving the quality of the process and outcome reduces OC. Similarly, the unpredictable variations of CI or high customer contact increase OC. Thus managing CI reduces OC in service operations. Thus, CI influences the perceived quality of service. Hence managing CI enhances QM and reduces OC. A conceptual framework (Figure 1), is designed to give a clear picture of how the three constructs interrelate.

The KBS operations are characterized as entities with a high degree of customer contact, knowledge intensity, and highly customized services. The Unified Services Theory denotes that the outcome of a service process is determined by customer contribution of essential inputs in form of customer tangible belongings, information, and the physical customer. Similarly, the Customer Contact Theory signifies the actual presence of the customer for service production. However, the reliance on customers as a contributor to essential inputs impedes the execution of quality management programs. Moreover, the presence of a customer in the service delivery process propagates the complexity of service operations. Also, the interrelatedness between key players in organizations has escalated the complexity of business operations as Complexity Theory illustrates.

Since the KBS operations rely on knowledge as the key outcome of the service

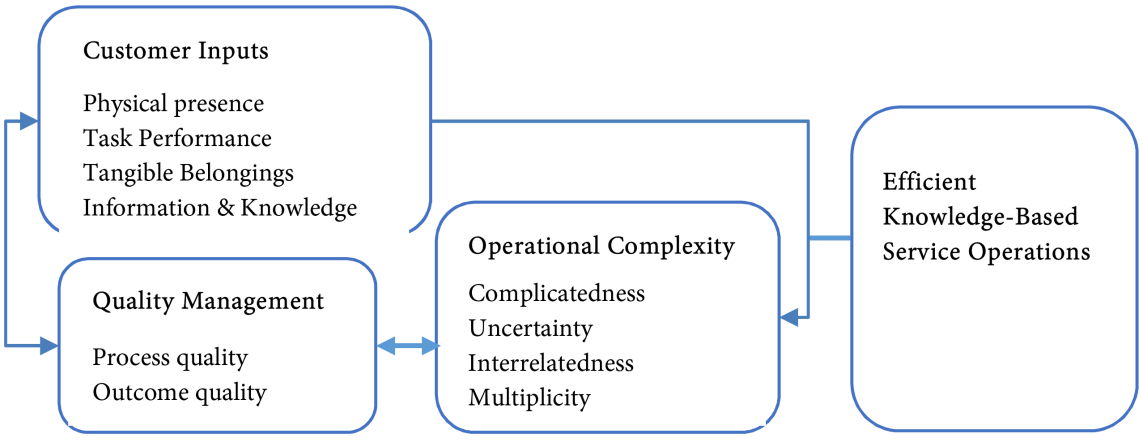

Figure 1. Quality management, customer inputs and operational complexity in knowledge-based service.

delivery process the Knowledge-Based Theory is applied, which describes knowledge as a critical resource for firms. Thus, this study investigates the existent literature on the interrelatedness and influence of QM, CI, and OC in the KBS operations. The empirical literature underpinnings are undertaken to describe the interrelationships between the key constructs to build the conceptual framework model and propositions, and to make valid conclusions and potential recommendations for further research.

The study provides significant information to the service managers on how to manage quality, CI, and OC in the KBS operations contexts. Based on the proposed conceptual framework, managers can understand the interrelationships among the QM, CI and OC and how they influence operations in KBS firms to diagnose problems and solutions.

The findings reveal that there is a bi-directional relationship between QM and CI and that the strength of this relationship is moderated by OC. Besides, the findings show that identifying a fit between customer needs and operational model enables service firms to manage and control CI, thus enhancing service quality and reducing the complexity of service operations. The study also suggests that since KBS firms are complex and have high customer contact, there is a need to focus on managing CI by exploring customers' hidden capabilities, guiding customers to actively participate in the production process, and encouraging open information sharing. The findings highlight the role of CI in the service delivery process indicating the value of enhancing both process quality and outcome quality of the KBS. By focusing on improving the quality of services, service firms can predetermine the roles of customers in the service production process that will optimize the efficient use of firm resources and reduce OC.

5. Conclusion

This study has synthesized the extensive literature on QM, CI, and OC to gain an in-depth understanding of their influence on the KBS operations. Since customers contribute indispensable inputs to the service delivery process, the service outcome is entirely dependent on the CI, which includes; customer-self, tangible belongings, and information (Sampson & Froehle, 2006). Also, the broad literature affirms that CI improves the quality of the service delivered as customers become responsible for their ultimate contentment (Dong et al., 2014; Liang et al., 2020). Conversely, other scholars confirm that the degree of customer contact or the presence of CI in the service delivery process affects QM decisions due to variations of CI (Hwang et al., 2015; Mills & Moshavi, 1999).

Since the customer evaluates the quality of a service based on the service experience and outcome, managing quality is critical for KBS operations. As a result, a bidirectional connection exists between QM and CI, which requires KBS firms to focus on improving both process quality and outcome quality. Also, since customer heterogeneity impacts directly on the quality of service outcome, empowering customers in decision-making is obligatory.

Complexity is one of the operational challenges that service firms strain to resolve on a day-to-day basis. The continuous interface between people, processes, and systems has accelerated the complexity of service operations. Hence, the degree and level of complexity in the service delivery process are determined by the number of the interrelatedness of systems (Calinescu et al., 1998). Nevertheless, uncontrolled complexity affects many operational decisions such as quality control, process stability, and scheduling. The QM is recognized as the most effective mechanism to eliminate complexity in service operations (Ferdows, 2018). Alternatively, a high degree of OC affects the QM programs of the firm due to the complicatedness, multiplicity, and uncertainty of systems (Jacobs & Swink, 2011; Wu et al., 2007). Consequently, focusing on improving the quality of process and outcome eliminates OC in production processes.

Any particular service delivery process relies on the contribution of essential CI. However, as observed in the extant literature OC escalates when CIs are incorporated into the service delivery process (Kreye, 2019; Scerri & Agarwal, 2018). Since CIs are a necessity in the service delivery process, the role of the customer has heightened from being a mere service evaluator to being an indispensable partner in the service production as they undertake various tasks of production (Bellos & Kavadias, 2018; Rew et al., 2018). Nevertheless, a high degree of customer contact increases OC (Sampson & Chase, 2020). Hence, managing CI in service operations is essential as it reduces OC and impacts customer satisfaction and firm performance by aligning customer needs to the firm's operational capabilities (Buell et al., 2020). The findings of this study contribute to the existing body of knowledge on the interrelationships among QM, CI, and OC and how these influence decision-making in KBS operations.

Recommendation for Further Research

The study provides foundations for further research to examine and generalize the approaches to QM, CI, and OC in KBS operations. Since KBS operations are known to offer complex and highly customized services that pose unique challenges, researchers should develop and test models of service quality for evaluating the operations of KBS firms. A systematic or exhaustive literature review on QM, CI, and OC is necessary to provide a detailed understanding of the volume and scope of the research.

In this study, the focus is on KBS operations, other service operations may generate further findings. To that extent, the findings of this study provide a good foundation for the concept of QM, CI, and OC in KBS.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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