Lean Process Improvements at Cleveland Clinic

Cleveland Clinic is one of America’s premier hospitals, known worldwide for its cardiovascular care. In 2007, the Surgery Division’s Throughput Council identified an ongoing issue that created dissatisfaction among the hospital surgical staff. Surgeons were unhappy that certain instrument sets were not available when needed and that, frequently, multiple requests were required to get all of the necessary instruments for surgeries. While this seemed a minor issue to some, the missing tools frustrated the surgical staff, and caused unnecessary delays in the surgery schedule.

The surgeons most often complained to Jim Stanicki, manager of the Surgical Processing Department (SPD). The SPD was responsible for cleaning, inspecting, sterilizing, and delivering over seven million instruments per year in four separate processing areas. These areas supported 65 main campus operating rooms that performed over 35,000 surgeries annually. Stanicki said, “The surgeons were concerned about the inability to start operating rooms on time and instruments that were not immediately available when requested.” Stanicki and his team were responsible for managing an extremely complex process. Although they were working around the clock, there were still complaints and they realized that something had to change in the way that they were processing the surgical instruments.

Overview of Cleveland Clinic

Cleveland Clinic was founded in 1921 under the principles of cooperation, compassion and innovation. It was created by four physicians, in what was considered an unusually collaborative model for the time. Over the 20th century, the nonprofit hospital system became one of the largest and most respected healthcare institutions in the country, known primarily for its excellence in cardiovascular care.

In 2006, there were 3.3 million outpatient visits to Cleveland Clinic and 71,643 surgical cases system-wide. Surgical cases over time are shown in Exhibit 1. Operating revenues in 2006 were $4.4 billion and the clinic employed more than 35,000 people in Ohio.

In the 2006 U.S. News & World Report “America’s Best Hospitals” survey, Cleveland Clinic was ranked number one in the nation for heart care, for the twelfth consecutive year. In addition, the survey recognized Cleveland Clinic as one of the nation’s best hospitals overall, ranking it as number three in the country. The clinic also ranked within the top ten institutions in ten other categories, including kidney disease, neurology and neurosurgery, and respiratory diseases.
In response to the rankings, Delos M. “Toby” Cosgrove, M.D., president and CEO of Cleveland Clinic, stated: “We continually strive to provide our patients with the most advanced, compassionate healthcare. The results of the America’s Best Hospitals survey are a positive affirmation of our efforts and the dedication of our medical staff and employees in the delivery of high-quality medical care.”

**Cleveland Clinic Culture: “Patients First”**

Cleveland Clinic, under the leadership of Cosgrove, adopted the mantra “Patients First.” The goal was to center all of the hospital system’s care on the patient. In Cosgrove’s words, “I tell our employees that the only reason they have a job is because we are taking care of patients. They are our priority and that’s the one thing that unites all of us.” The clinic designed a Quality & Patient Safety Institute that was tasked with measuring and improving the quality of care across the hospital system.

**Performance and Service Improvement (PSI)**

While the clinic was committed to superior clinical outcomes and patient care, many support functions kept the hospital operating smoothly. Problems in these support functions negatively impacted the overall patient experience. As an example, errors in scheduling appointments might result in patient dissatisfaction.

Cleveland Clinic realized that by improving these support functions, it could improve the overall efficiency of the hospital system and positively impact patient care and satisfaction. It established the Performance and Service Improvement team (PSI), which brought together seasoned process improvement leaders from numerous industries, such as consumer products, aerospace, and automotive, to work across the hospital system. PSI worked closely with staff to partner in designing appropriate solutions to improve efficiency for better-quality patient care and service.

PSI used approaches from numerous industries to improve efficiency at Cleveland Clinic. Depending on the specific attributes of a case, it drew on strategies such as the following:

- Six Sigma - DMAIC (Define, Measure, Analyze, Improve, Control)
- Lean (5S, Visual Controls, Value Stream Mapping)
- PDCA (Plan, Do, Check, Act)
- FMEA (Failure Mode and Effects Analysis)

**The Case of the Surgical Processing Department (SPD)**

**Overview of SPD**

In 2007, the E Building SPD operation was staffed by 25 individuals who provided the instrumentation used in surgeries performed by eight surgical services across 40 operating rooms. These operating rooms performed approximately 21,000 surgeries per year, or about 60% of the surgical volume performed at Cleveland Clinic’s main campus.

The SPD staff, which was located in the basement of the E Building, was responsible for disassembly and cleaning, inspection, reassembly, sterilizing, preparing case carts, and delivering all disposable and non-disposable surgical instruments that were used in the operating rooms. The SPD also had responsibility for the maintenance of surgical instruments as well as oversight of repairs and replacements of defective instruments.

The department worked around the clock to serve routine and emergency cases, and it operated with extreme precision to try to ensure that instruments were delivered on time and without mistakes.
large number of surgical sub-specialties supported and the thousands of surgical procedures performed created a nearly infinite number of instrument combinations required for a given case, and the differing sterility requirements for the instruments added another level of complexity. Beyond these requirements, the frequent need to support last-minute schedule changes and emergency cases required flexibility and nearly instantaneous responses that often overwhelmed the small staff.

Jim Stanicki had been the manager of SPD since 2005, a position he moved to after experience as a technician and supervisor within the same group. Stanicki had over 29 years in the healthcare field and had worked in surgical processing for the prior 21 years.

Challenges in the SPD

Over the last few years, complaints about the accuracy and speed of the SPD had arisen from nurses and physicians from surgical services. Instrument problems or delays in delivery would result in the inability to begin a procedure. Incorrect instruments being delivered would mean that the surgical team had to wait for the appropriate instruments. Multiple events in the same day could cause a ripple effect with delays of up to several hours for cases scheduled at the end of the day. These effects were exacerbated on particularly busy days or for emergency cases.

Delayed cases and even cancellations would result in discomfort for patients. Cleveland Clinic also suffered financial loss due to inefficient resource utilization. Costs from delays originating in the SPD were conservatively estimated at hundreds of thousands of dollars annually. The estimate included lost time in the operating rooms and processing fees for incorrect instrument trays. In addition to revenue loss, costs also resulted from patient dissatisfaction and cancellations, and overall loss of goodwill; these intangible costs were more difficult to estimate and were difficult to account for in strictly financial estimates of cost.

In 2006, Stanicki and the SPD realized that errors in its processes were negatively impacting the surgeons’ abilities to do their jobs. Stanicki knew that the conventional solution would have been to purchase more instruments or hire more staff, but he chose to institute new practices. He said, “We had the right resources, but they were not being properly utilized.” With this in mind, he turned to guidance from Cleveland Clinic’s PSI team to analyze current practices and partner in process improvement efforts. He told the team that his staff was frequently running into cases of missing instruments, and also had a hard time adequately preparing instruments in emergency situations.

Jim Leonard, a senior member of the PSI team, partnered with Stanicki to institute process improvements in the SPD. Leonard had a bachelor’s degree in mechanical engineering and a master’s degree in quality systems. He had over 20 years of experience in process engineering and operations management and was a certified Lean Six Sigma Master Black Belt.

Assessing the Problem

Leonard and Stanicki studied the most frequent problems in the SPD, which they identified as “instrument delays” and “missing instruments.” After considering numerous process improvement strategies, they decided that the lean approach would be most appropriate for remedying the particular challenges. While lean process improvement efforts were most commonly associated with their origin – the Toyota Production System and the manufacturing industry – the lean approach’s success in the service industry was being exemplified across a few enterprising organizations.
Lean Approach

Current State VSM

The first step in the team’s analysis was to create a current state value stream map, which outlined the processes being undertaken and the times to complete them within the SPD. In this map, the overall SPD process was considered to be comprised of four sequential sub-processes: Decontamination, Prep & Pack, Sterilization, and Case Cart Assembly and Delivery. Cycle times were determined by both “walking the flow” and consulting with SPD staff.

1. Decontamination

When the carts containing used surgical instrument entered the SPD area, bar codes on the carts were scanned into an electronic database that recorded the receipt of the cart. That triggered the first step in the current state process, which was decontaminating the instrument and cart.

Most instruments could be decontaminated in automated washers. The instruments and instrument trays were loaded onto washing trays, which were placed on a conveyor belt that automatically loaded washers designed for surgical instruments. Four of these washers were used for decontamination, through an automated cycle of washing and drying. At the completion, the instruments were fed onto a second conveyor that moved them to the prep & pack area.

Approximately one-third of the non-disposable instruments returning to the SPD were too fragile to undergo machine washing. These had to be washed by hand and delivered directly to the prep & pack area. Manual decontamination took longer than automated decontamination, but had a minimal rework rate, while automated decontamination took less time, but was frequently delayed due to breakdowns in the automated washers and loading system (25% of the time).

The cycle times and equipment down-times given for decontamination in the current state VSM were based on weighted averages that reflected the contribution of hand-washed and automated-decontamination processes; lead times were based on actual data taken from an instrument tracking system.

2. Prep & Pack

After decontamination, the instruments arrived in the prep & pack area where they were scanned to document their location and separated into stock, service special or surgeon unique instruments. Sorting instruments into service specials (instruments for eight surgical services) and surgeon unique (unique instruments for more than one hundred surgeons) accounted for most of the complexity and time (40 minutes on average in this step). The staff used colored adhesive tape on the instruments to identify the instruments belonging to specific services and surgeons. After sorting, instruments were wrapped individually or in instrument trays and taken to the sterilization area.

3. Sterilization

As with the other processes, the instruments were scanned into the system when they entered the sterilization process. There were a number of sterilization processes for instruments based on their materials composition, fragility and size. Steam sterilization was the most commonly used form for instruments made from surgical steel. Other processes were suitable for instruments made from composite materials that were sensitive to heat. The sterilization process included loading instruments into the sterilizer, waiting through the automated sterilization process, unloading the sterilizer and then waiting for the instruments to cool.
4. Case Cart Assembly, Delivery and Sterile Storage

After sterilization, carts were prepared for delivery to the operating rooms according to a detailed “recipe” or pull sheet that outlined the specific instrumentation combination for each case. When the components were loaded, cart assembly was complete. Following cart assembly, carts were taken directly to the operating room or placed in a holding area.

Most carts were prepared well ahead of time (usually during the night shift) and sat in the holding area until they were needed in the operating room. Carts leaving the SPD were scanned to the operating room to document their final location.

**Kaizen Events**

The SPD was staffed by hardworking and dedicated personnel who took considerable pride in their contributions to the care of surgical patients at Cleveland Clinic. However, the workers were affected by inefficiencies inside and outside the department at several levels. First, the large number and complexity of the instruments made correct sorting and cart assembly a challenge. Second, workers in each process throughout the value stream were isolated in their respective areas, which created a lack of versatility within the work force and problems with coverage. Third, considerable emotional impact resulted when there was an overflow in the process. Finally, inefficiencies in the floor layout were taking a physical toll due to long transit times for repetitive tasks.

In September of 2007, Stanicki and Leonard determined that there were probably inefficiencies across all of the sub-processes that were affecting the staff and impacting the number of missing instruments and delays. They decided to hold Kaizen events to analyze each sub-process, and brought in representatives from each of the three shifts to contribute to finding solutions. “We wanted to engage the people who were actually doing the work,” said Stanicki. “They were the closest to it, and without their buy-in we would never make any progress.” Leonard agreed: “Workforce engagement is extremely important. If they didn’t believe in it, it wouldn’t last for more than a couple of weeks.”

They began by recording the existing layout of the SPD, shown in Exhibit 2, and designing the Current State Value Stream Map, shown in Exhibit 3. From there, they tackled each sub-process through its own Kaizen event.

**Decontamination**

The Kaizen event for the decontamination process lasted one full week. The team described the current state as “erratic and inefficient” and sought to “create standardized process flows” and “develop standard work practices for the decontamination jobs.” The current state included the following statistics:

- Cycle time was estimated at 62.5 minutes per case cart
- Lead time was measured at 609 minutes per instrument (data average from the instrument tracking system)

In only one week, the team redesigned the process layout of the decontamination area and was able to reduce the cart breakdown time (which was identified as the biggest driver of process lead time) by 63%. Before and after pictures of the layout changes are shown in Exhibit 4. The team also reduced the walking time, which was identified as an inefficient part of the cycle time, by 56%.
Results for the decontamination event included:

<table>
<thead>
<tr>
<th>Redesigned material flow</th>
<th>Repositioned drier cabinet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balanced job duties</td>
<td>Initiated work orders for two safety issues</td>
</tr>
<tr>
<td>Developed standard work for jobs (including supervision)</td>
<td>Initiated trial of “tags” strategy to keep instruments together</td>
</tr>
<tr>
<td>Moved bar code station</td>
<td>Eliminated unneeded equipment and racks</td>
</tr>
<tr>
<td>Moved racks to match flow</td>
<td>Removed the automated conveyor system</td>
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<tr>
<td>Implemented visual controls for material path</td>
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Prep & Pack

The team, which had successfully achieved its goals in improving the decontamination process, sought similar objectives with the prep & pack sub-process, in which the decontaminated instruments were sorted and packed. The current state included the following statistics:

- Cycle time estimated at 15 minutes per set (average)
- Lead time measured at 414 minutes per set (data average from the instrument tracking system)

In one week, the team redesigned the floor layout and job assignments. In the current state, all employees in the prep & pack area supplied themselves with decontaminated instruments while they re-assembled sets. They were therefore constantly walking back and forth to pick out the right instruments for their sets. The new work flow assigned one individual as a material handler who would sort through the instruments from the decontamination process and supply the prep & pack operators, who would be assigned to specific instrument stations (i.e. colorectal surgery, neurological surgery, etc). The original workflow and future state workflow are shown in Exhibit 5. As a result of the prep & pack redesign, standard work was created, set assembly cycle time was reduced 26%, and missing tool counts went down 25%.

Results for the prep & pack event included:

<table>
<thead>
<tr>
<th>Moved work stations</th>
<th>Removed non-value tasks from prep &amp; pack assignment</th>
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</thead>
<tbody>
<tr>
<td>Installed “footprints” for cart locations</td>
<td>Changed material flow</td>
</tr>
<tr>
<td>Created material handler assignment</td>
<td>Added tip protectors for sharps at prep &amp; pack</td>
</tr>
<tr>
<td>Outlined Tech 1 supervisor duties</td>
<td>Installed “footprints” for emergency equipment</td>
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</tbody>
</table>

Sterilization

The sterilization Kaizen event involved the same shift leads and was completed in only three days in January of 2008. Sterilization included the following baseline statistics:

- Cycle time estimated at 47 minutes per set (average)
- Lead time measured at 598 minutes per set (data average from the instrument tracking system)

Much of the process was driven by the time that the machines took to complete the sterilization cycle. Some of the instruments required different sterilization techniques, which added a level of complexity into the process, but overall there was little technician control over cycle time. The team discovered that beyond
being driven by the machines, the process was also slowed by paperwork, scanning, and retrieving the printouts needed to maintain compliance records.

The Kaizen event therefore addressed some of these issues, primarily by reorganizing the layout of the sterilization process. The team created a “pull” system, moved the loading station closer to prep & pack drop-off, and added a printer in the area to decrease the time that it took to gather printouts. An improved work flow was established and standard work was created. The changes decreased walking time by 41%.

Case Cart Assembly Delivery and Sterile Storage

Assembling the carts involved pulling from the sterilized instruments and the disposable instruments that were specific for each surgical case. When team members observed the process, they saw that the case carts were assembled in an ad-hoc manner and they were not organized in the small space. The average for cart assembly was recorded as 6.6 minutes. By reorganizing the supply room and streamlining supplies, as well as placing tape on the floor to outline assembly lanes for the carts, the team reduced the cart assembly time to 4.1 minutes, which represented a 38% decrease. Also, by widening the aisles and relocating supplies that were used most often, the Kaizen event achieved a 21% decrease in walking time, which also lessened the physical strain on employees. The new cart assembly lanes are shown in Exhibit 6.

Results

The Kaizen events found that all of the “Seven Wastes” were present in SPD processes. The most prominent sources of waste were overproduction, rejects/rework, excess inventory, unnecessary motion and transport. At the end of the events, Stanicki and Leonard presented their achievements to the Throughput Council, the group that originally sanctioned the process improvement project in the SPD. While Stanicki and Leonard were proud of what they had achieved in a short period of time, they also conveyed to the council that “more than anything, we have changed the way our staff thinks about continuous improvement.”

They presented the council with a comparison of their Current State Value Stream Map (Exhibit 3) and Future State Value Stream Map (Exhibit 7). They also showed the council that their ratio of value-added to non-value-added work had gone from 14% to 22%. The result of the changes in these processes was clear. From the first Kaizen event in September 2007 to the time that Stanicki and Leonard presented to the council in February 2008, the missing instrument count in the E Building had been reduced by 26%, as shown in Exhibit 8, and the instrument set processing time had been reduced 24%, as shown in Exhibit 9.

In addition to these measurable changes, Leonard stated: “We are not only changing the way people do things, but we are changing the culture, which is what leads to real success. We are encouraging people to optimize what they do every day, and to realize that lean process improvement is a journey that has no end.”

The presentation to the Throughput Council concluded with a discussion of what to tackle next on their journey. Leonard and Stanicki had some ideas, but wanted to seek the council’s advice as well. They wondered what additional changes could be made in the SPD, and also how to expand their success throughout the Cleveland Clinic system, including a Cleveland Clinic expansion project in Abu Dhabi, in which the builders of a large new hospital were seeking their advice on how to design an SPD from scratch.

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"The Seven Wastes of the Toyota Production System are: Transport, Inventory, Motion, Waiting, Overproduction, Overprocessing, Defects"
Additional Process Improvement Projects at Cleveland Clinic

The SPD project was just one of numerous projects supported by the Performance and Service Improvement team. These projects were launched both through staff suggestions (bottom-up) and through proactive measures to improve overall system efficiency (top-down). In late 2007, the PSI team expanded its role at Cleveland Clinic to become the Strategic Planning and Continuous Improvement group (see Exhibit 10). The following are examples of other projects that the group completed between 2006 and 2009.

Magnetic Resonance Imaging Efficiency

Scheduling a patient for an MRI (magnetic resonance imaging) was proving to be an arduous task at Cleveland Clinic. Physicians were complaining that it was taking an average of 21 days for their patients to get an MRI, even though there were 30 imaging devices running 24 hours a day distributed throughout Cleveland Clinic and its affiliated hospitals. The result of this long wait time took a physical and psychological toll on the patients, who were often awaiting an MRI as a key piece of the puzzle in a diagnosis.

The SPCI team engaged and shadowed both the scheduling process and the process of running the expensive and time-consuming MRI procedures. By working closely with the team, they realized that there were numerous areas for improvement.

One element that was causing long delays was the injection of contrast agents, which allowed the MRI results to be analyzed more easily. Approximately 80% of the patients who were getting MRIs required the intravenous contrast agents, yet the MRI technicians were stopping the scan midway through the process to place the intravenous lines that were required for injection of the contrast into the patient. This interruption of the process was adding five to ten minutes to each MRI scan, resulting in backups and scheduling headaches. Part of the lean improvement project was to assess the need for contrast and start the intravenous line (if required) at the beginning of the MRI procedure, thereby not interrupting the scan process. The lean project also identified opportunities to better utilize existing equipment and off-site locations to schedule and serve patients.

All of these efforts combined resulted in an overall decrease of the MRI procedure lead time from a baseline of 21 days to a new average of 11.5 days. In addition, there was a year-to-year increase of 1,560 completed exams (4.7%) between 2008 and 2009. Team members said that, “there are still improvements to be made, but in many cases the wait time is even far below the 11-day average.” They also stressed that “we don’t try to solve problems by spending money or adding people, but instead by solving inefficiencies in the process.”

Reducing the Variance to Standard for Hospital Stays

Another project that the SPCI team undertook was related to days that patients sometimes spent waiting for surgery, in which they were undergoing pre-operative testing, occasionally with little value-added activity occurring otherwise. On one surgical service that dealt with particularly complex cases, pre-operative stays averaged seven days leading up to surgery. During these days, patients underwent numerous checks and tests to prepare them for the surgery, but the tests and analysis came slowly. The main steps in the pre-operation process were:

1. Checkup by nurse, who determined which tests were required
2. Tests performed
3. Physicians analyzed results (sometimes asking for additional tests)
4. Surgery scheduled
5. Surgery performed

The staff felt that on average the lead times for these processes were unnecessarily long, which cost the patient and the hospital precious time. When the SPCI team was called in to examine the situation, it found that all of the parties recognized the situation but expressed frustration over their inability to pinpoint causes or develop a satisfactory approach to shorten the long wait times.

To combat the problem, the team worked together to create a matrix board that was prominently displayed for staff review with rows of patients and columns with the required tests. Nursing staff placed colored dots in the boxes to indicate whether a patient needed a test or not, and the status of the required tests (e.g. waiting for test, waiting for analysis, completed). With this system in place, it became immediately apparent when excessive or multiple, overlapping tests were being ordered. It also became clear when physician review of test results needed to be expedited to quickly rule out the need for additional testing or to order more testing.

After the implementation of the checklist, the staff worked on training and actively managing the other aspects of the pre-operative evaluation process. Following institution of all of these measures, the number of overall tests being ordered and completed fell and the average in-hospital wait time for patients before surgery for this particular service shrank to six days. As with the other projects, staff members said they were working on achieving further efficiency gains, and in this case hoping to reduce the pre-operative wait time to five days.
Exhibits

Exhibit 1
Surgical Cases (in thousands) at the Cleveland Clinic

Source: Cleveland Clinic, Annual Report, 2006

Exhibit 2
Layout of Current State SPD
Exhibit 3
SPD Current State Value Stream Map
Exhibit 4
Decontamination Area Before and After Kaizen

<table>
<thead>
<tr>
<th>Before Kaizen</th>
<th>After Kaizen</th>
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<tbody>
<tr>
<td><img src="image1" alt="Image 1" /></td>
<td><img src="image2" alt="Image 2" /></td>
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<tr>
<td><img src="image3" alt="Image 3" /></td>
<td><img src="image4" alt="Image 4" /></td>
</tr>
</tbody>
</table>
Exhibit 5
Prep & Pack Original and Future State Workflows

Exhibit 6
Case Cart Assembly Lanes
Exhibit 7
SPD Future State Value Stream Map

Exhibit 7: SPD Future State Value Stream Map

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Exhibit 8
Missing Instrument Count Per Day (Oct 2007 to Feb 2008)

Exhibit 9
SPD Set Processing Time (Monthly Average)

Exhibit 10
The Strategic Planning and Continuous Improvement Group
Endnotes

1 Stanicki, James. Personal interview. 11 Mar. 2009.
2 “For the 14th year in a row, Cleveland Clinic’s cardiac care has been ranked No. 1 in U.S. News & World Report ‘America’s Best Hospital’ survey.” Cleveland Clinic Press Release, October 2008
4 Cleveland Clinic website. Cleveland Clinic Quality & Patient Safety Institute. <http://my.clevelandclinic.org/about/quality/default.aspx>
5 Duncan, Brian, et al. “Mapping the Value Stream in the Cleveland Clinic Surgical Processing Department: A Lean Based Approach to Performance Improvement.” 2008
6 Stanicki interview.
7 Stanicki, interview.
9 “Decontamination Kaizen Event.” Presentation to Surgical Processing Department (SPD) at Cleveland Clinic. November 2007.
12 “Case Cart Assembly Kaizen Event.” Presentation to SPD at Cleveland Clinic. February 2008.
13 Stanicki interview.
14 Leonard interview.
15 SPCI Team Member. Personal interview. 11 Mar. 2009.
Established at the University of Michigan in 1992, the William Davidson Institute (WDI) is an independent, non-profit research and educational organization focused on providing private-sector solutions in emerging markets. Through a unique structure that integrates research, field-based collaborations, education/training, publishing, and University of Michigan student opportunities, WDI creates long-term value for academic institutions, partner organizations, and donor agencies active in emerging markets. WDI also provides a forum for academics, policy makers, business leaders, and development experts to enhance their understanding of these economies. WDI is one of the few institutions of higher learning in the United States that is fully dedicated to understanding, testing, and implementing actionable, private-sector business models addressing the challenges and opportunities in emerging markets.