

Optimizing CT Scan Operational Efficiency in Hospitals: Workflow Arrangement Strategy and Improving Health Services

Laila Miftahul Khoir
Magister Manajemen, Fakultas Ekonomika dan Bisnis, Universitas Gadjah Mada, Yogyakarta 55281, Indonesia

Article Info	ABSTRACT
Article history: Received 10 27, 2024 Revised 11 15, 2024 Accepted 12 03, 2024	Computed Tomography(CT) has become an important diagnostic tool in the medical field, but its use often faces challenges in terms of operational efficiency. Hospitals in the United States, led by Dr. Steve Foster, showed that single-detector CT scans caused long scan times of up to 32 minutes, causing congestion and delays in service. To overcome this, multi-detector CT scan technology was introduced, which increased scan speeds by up to five times and reduced scan times to about 6.5 minutes per patient. Although it provides significant improvements, the implementation of this technology requires operational optimization involving reorganization of workflows, room layouts, and distribution of tasks between staff. Additional steps, including the use of AI in scan analysis and cross-department communication technology, are proposed to improve efficiency and maximize resource utilization. This is expected to improve operational efficiency, service quality, and patient satisfaction.
Keywords: Computed Tomography Multi Detector CT Scan Operational Efficiency Workflow Optimization	
Corresponding Author: Laila Miftahul Khoir laila.m.k@mail.ugm.ac.id	

INTRODUCTION

Computed Tomography(CT) has become an important diagnostic tool in medicine, especially in visualizing internal organs and structures with high-resolution image quality. However, the challenge in using this technology comes from inefficient operational processes. For example, a hospital in the United States, with the head of radiology being Dr. Steve Foster, experienced problems in 2005 with single-detector CT scans that took up to 32 minutes per scan, resulting in congestion and delays in patient care, as shown inFigure 1. A study shows that shorter scan times can improve the efficiency of radiographers' workflow, which is crucial in emergency situations.(Liang et al., 2016).

To address this issue, Foster decided to implement a multi-detector CT scan that could speed up the scanning process by up to five times. This technology provides significant advantages in image quality and scan speed, cutting scan time to just 6.5 minutes per patient, as shown inFigure 2. However, optimizing the use of this technology requires changes in operational processes and room layouts that support more efficient workflows, allowing for improved patient care and better resource utilization. Through the development of these multi-detectors, better visualization and spatial resolution are now

available, allowing for more accurate evaluation of various medical conditions.(Hallscheidt et al., 2006). Therefore, the utilization of this technology is expected to improve the efficiency and quality of health services as a whole.

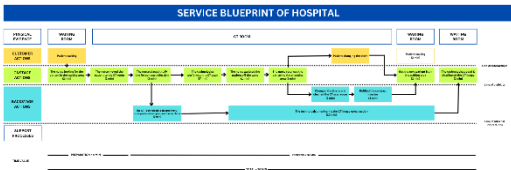


Figure 1. Service blueprint before using multi detector (scan time = 32 minutes)

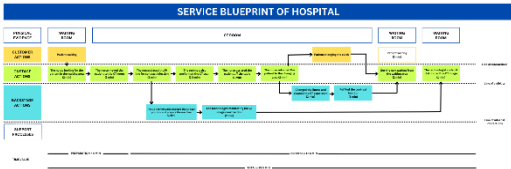


Figure 2. Service blueprint after using multi detector (scanning time = 6.5 minutes)

PROBLEM FRAMEWORK

The first problem found was the length of time required to perform a CT scan. This is because the hospital still uses a CT scan with a single detector, so it will take quite a long time to examine each

patient. This practice greatly hampers the smooth running of clinical services, causing congestion and long waiting times for patients to receive diagnostic results and examination results. This is supported by a study showing that longer scan times can reduce patient satisfaction with the services provided(Shweiki et al., 2018).

The second problem is related to the suboptimal empowerment of human resources, especially in the division of tasks between nurses and technicians who will operate the device. The current scanning process relies heavily on sequential steps, each of which must be completed individually by both nurses and technicians. This results in reduced work time efficiency and increases the workload of hospital staff, potentially reducing the quality of service. A study shows that reorganizing tasks and responsibilities within a medical team can improve operational efficiency and reduce workload(Schuppert et al., 2024).

The layout of the room in the hospital is also one of the problems that worsens operational conditions. The distance between the patient waiting room and the CT scan room is too far, resulting in longer patient transfer times. This not only reduces the efficiency of the workflow, but also increases the time spent by patients in the examination process. A study shows that a more efficient room design can reduce patient transfer times and improve workflow in a healthcare facility.(Gill et al., 2021).

A final issue that was also identified was the potential for future capacity increases if scan demand decreases. With the advent of more sophisticated multi-detector CT scanners, there is a risk that hospitals will have underutilized capacity if patient demand for scans decreases. Healthcare facilities need to plan capacity with demand fluctuations in mind to avoid wasting resources.(Leng et al., 2019).

SOLUTION RECOMMENDATION

In operations management, improving process efficiency and technological innovation are essential to improving company performance, especially in the medical field. One of the strategic actions that can improve operational efficiency is replacing CT scans as Foster has done. According to(Hadibroto et al., 2023),Investment in this technology is expected to increase productivity and provide a better return on investment.

Organizational theory also states that optimizing workflow is essential to increasing the effectiveness of human resource utilization by allowing nurses and technicians to work in parallel, thus reducing overall cycle time. For example, they do not have to wait for each other because the technician can prepare equipment while the nurse assists the patient. For example, patient transfer from the waiting room can occur at the same time as the

technician prepares equipment, or the cleaning process can occur while the technician completes the image distribution. This method is in accordance with the philosophy of human resource management that emphasizes effective and collaborative teamwork.(Pahira & Rinaldy, 2023).This can also increase productivity in empowering human resources more efficiently, as shown in Figure 3.

Revenue per CT Scan:	\$500
Expenses	
Technologists:	\$35/hour
Nurses:	\$50/hour
Supplies:	\$50/scan

Figure 3. Income and expenses from CT scans, adapted from (Chopra et al., 2017)

By reducing tasks that are not directly related to the transfer, such as preparing the patient and cleaning the room, the use of nurses and technicians in the hospital environment can be optimized. In this way, they can focus more on supervising and managing the CT scan process. According to research, human resource management in the healthcare sector can be successful by reducing unnecessary distractions. This allows medical personnel to pay more attention to the patient and the procedure at hand.(Kim & Roh, 2014).This can also improve the quality of service in addition to increasing patient satisfaction and improving clinical outcomes.(Vijay Kumar Tadia et al., 2021).

In addition, the physical arrangement of the space is very important in facility layout theory to maximize operational efficiency, as shown inFigure 4AndFigure 5. In this case, redesigning the waiting room to be closer to the CT scan room could speed up the process, as shown inFigure 6. In addition, centralization of other tasks, such as equipment setup or patient preparation, may also be considered. Shorter, more efficient access paths can reduce the time patients spend moving from the waiting room to the CT scan room, which will improve the utilization of nurses' and technicians' time.(Abdurrahman & Abdurrahman, 2023).

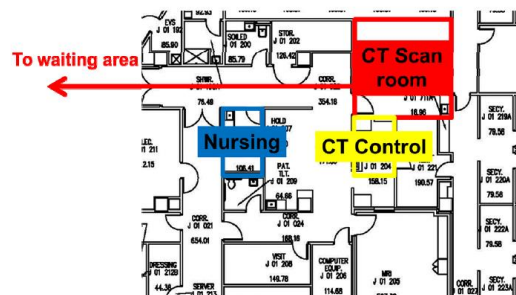


Figure 4. Original CT scan area configuration, adapted from (Chopra et al., 2017)

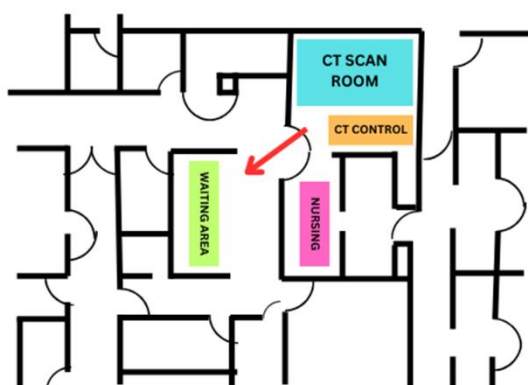


Figure 5. Recommended CT scan area configuration

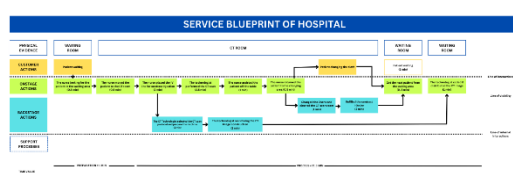


Figure 6. Service blueprint after using multi detector and changing the CT scan area configuration (total scan time efficiency = 33.5 minutes)

Matching service capacity to demand is essential, according to capacity and demand management theory, hospitals should project long-term patient needs and adjust the number of CT scans needed. Hospital scanning capacity may exceed demand as technology advances to provide better image quality and higher speeds. Data show a significant increase in the number of scans in the United States from 1998 to 2007, as presented in Figure 7, reflecting the trend of increasing scanning capacity. This suggests that hospitals may have more CT scans than they need, leading to resource inefficiencies. To maximize the use of existing equipment in this situation, hospitals should consider sharing CT scans across hospitals or centralizing scans in specific locations.(Choi et al., 2018).Thus, collaboration between hospitals in the use of CT scans can be a more efficient and economical solution in dealing with the potential for overcapacity.

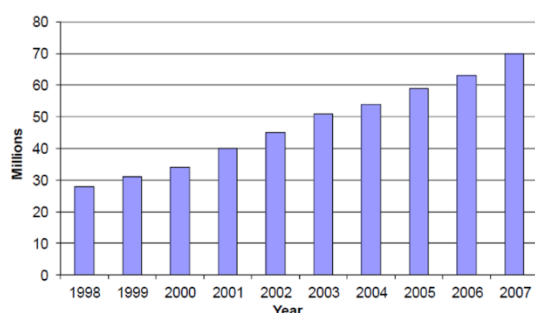


Figure 7. CT scan graph performed in the United States, adapted from

The use of information technology in hospital patient scheduling and flow can be an interesting and more sophisticated option to manage patient flow more efficiently by setting scan schedules, so that patients do not have to wait too long and the scanning process will run smoothly. In addition, this technology can be integrated into the hospital information system, reducing the amount of administrative work that must be done by staff. An example is the implementation of Electronic Medical Record (EMR), this system will automatically set the scan time based on the availability of existing slots and then send notifications to patients regarding their schedules. Hospitals can also use software such as epic systems or cerners that allow for real-time scheduling management.

In addition to designing an efficient workflow, competency improvement and further training for medical personnel must also be carried out, especially for nurses and technicians related to the use of new equipment so that it will reduce downtime during patient transfers. For example, an annual certification program can be held to ensure that employees always know the efficient use of the latest technology. In the analysis of scan images, Artificial Intelligence (AI) can be assisted, namely by automatically recognizing disease patterns and then providing fast results to doctors. The use of AI can also ease the task of interpreting and monitoring images. For example, hospitals can adopt Aidoc or Zebra Medical Vision which can analyze hundreds of images in just a few minutes and are able to provide automatic flags for cases that indicate potential serious problems.

The last is the improvement of collaboration between departments in the integration and efficiency of the process. For example, the use of Vocera Communications or Ascom, so that doctors, radiologists, technicians, inpatient doctors and other related parties can immediately communicate and share CT scan results immediately after the scan is completed. This will speed up the surgical decision-making process without having to wait for the radiologist to first manually check the report. Ultimately, this can increase efficiency across departments and reduce waiting times for patients.

CONCLUSION

The application of multi-detector technology can improve operational efficiency in a CT scan process in a hospital. By rearranging the radiologist and nurse areas to be more centralized with the CT scan room and placing the waiting room closer to the scanning room, patient transfer time and staff tasks can be reduced significantly. These steps will not only speed up the service process but also allow for

more effective utilization of human resources, resulting in improved service quality and patient satisfaction.

REFERENCES

- Abdurrahman, A., & Abdurrahman, A. (2023). Manajemen Komunikasi untuk Membentuk Iklim Kerja Efektif OSIM Madrasah Aliyah Nurul Jadid Paiton Probolinggo. *EDUKATIF : JURNAL ILMU PENDIDIKAN*, 5(6), 2549–2557. <https://doi.org/10.31004/edukatif.v5i6.5823>
- Choi, J. M., Kim, J. H., Kang, S. M., Yu, J.-S., Chung, J.-J., & Cho, E.-S. (2018). Attenuation-Based Automatic Tube Potential Selection in Cerebral Computed Tomography Angiography: Effects on Radiation Exposure and Image Quality. *Journal of the Korean Society of Radiology*, 78(1), 35. <https://doi.org/10.3348/jksr.2018.78.1.35>
- Chopra, S., Flamm, S. D., & Sachin, W. (2017). Body Scans and Bottlenecks: Optimizing Hospital CT Process Flows. *Kellogg School of Management Cases*, 1–6. <https://doi.org/10.1108/case.kellogg.2016.000044>
- Gill, S., Nisar, S., Sarfraz, L., Sidra, K., Faheem, A., & Mujahid, N. (2021). Diagnostic Accuracy of MDCT (Multidetector Computed Tomography) for Staging of Renal Cell Carcinoma. *Pakistan Journal of Medical and Health Sciences*, 15(7), 1471–1474. <https://doi.org/10.53350/pjmhs211571471>
- Hadibroto, T. S. A., Rahmat, A., Abdillah, M. R., & Hadiyati, H. (2023). RESILIENSI PETUGAS KESEHATAN SELAMA COVID-19. *Jurnal Daya Saing*, 9(2), 475–486. <https://doi.org/10.35446/dayasaing.v9i2.1059>
- Hallscheidt, P., Wagener, N., Gholipour, F., Aghabozorgi, N., Dreyhaupt, J., Hohenfellner, M., Haferkamp, A., & Pfizenmaier, J. (2006). Multislice Computed Tomography in Planning Nephron-Sparing Surgery in a Prospective Study With 76 Patients. *Journal of Computer Assisted Tomography*, 30(6), 869–874. <https://doi.org/10.1097/01.rct.0000230009.31715.5b>
- Kim, T., & Roh, H. (2014). Analysis of Risk Factors for Work-related Musculoskeletal Disorders in Radiological Technologists. *Journal of Physical Therapy Science*, 26(9), 1423–1428. <https://doi.org/10.1589/jpts.26.1423>
- Leng, S., Bruesewitz, M., Tao, S., Rajendran, K., Halawish, A. F., Campeau, N. G., Fletcher, J. G., & McCollough, C. H. (2019). Photon-counting Detector CT: System Design and Clinical Applications of an Emerging Technology. *RadioGraphics*, 39(3), 729–743. <https://doi.org/10.1148/rg.2019180115>
- Liang, M., Tang, W., Xu, D. M., Jirapatnakul, A. C., Reeves, A. P., Henschke, C. I., & Yankelevitz, D. (2016). Low-Dose CT Screening for Lung Cancer: Computer-aided Detection of Missed Lung Cancers. *Radiology*, 281(1), 279–288. <https://doi.org/10.1148/radiol.2016150063>
- Pahira, S. H., & Rinaldy, R. (2023). Pentingnya Manajemen Sumber Daya Manusia (MSDM) Dalam Meningkatkan Kinerja Organisasi. *COMSERVA : Jurnal Penelitian dan Pengabdian Masyarakat*, 3(03), 810–817. <https://doi.org/10.59141/comserva.v3i03.882>
- Schuppert, C., Salatzki, J., André, F., Riffel, J., Mangold, D. L., Melzig, C., Hagar, M. T., Kauczor, H.-U., Weber, T. F., Rengier, F., & Do, T. D. (2024). Feasibility of Reduced Iodine Loads for Vascular Assessment Prior to Transcatheter Aortic Valve Implantation (TAVI) Using Spectral Detector CT. *Diagnostics*, 14(9), 879. <https://doi.org/10.3390/diagnostics14090879>
- Shweiki, E., Martin, K. D., Judge, A., & Asher, M. (2018). The Positive Impact on Emergency Department Length of Stay of a Clinical Practice Guideline-Directed Process for Direct Admission from the Emergency Department Computed Tomography Scan Suite to the Intensive Care Unit of Highest Level Trauma Activation Patients. *Panamerican Journal of Trauma, Critical Care & Emergency Surgery*, 7(2), 89–96. <https://doi.org/10.5005/jp-journals-10030-1210>
- Vijay Kumar Tadia, Shakti Kumar Gupta, Sidhartha Satpathy, Arun Kumar Gupta, & Sanjay Kumar Arya. (2021). Utilization Review of Imaging Equipment: An insight into CT

Scanning. *Medico Legal Update*, 21(2),
1244–1252.

<https://doi.org/10.37506/mlu.v21i2.2861>