Proceedings of the International Conference on Industrial Engineering and Operations Management
Washington DC, USA, September 27-29, 2018

Systems thinking in a University

Cecilia Nembou
Divine Word University
P O Box 582, Konedobu
Port Moresby, National Capital District, Papua New Guinea
cnembou@dwu.ac.pg

Abstract

This paper serves as a contribution to the discussions on the *systems thinking approach* to organizational quality assurance and effectiveness of operations and fitness for purpose. It is demonstrated that the organizational characteristics of a university satisfy the assumptions of the systems thinking approach. A university consists of multiple academic and administrative units and a complex set of governance and administrative regulations and functions fulfilling a single purpose, which is to put out quality graduates who are upright citizens, whose behavior is guided by a set of core values and who are committed to serve the common good of the society. The author is inspired by the work of R. L. Ackoff and P. M. Senge on systems approach, systems thinking and learning organization.

Keywords

Systems, systems-thinking, systems approach, learning organization, organizational effectiveness.

1.0 Is there a difference between Systems Approach and Systems Thinking?

A *system* may be an organism or organization and consists of many elements which interrelate and interact with each other and with the environment within which the system exits. The health and wellbeing of the whole system depends on the health and wellbeing of all the interrelated and interacting elements, and the effectiveness of its response mechanisms to environment challenges. The human body is the most complex system imaginable because it is made up of many systems and subsystems such as the central nervous system, circulatory system or respiratory system. When a part of the human body malfunctions, a person feels sick. A similar context exists for an organization.

Systems approach is an analytical tool, a model, used to evaluate an organization's consistency with the purpose for which it exists by considering the organization it its entirety. The assumptions of the model are that the organization consists of many related and interactive elements having a single common purpose. In addition, the organization as a whole or by its elements interacts with its environment and is influenced by external environmental factors.

Systems thinking is a mindset which applies the systems approach to analyze and synthesize an organization's operations with the objective of resolving system deficiencies. The origin of systems thinking is attributed to Ackoff, R. L. (1971) and popularized by Peter Senge in his book, the Fifth Discipline, as reported in Smith, M. K. (2001). The essence of mastering systems thinking lies in the ability to see patterns that tell a story about the organization and people within it. Ackoff, R. L. (2000), gives a couple of reasons why few organization apply systems thinking. The

first reason is an error of judgement and the second is that the proponents do not promote it sufficiently to the potential users.

The emphasis is on the complexity of multiple relationships and interactions of the constituent elements and the influence of the environment all of which impact on the whole organization.

Thus, the basic characteristics of a system are: the whole consists of many elements, many interrelationships and many interactions between the elements. It is an open system in the sense that external factors in the environment impact on the system and the system responds to feedback from the outside as well from the inside.

A *learning organization* is one in which individuals within an organization are inspired by the same spirit of commitment to a shared vision, and who willingly align their individual aspirations with the organization's aspirations in such a way that the individual perceives the achievement of the organization's purpose as their own. Complete alignment is not possible due to multiple perspectives, socio-cultural, spiritual or personal reasons. However, an effective leader could achieve a significant level of alignment and achieve an aspired level of *organizational effectiveness*. It is a challenge of the leadership and management subsystems to realize a learning organization.

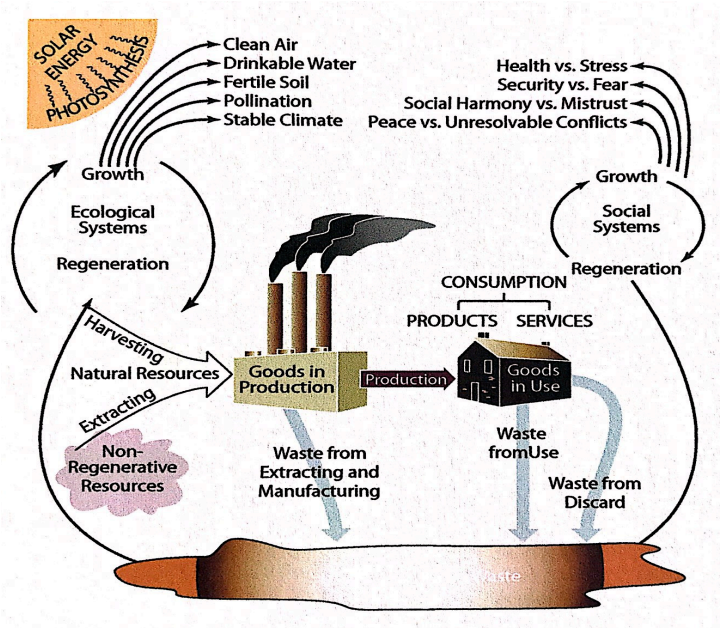
2.0 Trends in Applications of the Systems Approach and Systems Thinking

The context of this paper is influenced by the background of the author who combines mathematical optimization thinking and modelling with operations research methodology and applies it to leadership and management situations that exist in her workplace environment. A snap review of the literature shows that the application of systems approach with systems thinking is generating research interests in the areas of organizational effectiveness, strategy, leadership and management. The latest trends in applications appear in environmental studies, communications, workplace safety, development resources management and higher education. All the examples cited, involve various aspects of organization effectiveness, strategy and leadership and management. The rest of section 2 describes an example in each area of application. In section 3 a case study of the Divine Word University in Papua New Guinea is illustrated and the presentation concludes in section 4 with a response to a critique of Peter Senge's systems thinking and the learning organization.

2.1 Systems Approach in Environmental Studies

Regrettably not all world leaders acknowledge that climate change is the result of environmental pollution caused by industrial systems operations and careless or absence of responsible waste management practices over long periods to time. In Senge, et al (2008), the systems thinking is recommended as the lens to view the effects of global climate change as the outcome of many complex contributing factors from many and varied operations of the industrial age. When viewed with a Systems Thinking lens the global eco-system is so intricately related. Figure 1 shows the elements of the global eco-system, relationships and interactions between the various systems and subsystems that contribute to environment sustainability or degradation as the case may be. The elements include sun, water, air, soil, plants, animals, marine creatures, industrial operations, natural resources, socio-cultural attributes, and waste.

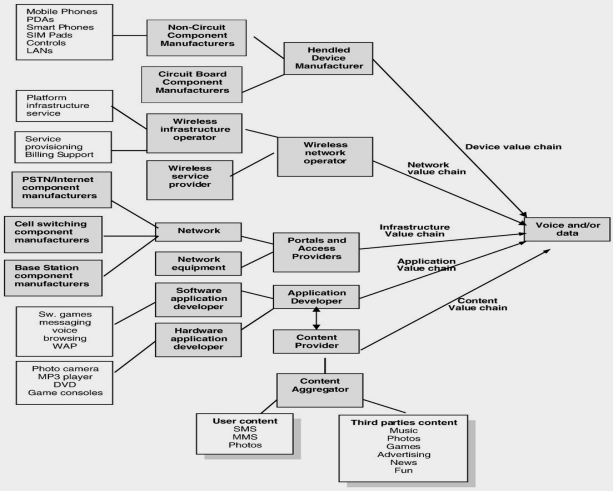
Figure 1: The global environment viewed through the systems thinking lens
(Taken from Senge et al, 2008)



2.2 Systems Approach in Communication Networks

An example of the systems approach with systems thinking applied in communications is reported in Pagani, M. and Fine, C.H. (2007), by which the relationships and interactions of the elements that constitute the third generation (3G) wireless networks are analyzed to assess the value of 3G communication products in a strategic manner so as to achieve competitive advantage and maximize profit. Elements of the system include user population size, service provider profile, installation cost, price, content variety, network dynamics, all of which affect the perspective of the user and their value judgement of the existing 3G or future 4G network products. Figure 2 shows the visualization of the systems approach and systems thinking of wireless communications products marketplace.

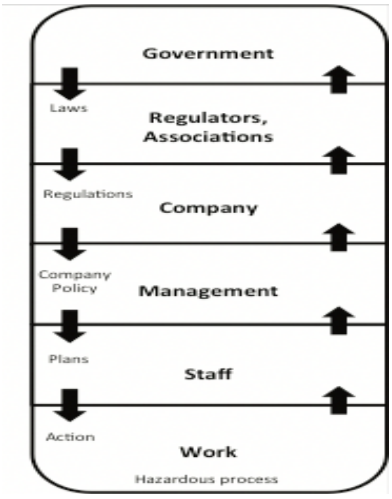
Figure 2: Wireless network systems thinking design for value assessment (Taken from Pagani and Fine (2007)



2.3 Systems Approach in Workplace Safety Management

Donovan, S-L., Salmon, P.M. and Lenne, M.G. (2015), describes a case study of workplace safety leadership in which systems approach and systems thinking are combined with a specialized risk management framework to achieve an optimal decision outcome. The elements of the system include external factors such as government regulations and other stakeholder regulations while internal factors include corporate governance, leadership and management, staff, company operations and workplace safety.

Figure 3: Risk Management Framework (Taken from Donovan, Salmon and Lenne)



The application of the systems approach led to the development of "visual mapping of the elements identified, illustrating the interrelations between safety leadership decisions and actions and the role these elements played in

ensuring the positive safety outcome".

2.4 Systems thinking in Development Resources Management

Nembou, C. (2006) shows that in development resources management, systems thinking is referred to as *sector wide approach* (SWAP) and it is used to manage the relationships that exist between external aid donor(s) and recipient country and within the recipient country between the recipient country government and its delivery partners, and the people.

It serves as an analytical approach which if applied correctly can yield maximised outcomes for all stakeholders: donors, recipient-country decision-makers, implementers, and beneficiaries. SWAP has certain attributes which make it more attractive as a preferred model for disbursing and accounting for donor funds in such a way that the rural people actually receive the intended benefits be it curriculum materials for rural primary schools or malaria medicine for rural health centres.

2.5 Systems thinking in Higher Education

Furst-Bowe, J. (2009) reports the case of the University of Wisconsin Stout Campus (UW-Stout), where systems approach and systems thinking have been applied in combination with specialized quality assessment criteria to win the United States National Quality Award for performance excellence and continuous improvement in higher education. For the sake of analytical convenience, the author has aggregated the various subsystems of UW-Stout system into four most influential subsystems. They are, inclusive leadership, clearly defined stakeholder groups and their requirements, participatory planning process, and a comprehensive system for measuring institutional performance. This example has demonstrated the power of systems approach and systems thinking in higher education by breaking down 'institutional silos' and providing "the ability to achieve institutional goals and sustain consistent performance improvement over time".

3.0 Case study – Systems approach and systems thinking in the Divine Word University, Papua New Guinea

A university system exists in a higher-level system of higher education in a country. Depending on a country's governance framework it may be part of the national education system or it may be autonomous. Higher education is generally a national function authorized to operate by a legislation. A university's purpose is mandated by a government legal instrument subordinated to higher education legislation. Within a university system there may be a single or multiple campuses comprising of a complex set of interrelated and interacting systems and subsystems which can be broadly categorized into systems such as, core values and governance, identity and mission, leadership and management, academic and student affairs, information, communication technology and library, finance and human resource management, corporate affairs and university owned enterprises.

A university system can be likened to a small township in which the President or Vice Chancellor is the mayor. It has all the features of a township including people, facilities and services. Academic units have faculties at the higher level, served by a subsystem of departments which include students, programs, and curriculum. The student support system comprises the subsystems of recruitment, admissions, enrolment, progression, lecture and examinations scheduling and graduation. The human resource management system comprises the subsystems of recruitment, appointment, contracts, payroll, promotions, retention, and professional development. A finance system consists of two subsystems, treasury and accounting services. Information, communication technology and library system comprises computer deployment subsystem, Internet services, learning management subsystem, student information management subsystem, accounting management subsystem, data center security management system, infrastructure network monitoring and maintenance subsystems, and helpdesk subsystems. The corporate affairs system has as its subsystems, physical facilities management subsystem, transport subsystem, community security subsystem, corporate risk management subsystem, electricity distribution subsystem, water supply subsystem, alumni relations management, partnership management system, and university owned enterprises systems, which are commercial

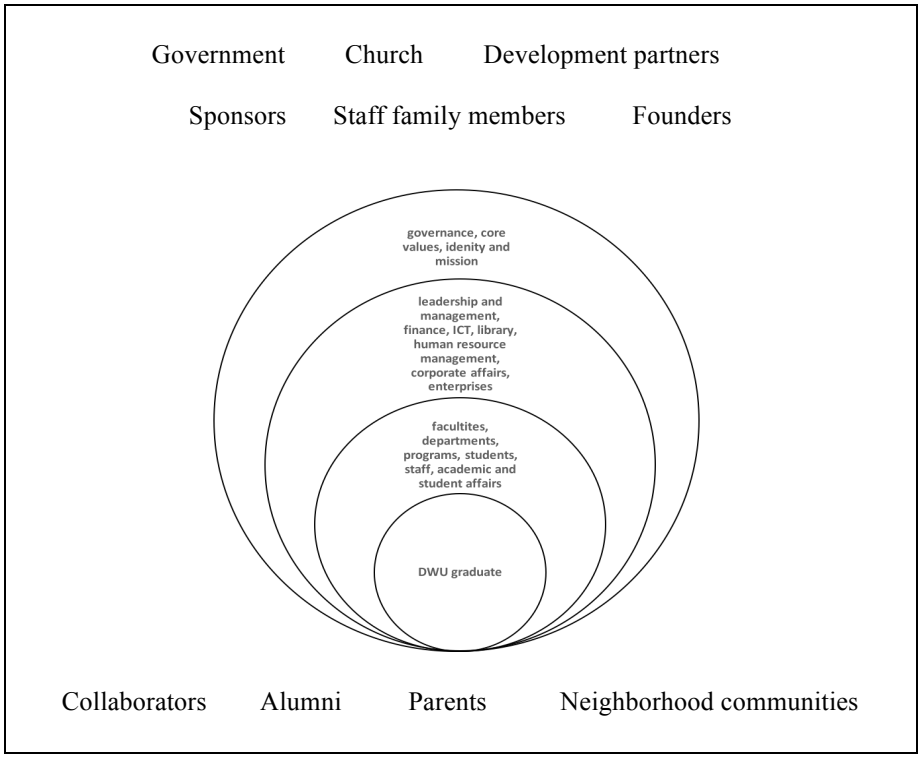
enterprises wholly owned by the university. All of the systems and subsystems are interrelated and interact in some form or other to collectively serve a single purpose which is to output a quality graduate who has all the attributes desirable of an upright citizen and who has the will and commitment to serve the greater good of society. The structural form is a very complex network of relationships and interdependencies.

For the sake of analytical convenience, a degree of aggregation is necessary as has been done in the example of UW-Stout. The DWU system can be aggregated into four subsystems,

- governance, core values and governance, identity and mission,
- leadership and management, finance, ICT, library, academic and student affairs, information and communication technology and library, human resource management, corporate affairs and enterprise,
- faculties, departments, programs, students, staff, academic and student affairs
- DWU graduate is the core output

The environmental factors include the stakeholders such as the government, church, development partners, sponsors, founders, alumni, parents, collaborators, staff family members, and neighborhood communities.

Figure 4. DWU systems approach/systems thinking design layout



In order to achieve organizational effectiveness, three issues are paramount. They are, accountable leadership, acute management acumen and effective communication both interpersonal and information and communication technology. Periodic external feedback by way of external quality assessments by the government or other collaborators is good practice. Norman, P. A. (2018), presents documented evidence of the systems approach/thinking as it is practiced at DWU.

The role of collaborative leadership is to inspire and motivate the staff to align their personal aspirations with the University's aspirations and core values, through constant and consistent transparent communication and encouragement through coaching and mentoring by shared conversations and professional and academic capacity

enhancement. This is the essence of the concept of learning organization. The characteristics of a learning organization as defined by P. M. Senge (1990) involve, personal mastery, mental models, team learning, shared vision, and systems thinking.

Applying these principles in the University implies contextualizing in the following sense:

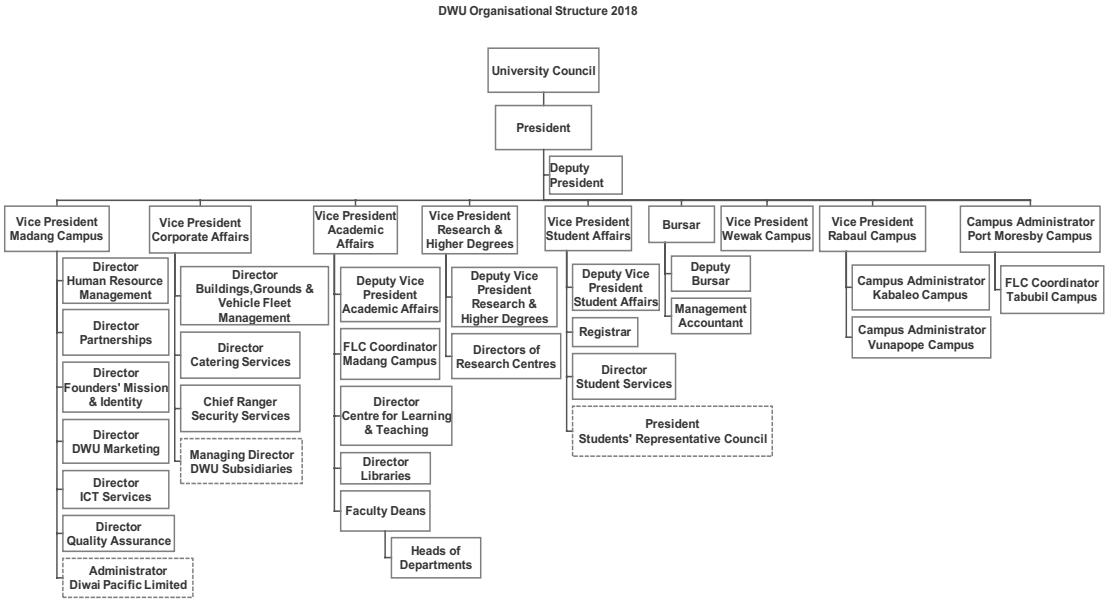
- Personal mastery means a thorough understanding the university's organizational system in its entirety from a systems-thinking mindset and alignment of personal aspirations with the DWU's core values and aspirations;
- Mental models involve having to make a systemic mind scan of how the patterns of organizational structures, culture, governance, and administrative subsystems interrelate and interact with each other;
- Team learning means individuals taking ownership and responsibility for personal mastery and participating in collective thinking, visioning and problem solving with the objective of co-creating the future direction of the university;
- Shared vision means employing team-spirit and collaboration leadership to co-design a desired future that everyone understands and is committed to achieving it.
- Systems thinking means to take responsibility for the corporate body or whole organization and see how all its many parts interact and operate together to achieve organizational objectives.

Viewed with the systems thinking mindset the complexities of governing, leading and managing a University system of people with multiple perspectives, organizational structures, and functions become mentally and practically discernable by the governing council and leadership and management teams.

3.1 DWU Organizational structure

The University has established a sound system of leadership and management across the University with an organizational structure and a governance structure aligned with university functions. These are clearly documented in the current Strategic Master Plan and the Governance and Administration Manual. The positions reflect the University's hierarchical structure of positions of authority and are considered to be appropriate for the University's purposes and management processes. The hierarchical structure is pertinent for delineating lines of reporting, mentoring and performance appraisal processes.

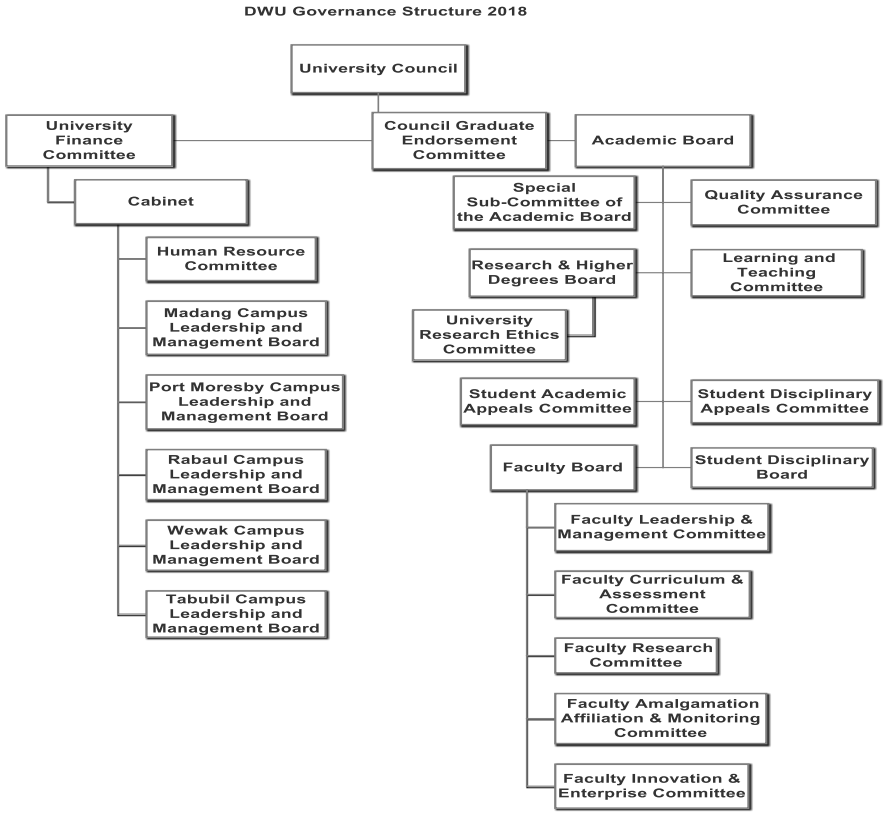
Figure 5: DWU Organizational Structure



3.2 DWU Governance structure

Following on from the organizational structure, the committee system gives effect to the authorities of the University, which is referred to as the governance structure. Top-tier decision-making bodies include the University Council and its sub-committees, which are, Council Graduate Endorsement Committee, Academic Board and University Finance Committee. The second-tier and third-tier levels of authority are referred to as the President's management committees, which include, Cabinet, Human Resource Committee, and the sub-committees of the Academic Board and Cabinet. Each committee and sub-committee has a unique and important role in the efficient and effective operations of the University functions.

Figure 6: DWU Governance Structure



3.3 Senior staff position descriptions

Significant improvements have been made in regard to management of human resource matters and the establishment of the Human Resource Committee and the design and development of the position register for human resource planning, budgetting and monitoring. Position descriptions, which are further elaborated upon in duty statements, are provided for senior positions such as the President, Deputy President, Vice Presidents, Deans, Heads of Departments, Campus Administrators, and Directors of Divisions.

3.4 DWU policies

The Policy Library in the DWU Intranet holds a comprehensive collection of policies covering academic matters, research, students, quality assurance, corporate services, finance, risk management, ICT services, human resource management, library, media and partnerships. It is accessible by all staff. Efforts are ongoing to update policies to keep them current.

3.5 Information and Communication Technology System

The governance and administration system is well support by a ICT Services Division with more than 20 technology officers who support the ICT requirements of all campuses. DWU is able to maintain a data center and ICT infrastructure to service all its higher education operations, with appropriate confidentiality and security, and to backup data. University 10 is the student data management software system used at DWU. This provides detailed comprehensive information on all students, including enrolment status, demographic details, assessment outcomes and grades, data on enrolment, progression, attrition, graduation, and violations of the student disciplinary policy. Moodle is the learning management system used. The Director of ICT Services oversees the provision of the highest levels of ICT services for staff and students of the University across all DWU campuses.

3.6 Quality Assurance Mechanisms

Attention to quality assurance (QA) matters is embedded in the DWU culture. There is a QA division of administration dedicated to oversee the QA activities across the DWU multi-campus system. A variety of QA mechanisms are used to seek and evaluate feedback from the stakeholders, including users and sponsors. A centralized system for student evaluation of units taught is in use. This is conducted electronically for fulltime students at the end of each semester using the Moodle platform. The flexible learning center administrative officers use a paper-based questionnaire for students in flexible learning programs. The views of the students and external stakeholders form part of the cyclic reviews and updating of academic programs and to inform and bring about immediate improvements in students' support mechanisms. The Director for Partnerships is a key person in managing the quality of processes for partnership arrangements. The Quality Assurance Committee (QAC) and Faculty Curriculum and Assessment Committees (CACs) are active in monitoring curriculum development, delivery and assessment activities.

3.7 Planning the academic year

In March of each year the University Council approves the calendar of dates and events for the following year. This enables academic activities and special events to be appropriately planned in a timely manner. Aligned with the Strategic Master Plan, Learning and Teaching Plan and Research Plan, the faculties develop annual operational plans. These are presented during Induction Weeks at the beginning of each year and subsequently achievements and lessons learnt are presented during Review Week in November of each year with plans indicated for future improvement.

3.8 Integrity of Certificates

Strong efforts are made to ensure the quality of certificates and they are issued in a manner to avoid fraudulent practices. Certificates are prepared by a trusted graphic artist in the DWU Marketing Division and forwarded to the Registrar's Office for processing. Each certificate caries the student's unique ID number, has an embossed gold logo, and is clamped with an imprint of the Registrar's seal, before being signed by the President and University Council Chair. The Registrar is alert to identify cases of potentially fraudulent certificates being received and checks are made with official records.

4.0 Conclusion

Systems thinking has been severely criticized by Caldwell, R. (2012) as *"…critically flawed in two major respects. First, as a systems or structural model, it is theoretically flawed, because it cannot theorise the organizing practices by which learning and change occurs in organizations. Second, it is substantively flawed as a practice for increasing the dispersal of human agency, power, knowledge and autonomy within the workplace. It is concluded that Senge's concept of the learning organization now faces its final abandonment as a theoretical and practical guide to organizational change."*

As a strong advocate of systems thinking the author rejects Caldwell's critique as using a different lens to what was intended by Peter Senge in 1990. Caldwell's perspective is highly theoretical and unnecessarily complex. In this paper, the author has amply demonstrated the power of systems thinking as a mindset used in combination with systems approach and the concept of learning organization as an analytical tool for the optimization of industrial or management operations. In the case study reported in this paper, the DWU system is a successful example of the practical application of systems approach/systems thinking modelled by Russell Ackoff and popularized by Peter Senge. According to uniRank University Ranking, DWU leads the six universities in Papua New Guinea in "a non-academic *League Table* of all Papua New Guinea Universities based on unbiased and valid web metrics".

Acknowledgements

The author acknowledges the kind acceptance of my paper by the Conference Organizing Committee and the opportunity to present here in IEOM 2018, Washington DC.

References

Ackoff, R. L., Towards, a system of systems concepts, *Management Science*, Vol. 17, No. 11, pp. 661 – 671, Pennsylvania, U.S.A, July, 1971.

Ackoff, R. L., Why few organizations adopt systems thinking, *Systems Research and Behavioral Science*, Vol. 23, Issue 5, pp. 7.5 – 708, September/October, 2006. Available: www.interscience.wiley.com. doi: 10.1002/sres.791. Also available: ackoffcenter.blogs.com.

Caldwell, R., Systems thinking, organizational change and agency: a practice theory critique of Senge's Learning organization, *Journal of Change Management*, iFirst article, pp. 1 – 20, 2012.

Donovan, S-L., Salmon, P.M. and Lenne, M.G., The leading edge: A systems thinking methodology for assessing safety leadership, *Procedia Manufacturing*, Vol. 3, pp. 6644 – 6651, 2015.

Norman, P. A., Divine Word University Self-Assessment Report for quality assurance reviews under the Higher Education (General Provisions) Act 2014, pp. 30 – 32, September 2018.

Furst-Bowe, J., Systems thinking: critical to quality improvement in higher education, *Quality Approaches in Higher Education*, Vol. 2, No. 2, pp. 2 – 4, 2009. Available: *www.asq.org/edu/index.html*.

Pagani, M. and Fine, C.H., Value network dynamics in 3G-4G wireless communications: S systems thinking approach to strategic value assessment, *Journal of Business Research*, Vol. 1, pp. 1102 – 1112, 2008. Available: www.sciencedirect.com.

Senge, P., Smith, B., Kruschwitz, N., Laur, J. and Schley, S., The necessary revolution: how we got into this predicament, *Reflections*, Vol. 9, No. 2, pp. 20 – 32, 2008. Available: reflections.solonline.org.

Nembou, C., Closing remarks, International Stakeholders' Conference on Sector Wide Approach in National Development: Opportunities and Challenges, Madang, Papua New Guinea, February 10 - 11, 2006.

Smith, M. K., Peter Senge and the learning organization, *The encyclopedia of informal*

education, 2001. Available: http://infed.org/mobi/peter-senge-and-the-learning-organization/.
uniRank (formerly 4 International Colleges & Universities) University Ranking, 2018 League Table. Available: https://www:4icu.org/pg/.

Biography

Professor Cecilia Nembou is the President and Vice Chancellor of the Divine Word University (DWU) in Papua New Guinea, and Professor of Higher Education Leadership and Management. She holds a BSc in Mathematics from the University of Papua Guinea (1975), MSc in Operational Research from the University of Sussex (UK, 1978) and PhD in Operations Research from the University of New South Wales (Sydney, Australia, 1992). She has held various academic and senior management positions at the University of PNG, University of Wollongong in Dubai and at the Divine Word University over a period spanning over 40 years.

Professor Nembou's research interests include, applications of systems thinking, leadership and management, and analytics in higher education.

Professor Nembou is a regular member of INFORMS and IEOM Society International.

She is a former Head of Mathematics Department, Executive Dean of the School of Natural and Physical Sciences, Pro Vice Chancellor Planning and Development and Acting Vice Chancellor at the University of Papua New Guinea; Academic Registrar and Senior Lecturer at the University of Wollongong in Dubai, and Deputy President of the Divine Word University.