

Research Article

Digital Transformation of University-industry Collaborations: An Information Systems Approach in a Developing Country Context

Justine Mukalere^{1,*} , Martin Kabanda² , Simon Mukisa³ 

¹Computing and Technology, Uganda Christian University, Mukono, Uganda

²Business Administration, Uganda Christian University, Mukono, Uganda

³Economics and Statistics, Uganda Christian University, Mukono, Uganda

Abstract

University–industry collaborations (UICs) are increasingly recognized as essential for fostering innovation, skills development, and knowledge transfer. However, in developing countries, these collaborations are often constrained by weak governance structures, limited resources, and lack of sustainability mechanisms. This study aimed to explore the current state of UICs at Uganda Christian University (UCU) and industries in Mukono Municipality, and design an ICT-enabled model to strengthen UICs in developing countries. The study employed a qualitative approach, and data was collected from 21 participants through interviews with university (senior administrators, faculty heads) and representatives from the industry (service, manufacturing, research, and not-for-profit organizations). Insights from General Systems Theory, Collaborative Control Theory and Rybníček & Königsgruber model, informed thematic analysis. From the analysis, five themes emerged, which are: Nature of Collaborations; Management Structures and Platforms for UICs; Stakeholder Capacity and Readiness for UICs; Information Exchange & Dissemination; Impact and Sustainability of UICs. The study findings revealed that UICs have weak governance & coordination mechanisms, lack sustainability & digital implementation, are largely informal, under-resourced. Internship was seen to be the dominant form of engagement between universities and the industry. This suggests that; adopting ICT-mechanisms improves UIC effectiveness and sustainability. This study therefore proposes a context-sensitive, systems-oriented JMS Model to enhance UIC management in developing countries which contributes to literature and practice.

Keywords

University–industry Collaboration, Digital Transformation, ICT-enabled Model, University Education, Developing Countries

1. Introduction

1.1. Background

University-Industry Collaborations (UICs) are structured

partnerships between universities and the industry (manufacturing, service, research organizations, not-for-profit organizations), encompassing internships programs, joint research

*Correspondence: Justine Mukalere (jmukalere@gmail.com)

Received: 22 December 2025; Accepted: 6 January 2026; Published: 2 February 2026



Copyright: © The Author(s), 2026. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

and development projects, consultancy, information and technology transfer, and curriculum co-design activities, with an aim to promote real-world learning, drive innovation and contribute to economic development [1-3]. Though not limited to these disciplines, UICs are mostly applied in STEM, business, and social sciences [4, 5]. There is evidence of growing application of UICs in emerging economies to aid in bridging the skill gap and increase relevance, applying frameworks which integrate particular stakeholders though limited technology use [6-8].

For universities in Uganda like Uganda Christian University (UCU), the application of UICs is majorly through internship programs, joint research projects, community outreach and remains largely informal, with its governance system greatly unstructured [9]. This limits their potential to align with Sustainable Development Goals (SDGs) such as SDG 4 (Quality Education), SDG 9 (Industry, Innovation & Infrastructure), and SDG 17 (Partnerships for the Goals) [10-14].

Improving UIC coordination and scalability while upholding transparency can be aided by the adoption of digital mechanisms, however, scholarly understanding of the application of digital transformation for UICs in the context of developing countries is still low as traditional manual approaches are largely used in the frameworks adopted in such collaborations [4, 9, 15-17].

Conceptualization of this study draws insights from the Rybnicek and Königsgruber (2019) Model, which focuses on transforming academic output into tangible academic and economic benefits while promoting strong industry-university partnerships through its key areas: Establishing mutually profitable relations between universities and business entities; Industry-University Collaboration and Relationship Management; Technology Access; Commercialization of Knowledge; and Income Generation [18]. It categorizing success factors of collaborations into institutional, relational, output, and framework domains. While the Rybnicek and Königsgruber model provides a structured understanding of UIC success factors, it lacks the systematic structural implementation component which can be addressed with the integration of Information and Communication Technology (ICT). This indicates a need to design an ICT-enabled context-based model to support UICs [8, 17, 15].

1.2. Theoretical Grounding

General Systems Theory (GST)

The general system theory (GST) describes how to break whole things into parts and then learn how the parts work together in systems while emphasizing the relationship between parts and describing how these parts function and behave [19], with focus on interdisciplinary integration [20, 21]. GST conceptualizes UICs as interdependent systems with emergent behaviors arising from the interactions among university, industry, and ICT components.

Collaborative Control Theory

The Collaborative Control Theory describes how policies, principles and tools are used to enable and sustain collaborative ventures [22]. This speaks to UICs with focus on how digital tools support; coordination, performance monitoring, and accountability for multi-stakeholder collaborations.

1.3. Research Aim and Objectives

The aim of this study was, to develop an ICT-enabled model for strengthening University-Industry Collaborations (UICs) in a developing country context.

The specific objectives were;

To identify needs and barriers of University-Industry Collaborations at Uganda Christian University and industries in Mukono Municipality.

To map these findings against General System Theory, Collaborative Control Theory, and Rybnicek and Königsgruber's model.

To develop an ICT-enabled model for effective and sustainable University-Industry Collaborations in developing countries.

2. Methods

2.1. Study Design

The study employed a case study design, using a qualitative approach to explore deep insights in the implementation and management of UICs in Uganda as used in similar studies like [23, 24]. In this study, UCU and industry players within Mukono municipality were used as the cases to provide a context for understanding the perceptions, attitudes, needs, capacity, barriers and motivation in the establishment, implementation and sustainability of UICs, to inform the design of an ICT-enabled UIC model to aid the implementation of such collaborations in a developing country context.

2.2. Study Setting

This study was conducted in Uganda-Mukono Municipality. Uganda Christian University-UCU (University) and different industry players in Mukono municipality were considered for the study.

2.3. Participants and Sampling

The stakeholders/ participants were selected using Maximum Variation Sampling (MVS), a type of purposive sampling involving drawing of samples from a wide range of the population based on the purpose of the study [25], to enable inclusion of all the relevant stakeholders in the research project.

A total of 21 participants were purposively selected based on their relevance to the implementation of UICs, across two

stakeholder categories with sub-divisions: University Stakeholders (Administrators, Faculty heads); Industry Stakeholders (Service, Manufacturing, Not-for-profit organizations, research organizations). The 21 selected are those entities that have departments/sections of research and partnerships in

their structure. This non-probability sampling technique helped to ensure that perspectives from major stakeholder categories, directly involved in the establishment and management of UICs were captured. Each category contributed a different percentage to the sample size (See Table 1 below).

Table 1. *Weights of Participant Categories.*

Categories	Sub-categories	Number	Percentage
University Stakeholders (42.86%)	Administrators – Uadmin	3	14.29%
	Faculty Heads – UFH	6	28.57%
	Service – IS	9	42.86%
Industry stakeholders (57.14%)	Manufacturing – IM	1	4.76%
	Research organizations – IRO	1	4.76%
	Not-for-profit organizations - INP	1	4.76%
Total		21	100%

2.4. Data Collection

Data was collected over a period of three months (March-May, 2024) using semi-structured, open-ended and face-to-face interviews [24]. A total of 21 participants were interviewed, including; 3 University-Administrators, 6 University-Faculty heads, 9 Industry-Service, 1 Industry-Manufacturing, 1 Industry-Research organizations, and 1 Industry-Not-for-profit organizations. While the interviews were tailored for the different stakeholder categories, the focus was on common themes including: Perspectives and attitudes of UICs; Assessing readiness and capacities for collaborations; Understanding needs, motivations, and challenges. Interviews were conducted in English, and lasted between 20-35 minutes. Data collection sessions were audio recorded and intelligent verbatim used in the transcription.

2.5. Data Analysis

A clean transcription was performed on the voice recordings from the interviews to drive the qualitative data analysis process. Transcripts were imported into NVivo 10 software, employing a thematic approach based on the Braun and Clarke's six-step framework [26], involving: familiarization with data, coding, development of themes, review, definition and reporting. Initial codes were inductively generated from data and then categorization into broader themes aligned with the study objectives. The coding was done iteratively, which allowed for the refining of codes in the process of analyzing. This tool enabled data management and coding strategies which aided the interpretation of the findings [27].

Ethics approval and consent to participate: Ethical approval was obtained from Uganda Christian University-Research Ethics Committee (UCU-REC). All participants provided informed consent before participation. Throughout the study, anonymity and confidentiality were maintained.

Consent for publication: All quotes from individual participants are permitted for publication as per the consent forms signed by the participants. Coding has been used to ensure anonymity and confidentiality.

3. Results

Findings from the study are organized into key themes. The analysis revealed strengths and challenges of the current implementation structures of UICs at UCU and the industry. Representative quotes from participants are included to support the different themes.

3.1. Participants Characteristics

The 21 stakeholders who took part in the study varied in age and their roles in UICs. University Administrators were directly involved in managing the UICs at a strategic level; University faculty heads were directly involved in seeking for potential UICs, establishing, and managing the UICs; Industry participants were administrators involved in planning for and managing UICs. Participants were distributed as represented in Table 2 below.

Table 2. Distribution of Participants by Stakeholder Categorization.

Total Participants	N=21
Categories	Sub-categories
University-U (9)	Administrators - UAdmin (3)
	Faculty Heads - UFH (6)
	Service - IS (9)
Industry- I (12)	Manufacturing IM (1)
	Research organizations - IRO (1)
	Not-for-profit organizations - INP (1)

3.2. Thematic Analysis

3.2.1. Nature of Collaborations

At UCU, UICs are often initiated in an informal manner with a heavy reliance on individual connections and goodwill rather than institutional structured arrangements, seen from participant submissions where university participants stated that most collaborations happen when faculty members use their personal networks. This narrative was supported by the industry participants' submission, decrying the difficulty in sustaining engagements due to the lack of formalized channels.

"But then our interaction which I may say is not formalized... But like I have said, there is no formal written agreement with some of these people" - U2BSJ.

"We have a lot of informal collaborations" - U3SJJ.

While most of the UICs are in the area of Internship and Outreach, some industry stakeholders assert that UICs can only happen in a win-win situation.

"for any partnership,... it must be a win-win situation." - I4SLJ.

"we have tried to come up with an MOU with the municipality because we do a lot of engagement with them through the outreach." - U1FEDTS.

"we have been working with colleges, universities and other institutions of learning by offering internship opportunities." - I4RCM.

3.2.2. Management Structures and Platforms for UICs

UCU operates a directorate of research partnership and collaborations as a conduit for managing UICs, but most industry entities do not have such an administrative unit much as they have policies which govern collaborations under their central management.

"every collaboration is signed through the curtesy of the directorate of research, partnerships and innovations... that directorate has to be in the know and the legal officer and the VC." - U1SSJ.

"We usually have memos to be signed at the head quota

with all partners." - I4RCM.

"Yes, we have policies for partnerships." - I4SLJ.

Despite the existence of an administrative unit for partnerships at UCU with policies on partnerships, it is a centralized unit with weak implementation, no representation, and unclear governance documents at school/faculty level, breaking the UIC eco-system hence subjecting industry partners to fragmented communication, creating barriers in the operation of UICs.

"we are operating in a fluid system, where there is no single person who coordinates our partnerships." - U1SSJ.

"it is important to be clear, what each partner is going to benefit... we have been a bit vague on that and we need to probably improve on that." - U1FEDTS.

"Yes, and as far as we're concerned, as a university, we have the framework, policy frameworks and intellectual property frameworks that should support or that should guide. These kinds of interactions." - U1RIM.

UCU reports that they have not yet hit a comfortable number of partnerships, and industry stakeholders report unmet expectations from the university for collaborations like internship.

"Partnerships with the industry are still very few" - U1RIM.

"We were receiving students from the university and never had a reporting tool for their reporting which we would expect from university to do before they are sent to the field." - I4RCM.

The absence of a centralized ICT platform was a shared concern. Both university and industry participants indicated that communication is fragmented with heavy reliance on emails, phone calls and face-to-face meetings. Industry respondents felt this undermined accountability and transparency. It was also indicated that university values often influence partnership decisions, which limits engagement opportunities.

"That is a very good one and you will see that, because of who we are, in terms of our philosophy, in terms of our values, certainly, we don't attract certain types of collaborations. Otherwise, that's why I talked of credibility. That those who come to us, are the ones that are credible and can identify with our values" - U2BSJ.

3.2.3. Stakeholder Capacity and Readiness for UICs

The study revealed that stakeholder's capacity and readiness for UICs is still wanting in regard to human resource, infrastructure and facilities, motivation, finance and budgeting. Faculties report having a high ratio of part-time to full-time staff in addition to high teaching work-load which affects staff availability and commitment to UIC activities. It was also reported that: staff need incentives to be motivated into the UIC agenda more so where research is involved; facilities like labs are not adequate to support certain collaboration projects types; facilitation for UICs is not adequate with existing budgeting gaps in line with UICs; there is need for capacity building trainings as an avenue that would not only sensitize stakehold-

ers of their roles, operations of UICs and policies and regulations governing UICs but also build interest and motivation for involvement. This was not different from submissions from the industry stakeholders who also stated that they feel the universities need to do more and lead the UIC venture.

"No we do not have budgets for partnerships. Our budgets only facilitate our day-to-day operations. Otherwise the partners fund their activities." - I4RCM.

3.2.4. Information Exchange & Dissemination

Knowledge exchange between UCU and the industry exists but is inconsistent and sometimes incomplete, hindering feedback or follow-up. While traditional communication channels of information exchange like phone calls, emails and face-to-face interactions such as public lectures are largely used for most of the information flow at UCU, technology has been embraced for particular processes. The grants management system is used to handle the research process data flow and platforms like social media used during particular events.

"Dissemination, we usually have social media. Like when the programs were running, we got someone to take care of the social media platform to alert people. Facebook, twitter which is X, and then WhatsApp... On Facebook, there was a live stream during the engagements." - U1SSJ.

"one of the things we have put in place is a is an online system, what we call the grants management system. And in that system, hopefully, we should be able to track performance and be able to pick challenges early on." - U1RIM.

"We were receiving students from the university and never had a reporting tool for their reporting..." - I4RCM.

Industry participants noted with concern that sometimes output from joint works is not publicly availed, which affects the learning curve. This speaks to the need to leverage ICT for knowledge sharing.

"There should be a digital repository where joint research can be accessed" - I3MDS.

3.2.5. Impact and Sustainability of UICs

Findings show that many collaborations are short-lived and therefore do not benefit from long-term impact. Much as industry partners assert that sustained collaborations have the potential to lead to co-developed solutions and innovations, student internships and temporary research outputs are largely the results of the engagement with universities and not many long-term partnerships or sustained innovations, revealing the need to have a structured ICT-supported systems to support the continuity of such engagements.

The impact of UICs is perceived differently by the different stakeholders. University stakeholders look at it in-terms of graduate quality and employability while the industry looks at it in-terms of business gain and promotion fronting the "win-win" notion.

3.3. Summary of Gaps/Challenges Faced by UICs

Looking at the thematic findings from the study, there are a number of gaps/challenges facing UICs which affects their successful implementation and sustainability. A summary of these challenges/gaps is seen in Table 3 below;

Table 3. Summary of Gaps/Challenges facing UICs.

Sn	Theme	Findings
1	Nature of Collaborations	These are mostly informal with few MoUs, since most collaborations are individual-driven
2	Management Structures and Platforms for UICs	There is weak policy implementation, fragmented communication and collaborations filtered based on values and individual stake-holder interests
3	Stakeholder Capacity and Readiness for UICs	No dedicated staff; underfunding; donor dependence
4	Information Exchange & Dissemination	Weak feedback loops, poor research visibility
5	Impact and Sustainability of UICs	Short-lived, internship-focused, weak follow-up

4. Discussion

4.1. Overview

The findings in this study confirms that in Uganda, Univer-

sity-Industry Collaborations are largely informal, hardly sustainable and characterized by fragmented management mechanisms, limited implementation capacity, and weak knowledge & information exchange structures. Whereas this is consistent with a prior study on African UICs [3], this study highlights ICT adoption in UICs as a paradigm-shifter, causing a transition from ad hoc collaborations to structured systems which foster sustainability and yield a lasting impact not

only on universities and industry but the entire UIC eco-system.

4.2. Thematic Reflections

Systemic Gaps in Structuring UICs: Study findings reveal the informality and semi-structured management of UICs which is a breeding ground for unsustainable and risky partnerships which limits UIC impact. From a General Systems Theory (GST) perspective, this suggests a loosely integrated system with components such as; stakeholder management, communication, financing and general collaboration management interacting sporadically with no clear structure and systemic functioning which undermines the very purpose for the UICs. This is emphasized by the Collaborative Control Theory which asserts that; clear formal agreements, multi-stakeholder environments, and accountability structures are crucial in the coordination of such engagements otherwise this may give rise to risks such as illegitimacy and inconsistency; and the Rybníček and Königsgruber (2019) model which emphasizes formalized structures and long-term strategies. ICT has the potential to support the formalization of these collaborations through a digital system which not only integrates the major components of UICs but also supports; digital MoU control with automated renewal reminders, a centralized database for structured and controlled record management, Monitoring and Evaluation features. Much as UCU currently has a grants management system, this only handles research grants which is an isolated component of UICs, creating a need to develop and implement an ICT-enabled UIC management model that aids systematic, structured, integrated, trackable yet sustainable UICs.

Managing Partnerships: Structures, Platforms, and Accountability: Both university and industry respondents raise concerns about weak operationalization of policy and communication fragmentation which is a clear UIC governance challenge. Our findings show gaps here — many collaborations are person-dependent and not institutionalized. ICT can operationalize these governance elements through transparent management dashboards.

Similar to the Rybníček and Königsgruber (2019) model which argues for; contractual agreements, clear governance, and clear partner role definition in UICs, the GST states that clearly defined structures, complete and functional feedback loops, and clear coordination points are important for systems to function effectively. This is strengthened by the Collaborative Control Theory which argues that; to reduce uncertainty, transparency challenges and illegitimacy risks in multi-stakeholder engagements, monitoring mechanisms and well-structured accountability channels are vital.

Despite the use of ICT for grants management and communication through emails, social media platforms and grants management system, there is no integrated digital platform that helps to manage UICs hence a need for a platform where

stakeholders can access relevant information, request or initiate partnerships, and monitor their progress. Adjustments such as embedding digital-dashboards and monitoring & evaluation tools, can support policy implementation and operationalize UIC models.

Capacity Deficits in UIC Engagement: Findings show a challenge of inadequate infrastructure and a general shortage of human and financial resources in both university and industry. GST and the Rybníček and Königsgruber (2019) model stress resource availability, commitment and system capacity as key determinants of general system performance. Similarly, clear role allocation and supporting tools are highlighted by the Collaborative Control Theory as major drivers for system effectiveness.

ICTs can affect stakeholder readiness and supplement the limited capacity for UICs by automating most of the administrative tasks such as communications, internship tracking, Partnership monitoring, scheduling, information transfer, and regular stakeholder-training modules. With all this implemented, policies and regulations ought to be developed and enforced to support the smooth running of these collaborations.

Communication, Feedback, and Knowledge Sharing in UICs: Based on the study findings, knowledge sharing is fragmented and inconsistent. Whereas a measure of dissemination occurs on social media platforms, and through public lectures and workshops, the knowledge sharing function of UICs does not have a systematic mechanism. GST categorizes this as a feedback problem, asserting that if we do not feed outputs back into the system, then we limit adaptive learning. In support for this, the Collaborative Control Theory emphasizes that trust between stakeholders deteriorate where there is no accountability and reliable communication channels while the Rybníček and Königsgruber (2019) model asserts the need for bidirectional mechanisms of communication and knowledge flow. All this can only be achieved by strengthening and structuring the information exchange and dissemination structures.

A centralized digital repository where all necessary information, reports, research outputs, and collaboration outcomes are accessed by stakeholders/partners, not only enables adaptive-learning and innovation diffusion but also ensure transparency.

From Short-Term Projects to Sustainable Partnerships: The concern of most UICs primarily focusing on internships or donor-funded research projects and being short-lived, came out strongly. This limits the would-be impact of relatively long-term innovations and the subsequent knowledge transfer.

While the Rybníček and Königsgruber (2019) model argues that for UICs to succeed, it is important to have a measurable impact and a long-term value, the GST states that, achieving a sustainable system necessitates building resilience and long-term adaptability mechanisms. This is not far from the Collaborative Control Theory which suggests that this UIC challenge is due to inadequate performance tracking and absence of continuity mechanisms which allow for partnerships to evolve over time.

ICT tools and strategies can ensure the sustainability of UICs by providing digital monitoring mechanisms through which partnerships are tracked beyond the initial phase, and also enable the systematic measurement of outcomes.

4.3. Thematic UIC Challenges, ICT Solutions & Supporting Theory

It is clear that there are challenges which ought to be addressed for the success of UIC implementation. These among others are ICT-based solutions hinged on information systems and UIC theories. Table 4 below presents a summary of challenges per theme, possible ICT solutions and supporting theories.

Table 4. Summary of thematic UIC challenges, ICT solutions and supporting theories.

Sn	Theme	Challenges	ICT Solutions	Supporting Theory
1	Nature of Collaborations	Informal collaborations mechanisms Semi-structured Management Fragmented partnerships	Digital collaboration platforms (e-MOU systems) Centralized information repository Stakeholder mapping dashboards	General Systems Theory (GST): promotes holistic, interconnected structures. To replace unstructured, fragmented systems [19].
2	Management Structures and Platforms for UICs	Weak Policy operationalization Communication fragmentation Weak governance mechanisms	ICT-enabled management systems for collaborations (centralized UIC portal, workflow automation, digital monitoring tools)	Collaborative Control Theory: supports distributed and coordinated control through shared ICT platforms [22].
3	Stakeholder Capacity and Readiness for UICs	Inadequate infrastructure Shortage of human resource Inadequate funding and budgeting deficits Skillings and knowledge gaps	E-system modules for UIC skills Online training portals Resource-mapping tools Budgeting and Funding policies	Rybnycek and Königsgruber (2019): stresses resourcing and readiness; ICT expands capacity beyond physical limits GST: specifies skillings and resource availability [19].
4	Information Exchange & Dissemination	Fragmented and inconsistent knowledge sharing	Knowledge management systems Real-time communication apps Virtual dissemination forums AI-driven analytics dashboards	GST: ensures flow of information across subsystems [19]. Collaborative Control: balances control & feedback loops [22].
5	Impact and Sustainability of UICs	Short-lived Limited focus, Weak follow-up and sustainability strategies	ICT-based impact tracking dashboards Longitudinal databases for outcomes Digital sustainability scorecards	Collaborative Control Theory: emphasizes adaptive feedback for sustainability [22]. GST: aligns outputs with system-wide goals [19].

4.4. Proposed ICT-enabled JMS Model

The JMS model places ICT at the core of UIC operations as an enabler of mutually beneficial yet structured and sustainable university–industry collaborations in the context of developing countries. Based on insights from the Rybnycek and Königsgruber (2019) model, General Systems Theory (GST) and Collaborative Control Theory, UICs are Conceptualized as interdependent systems that require structured coordination, continuous systematic feedback, and adaptive learning. The model has major components categorized as input, process, output expounded below;

Input: [This specifies the stakeholders, institutional values

and resources which provide the basis for collaboration. Stakeholders (university stakeholders, industry stakeholders); Institutional values (university stakeholder’s values, industry stakeholder’s values); Resources (human resource, infrastructure, finances)].

Process: [This describes ICT-enabled collaboration mechanisms that enable structured processes and engagements. Knowledge Exchange Systems (digital dissemination forums, ICT-enabled feedback loops, open-access repositories); UIC governance (workflow automation, monitoring & evaluation platforms, finance management platforms, decision-support dashboards); ICT-enabled Capacity Building (online training modules, virtual co-creation labs, digital mentorship programs)].

Output: [This specifies the expected result of the collaboration including; evolving formal and mutually benefiting partnerships, regular and systematic knowledge sharing, Strengthened capacity for UICs, Sustainable long-term impact. partnerships (collaboration works repository); Regular and systematic knowledge sharing (centralized accessible knowledge base, stakeholder feedback platforms); Strengthened capacity (empowered staff and partners, governance documents<policies, rules and regulations, Memorandums of Understanding>, availability of necessary tools); Sustainable long-term impact

(Impact metric dashboard, long-term and scalable partnerships aligned to the institutional goals)].

The model embeds ICT at all stages of the collaboration cycle to address; weak management strategies, informality, sustainability gaps and limited capacity challenges. This systems-oriented approach not only aligns UICs with the Sustainable Development Goals (SDG 4 - quality education; SDG 9 - industry, innovation, and infrastructure; SDG 17 - partnerships for the goals), but also strengthens the effectiveness of these collaborations. The JMS Model is graphically represented in Figure 1 below;

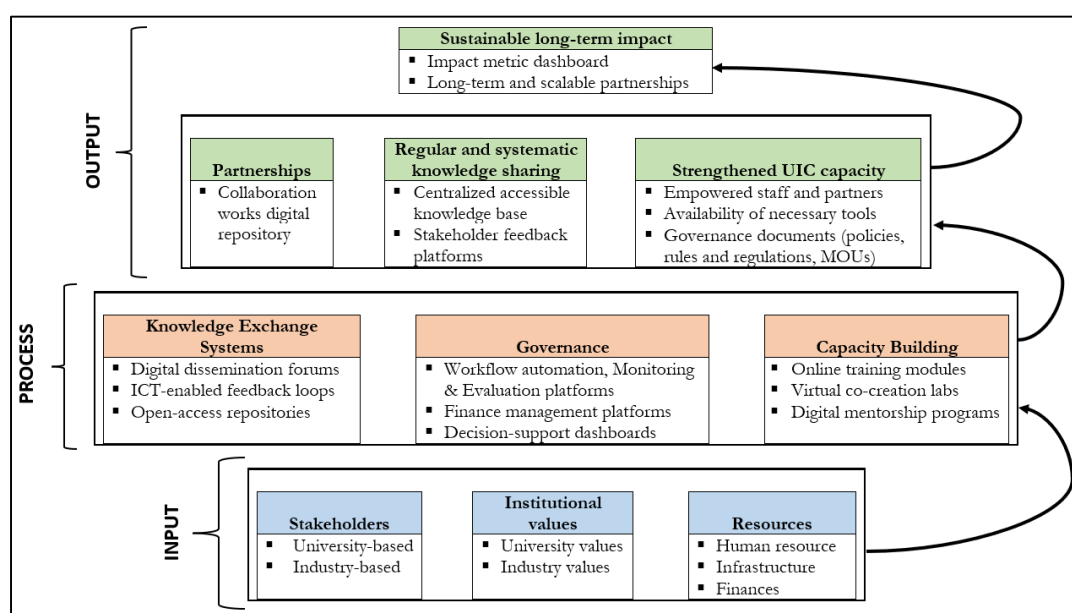


Figure 1. A Diagrammatic Representation of the JMS Model.

4.5. Recommendations

This study reveals the need for strategic ICT-based management of UICs with the enforcement of ICT systems and structures. We suggest the following;

Institutionalize ICT-enabled partnership platforms: universities need to establish centralized digital platforms to aid in the management of UICs for transparency and continuity, while reducing the reliance on informal and ad-hoc collaborations; **Strengthen knowledge management and dissemination through ICT:** institutions running UICs should invest in digital repositories, real-time communication channels and virtual dissemination platforms to enhance stakeholder access to collaboration output while strengthening feedback loops and building trust; **Build digital capacity of stakeholders:** In order to smoothly run ICT-enabled systems, it is important to develop and avail e-learning modules and virtual mentorship programs that enhance digital collaboration skills and digital literacy for partners hence closing the readiness skill gap; **Adopt ICT-enabled monitoring and evaluation frameworks:**

This is vital in ensuring that UICs are on track and performing as expected while allowing continuous learning and improvement. Mechanisms such as dashboards and data analytics can be used to track impact and sustainability of UICs while ensuring structured accountability and data-driven decision-making; Align UIC strategies with broader development priorities; Universities and industries ought to employ digital systems to jointly align their activities to development goals which not only enhances visibility, but also attracts donor support while creating sustainability of partnerships beyond the short-term engagements. We recommend that institutions invest in the operationalization of the JMS Model by building digital platforms to support UICs. This will create an opportunity for empirical validation, through practical testing, data collection and analysis, which will yield information to aid in the improvement or validation of this model for extended use.

4.6. Limitations

This study has the following limitations; the research fo-

cused on one private university and selected industries participants from within Mukono Municipality. Much as this gives in-depth insights, findings may not fully represent UIC dynamics across Uganda. The study used qualitative methods which may limit insights from other methods. Future research should therefore; focus on a broader scope, possibly using various methods and approaches, and validate the proposed ICT-enabled JMS Model in a practical context. Despite these limitations, this study provides a valuable foundation for understanding the operations of UICs and provides an ICT-enabled model to support such engagements in a similar context.

5. Conclusions

This study examined dynamics of university–industry collaborations (UICs) in the context of a developing country, with a focus on Uganda Christian University and industries within Mukono Municipality. Findings revealed that whereas UICs are highly recognized for; innovation, knowledge transfer and development, their implementation suffers hinderances due to; their informal nature, weak coordination and management mechanisms, limited implementation capacity, and weak sustainability structures. Based on survey findings and insights drawn from the Rybníček and Königsguber (2019) model, the General Systems Theory (GST) and Collaborative Control Theory, this study highlights the need for ICT-enabled structured complete feedback loops, coordination mechanisms and systemic integration of actors. The study therefore proposed an ICT-enabled JMS Model, structured around inputs, processes, and outputs aligned to information system functions. This model fronts ICT as the core enabler for improving and strengthening the management of UICs while allowing for sustainability and evolution of partnerships. The study contributes by theoretically grounding UIC operations and providing a context-based model to support UICs. Finally, this study calls upon universities and industries to deliberately build management strategies and structures to cause a digital shift in the operations of UICs which will help in closing the industry skill, innovation and research gap.

Abbreviations

UICs	University Industry Collaborations
UCU-REC	Uganda Christian University-Research Ethics Committee
UCU	Uganda Christian University
SDG	Sustainable Development Goals
GST	General System Theory

Acknowledgments

We wish to sincerely thank the: Directorate of Research, Partnership and Innovation - Uganda Christian University

who funded this research plus university administrators, university faculty heads and the various Industry participants who participated in this study, offering time and insights during data collection phase.

Author Contributions

Justine Mukalere: Conceptualization, Funding acquisition, Data curation, Methodology, Investigation, Formal analysis, Validation, Visualization, Writing – original draft, Writing – review & editing

Martin Kabanda: Conceptualization, Funding acquisition, Methodology, Investigation, Validation, Methodology, Project administration, Writing – review & editing

Simon Mukisa: Conceptualization, Funding acquisition, Methodology, Investigation, Formal analysis, Validation, Writing – review & editing

Funding

This work is supported by Directorate of Research, Partnership and Innovation - Uganda Christian University.

Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] A. Alexander, D. P. Martin, C. Manolchev, and K. Miller, “University–industry collaboration: using meta-rules to overcome barriers to knowledge transfer,” *Journal of Technology Transfer*, vol. 45, no. 2, pp. 371–392, Apr. 2020, <https://doi.org/10.1007/s10961-018-9685-1>
- [2] F. Ahmed, M. T. Fattani, S. R. Ali, and R. N. Enam, “Strengthening the Bridge Between Academic and the Industry Through the Academia-Industry Collaboration Plan Design Model,” *Front Psychol*, vol. 13, Jun. 2022, <https://doi.org/10.3389/fpsyg.2022.875940>
- [3] Z. Hojeij, “An overview of university-industry collaboration in the Arab world,” Dec. 01, 2024, Springer Science and Business Media Deutschland GmbH. <https://doi.org/10.1186/s13731-024-00400-9>
- [4] E. C. Bastos, A. R. Sengik, and J. Tello-Gamarra, “Fifty years of University-industry collaboration: a global bibliometrics overview,” *Sci Public Policy*, vol. 48, no. 2, pp. 177–199, Jun. 2021, <https://doi.org/10.1093/scipol/scaa077>

- [5] Y. Zhang and X. Chen, "Empirical Analysis of University–Industry Collaboration in Postgraduate Education: A Case Study of Chinese Universities of Applied Sciences," *Sustainability* (Switzerland), vol. 15, no. 7, Apr. 2023, <https://doi.org/10.3390/su15076252>
- [6] K. Atta-Owusu, R. D. Fitjar, and A. Rodríguez-Pose, "What drives university-industry collaboration? Research excellence or firm collaboration strategy?," *Technol Forecast Soc Change*, vol. 173, p. 121084, Dec. 2021, <https://doi.org/10.1016/j.techfore.2021.121084>
- [7] M. Zheng, S. Yan, and S. Xu, "Digital Economy, Industry–Academia–Research Collaborative Innovation, and the Development of New-Quality Productive Forces," *Sustainability*, vol. 17, no. 1, p. 318, Jan. 2025, <https://doi.org/10.3390/su17010318>
- [8] F. Naseer, R. Tariq, H. M. Alshahrani, N. Alruwais, and F. N. Al-Wesabi, "Project based learning framework integrating industry collaboration to enhance student future readiness in higher education," *Sci Rep*, vol. 15, no. 1, p. 24985, Jul. 2025, <https://doi.org/10.1038/s41598-025-10385-4>
- [9] B. N. Kayondo and M. T. Kamondo, "Towards a Prospective Communication Model for University-Industry Collaborations in Uganda," *University of Dar es Salaam Library Journal*, vol. 19, no. 2, pp. 66–81, Dec. 2024, <https://doi.org/10.4314/udslj.v19i2.6>
- [10] 2030 Agenda United Nations, "70/1. Transforming our world: the 2030 Agenda for Sustainable Development Transforming our world: the 2030 Agenda for Sustainable Development Preamble," 2015.
- [11] P. P. Walsh, A. Banerjee, and E. Murphy, "The UN 2030 Agenda for Sustainable Development," 2022, pp. 1–12. https://doi.org/10.1007/978-3-031-07461-5_1
- [12] L. Alcántara-Rubio, R. Valderrama-Hernández, C. Solís-Espalargas, and J. Ruiz-Morales, "The implementation of the SDGs in universities: a systematic review," *Environ Educ Res*, vol. 28, no. 11, pp. 1585–1615, 2022, <https://doi.org/10.1080/13504622.2022.2063798>
- [13] J. Liu, X. Wang, W. Miao, and X. Wang, "What factors enable sustainable university-industry collaboration communities? Evidence from a symbiosis theory perspective," *Sustainable Futures*, vol. 10, p. 101166, Dec. 2025, <https://doi.org/10.1016/j.sfr.2025.101166>
- [14] G. Tolin and A. Piccaluga, "Commercializing technology from university-industry collaborations: A configurational perspective on organizational factors," *J Bus Res*, vol. 188, p. 115105, Feb. 2025, <https://doi.org/10.1016/j.jbusres.2024.115105>
- [15] A. L. Rossoni, E. P. G. de Vasconcellos, and R. L. de Castilho Rossoni, "Barriers and facilitators of university-industry collaboration for research, development and innovation: a systematic review," *Management Review Quarterly*, vol. 74, no. 3, pp. 1841–1877, Sep. 2024, <https://doi.org/10.1007/s11301-023-00349-1>
- [16] T. Zhuang, M. Oh, and K. Kimura, "Modernizing higher education with industrial forces in Asia: a comparative study of discourse of university-industry collaboration in China, Japan and Singapore," *Asia Pacific Education Review*, vol. 26, no. 1, pp. 195–210, Mar. 2025, <https://doi.org/10.1007/s12564-024-10033-y>
- [17] D. Bamford, I. Reid, P. Forrester, B. Dehe, J. Bamford, and M. Papalexi, "An empirical investigation into UK university–industry collaboration: the development of an impact framework," *J Technol Transf*, vol. 49, no. 4, pp. 1411–1443, Aug. 2024, <https://doi.org/10.1007/s10961-023-10043-9>
- [18] R. Rybníček and R. Königgruber, "What makes industry–university collaboration succeed? A systematic review of the literature," *Journal of Business Economics*, vol. 89, no. 2, pp. 221–250, Mar. 2019, <https://doi.org/10.1007/s11573-018-0916-6>
- [19] I. L. Von Bertalanffy, "An Outline of General System Theory," 1950.
- [20] O. Granstrand and M. Holgersson, "Innovation ecosystems: A conceptual review and a new definition," Feb. 01, 2020, Elsevier Ltd. <https://doi.org/10.1016/j.technovation.2019.102098>
- [21] H. S. Leonard, R. R. Kilburg, and A. M. Freedman, *Essential strategies for organizational and systems change: An overview for consultants*. Washington: American Psychological Association, 2023. <https://doi.org/10.1037/0000328-000>
- [22] S. Y. Nof, "Collaborative control theory for e-Work, e-Production, and e-Service," *Annu Rev Control*, vol. 31, no. 2, pp. 281–292, Jan. 2007, <https://doi.org/10.1016/j.arcontrol.2007.08.002>
- [23] M. O'Dwyer, R. Filieri, and L. O'Malley, "Establishing successful university–industry collaborations: barriers and enablers deconstructed," *Journal of Technology Transfer*, vol. 48, no. 3, pp. 900–931, Jun. 2023, <https://doi.org/10.1007/s10961-022-09932-2>
- [24] N. Evans, A. Miklosik, and J. T. Du, "University-industry collaboration as a driver of digital transformation: Types, benefits and enablers," *Heliyon*, vol. 9, no. 10, Oct. 2023, <https://doi.org/10.1016/j.heliyon.2023.e21017>
- [25] I. Etikan, "Comparison of Convenience Sampling and Purposive Sampling," *American Journal of Theoretical and Applied Statistics*, vol. 5, no. 1, p. 1, 2016, <https://doi.org/10.11648/j.ajtas.20160501.11>
- [26] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qual Res Psychol*, vol. 3, no. 2, pp. 77–101, Jan. 2006, <https://doi.org/10.1191/1478088706qp0630a>
- [27] D. Mortelmans, "Springer Texts in Social Sciences Doing Qualitative Data Analysis with NVivo," 2025.

Biography



Justine Mukalere is a lecturer at Uganda Christian University, Department of Computing and Technology. Her research fields are; E-health, Information systems integration, Artificial Intelligence, Mobile technologies, System design and frameworks, Monitoring and Evaluation.



Martin Kabanda is a lecturer at Uganda Christian University, Director E-Learning and affiliated to department of Business Management. His research fields are; Entrepreneurship, Monitoring and Evaluation, Project management, Development studies, Marketing.



Simon Mukisa is a lecturer at Uganda Christian University, Department of Economics and statistics. His research fields are; Business Ethics, Business Administration, Micro and Macro Economics, Business Economics.