Volume 1, Issue 1 (January 2025), pp. 01–10 *Journal of Digital Business and International Marketing*
| Regular Article | Open Access

An ANP based Approach to Strategic Resource Allocation of Intellectual Capital Assets

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Article Info
Journal of Digital Business and International Marketing
https://www.ansispublications.com/journals/jdbim/jdbim.html

https://doi.org/10.64026/JDBIM/2025001

Received 02 November 2024
Revised from 19 December 2024
Accepted 20 December 2024
Available online 05 January 2025
Published by Ansis Publications.

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Abstract – Intellectual Capital Assets (ICAs) refer to the intangible resources that are critical to the creation of organizational value out of human, customer, innovation and process capital. High impact ICAs should be identified and prioritized for investment in by organizations as they strive to increase their value. This research aims at assessing and ranking ICAs by using Analytic Network Process (ANP) model for capturing the interactions between the assets. The method used to gather the pairwise data aimed at supervising CEOs, scientific supervisors, shareholders, employees and customers in order to determine the relative value each ICA contributes to value creation. A mathematical model is employed to translate qualitative assessments into quantitative results with regard to Consistency Index (CI) and Consistency Ratio (CR) to check the reliability of the judgments. Cost benefit analysis shows the ICAs which yield the greatest return on investment. Our findings suggest that knowledge sharing and innovation are the most dominant ICA that positively and significantly affects value creation. These assets involve moderate investment but have huge returns, while other assets such as employee training and customer relations also have greater potential but involve high investment. The results offer practical guidance to organizations in terms of how to effectively prioritize ICAs to support their achievement of strategic objectives in creating innovative value.

Keywords – Intellectual Capital Assets, Analytic Network Process, Knowledge Sharing, Consistency Ratio, Consistency Index, Value Creation Process.

I. INTRODUCTION

Digital revolution and the Internet have profoundly disrupted the conventional equilibrium between a university and its personnel about their ownership and copyright claims to intellectual property. Typically, modifications to these balances should be resolved via negotiations for contract amendments with academic personnel, rather than through the university's claim of copyright authorship over faculty work. Universities periodically attract media attention due to varied applications or alleged misuses of computers and the Internet. University spin-off enterprises exploit the aspirations of prospective students and researchers. As anticipated, all of them can be found in locations such as university campuses globally. The Universities of Berne and Zurich endorse and facilitate the creation of spin-off businesses to promote successful technology transfer [1]. The university spin-off enterprises represent not only another entrepreneurial iteration, but something beyond that. Such firms are funding essential and obligatory research initiatives overseen by university officials.

Hansen and Lema [2] investigate spin-outs as a mechanism for technical dissemination in rapidly advancing high technology sectors. Innovations are often pertinent and fulfill an essential role in our everyday existence. Bahoo-Torodi [3] underscore the importance of spin-outs in the semiconductor and rigid disk drive industries, which exemplify high-tech firms. Aspiring students have first developed several medications in research facilities. Many automobile applications and technology devices have been thoroughly analyzed inside academic institutions before their market release, therefore improving the ease and comfort of our lives. Presently, higher education institutions in the UK own 9,000 active patents. The number of spin-off companies linked to Higher Education Institutions (HEIs) is rising, with increased commercial research and intellectual property income underscoring the substantial economic contribution of higher education. The

importance of spin-off businesses is considerable. These firms finance university laboratory initiatives and enable the fulfillment of students' academic ambitions. The quality of these organizations is enhancing, as the quantity of spin-offs from companies aged three years and older rose from 592 in 2004-05 to 669 in 2005-06.

Intellectual Capital Assets (ICAs) serve as an effective source of competitive rivalry and are essential components in the Value Creation Process (VCP) for both SMEs and big corporations. Consequently, executives must conduct a precise study of every ICA's contribution to the VCP and delineate their causal-effects dynamics [4]. Moreover, management must meticulously assess the ICAs' investment strategy and project expenses related to organizational ramifications, timeline, and required modifications resulting from the new investment. Ultimately, managers must effectively balance these aspects and identify the ICAs suitable for further expenditures.

The idea of intellectual capital emerged when the phrase “human assets accounting” is introduced to quantify the worth of an organization’s personnel for inclusion in financial statements alongside other categories. Subsequently, Asfahani [5] used the phrase “human resources accounting” to denote the provision of management information. Most material on Intellectual Capital originates from accounting and finance but has expanded into other disciplines under various terminologies. In accounting literature, the phrase “intangible assets” is used as a synonym, despite its absence on the company's balance sheet. For economists, intellectual capital is referred to as knowledge assets. Intellectual capital is more often used in management and legal writings. Ultimately, the phrases “intangible assets,” “knowledge assets or capital,” and “intellectual assets or capital” are used interchangeably.

Defined Intellectual Capital refers to the amalgamation of intangible assets that facilitate the operation of a corporation. Intellectual Capital is the aggregate knowledge of a company's members and the actual application of this information, such as trademarks, patents, and brands. Intellectual Capital is defined as a source of intangible assets that often do not reflect on the balance sheet. According to Edvinsson and Sullivan [6], Intellectual Capital encompasses a collection of valuable knowledge, including a firm’s technology, processes, patents, skills, personnel, and information on stakeholders, suppliers, and customers. Moreover, Chen, Shih, and Yang [7] defines Intellectual Capital as the knowledge, experience, and cognitive abilities of employees, together with the knowledge resources embedded in an organization's database systems, procedures, culture, and philosophy.

This paper aims at promoting the concept of prioritisation of Intellectual Capital Assets (ICAs) as a tool of improving organisational value creation. To fill this gap, the research employs the Analytic Network Process (ANP) to provide a systematic means of assessing ICAs according to stakeholder perspectives, and to guarantee the identification of the most valuable assets for investment. The findings identify the key ICAs, including knowledge sharing and innovation, with the associated investments and expected returns for organizations, helping with decision-making. The remaining sections of this study have been organized in the following manner: Section II presents a description of the case scenario that will be used to undertake this research. Section III defines the data and methods used to compose our research. A detailed account to the findings has been provided in Section IV and V, describing the CBA and alignment assessment of interviewees on comparative analysis. Section VI concludes our research offering a practical guidance to firms on the basis of their effectiveness in prioritizing ICA.

II. CASE SCENARIO

The Operations Management Team (OMT) s.r.l is a privately limited corporation established as a university spin-off in Italy. Tor Vergata institution, the second biggest public institution in Rome, with a ten percent stake in the firm’s capital stock. The primary objective of the firm's establishment was to safeguard the information and expertise accumulated from several consulting projects conducted as University Research Group (URG), and to penetrate the marketplace as experts in high value addition consulting services. The company's operational approach is predicated on the team's specialized expertise in using various advanced Operations Management strategies and methods for the production of products or services.

The marketplace for ideas and technologies allows an individual to articulate the decision-making challenges in the transfer of information from research institutions and universities within and to the sector to enhance open innovation. The dissemination of information is facilitated by a multifaceted array of environmental and cultural factors, which include organizational, political, and innovation systems, all of which further support research financing [8]. Open innovation in markets extends beyond large-scale commercialization of underutilized capabilities, technologies, knowledge, and ideas by firms; it includes the formulation of a robust business model and the collaboration, acquisitions, mergers, and strategic alliances among firms for resource complementarity.

Assessing intellectual capital is a priority for the majority of 21st century enterprises. This form of assessment focuses commitment, consumer loyalty, innovation, brand value, and other pertinent ideas, highlighting the significance of deploying intellectual capital, which is characterized as a synthesis of human capital, external (customer) capital, and internal (structural) capital [9]. Most assessment techniques used for classifying intellectual capital neglect the interdependencies among subcomponents. Numerous categorization methods using the Analytic Hierarchy Process for project evaluation and selection have been examined by various scholars Saaty proposed the use of the Analytic Hierarchy Process (AHP) to address the issue of independence among criteria or alternatives, and ANP to tackle the issue of dependency among criteria or alternatives.

The interviews were chosen among the most seasoned OMT spin-off stakeholders. We conducted interviews with the Scientific Supervisor (SS), Shareholder (SHA), OMT CEO, an employee responsible for the spin-off from its inception (EM), and a long-term client (CUS). Each respondent received comprehensive information about the characteristics of each ICA, the study's objective, and the mechanics of the pairwise comparisons. Interviewees used the "Super Decisions" program (version 2.2.3) [10] to conduct pairwise comparisons for analyzing the ICA's relative influence on value generation and the anticipated ICAs relative investment. Super Decisions is an effective instrument that use the ANP.

III. METHODOLOGY

This research employs the ANP technique to evaluate and position the ICAs in terms of their contribution on value addition and the expected investment. The ANP is a relative measuring theory with the base of absolute scales for physical and intangible criteria based on the particular assessments of professional experts. The chief concern of the mathematics of the ANP is the measurement of things that cannot be easily expressed in monetary terms. Ultimately, we must integrate our whole worldly experience into our hierarchy of priorities to achieve comprehension. The ANP simplifies a multidimensional issue into a unidimensional format. Decisions are dictated by a singular value for optimal results or by a vector of priorities that establishes a hierarchy among several potential outcomes. This approach involves taking probabilities and statistical mechanisms to assess and monetize stakeholder conceptions and ideals.

To assess the relative importance of ICAs, we first collected pairwise comparison data from five stakeholders: A pilot sample of six participants has been recruited: the CEO, the SS, the SHA, the EM, and the CUS. Saaty's 9-point scale was used to ask each stakeholder about his/her relative comparison of ICAs. For instance, one on the scale is used to represent equal importance of two or more specific ICAs, whereas a numerical value of 9 means one ICA is much more important than another. The pairwise comparison matrix for each stakeholder is represented by $A^{(k)}$, where $A^{(k)} = a_{ij}^{(k)}$ where stakeholder k provides the comparison matrix k. The entry $a_{ij}^{(k)}$ symbolizes the extent of importance of ICA i over ICA j for the stakeholder k which is defined as:

$$a_{ij}^{(k)} = \begin{cases} 1, & f\ i = j \\ 1/a_{ji}^{(k)}, & f\ i \neq j \end{cases} \quad (1)$$

The pairwise comparison matrix $A^{(k)}$ is normalized for each stakeholder k the value in each element is divided by the sum of the column. The normalized matrix $A_{norm}^{(k)}$ is computed as follows:

$$A_{ij,norm}^{(k)} = \frac{a_{ij}^{(k)}}{\sum_{i=1}^{n} a_{ij}^{(k)}} \quad (2)$$

Where n is the number of ICAs. The normalized matrix represents the proportional importance of each ICA relative to the others. Next, the priority vector $w^{(k)}$ for each stakeholder k is calculated by averaging the values in each row of the normalized matrix. This vector provides the relative weights of the ICAs for stakeholder k:

$$w_i^{(k)} = \frac{1}{n}\sum_{j=1}^{n} a_{ij,norm}^{(k)} \quad (3)$$

Where $w_i^{(k)}$ is the weight of the ICA i that is assigned to stakeholder k. The priority vector shows the stakeholder's perception of the importance of the corresponding ICA. For the consistency of pairwise comparison, the Consistency Index (CI) and the Consistency Ratio (CR) are calculated. The CI is calculated as:

$$CI^{(k)} = \frac{\lambda_{max}^{(k)} - n}{n-1} \quad (4)$$

Where $\lambda_{max}^{(k)}$ is the maximum of eigenvalue of matrix $A^{(k)}$. Subsequently the CR is given by the CI divided by the Random Consistance Index (RI) which a value relevant to the size of the inter matrix n. The CR is expressed as:

$$CR^{(k)} = \frac{CI^{(k)}}{RI} \quad (5)$$

Values less than 0.1 are generally acceptable in the context of the relative stability of pairwise comparison matrices with regard to the CR measurement criterion. The specific priority vectors derived from each of the stakeholder k are summed up to give the global priority vector, which is an index of the overall importance of the ICAs from all the stakeholders. This is computed using a weighted average of the individual priority vectors:

$$W_{global} = \sum_{k=1}^{m} p_k W^{(k)} \quad (6)$$

Here p_k is the power coefficient that is accommodated to the stakeholder k and mmm is overall quantity of the stakeholder. For each ICA i, the impact on value creation β_i is calculated by summing the product of the global priority vector and the stakeholder-specific value judgment $v_{ij}^{(k)}$ for ICA iii from stakeholder k:

$$\beta_i = \sum_{k=1}^{m} p_k \cdot v_{ij}^{(k)} \cdot w_i^{(k)} \quad (7)$$

Where $v_{ij}^{(k)}$ is an index of the judgment by the stakeholder of the value of ICA i for value creation. Similarly, the expected investment γ_i for each ICA is calculated using stakeholder judgments on the required investment $c_{ij}^{(k)}$:

$$\gamma_i = \sum_{k=1}^{m} p_k \cdot c_{ij}^{(k)} \cdot w_i^{(k)} \quad (8)$$

Where $c_{ij}^{(k)}$ is a judgment of investment by stakeholder k in ICA i. A key factor applied in trying to establish whether an ICA warrants further investment is cost/benefit ratio. Each is calculated as the cost/benefit ratio for each ICA i as β_i/γ_i. An ROR greater than 1 implies that value created exceeds the cost-of-capital and an ROR less than 1 implies that total cost is greater than total value created.

IV. RESULTS

Subsequently, we show the findings derived from a synthesis of decisions articulated by the respondents; we were able to determine the ICAs for which the CBA (Cost/Benefit Analysis) advocates more costs and examine the congruence of perspectives from interviewees about the ICAs.

Cost/Benefit Analysis

The Saaty scale is used by decision-makers or analysts to conduct pairwise comparisons based on semantic preferences from the scale's left column, or based on a direct connection. The numerical values in the second and third columns of **Table 1**, corresponding to the semantic preference in the left column, are recorded in the square comparison matrix. Given that a$a_{ii} = 1$ and $a_{ji} = 1/a_{ij}$ for each $i, j = 1,2, \dots n,$ matrix A is symmetric, reciprocal, and positive. Critical data about preference components resides only in the top triangle of the matrix; nevertheless, all analytical approaches subsequently used utilize the reciprocal figures from the bottom triangle [11]. In the use of Saaty's classical scale, the relationships in pairwise comparisons are explicitly delineated. However, often, while delineating these values, one cannot be quite certain of the relationships between the compared pairings.

Table 1. Saaty's Scale for Grouped Assessment

Definition	Standard Values	Inverse Values
Intermediate values	2, 4, 6, 8	1/2, 1/4, 1/6, 1/8
Absolute dominance	9	1/9
Very high dominance	7	1/7
High dominance	5	1/5
Low dominance	3	1/3
The same importance	1	1

Consequently, the literature increasingly features papers that examine the fuzzification of Saaty's scale through various methodologies [12]. Many authors employ a predefined intermission of a fuzzy number during fuzzification, specifically establishing the left and right distributions of the often-utilized triangular fuzzy number $T = (t_1, t_2, t_3)$. Certain authors have acknowledged the imperative to accommodate a degree of uncertainty, as evidenced in [13], wherein the uncertainty level for the entire scale is predetermined, facilitating the calculation of the left and right distributions of the fuzzy number T. The degree of uncertainty, specifically the confidence interval, varies based on the context of the decision-maker. Verbal assessments were converted into numerical **Figs (1, 3** correspondingly). Assessments below were necessary to evaluate the relative significance of ICAs:

- Assessments between $S.i$ and $S.j$ (for $i, j = 1 \dots 3$) regarding the VC procedure (such as Consumers have 3 times more significance compared to employees in relation to VC).
- Assessments between $ICA.h$ and $ICA.k$ (for $h, k = 1 \dots n$) regarding $ICA.z$ (for $z = 1 \dots n$, in case both $ICA.h$ and $ICA.k$ are directly linked to $ICA.z$ via arches) (such as Knowledge is 5 times more significant than Relationships with Investors concerning the advancement of Intellectual Property & Technology (IP&T), which might influence Venture Capital).
- Assessments between $ICA.h$ and $ICA.k$ (for $h, k = 1..n$) about $S.i$ ($i = 1..3$) (such as Corporate Culture has 9 times more significance than Relationships with different institutions regarding the figure generated for employees).

Every interviewee's summary of paired comparisons yielded a weight vector, which represented each ICA, with the total summing to 1. Each weight signifies the significance of an ICA for organizational value development, as seen by the interviewee. Likewise, the framework facilitated the evaluation of the anticipated investment deemed essential for each ICA in relation to others. **Table 2** presents the standard deviations and mean values of 8 different ICA weights derived from the paired assessments supplied by every respondent. **Table 2** illustrates the influence of creating value for every ICA, with their anticipated expenses and CBA, where β is characterized as the effect of ICA on creation of value and γ is the anticipated investments required.

Various methodologies may be used to do a CBA. Within the predominant analysis, the benefits ratio ($\bar{\beta}_j = \frac{\sum_{i=1}^{5} \beta_{ij}}{5}$) to costs (i.e. $\bar{\gamma}_j = \frac{\sum_{i=1}^{5} \gamma_{ij}}{5}$) is computed, and the j^{th}ICA is deemed appropriate if this ratio exceeds one (i.e. benefits surpass costs). Another method for gathering the perspectives of interviewees computes the average values of $\frac{\beta_j}{\bar{\gamma}_j}$ for each i-th interviewee, represented as $\frac{\bar{\beta}_j}{\bar{\gamma}_j} = \frac{1}{n}\sum_{i=1}^{n} \frac{\beta_{ij}}{\gamma_{ij}}$.

Cost-benefit analysis is a broad science grounded on core ideas that, although not entirely contentious, have been subject to scrutiny about their validity. Divisiveness escalates with the imposition of different supplementary criteria. A trade-off exists between enhanced usability (by fixed formulas) and broader acceptability (via permitting parametric modifications). The study analyzes the advantages and disadvantages of these additional criteria. The prevalent variation of the cost-benefit method is significantly constrained due to its reliance on valuing only via a market mechanism comparison. This permits just a limited range of prices and requires consumers to disregard several significant changes overlooked in the market assessment process. Utilizing a generic social choice framework permits enhanced valuation flexibility and accommodates a broader range of data inputs.

The largest circle in **Fig. 1** is denoted as ICA_F (Institutional Relationships); despite its relatively little influence, the anticipated investment is much lower. This seems justifiable since the firm, like with most University Spin-Offs, gains advantages from preferential connections with the University and, subsequently, with Institutions. Consequently, this creates a favorable opportunity for more investments. ICA_D (Processes) has the greatest influence on the creation of value; however, its anticipated relative investments is below the norm. Third, ICA_H (Suppliers and Partners Relationships) may be prioritized for more investments. Despite G, C, B, and A have positive figures of $(\frac{\bar{\beta}_j}{\bar{\gamma}_j})^{-}$(as shown by **Fig. 1** visible circles), they are situated beneath a bisector and hence are deemed unacceptable regarding $\frac{\bar{\beta}_j}{\bar{\gamma}_j}$.

Alignment Assessment of Interviewees on Comparative Analysis

Table 2 clearly underscores the most significant uncertainties in the respondents' views of ICAs, as shown by the standard deviation. The elevated standard deviation values for the creation of value are based on ICAs_D (Processes), H (Suppliers and Partners Relationships), and B (IP&T). The elevated standard deviation values of anticipated investments pertain to ICAs_H (Investors Relationships), E (Customer Relationship), and B (IP&T). The respondents' evaluations exhibited the greatest divergence about the anticipated investment in ICAs, as opposed to their appraisal of the effect on value generation. This outcome may be characteristic of newly established spin-off companies: the stakeholders exhibit significant alignment about market strategy, since they fully share the company's objective. Conversely, their deficiency of skill or entrepreneurial experience underscores challenges in achieving an equitable assessment of expenses.

Table 2. Average and Standard Deviation Results for The Eight Icas' Cost/Benefit Analyses, Effect on Value Creation (B) and Predicted Relative Investment (γ)

	ICAs	Impact $\bar{\beta}_j$	Impact (SD)	Investment $\bar{\gamma}_j$	Investment (SD)	$\frac{\bar{\beta}_j}{\bar{\gamma}_j}$	$\frac{\bar{\bar{\beta}}_j}{\bar{\gamma}_j}$
A	Internal relationships & corporate culture	0.077	0.0319	0.104	0.0543	0.7404	1.105
B	Technology and intellectual property	0.146	0.0584	0.155	0.0897	0.9418	1.487
C	Knowledge and competence	0.145	0.0180	0.148	0.0691	0.9796	1.233
D	Processes	0.162	0.0593	0.104	0.0647	1.5577	1.867
E	Relationship with customers	0.141	0.0432	0.202	0.0862	0.6980	0.839
F	Institutional relationships	0.091	0.0306	0.045	0.0182	2.0221	2.507
G	Investor relationships	0.114	0.0080	0.146	0.1132	0.7807	1.086
H	Suppliers and Partners relationships	0.123	0.0469	0.097	0.0702	1.2680	1.565
Total Mean		0.0819	0.125	0.13	0.125		

In **Fig. 1**, the circles' diameter signifies the mean figure from the CBA for every eighth ICAs. **Fig. 2** and **Fig. 3** illustrate the disseminations of the effect on the creation of value for every ICA and corresponding projected investments, determined independently by every respondent.

Subsequently, this study will examine the most contentious ICAs indicated by standard deviation and explore the potential sources of the discrepancies. Interviewees exhibit divergent viewpoints about the effect and expense of investing

in ICA_D (refer to **Table 3**): the OMT customer acknowledges the significance of D, however considers the associated expenditure to be futile. The resultant CBA ranks as the third greatest value among the 40 recorded in our research. EM exhibits less enthusiasm but remains persuaded of the significance of investing in D, and all other stakeholders concur on the prudence of such an investment.

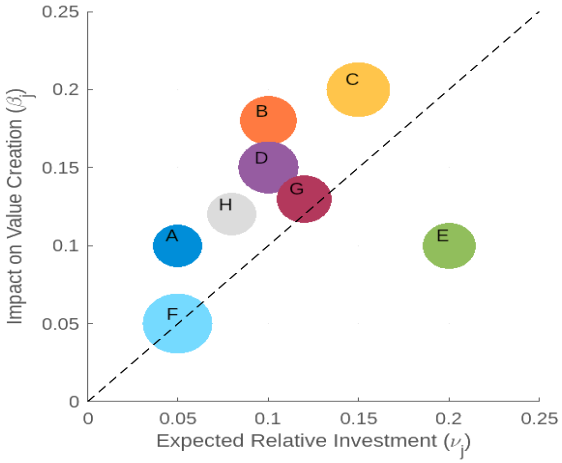

Fig 1. Average Values Pertaining to Influence on The Creation of Value and Anticipated Relative Investments.

The scientific supervisor observes a significantly diminished effect on both the value production of the Process and the anticipated investment, while maintaining a favourable ratio. This outcome aligns with the disposition of interviewees and his innovative work methodology, which is less restrictive and methodical than the methods established inside OMT. Certainly, SHA, CEO, and EM are meticulous in adhering to firm's protocols, and it is likely that CUS exploited their methodology.

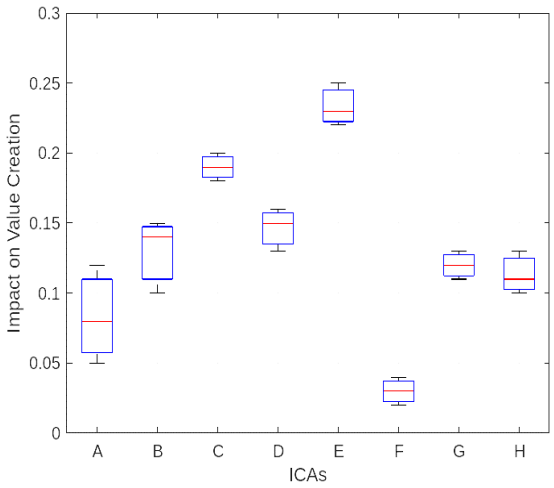

Fig 2. Weights Distribution About the Influence of Generating Value of Every ICA, As Determined by The Interviewees.

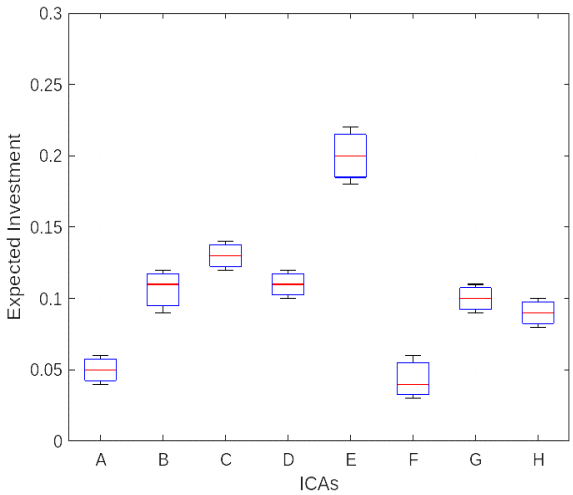

Fig 3. Weights Distribution in Relation to The Projected Investments for Every ICA, As Reported by The Interviewee.

Table 3. Explicit Effect on ICA_D (Processes) Value Creation, Anticipated ICA_D Investment and CBA Ratios Computed Individually by Interviewees

Interviewee	Impact on the value creation process (β_{ID})	Impact on the value creation process (γ_{ID})	$\frac{\beta_{ID}}{\gamma_{ID}}$
CEO	0.056	0.035	1.600
SS	0.184	0.181	1.022
SHA	0.192	0.089	2.167
EM	0.184	0.055	3.368
CUS	0.192	0.163	1.180
Mean	0.162	0.1044	1.8672
SD	0.0592	0.0646	0.8586

As seen in **Table 4**, the evaluated influence on ICA_B (IP&T) creation of value is notably consistent across the respondents, with significant outliers being the SS, who perceives its influence as very high, and the CEO, who conversely regards its influence as very low. The findings align with the previous role, which appropriately prioritizes the scientific dimensions of the endeavor. Conversely, the latter's perspective stems from a role-affected approach that is significantly focused on the advantages arising from robust external interactions and an effective procedure. The consensus among the other shareholders yields an average value likely indicative of an equitable evaluation of B's contribution to value production. The CUS significantly overestimated the anticipated investments in B relative to the internal shareholders, who exhibited an increased rational alignment (having a SD of 0.07). The outcome necessitates discussion between the SS and CEO, who were likely individually invested in the anticipated investment in B, and should enhance their communication with external stakeholders regarding the substantial costs incurred to acquire OMT's IP&T.

Most OMT shareholders acknowledge on the application of ICA_H (Suppliers and Partners Relationships) (see **Table 5**); nonetheless, the consumer perceives a much higher investment necessity compared to their counterparts and thus prefers to allocate resources to other ICAs. The CEO perceives H's effect on the creation of value as far below that of any other shareholders, a viewpoint that is, however, offset by a comparably low assessment of the anticipated investment. Regarding ICA_E (Relationship with customers), the interviewees evaluate the anticipated investments distinctly (refer to **Table 6**): the SHA and EM regard E as significantly more expensive than other ICAs; the CEO and SS view the investment as less expensive, yet still exceeding the average figure of the rest of ICAs (as shown in **Table 2**); ultimately, the CUS holds the least notion of the projective investment in E. The outcome may notify internal stakeholders: the consumer has a skewed perception of the needed expenses to sustain and establish relationships between OMT and its clientele. The individual tends to contend that a little investment may significantly enhance the process of value generation of OMT, whilst internal shareholders assert that substantial investments are necessary for effectiveness.

Table 4. Explicit Effect on IP&T Value Creation, Anticipated Investments In IP&T and CBA Determined Individually by Interviews

Interviewee	Impact on the value creation process (β_{IB})	Impact on the value creation process (γ_{IB})	$\frac{\beta_{IB}}{\gamma_{IB}}$
SS	0.231	0.234	0.986
SHA	0.145	0.115	1.254
EM	0.145	0.131	1.108
CUS	0.145	0.038	3.836
CEO	0.066	0.255	0.258
Mean	0.1462	0.1546	1.4884
SD	0.0584	0.0897	1.2229

Table 5. Explicit Effective on Value Creation from Suppliers and Partners Relationships, Anticipated Investments in Partnerships with Suppliers and Collaborators, along with CBA Conducted Independently by The Interviewee

Interviewee	Impact on the value creation process (β_{IH})	Impact on the value creation process (γ_{IH})	$\frac{\beta_{IH}}{\gamma_{IH}}$
SS	0.130	0.074	1.745
SHA	0.149	0.115	1.290
EM	0.148	0.061	2.422
CUS	0.149	0.208	0.715
CEO	0.041	0.025	1.654
Mean	0.1232	0.0966	1.5652
SD	0.0468	0.0701	0.5608

While this outcome is comprehensible, it may indicate the need for a more effective communication strategy to inform consumers about the expenditures being made on their behalf. To assess consistency among the respondents, we created **Table 7** that indicates, for every ICA, whether every interviewee concurs with the advice presented in the preceding section. We achieved a mean agreement ratio of 70% with the provided suggestions. Excluding the customer from our research and doing an internal-only evaluation would result in an increase of the average agreement ratio to 75%.

Table 6. Detailed Effect on Value Creation from Customer Relationship, Anticipated Investments in Customer Relationships and Cost/Benefit Ratios Estimated Individually by Interviewee

Interviewee	Effect on the process' value creation (β_{IE})	Effect on the process' value creation (γ_{IE})	$\frac{\beta_{IE}}{\gamma_{IE}}$
SS	0.192	0.196	0.976
SHA	0.110	0.305	0.361
EM	0.110	0.272	0.404
CUS	0.110	0.106	1.034
CEO	0.186	0.131	1.421
Mean	0.1414	0.202	0.8391
SD	0.0431	0.0861	0.4033

Table 7. Depiction of A Dummy Variable That Assumes a Value of 1 If the Interviewee Concurs with The Suggestion, and 0 Otherwise; Inside Parentheses (B_{ij}-C_{ij})/ C_{ij}-V) Representing The i^{th} Interviewee and j^{th} ICA

ICAs	Recommendations	SS	SHA	EM	CUS	CEO	Agree (%)	Internal Agree (%)
A	√	1[0,17]	0[2.4]	1[0.71]	0[0.79]	1[0.46]	60	75
B	X	1[0.99]	0[1.25]	0[1.11]	0[3.84]	1[0.26]	40	50
C	√	1[0.63]	0[2.05]	1[0.71]	1[0.82]	0[1.95]	60	50
D	X	1[1.6]	1[1.02]	1[2.17]	1[3.37]	1[1.18]	100	100
E	√	1[0.98]	1[0.36]	1[0.4]	0[1.03]	0[1.42]	60	75
F	X	1[4.98]	1[1.14]	1[1.15]	1[2.23]	1[3.03]	100	100
G	X	0[1.54]	1[0.95]	0[1.64]	1[0.32]	1[0.99]	60	50
H	X	1[1.74]	1[1.74]	1[2.42]	0[0.72]	1[1.65]	80	100

V. DISCUSSION

Cost-benefit analysis is the most thorough and hypothetically robust approach of economic assessment, having served as a tool for decision making across several fields of social and economic policy within the public sector during the last five decades. Numerous scholars, such as Sepulveda [14], address the theory and practice of the generic approach. The basic variation between CBA and the previously stated economic assessment methodologies is aim to allocate monetary values to

both costs (inputs) and benefits (outputs) in health care. This facilitates the comparison of monetary returns on health investments with those from other sectors of the economy. In the medical sector, assigning monetary values to outcomes results to the evaluation of whether certain programs or operations provide an overall societal benefit, where overall benefits are more than the total expenditures. Cost-utility and cost-effectiveness analyses fail to do this due to their measurement of costs and benefits in disparate units.

This study identifies the most significant ICAs by using a hybrid technique that concurrently synthesizes the interviewees' perspectives in various manners, as numerous CBAs have been suggested in research`. Three ICAs emerged as the most deserving candidates for further investments based on the following perspectives considered: Institutional Relationships, Processes, and Partnerships with Suppliers. However, in other instances, some respondents markedly differed with others about the effect of ICAs on value generation and/or the projected expenditures required for them. Organizational effectiveness is becoming a matter of knowledge. The primary academic discourses about knowledge inside firms are the fields of Knowledge Management (KM) and Intellectual Capital (IC). The former emphasizes intangible assets, which facilitate value creation, such as relational capital, structural, and human assets managed by an organization, while the latter focuses on knowledge-based management activities and processes within companies. The IC research investigates the many intangible resources inside organizations, while the KM literature focuses on the methods for controlling and managing these resources.

Intellectual capital constitutes the foundation of a firm and a nation, providing the essential sustenance for future strength and development. It encompasses all production aspects, not apparent on the conventional balance sheet, but critical to a company's long-term prosperity. This is a current issue in the business sector. The concept and significance of intellectual capital have fundamentally transformed standard accounting practices. Conventional accounting practices focus on historical data and only assess tangible assets. Intellectual capital encompasses assets like brands, consumer connections, patents, trademarks, and expertise. The increasing divergence between a corporation's market value and book value is mostly ascribed to intellectual capital, the intangible assets that support future development. The significance of individuals has become more paramount. Human Resource Management is the pivotal element in enhancing employee productivity. Human resource methods transform personnel into developmental assets and competitive advantages [15]. Currency communicates, but it lacks cognition. Machines execute tasks, often surpassing human capabilities, although they lack the ability to innovate.

Thought and innovation are the fundamental elements upon which knowledge labour and knowledge enterprises rely [16]. There is no longer only a physical employee; instead, there exists a knowledge employee. The task is mostly cognitive rather than mechanical. Spreitzer [17] asserts, “ideas and intellect, not physical assets, are the foundation of great companies”. The past is termed the “old economy,” characterized by materialism, while the present and future are referred to as the “new economy,” which emphasizes knowledge and creativity. Intellectual capital is garnering heightened attention from both the academic community and corporations due to the impact of innovation and learning on the attainment of competitive advantage in the new economy. The emergence of the “new economy,” mostly propelled by information and knowledge, global competition, and evolving interpersonal dynamics, is linked to the heightened significance of intellectual capital management as a focal point in management and research. The ICAs framework was successful and straightforward to adopt in a University Spin-Off, offering valuable insights that might influence tactical and strategic planning, human resource management, and customer relationship management.

VI. CONCLUSION

We highlight the importance of Intellectual Capital Assets (ICAs) for creating organizational value and provide a comprehensive framework for their assessment using the Analytic Network Process (ANP). Though pairwise comparison assessment is systematic, the study incorporates many stakeholders whose perception provides a comprehensive solution to different ICAs that shape organizational success. The methodology helps ensure that sources of bias are systematically transformed into measurable values; the use of checklists makes these assessments more reliable. The study also shows that out of all the activities, knowledge sharing and innovation are capable of generating the highest amount of value but need only moderate investment; such activities should thus be given more investment. In addition, assets like employee training and customer relations also take relatively higher investment and they also promise to yield huge returns. This cost/benefit analysis helps organizations to better coordinate their investments in ICA in relation to long-term values. Furthermore, the research puts much stress on the aspect of ICA monitoring and flexibility; it is because business environments are ever evolving to warrant reviews of asset value. The findings of this research provide useful insights which may assist the decision-makers to understand the issues related to intellectual capital management and to improve organizational performance. Future research may build from these findings by using real-time case studies and examine how new technologies will help enhance the effectiveness of ICA.

CRediT Author Statement

The author reviewed the results and approved the final version of the manuscript.

Data Availability

The datasets generated during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interests
The authors declare that they have no conflicts of interest regarding the publication of this paper.

Funding
No funding was received for conducting this research.

Competing Interests
The authors declare no competing interests.

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ISSN : 3104-4115