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# A FRAMEWORK FOR ASSESSING ORGANIZATIONAL WORKFORCE MATURITY TO ENHANCE OFF-SITE CONSTRUCTION

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**ABSTRACT:** The construction sector has faced stagnant productivity growth, struggling to match advancements in other industries and meet rising demands and sustainability goals. The International Council for Research and Innovation in Building and Construction (CIB) developed a framework to increase uptake of off-site construction (OSC), by assessing the maturity of organizations to adopt OSC. The framework, focuses on design, manufacturing, and construction phases of OSC, evaluating organizational maturity in three dimensions: Process, Technology, and People. Until recently, the "People" dimension was viewed as a supplementary resource rather than a central driver of OSC organizational capability. This research explores and emphasizes People as essential alongside "Process" and "Technology," and develops an evaluation framework to enable benchmarking of People within the organizational maturity levels of OSC. A comprehensive literature review and exploration of frameworks from the construction and other sectors identified gaps in the existing CIB model. The People aspect of the CIB framework was enhanced by incorporating detailed constructs of seven people's parameters from Spheres of Influence, which were categorized into the CIB's Capability Dimensions of Shaping the Workforce, Monitoring and Managing, Building Workgroups, and Developing Individual Capacity. The structured approach enables a quantitative evaluation of people's roles in organizational maturity, and advances the understanding of the potential value in technical skills development, agility, and collaboration. Ultimately, the newly integrated evaluation framework for People alongside existing Technology, and Process evaluation will help construction organizations align with best practices and drive improvement.

**Keywords:** Off-site Construction (OSC), Organizational Maturity, People, Workforce, Framework, Maturity Model, Spheres of Influence, Capability.

## 1. INTRODUCTION

### 1.1 Background

The construction industry is a pivotal component of Canada's economy, contributing approximately $166.59 billion to the national GDP as of 2024 (Statistics Canada, 2024) and employing about 1.63 million people in 2024 (Statistics Canada, 2024). Despite this significance, the construction industry, including in Canada, has persistent productivity stagnation lasting decades, limiting its ability to meet the rising demand for housing, infrastructure, and sustainability. The construction industry, although making a huge contribution to Canadian GDP, the industry has yet to realize the full productivity benefits from advancements in adopting innovative technological, process, and people management practices to improve efficiency and sustainability, highlighting the necessity for significant advancements. (McKinsey Global Institute, 2024). If this gap is addressed effectively, it could result in a significant increase in Canadian GDP and job opportunities in Canadian Construction Industry.

Off-site Construction (OSC) addresses these challenges by shifting significant portions of construction activities to controlled factory environments to minimise traditional construction risks and inefficiencies, such as prolonged project timelines, resource wastage, and cost certainty (Rashidian et al., 2024). At a project level and at scale, OSC offers substantial potential benefits of enhanced efficiency, better working conditions, sustainability, and cost certainty across the construction value chain. Value chain is an integrated process to deliver construction value. The successful implementation and scalability of OSC within the Canadian construction sector, however, depends heavily on the maturity and capabilities of the organizations involved (Goulding et al., 2023). Therefore, the objective of this paper is to advance adoption of OSC at scale, by developing a detailed science-led assessment criteria for benchmarking organizational maturity from the perspective of workforce development. Given OSC's reliance on advanced technologies and integrated workflows, workforce maturity becomes pivotal and therefore, a proposed framework targets upskilling to support OSC.

According to Goulding and Arif (2013) organizational maturity, particularly in the context of OSC, encompasses an organization's ability to effectively manage three critical dimensions: Process, Technology, and People. Arguably, there is more emphasis placed on optimizing "Processes" (e.g., through the application of lean principles) and integration of advanced Technologies" (e.g., digital tools and robotics), while the People dimension has historically been treated as a supplementary resource rather than a central driver of organizational capability within the construction sector. This may be in part because OSC frameworks prioritized process and technology, lacked clear workforce metrics and assumed people would adapt passively without targeted development. As stated by Chinowsky et al. (2007), and Karim et al. (2022) the term 'People Maturity' extends beyond technical expertise to include the readiness and proficiency of individuals and teams to adopt and implement advanced technologies and methodologies. It reflects organizational culture, leadership support, and collaborative practices, all pivotal for successfully adopting advanced technology and practices to achieve maturity in OSC capability.

## 1.2 CIB Framework

The International Council for Research and Innovation in Building and Construction (CIB)'s widely recognized maturity framework to assess organizational performance in OSC evaluates maturity across three phases in a multi-layer presentation—design, manufacturing, and construction (Layer 1) —focusing on the three dimensions of Process, Technology, and People (Layer 2) (see Figure 1).
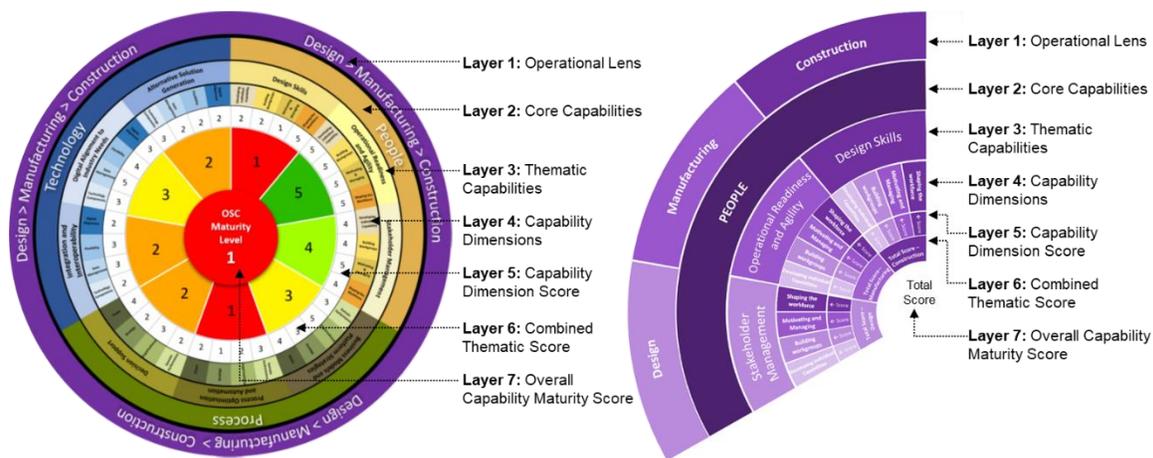


*(Goulding et al., 2023)*

Figure 1: Existing CIB Framework (Left) and zoomed representation of People's Dimension (Right)

The multi-layer evaluation criteria has been applied to all three dimensions in the existing CIB framework (As shown in Figure 1). In the people dimension Layer 3 consists of 3 Thematic Capabilities—Stakeholder Management, Operational Readiness and Agility and Design skills. Each thematic capability consists of four Capability Dimensions— Shaping the Workforce, Monitoring and Managing, Building Workgroups, and

Developing Individual Capacity, named as Layer 4.A total score is calculated by summing component parts (This requires users to evaluate their current maturity position using a capability maturity scale of 1-5; where 1 = low (Initial), and 5 = high (Continuous Improvement). and taking the lowest score from the overall assessment of technology, process and people (Goulding et al., 2023). The people dimension has seven parameters based on Goulding and Arif's (2013) Spheres of Influence. These are condensed into Layer 3 – Thematic Capabilities. The seven spheres of influence (People) are based on human capital and organizational learning theories and were designed to capture critical workforce competencies which are essential for organizational maturity in OSC. Currently, an underdevelopment of the people dimension has limited its readiness for use as it underrepresents the workforce's role in driving innovation, achieving operational readiness, and managing stakeholder engagement (Wang et al., 2024; Gambatese et al., 2019). Developing the people component of the framework will enable organizations to align their workforce capabilities with broader organizational goals, technological advancement and industry best practices to achieve OSC benefits.

This research enhances the people dimension of the CIB framework.


## 2. METHODOLOGY

This study had seven steps (see Figure 2): Step 1 explored the CIB framework and its origins, Step 2 compared current models in literature, Steps 3 and 4 expanded the theoretical underpinnings of the People Dimension of the CIB framework, Step 5 and 6 built descriptions of levels of maturity and Step 7 validated the methodology, findings and framework through expert feedback and in future, with industry data.
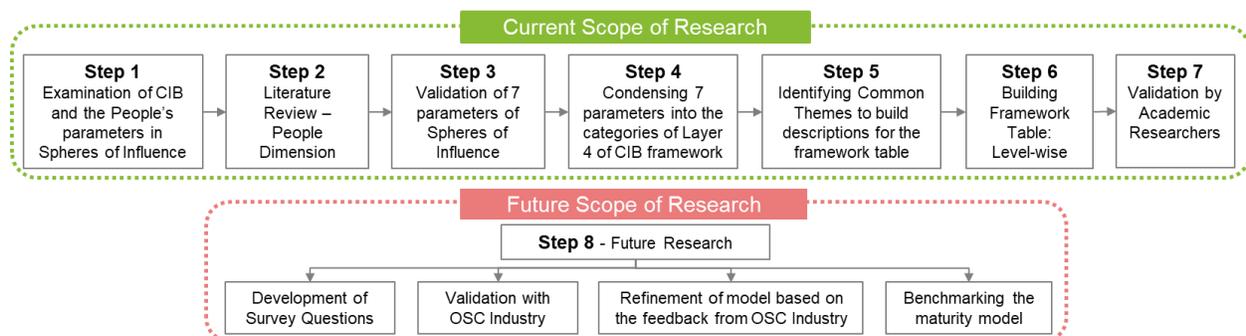


Figure 2: Research Methodology

**Step 1: Examination of CIB and the origins of parameters in the Spheres of Influence – People Dimension:** A comprehensive review of the CIB framework was conducted, focusing on its structure, principles, and the sources used in its development. This analysis delved into the foundational concepts and theories (Crosby's Quality Management Principles, Paulk et al.'s Capability Maturity Model (CMM), Leavitt's Diamond Model (LDM), Winch's Innovation Dynamics in Complex Product Systems (ID-CPS), and sustainability-focused models like Technology Diffusion for Sustainability (TDfS) and the Triple Bottom Line (TBL)) that contributed to the creation of the CIB framework and application of the people dimension in the context of the OSC industry. The study also explored the seven parameters relevant to the people perspective in the Spheres of Influence, as outlined by Goulding and Arif (2013), to understand their relevance to the people dimension within the framework. Furthermore, the integration of the people dimension into the CIB framework was assessed through the lens of the Spheres of Influence.

**Step 2: Literature Review – People Dimension:** Papers with existing maturity assessment models relevant to the CIB people dimension were identified to understand current industry and academic thinking. A comprehensive literature review of organizational maturity frameworks from various industries was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method. The construction, education, financial services, healthcare, IT, manufacturing, non-profit, and mixed sector industries were selected to capture a broad swathe of approaches to maturity assessment.

This process began with database searches, primarily using Scopus, and involved a wide range of keywords (single words and combinations of: people, maturity, personnel, organizational, skill development, maturity assessment, competency, models, frameworks, people capability, individual, and construction).

**Step 3: Elaboration of the seven parameters of the Spheres of Influence:** The literature papers extracted in Step 2 were explored to understand, add detail and update the seven parameters relevant to people in the Spheres of Influence, ensuring their alignment with contemporary maturity models. The people parameters from the Spheres of Influence (Goulding and Arif, 2013) were then compared with constructs identified in the reviewed literature to assess relevance and identify any gaps.

**Step 4: Condensing the seven Spheres of Influence into the Layer 4 People Capability Dimensions of the CIB Framework:** The seven parameters of Spheres of Influence were grouped into the existing Capability Dimensions within Layer 4 of the CIB framework based on insights from the literature reviews.

**Step 5: Building the People Table: Identifying Common Themes to build comprehensive descriptions of organizational maturity for OSC:** To provide highly detailed descriptions of Layer 4 People Capability Dimensions, the detail in the Spheres of Influence model was insufficient. The constructs from the maturity models found in the literature review were examined and common themes consistent with the Spheres of Influence were used to provide detailed descriptions in the framework tables.

**Step 6: Building the People Table: Define different maturity levels in OSC:** The people constructs of the CIB maturity model wheel were refined to reflect five levels of maturity for each Layer 4 Capability Dimension. The defining of the levels of maturity was informed by the common themes identified in Step 5 and through comparison and analysis of maturity models. This was undertaken for all phases of OSC (Design, Manufacturing and Construction).

**Step 7: Validation by Academic Researchers:** The updated framework was validated through regular consultations with an academic advisory committee of Canadian researchers specializing in the construction sector with emphasis OSC Sector, organizational maturity, and workforce development to ensure theoretical robustness and alignment with research best practices.

**Step 8: Future Validation:** Future steps will validate the construct validity of the descriptions and defined levels of maturity in the framework tables, through nationwide OSC industry pilot validation studies and reviews by the scientific advisory committee.   Comprehensive analysis of feedback to refine the model further will ensure its applicability and effectiveness across OSC, as well as benchmarking the maturity model.


## 3.  FINDINGS AND DISCUSSION


### 3.1    Step 1: Examination of CIB and the origins of seven Spheres of Influence – People Dimension

In Step 1, the CIB Framework and the work of Goulding and Arif (2013) were examined to explore the origins of the seven Spheres of Influence, with a specific focus on the people dimension. The key findings of this examination were:
• The CIB Framework emphasized the importance of the people dimension, an area often underrepresented in other maturity models. This highlighted its critical role in assessing organizational readiness for OSC.
• The comparison of the seven people's parameter constructs in Spheres of Influence (Goulding and Arif, 2013) against existing maturity models confirmed their robustness as well as their relevance to OSC.
• A significant limitation of the CIB framework was the absence of a clear method for implementing the framework or using it as a tool to assess workforce maturity for OSC adoption.
• While the People Dimension was included in the CIB framework, there was a lack of detailed definitions and clarity on its application, suggesting the need for further research and development.

### 3.2    Step 2: Literature Review – People Dimension

A total of 851 papers were initially extracted through the keyword search from the database. The dataset was refined for relevance using the keywords (see Section 2, Step 2) to  focusing on those that discussed maturity models centred on the people dimension and their relevance within this context refining the dataset, 73 papers were selected for the study,. The distribution of these 73 papers across various sectors was: Construction (14 papers), Mixed Sector (10 papers), Manufacturing (10 papers), Information Technology (10 papers), Non-Profit/Government Services (4 papers), Education (4 papers), Financial Services (3 papers), and Healthcare Services (18 papers). Key frameworks analysed include the CIB Maturity Framework, Capability Maturity Model (CMM), People Capability Maturity Model (P-CMM), and other specific frameworks.

### 3.3    Step 3: Elaboration of the seven parameters of the Spheres of Influence

After a comprehensive review of the 73 literature papers, key constructs mentioned in the papers for evaluating individuals' maturity were extracted from various existing maturity models and presented in a summary table from each source. This table serves as a critical tool for assessing the comprehensiveness of existing maturity models concerning individuals, while also identifying potential gaps in the CIB framework's inclusion of these seven parameters.

For instance, Table 1 highlights that the people's parameter *Communication* from the seven Spheres of Influence was aligned with constructs such as *collaboration, governance*, and *stakeholder management* (as defined in Literature Review Paper 1), while *Critical Thinking* and *Adaptability/Agility* were associated with constructs emphasizing resilience and responsiveness to change based on development of organizational *strategies and plan* (as defined in Literature Review Paper 1). This mapping process served as a benchmarking exercise, applied across all reviewed literature models addressing the people dimension, to align our workforce-centric constructs with best practices and definitions from established maturity models across sectors. This ensures that the parameters in the seven Spheres of Influence are both comprehensive and industry relevant.

### 3.4    Step 4: Condensing the seven Spheres of Influence into the Layer 4 People Capability Dimensions of the CIB Framework

To enhance the effectiveness of the CIB Framework, the validated seven parameters of Step 3 were prioritized based on their relevance to OSC workforce maturity and aligned with Capability Dimensions of Layer 4. The foundational ideas in the seven parameters from Goulding and Arif (2013) were closely interconnected and interdependent. The categorization of the seven parameters within the four Capability Dimensions in Layer 4 focused on matching by relevancy (See Figure 3). This alignment ensures that there is no redundancy or repetition of any parameter, streamlining the framework while maintaining its comprehensive nature and enhancing the clarity of the maturity assessment.

**1. Shaping the Workforce:** The parameters of Skills and Competencies, and Adaptability/Agility, were grouped under this capability dimension. This alignment highlights the importance of assessing, developing, and optimizing employees' abilities to meet organizational goals. For example, prioritizing adaptability ensures that the workforce is prepared to navigate dynamic challenges and opportunities.

**2. Motivating and Managing:** The parameters of Critical Thinking, and Innovation Premium were categorized here. The grouping emphasizes creating an environment where employees are inspired to contribute creatively and supported in their professional growth. By fostering critical thinking and promoting innovation, through activities like open discussions, collaborative brainstorming, and offering challenges that require thoughtful analysis, organizations inspire creativity, enhance problem-solving, and maintain a competitive edge.

**3. Building Workgroups:** The parameters of Communication and Culture were aligned with this capability dimension. Building cohesive teams requires effective communication and a collaborative/ inclusive culture, ensuring team members work harmoniously towards shared objectives. This alignment enhances team productivity, innovation, and overall performance.

Table 1: Example of Mapping Parameters from Literature

| Literature Review Paper 1 (P1) | |
|---|---|
| **Paper Name:** | Organizational sustainability excellence of construction firms – a framework |
| **Year:** | 2016 |
| **Model Source:** | (Terouhid & Ries, 2016) |
| **Focus Area:** | Sustainability models |
| **Models covered:** | 1. Innovation Excellence Model (Two) (2008,2010) <br> 2. Four-Phase Model (1995) <br> 3. Maturity model of Spectrum Innovation Group (2011) <br> 4. Business Sustainability maturity model (Two) (2005,2012) |

**Key attributes to use from this study and their alignment with 7 parameters of CIB (People's Dimension)**

| Model Name | 7 Parameters of CIB Framework | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Skills and Compet-encies** | **Training and Education** | **Communicat-ion** | **Innovation** | **Critical Thinking** | **Adaptability / Agility** | **Culture** | **Added** |
| Innovation Excellence Models | – | People | Collaboration, Governance and Stakeholder | Innovation, Knowledge Management | Strategies and Plan | Strategies and Plan | Leadership, Partnership, Collaboration | – |
| Four-Phase MODEL | – | – | – | – | – | – | Socialization | – |
| Maturity model of Spectrum Innovation Group | People and skills | – | – | – | Strategies and Plan | Strategies and Plan | Leadership, Corporate Culture | – |
| Business Sustainability Maturity Model | Compet-encies | – | Communication, Governance and Stakeholder | – | Strategy | Strategy | Partnership, Motivation | – |

**4. Developing Individual Capabilities:** The parameters of Training and Education were aligned here, emphasizing continuous learning and flexibility as critical components of individual growth. By providing relevant training, organizations equip employees to excel in evolving roles and contribute to sustained organizational success.
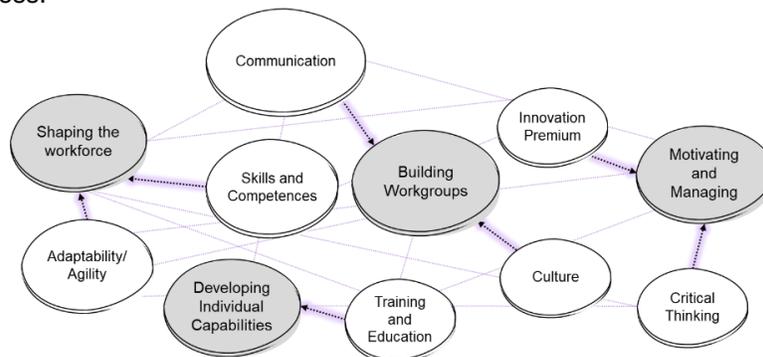


Figure 3: The alignment of the seven parameters with the CIB framework's Layer 4 Capability Dimensions

**3.5    Step 5: Building the People Table: Identifying Common Themes to build comprehensive descriptions of organizational maturity for OSC**

The analysis of constructs from other model's provided a detailed 360-degree view of the people's dimension across all industries and identified gaps in the construction sector when compared to the existing maturity models of other sectors. For instance, key themes were identified and shown in Table 2.

Table 2: Key Themes Identified for each People Parameter across the seven parameters of Goulding and Arif's (2013) Spheres of Influence

| Parameter | Themes extracted from existing models |
|---|---|
| Skills and Competencies | Customer Orientation, Human Resource Requirements, Resourcefulness, Reward and remuneration system, Upskilling. |
| Training and Education | Education, Training, Support |
| Communication | Clarity in structure, Collaborative and Participatory approach, Proactive communication |
| Innovation | Human Resource, Performance quality and compliance controls |
| Critical Thinking | Self Diagnostic and Strategic Integration |
| Adaptability and Agility | Capacity for Change Management (Skills), Readiness Assessment (Strategies) |
| Culture | Employee Focus, Commitment and Involvement, Organizational Culture, Top-down Leadership |

These themes were used to define detailed descriptions for five levels of maturity, for each parameter.

**3.6    Step 6: Building the People Table: Define different maturity levels in OSC**

The granular detailing facilitated a clear understanding of workforce maturity across the people dimension. The descriptions of maturity level for each capability dimension will allow organizations to assess their level of maturity for each parameter: basic (Level 1), developing (Level 2), established (Level 3), advanced (Level 4), or innovative (Level 5) stage.

Optimizing the CIB maturity wheel by integrating some enhancements, in:

**Layer 3: Thematic Capabilities:** A terminology adjustment was made to replace the thematic capability "Design Skills" with "Technical Skills" to reflect the broader range of competencies required across all three Design, Manufacturing, and Construction phases. This change ensures inclusivity and accuracy in skill representation. Secondly, the Layer 3 thematic capabilities Technical Skills, Operational Readiness and Agility, and Stakeholder Management were condensed into a single thematic capability to avoid the repetition of definitions and to streamline the assessment process between phases of construction.

**Layer 4: Capability Dimensions:** The seven validated parameters of Goudling and Arif's (2013) Spheres of Influence (Skills and Competencies, Adaptability/Agility, Communication, Critical Thinking, Innovation Premium, Culture and Training and Education) of the people's dimension are housed within the Layer 4 Capability dimensions, rather than adding an extra Layer to the CIB maturity model wheel. A layer was not included in the wheel to maintain consistency with the existing layers of Process and Technology. Instead, the details of these parameters are included within the table/ framework's descriptions. This ensures that the specific aspects of the people's dimension are clearly defined and assessed, providing a deeper understanding of the workforce's maturity in OSC. The scoring process takes into account the specific criteria and characteristics defined and detailed at each level, ensuring a structured and consistent assessment of each parameter and providing valuable insights into the OSC organization's current position and areas for improvement.

An example table can be seen in Table 3, illustrates framework highlights the progression from minimal skills and chaotic processes at Level 1 to highly refined and innovative workforce capabilities at Level 5 in OSC design phase.

Table 3: Framework Table with description (Example: Shaping the workforce - Skills and Competencies)

| | DESIGN - PEOPLE | | | | |
|---|---|---|---|---|---|
| | **Technical Skills – Operational Readiness and Agility – Stakeholder Management** | | | | |
| **Alignment of 7 Parameters (From Spheres of Influence)** | **Level 1 (Ad-Hoc)** | **Level 2 (Structured)** | **Level 3 (Standardized)** | **Level 4 (Optimized)** | **Level 5 (Innovative)** |
| | *Processes are informal and reactive, with limited consistency and minimal integration of technology, relying heavily on individual efforts without formal procedures.* | *Basic structures and processes are in place, with some technology adoption and initial training efforts, but execution is still inconsistent across projects.* | *Standard operating procedures and formal training are widely implemented, achieving consistent use of technology and processes across projects with coordinated efforts.* | *Processes are refined and technology is fully integrated to enhance efficiency, with skilled personnel driving continuous improvements across all areas of design, construction, and manufacturing.* | *The organization actively leverages cutting-edge technology and fosters a culture of innovation, consistently optimizing processes and setting industry standards.* |
| **Shaping the Workforce - Skills and Competencies** | • Workforce holds foundational technical design knowledge. | • The workforce demonstrates competent technical design skills, with some OSC-specific knowledge. | • The workforce at unit level demonstrates strong technical design and project management skills (e.g. - Succession planning, Competency modelling, Workforce analytics). | • The workforce is recognized as subject matter experts in OSC design with advanced technical skills. | • The workforce has expert-level design skills. |
| | • Requires substantial support and supervision. | • Requires guidance and supervision, particularly in handling complex situations. | • Requires minimal supervision; works independently in most situations. | • Requires limited supervision; mentorship and guidance are provided in OSC design best practices. | • Requires minimal to no supervision; leads continuous improvement and innovation in OSC design. |
| | • Formalistic sense of responsibility for quality, basic functional capability, and minimal focus on customer service. | • Growing sense of responsibility for quality, functional capability; and customer service. | • High functional capability with a strong sense of responsibility for quality and customer service. | • Exceptional sense of responsibility for quality and functional capability with a strong customer service focus. | • Deep commitment to quality, sets new standards in customer service and innovates in design solutions. |
| | • Work units operate independently, with minimal collaboration. | • Work units start to contribute to OSC design initiatives with basic data-driven insights | • Work units contribute effectively to OSC design initiatives with proficient knowledge and developing synergy across units. | • The organization enhances synergy through professional development strategies sharing design experiences. | • The workforce influences organizational strategy and provides strategic guidance, contributing to long-term success. |
| | • Yet to gain practical experience or depth in specific areas crucial for OSC. | • Experience in technical design knowledge related to OSC. | • Good level of practical experience of OSC. | • Deep industry experience of OSC. | • Recognized for advancing industry best practices. |

As the workforce matures, they transition from needing substantial supervision to becoming experts in their fields, leading continuous improvement and innovation in OSC design and organizational strategy. This framework also allows organizations to assess the existing capability of their workforce and identify which level they currently occupy. By doing so, the organization can pinpoint areas that require improvement and take targeted steps to grow and advance to the next level or beyond. This understanding not only fosters development but also helps streamline the organization's strategy toward continuous workforce enhancement.

### 3.7 Step 7: Validation by Academic Researchers

The validation phase with academic researchers provided several key outcomes. Firstly, the framework's parameters and categories were thoroughly evaluated, confirming their theoretical soundness and relevance to the field. Researchers affirmed that the framework aligns with current academic understanding and research on OSC industry. Additionally, feedback emphasized the framework's coherence with broader maturity model paradigms, ensuring integration within established academic theories and practices. Researchers also identified some topics for consideration in the descriptions within the framework table, providing valuable suggestions for further refinement, ensuring the framework's completeness and applicability.

### 3.8 Step 8: Future Validation

Further steps will involve developing and distributing survey questions, creating a comprehensive database from industry responses, and validating the framework through consultations with industrial specialists, ensuring its practical relevance. Industrial specialists will include a diverse group of professionals with expertise across the various facets of OSC, covering key areas such as design, manufacturing, and construction. Their combined knowledge and experience will provide a comprehensive perspective on the entire OSC process, ensuring that all stages are effectively integrated and optimized. Further focus will be on refining the framework based on the feedback from both survey data and expert consultations, addressing any gaps or limitations identified during the validation process. In parallel, future steps will also include strategies to advance to the next level, enabling organizations to identify their current maturity stage and adopt targeted strategies/measures for progression, thereby fostering continuous improvement. The final aim is to benchmark the model by collecting data into a data platform, analyzing the collected data to establish baseline maturity levels across the OSC sector, providing a robust foundation for continuous improvement and industry-wide adoption and to measure progress at an industry level. In future, new skills or other relevant parameters can be incorporated into this framework, allowing it to be modified and upgraded as the industry evolves.

## 4. CONCLUSION

This research presents a comprehensive framework for assessing OSC maturity by integrating the enhanced people dimension with the existing Process and Technology dimensions. Through literature review, exploration of frameworks, and expert validation, it bridges key workforce assessment gaps across OSC phases, improving evaluations of workforce. The structured maturity levels, ranging from Basic to Innovative, establish a standardized assessment tool for benchmarking and continuous improvement across organizations. By quantifying maturity levels, organizations can target workforce development strategies that foster innovation. To ensure practical application, future research will focus on empirical validation, industry-wide implementation, and framework refinement through surveys and data analysis. A workforce maturity database will facilitate sector-wide benchmarking, while incorporating digital tools, AI-driven analytics, and automation will enhance workforce adaptability. Ultimately, this research aspires to create a scalable, dynamic workforce maturity framework that evolves with industry advancements, fostering a skilled, resilient, and future-ready OSC sector.

## ACKNOWLEDGMENTS

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