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Initial Validation of Information Management Performance Indicators

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Abstract: The goal of our research is to develop an information management (IM) assessment model to holistically measure the organizational-level IM performance in construction organizations. The objective of the work reported in this paper is to validate 46 developed performance indicators (PIs) within a proposed IM framework. The PIs are validated by checking both the appropriateness, and use of the PIs for IM performance measurement. The appropriateness of the PIs is checked through an online questionnaire survey of seven construction IM researchers in Canada. The results show a 92% agreement on the appropriateness of the PIs for IM performance measurement. The use of the PIs is checked through the assessment actions performed by four information managers on the PIs in a large construction organization in New Brunswick, using a structured interview survey. The results show a 57% inconsistency across the managers' responses, and a 6% inconsistency in the assessment actions performed on the PIs. The inconsistencies are caused by the assessment actions not being performed by the managers on each PI. This paper provides 46 initially-validated PIs that will be useful to those IM researchers and industry professionals who seek to improve IM in construction organizations. The next step in this research will further validate the use of the PIs in multiple construction organizations.

1 Introduction

Information is an essential functional requirement for construction organizations (Titus and Brochner 2005, Hicks et al. 2006, Sheriff et al. 2012). Measuring the value of information enables organizations to efficiently and effectively identify, create, analyze, access, and use information to improve performance (Hicks et al. 2006, Stewart 2007, Zhao et al. 2008, Lee and Yu 2012, Sheriff et al. 2012). A holistic approach to information management (IM) is required to optimise the capability of people with information communication technology (ICT) to control and use information to improve performance (Sheriff et al. 2012). A holistic IM approach is described by Sheriff et al. (2012) to consist of skills, strategies, processes, and tools that are used to manage the life cycle of information within an organization.

The goal of this research is to develop an IM assessment model to holistically measure the organizational-level IM performance in construction organizations. To achieve this research goal, the authors have developed the IM framework in Figure 1 (Aziz et al. 2012), as the basis for the IM assessment model in development. In this research, holistic refers to the integration of the 46 PIs, the eight IM components, and the relationships between the components within the IM framework in a single organization. The objective of this paper is to check: (i) the appropriateness of the PIs, and (ii) the use of the PIs for organizational-level IM performance measurement in a construction organization.

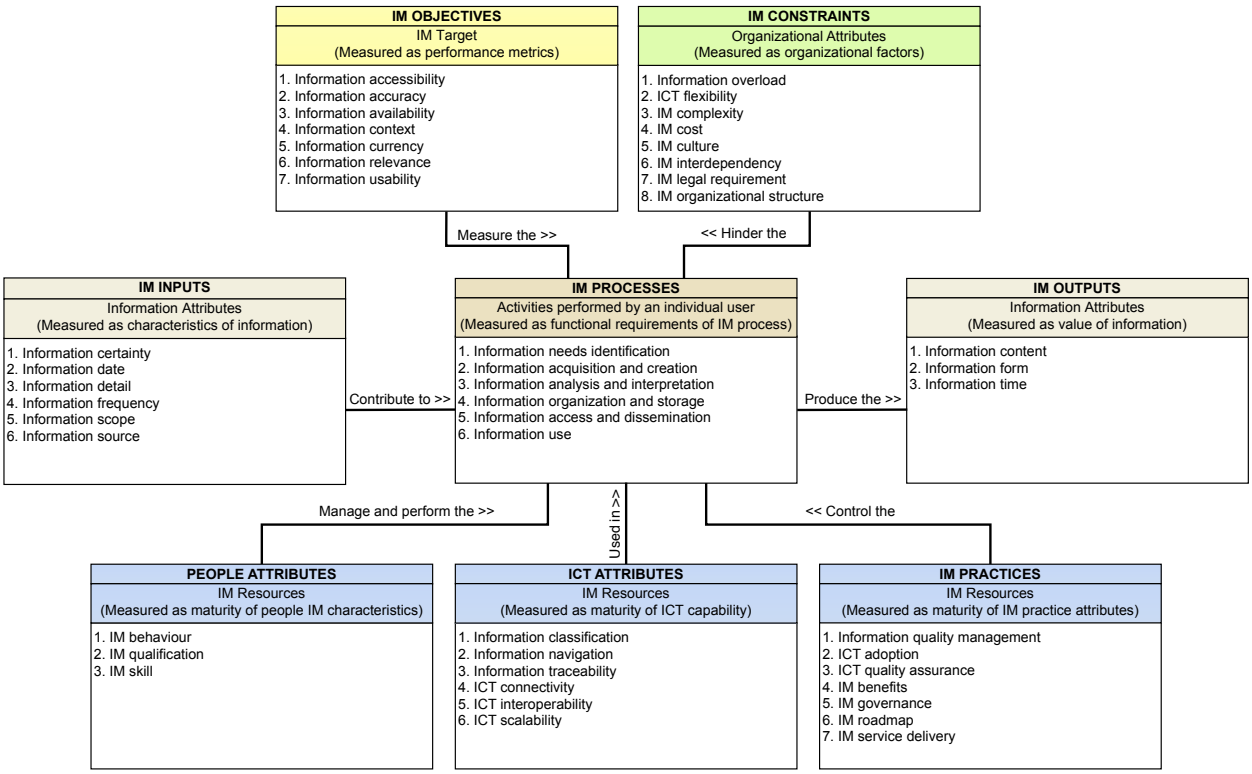

Figure 1: The previously developed IM framework

2 Methodology

The validation methodology used to check the appropriateness and the use of the PIs is shown in Figure 2. The steps to check the appropriateness of the PIs are outlined in Steps I and II. The steps to check the use of the PIs are outlined in Steps III and IV, and the steps to confirm the use of the PIs are outlined in Steps V and VI. Each step is described subsequently, and the results are described in Section 3.

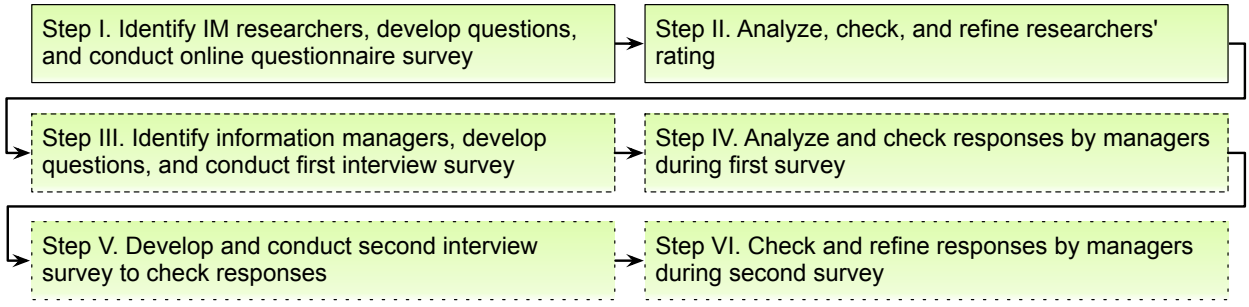

Figure 2: The steps in the validation methodology

Step I. Identify IM researchers, develop questions, and conduct online questionnaire survey: The sampling method used to determine the IM researchers was similar to the purposive sampling (i.e., expert sampling) described by Trochim (2006). A total of 13 construction IM researchers from across Canada were contacted by email to participate in an online questionnaire survey. Canadian construction IM researchers were selected because this research is based on the construction industry in North America, specifically Canada.

The steps used to develop the questionnaire were similar to those suggested by Iarossi (2006) and Pickard (2007). The questionnaire consisted of 54 questions in the eight IM components as shown in Figure 1. Each component of the questionnaire consisted of a single Likert scale question for each PI within that component and one open-ended question. The Likert scale questions used a five-point scale (i.e., *strongly disagree, disagree, neutral, agree,* and *strongly agree*) with each point coded as 1, 2, 3, 4, 5, to rate the appropriateness of the PIs' for IM performance measurement, based on the assumption that adequate level of details was provided for the PIs (Kothari 2004, Trochim 2006). The open-ended questions collected additional PIs and comments that the researchers' deemed relevant to improve the PIs and the research. The Likert scale was selected because of the advantages described by Oppenheim (1992) and Kothari (2004). An online questionnaire survey was conducted to collect the IM researchers' rating of each PI. This type of survey was selected because it was convenient and easy to reach the IM researchers across Canada.

Step II. Analyze, check, and refine researchers' rating: The appropriateness of the PIs was checked through the researchers' agreement with the importance of the PIs for organizational-level IM performance measurement. The researchers' agreement was calculated by dividing the *strongly agree* and *agree* ratings by the maximum number of ratings. There was no discrimination between the *strongly agree* and *agree* ratings in the calculations. The comments provided by the researchers in the open-ended questions for the *neutral* and *disagree* responses were used to revise the PIs.

Step III. Identify information managers, develop questions, and conduct first interview survey: The organization's hierarchy structure was used to select two strategic and two operation managers of information from the information technology (IT) and engineering departments within a large construction organization in New Brunswick. The IT strategic manager controls the quality, efficiency, and effectiveness of the organization's computer information system (CIS), while the IT operation manager maintains the storage and access of information in the CIS. The engineering strategic manager administers the quality, efficiency, and effectiveness of IM within the department, while the engineering operation manager controls the construction cost, time, quality, and scope information for projects. The managers were contacted by email to participate in the interview surveys.

The process used to develop the interview questions was similar to the processes suggested by Iarossi (2006) and Pickard (2007). Each interview consists of one "Yes/No" type question for each of the 46 PIs. The questions were coded with one for "Yes" and zero for "No" to indicate whether the managers performed the assessment actions on each PI in the management cycle. Two groups of assessment actions were examined in the management cycle because of the characteristics of the PIs. The first group examined the following four assessment actions for the 19 PIs in three IM components (i.e., *IM processes*, *ICT attributes*, and *IM practices*).

(i) *Plan* (i.e., developing ways to achieve the desired level of performance)
(ii) *Measure* (i.e., capturing and analyzing the performance)
(iii) *Control* (i.e., comparing the plan and actual performance for quality achievement)
(iv) *Improve* (i.e., taking corrective actions to refine the performance)

The second group examined the following four assessment actions for the 27 PIs in the remaining five IM components (i.e., *People attributes*, *IM inputs*, *IM outputs*, *IM constraints,* and *IM objectives*).

(i) *Identify* (i.e., establishing the level of performance)
(ii) *Document* (i.e., recording the performance in written or other form)
(iii) *Assess* (i.e., analyzing, and comparing the plan and actual performance for quality achievement)
(iv) *Improve* (i.e., taking corrective actions to refine the performance)

An interview survey was conducted to collect the managers' responses on the use of each PI. This type of survey was selected because it was convenient to meet with the managers to clarify the questions and collect feedback on the PIs. The techniques used to reduce biases from the interview surveys were similar to those suggested by Janina and Jolley (2012). Neutrally structured and scripted questions were used to avoid leading biased questions and to reduce the authors' influence from the responses provided

by the managers. Each PI was constructed to be simple, clear, and concise to reduce misunderstanding. The developed questions were specific, unaided, and positive to minimize question order biases. A scripted summary was used to describe the research goal and the purpose of the interview to each manager. A structured approach was used to conduct the interviews to ensure each manager has the same information.

Step IV. Analyze and check responses by managers during first survey: The use of the PIs was checked through the managers' responses. The responses were checked across the managers for inter-respondent (IR) inconsistencies, and across the assessment actions for assessment actions (AA) inconsistencies. The IR inconsistencies occur when the four managers did not provide the same response, either "Yes" or "No," to an assessment action performed on each PI.

The authors' did not expect an increase across the assessment actions in the management cycle (i.e., the responses for *plan* to *improve,* or *identify* to *improve,* have a "No" response followed by a "Yes" response). The AA inconsistencies occur when there was an increase in the subsequent assessment action performed on a PI in the management cycle (i.e., "No" response followed by a "Yes" response).

Step V. Develop and conduct second interview survey to check responses: A second interview survey was developed and conducted to collect details on the assessment actions to check that the actions were performed as indicated by the managers in the first interview survey. This second survey consisted of four discussion-type questions. The first question checked "*what information was managed and assessed,"* as well as, "*what performance metrics were used in the assessment*." The second question checked "*who managed the information,"* and "*who performed the assessment actions."* The third question checked "*how the information was managed (i.e., the processes and procedures),"* and "*how the assessment actions were performed*." The fourth question checked "*when the managers performed the IM assessment tasks (i.e., as specified in policies and schedules)*," and "*when the assessment actions were performed*."

Step VI. Check and refine responses by managers during second interview survey: The responses were checked through examples provided by each manager that showed how each assessment action was performed for inconsistent PIs. The IR inconsistencies and AA inconsistencies were checked through the explanations provided by each manager for not performing an assessment action in the management cycle, and these explanations were used to refine the responses.

Limitations of the Methodology

The validation methodology is adequate and serves the research purpose. However, there is an inherent limitation in the use of small sample sizes to determine the appropriateness and the use of the PIs. This limitation is owed to a time constraint in the research.

3 Results and Discussion

The appropriateness of the PIs, as rated by the IM researchers, and the use of the PIs, as given by the information managers, are presented and discuss in this section.

3.1 Appropriateness of the PIs

Ten of the 13 researchers contacted agreed to participate in this study and seven completed the survey. The survey was available to the researchers for period of 30 days (February 20 to March 20 2012). A one-month period was chosen owed to a time constraint in this research. On average, the survey took approximately 45 minutes to complete. The researchers' ratings agreeing with the appropriateness of the PIs for organizational-level IM performance measurement are shown in Figure 3. There is a 92% agreement rating *(i.e., 57% strongly agree* and *35% agree)* on the appropriateness of the PIs, a *7% neutral* rating*, a single disagree* rating, and no *strongly disagree* rating. The comments provided by the researchers in the open-ended questions for the *neutral* and *disagree* ratings and the revisions made by

the authors to each PI are described subsequently for the eight IM components. The revisions made to the PIs were assumed to be adequate for use and were not rechecked by the researchers.

- **IM Processes:** The ratings for the PIs within this IM component show a 93% agreement *(i.e., 62% strongly agree* and *31% agree), 7% neutral*, and no *disagree*. One researcher provided the *neutral* rating and comments for the PIs *information needs identification*, *information access and dissemination*, and *information use*. The comments indicated that the definitions of the PIs did not fully encapsulate the requirements of the PIs; consequently, the definitions were revised to better summarize the essential features of the PIs.

- **ICT Attributes:** The ratings for the PIs within this IM component show an 86% agreement *(i.e., 59% strongly agree* and *27% agree)*, *14% neutral*, and no *disagree*. Three researchers provided the *neutral* rating and comments for the PIs within this component, except for the PI *information system (IS) interoperability*. The comments indicated that the definitions of the PIs did not fully encapsulate the requirements of the PIs, and recommended revisions to the PIs *information structure, IS interoperability,* and *network and system connectivity,* as well as merging the PI *IS capacity* with *IS scalability,* and including *portability and remote field accessibility* in the PI *network and system connectivity*. Consequently, the definitions were revised to better summarize the essential features of the PIs, while *information structure* was revised to *information traceability*, *IS interoperability* was revised to *ICT interoperability*, *IS scalability* and *IS capacity* were revised to *ICT scalability*, and *network and system connectivity* was revised to *ICT connectivity*, incorporating *portability and remote accessibility* in the definition of the PI.

- **IM Practices:** The ratings for the PIs within this IM component show a 94% agreement *(i.e., 59% strongly agree and 35% agree)*, *6% neutral,* and no *disagree*. Two researchers provided the *neutral* rating and comments for the PIs *IM roadmap* and *information service delivery*. The comments indicated that the definitions of the PIs did not fully encapsulate the requirements of the PIs, and recommended revisions to the PIs *CIS development and adoption* and *tangible and visible benefit*. Consequently, the definitions were revised to better summarize the essential features of the PIs, while *CIS development and adoption* was revised to *ICT adoption*, and *tangible and visible benefit* was revised to *IM benefit*.

- **People Attributes:** The ratings for the PIs within this IM component show an 85% agreement *(i.e., 52% strongly agree* and *33% agree), 10% neutral*, and *5% disagree*. Two researchers provided the *neutral* and *disagree* ratings and comments for the PIs *IM attitude* and *IM skill*. The comments indicated that the definitions of the PIs did not fully encapsulate the requirements of the PIs, and the comments for the disagree rating recommended revision to the PI *IM attitude*. Consequently, the definitions were revised to better summarize the essential features of the PIs, while *IM attitude* was revised to *IM behaviour*.

- **IM Inputs:** The ratings for the PIs within this IM component show an 86% agreement *(i.e., 41% strongly agree* and *45% agree), 14% neutral,* and no *disagree*. Two researchers provided the *neutral* rating and comments for all the PIs within this component, except for *information detail*. The comments indicated that the definitions of the PIs did not fully encapsulate the requirements of the PIs, and recommended revision to the PI *information time*. Consequently, the definitions were revised to better summarize the essential features of the PIs, while *information time* was revised to *information date*.

- **IM Outputs:** The ratings for the PIs within this IM component show a 100% agreement *(i.e., 57% strongly agree and 43% agree)* with no *neutral* or *disagree* rating. However, one researcher's comment indicated that the definitions of the PIs did not fully encapsulate the requirements of the PIs; consequently, the definitions were revised to better summarize the essential features of the PIs.

- **IM Constraints:** The ratings for the PIs within this IM component show 96% agreement *(i.e., 50% strongly agree* and *46% agree), 4% neutral*, and no *disagree*. One researcher provided the *neutral* rating and comments for the PIs *IS flexibility* and *legal requirement*. The comments indicated that the definitions of the PIs did not fully encapsulate the requirements of the PIs, and recommended revisions to the PIs *cost and budget* and *IS flexibility*. Consequently, the definitions were revised to better summarize the essential features of the PIs, while *cost and budget* was revised to *IM cost*, and *IS flexibility* was revised to *ICT flexibility*.

- **IM Objectives:** The ratings for the PIs within this IM component show a 98% agreement *(i.e., 74% strongly agree* and *24% agree), 2% neutral,* and no *disagree*. One researcher provided a *neutral* rating and comment for the PI *information relevance*. The comment indicated that the definition of the PI did not fully encapsulate the requirement of the PI; consequently, the definition was revised to better summarize the essential features of the PI.

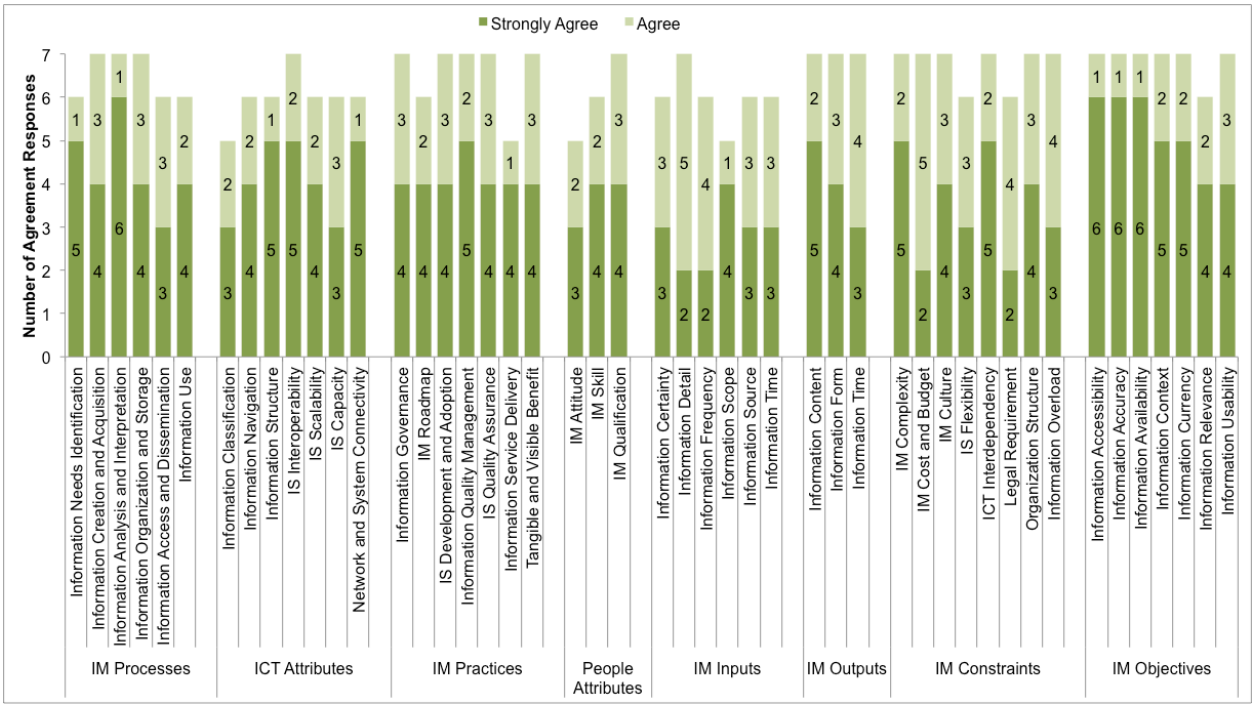

Figure 3: The IM researchers' ratings for each PI in the eight components of the IM framework.

3.2 Use of the PIs

The first survey was conducted between June and December 2012 based on the availability of the managers, and each interview took approximately one hour to complete. The second survey was conducted in December 2012, and each interview took approximately 50 minutes to complete. The first operation manager interviewed could not provide accurate responses for the PIs because the scope of the questions focused on information managed in the entire organization. Consequently, the scope of the questions was reduced to focus on information controlled by each manager to obtain accurate responses. The four interviews were conducted following the scope change, and the managers confirmed their responses at the end of the first survey.

The second interview survey was conducted because the managers' responses in the first survey indicated that inconsistent actions were performed on the PIs. The details collected in this second survey confirmed that each manager performed the assessment actions indicated in the first interview and provided explanations for the inter-respondent (IR) inconsistencies and the assessment actions (AA)

inconsistencies for each PI. The IR inconsistencies and AA inconsistencies for the PIs within each IM component were checked as demonstrated in the following example.

This example demonstrates the case with both IR inconsistencies and AA inconsistencies. The managers' responses for the PI *information accuracy* in the *IM objectives* component are shown in Table 1. The responses show that the IT strategic manager did not evaluate this PI, and the engineering operation manager did not perform the assessment action *document* on the PI.

Check for IR inconsistencies: The columns in Table 1 show that the IT strategic manager response is inconsistent for each assessment action, and the engineering operation manager response is inconsistent for the assessment action *document* relative to the IT operation and engineering strategic managers. Therefore, the number of IR inconsistencies for this PI is four (i.e., there is one IR inconsistency for each assessment action, as described in Section 2, Step IV), and the potential number of IR inconsistencies is four (i.e., the maximum number of assessment actions for the PI). The IR inconsistencies for this PI are calculated by dividing the actual inconsistencies by the potential number of inconsistencies, i.e., 4/4 = 1 or 100%.

Check for AA inconsistencies: The rows in Table 1 show that the engineering operation manager response indicates an increase from the assessment action *document* to the assessment action *assess* (i.e., a "No" response followed by a "Yes" response, as described in Section 2, Steps III and IV). Therefore, the number of AA inconsistency for this PI is one. The potential number of AA inconsistencies is four (i.e., a "No" response is followed by a "Yes" response for each of the four managers). The AA inconsistencies for this PI are calculated by dividing the actual inconsistencies by the potential number of inconsistencies for this PI, i.e., 1/4 = 0.25 or 25%.

Table 1: The managers' responses for the PI information accuracy

Respondent	**Identify**	**Document**	**Assess**	**Improve**	**No. of AA inconsistencies**
IT strategic manager	No	No	No	No	**0**
IT operation manager	Yes	Yes	Yes	Yes	**0**
Engineering strategic manager	Yes	Yes	Yes	Yes	**0**
Engineering operation manager	Yes	No	Yes	Yes	**1**
No. of IR inconsistencies	**1**	**1**	**1**	**1**	

The IR inconsistencies and AA inconsistencies for the PIs within each IM component, the cause for the inconsistencies, as well as the explanation provided for the inconsistencies by the IT and engineering managers, are described subsequently for the two groups of assessment actions. The first group checked the four assessment actions *plan*, *measure*, *control*, and *improve* performed on the 19 PIs in the following three IM components.

- **IM Processes:** The 67% (16/24) IR inconsistencies within this component were caused by both IT managers not evaluating the PIs *information needs identification, information creation and acquisition, information analysis and interpretation,* and *information use*. The IT managers' explanations indicated that these PIs were not evaluated because the engineering department created and used the information, and the IT department supported the storage and access of the information in the CIS. The engineering managers' responses showed that the four PIs were evaluated within the engineering department, and their explanations indicated that the information was created and used in within the department. There were no AA inconsistencies for the PIs within this component.

- **ICT Attributes**: The 67% (16/24) IR inconsistencies within this component were caused by the IT operation manager not evaluating the PIs *ICT connectivity, ICT interoperability*, and *ICT scalability*; the engineering strategic manager not evaluating the PI *ICT scalability*; and the engineering operation manager not evaluating the PI *information classification*. The IT managers' responses showed that the IT strategic manager evaluated the three PIs, and their explanations

indicated that the IT strategic manager was responsible for the evaluation of the PIs in the management cycle. The engineering managers' responses showed that the engineering operation manager evaluated the PI *ICT scalability*, and the engineering strategic manager evaluated the PI *information classification*. The engineering managers' explanations indicated that the PI *ICT scalability* was not applicable to the engineering strategic manager and the PI *information classification* was not applicable to the engineering operation manager. Both PIs were evaluated to provide feedback to the IT department. There were no AA inconsistencies for the PIs within this component.

- **IM Practices**: The 43% (12/28) IR inconsistencies within this component were caused by the IT operation not evaluating the PI *IM roadmap*; and the engineering strategic manager not evaluating the PIs *ICT adoption, ICT quality assurance*, and *information service delivery*. The IT managers' responses showed that the IT strategic manager evaluated the PI *IM roadmap*, and their explanations indicated that the IT strategic manager was responsible for the continuous improvement of IM and evaluated the PI annually within the organization. The engineering managers' responses showed that the engineering strategic manager did not perform the assessment action *measure* on the PI *Information service delivery* and the engineering operation manager evaluated the three PIs. The engineering managers' explanations indicated that the engineering operation manager evaluated the PIs and reported the outcomes to the engineering strategic manager. There were 4% (1/28) AA inconsistencies because the engineering strategic manager did not performed the assessment action *measure* on the PI *information service delivery*, and the explanation indicated that the outcomes from the engineering operation manager evaluation were used as the measured value for the PI.

The second group checked the four assessment actions *identify*, *document*, *assess*, and *improve* performed on the 27 PIs in the following five IM components.

- **People Attributes**: The 100% (12/12) IR inconsistencies within this component were caused by the IT and engineering operation managers not evaluating the three PIs *IM behaviour, IM qualification,* and *IM skill*. The IT managers' responses showed that the IT strategic manager evaluated the PIs. Similarly, the engineering managers' responses showed that the engineering strategic manager evaluated the PIs and did not perform the assessment action *improve* on the PI *IM qualification*. Both IT and engineering managers' explanations indicated that the PIs were not applicable to the two operation managers. The engineering manager's explanation also indicated that the PI *IM qualification* was improved indirectly through training provided to engineers. There were no AA inconsistencies for the PIs within this component.

  IM Inputs: The 17% (4/24) IR inconsistencies within this component were caused by the IT operation manager not evaluating the PI *information scope*. The IT managers' responses showed that the IT strategic manager evaluated the PI, and their explanations indicated that the PI was not applicable to the IT operation manager. The engineering managers' responses showed that the PI was evaluated within the engineering department. There were no AA inconsistencies for the PIs within this component.

- **IM Outputs:** The 67% (8/12) IR inconsistencies within this component were caused by both IT managers not evaluating the PIs *information content* and *information form*, and the engineering operation manager not documenting these two PIs. The IT managers' responses showed that the two PIs were not evaluated within the IT department, and their explanations indicated that the PIs were not applicable to the department because the engineering managers evaluated the value of information. The engineering managers' responses showed that the two PIs were not evaluated in the engineering department, and their explanations indicated that the PIs *information content* and *information form* were documented only when information did not meet users needs and expectations. There were 17% (2/12) AA inconsistencies because the engineering operation manager did not perform the assessment action *document* on the PIs *information content* and

information form and the explanation provided is the same for the IR inconsistences in the previous sentence.

- **IM Constraints:** The 91% (29/32) IR inconsistencies within this component were caused by the IT operation manager not evaluating the PIs *IM cost, IM culture, IM legal requirement,* and *IM organizational structure*; the engineering strategic manager not evaluating the PIs *information overload,* and *ICT flexibility*; and the engineering operation manager not evaluating the PIs *IM cost* and *IM interdependency*. The IT managers' responses showed that the IT strategic manager evaluated the four PIs, and their explanations indicated that the PIs were not applicable to the IT operation manager. The engineering managers' responses showed that the engineering strategic manager evaluated the PI *IM cost* and performed the assessment actions *identify* and *document* for the PI *IM interdependency*, and the engineering operation manager evaluated the PIs *information overload* and *ICT flexibility*. The engineering managers' explanations indicated that the engineering operation manager evaluated the PIs *information overload* and *ICT flexibility* and reported the outcomes to the engineering strategic manager. The PI *IM cost* was not applicable to the engineering operation manager, and the outcome for the PI *IM interdependency* was reported to the IT strategic manager for evaluation. There were no AA inconsistencies for the PIs within this component.

- **IM Objectives:** The 29% (8/28) IR inconsistencies within this component were caused by the IT strategic manager not evaluating the PI *information accuracy,* and the engineering operation manager not documenting the PIs. The IT managers' responses showed that the IT operation manager evaluated the PI *information accuracy*, and their explanations indicated that the outcome from the evaluation of the PI was reported to the IT strategic manager. The engineering managers' responses showed that the engineering strategic manager documented the PIs, and their explanations indicated that the engineering operation manager performed the assessment action *document* when there was an information issue that hindered project problem solving and decision-making within the department. There were 29% (8/28) AA inconsistencies because the engineering operation manager did not perform the assessment action *document* on the seven PIs within this component, and the explanation provided is the same for the IR inconsistences in the previous sentence.

4 Summary

This paper provides a structured validation process to check the appropriateness and the use of the PIs for holistic organizational-level IM performance measurement in a construction organization. The appropriateness of the PIs for IM performance measurement is checked through seven Canadian construction IM researchers. The results show an 8% disagreement (i.e., the *neutral* and *disagree* responses) with the appropriateness of ten PIs. This disagreement is caused by brief definitions, which did not fully encapsulate the requirements of the PIs. The use of the PIs for IM performance measurement is checked through four information managers in a large organization. The results show total inter-respondent (IR) inconsistencies of 57% (105/184) and total assessment actions (AA) inconsistencies of 6% (11/184) for the 46 PIs. The managers' explanations from the second survey revealed that the IR inconsistencies are caused by the four managers not performing similar assessment actions on 33 PIs, and the AA inconsistencies are caused by the managers not performing each assessment action on 11 PIs. The main contributor to the IR inconsistencies is the IT operation manager, and the main contributor to the AA inconsistencies is the assessment action *document*.

These results provide understanding of the PIs and the methodology used to check appropriateness and the use of the PIs. Two potential opportunities are identified to improve the accuracy and reliability of the methodology that checked the use of the PIs. The first opportunity is to use the strategic managers in the survey because the results show that the IR inconsistencies are caused by several PIs not being evaluated by the operation managers or applicable to the operation managers. The explanations provided in the second survey indicate that the strategic managers are responsible for evaluating the PIs within the organization. The operation managers participated in the evaluation process, and reported the outcomes

of their evaluation to the strategic managers. The explanations also indicate that the strategic managers in the two departments were aware of the assessment actions performed in both departments. The second opportunity is to revert the scope of the questions to the organizational-level; by focusing on strategic managers the accuracy and reliability of the organizational-level IM performance can be determined with fewer managers in the organization. The scope of the questions was initially reduced from information managed within the organization to information controlled by each manager because the first operation manager interviewed could not provide reliable responses to the questions.

The initial validation process has achieved the objective of this paper by checking the appropriateness and the use of the PIs for IM performance measurement through seven IM researchers and four information managers. The deliverable of this paper is the 46 initially-validated PIs, which form the core of the IM assessment model currently in development. The PIs can be used to measure the organizational-level IM performance in organizations. However, this is a work in progress, and further investigation is required to confirm the appropriateness and use of the PIs in IM performance measurement. Therefore, it is recommended that IM researchers further investigate the appropriateness of the PIs for construction organizations through a survey of both national and international IM researchers and industry practitioners. It is recommended that information managers identify and document the assessment actions that are not being performed within the organization in order to understand the impact on organizational-level IM performance. The next step in this research will focus on further checking the use of the PIs for IM performance measurement in multiple construction organizations. This will provide insight that will be used to refine and finalize the IM assessment model.

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