

Pilot Testing and Reliability of Research Instruments for Training Systems in Manufacturing

Mr. Ashish Ghanwat¹, Dr. Poonam Vatharkar²

¹Research Student, MES Institute of Management & Career Courses (IMCC), Pune, Affiliated to Savitribai Phule Pune University (SPPU).

²Assistant Professor, MES Institute of Management & Career Courses (IMCC), Pune, Affiliated to Savitribai Phule Pune University (SPPU).

Abstract

Training and development are significant parts of workforce capability in manufacturing organizations, especially in settings that have technological changes, evolving job requirements, and ongoing needs for skill development. A thorough examination of organizational training systems needs research tools that can consistently gather relevant dimensions from suitable organizational stakeholders. This study presents the pilot testing and initial reliability evaluation of two structured research tools created for a larger study on training systems in manufacturing industries.

Separate questionnaires were created for Human Resource Heads and Learning and development Managers. The Human resource head questionnaire included 20 items allocated into five sections, while the Learning and development Manager questionnaire included 30 items also allocated into five sections. Both questionnaires used a five-point Likert type response scale. A pilot sample of 20 respondents was utilized for the initial assessment, consisting of 10 Human resource heads and 10 Learning and development Managers. Cronbach's alpha was used to analyse internal consistency for both the overall instruments and their sections.

The Human Resource head questionnaire showed an overall Cronbach's alpha of 0.903, with section wise coefficients ranging from 0.817 to 0.966. The Learning and development Manager questionnaire showed an overall Cronbach's alpha of 0.933, with section wise coefficients ranging from 0.730 to 0.884. No items were removed or altered based on the pilot results, and both instruments were kept for main study. The findings indicate initial evidence of acceptable internal consistency, although the small pilot testing sample does not permit for conclusive psychometric validation.

Keywords: Competency Mapping, Training Systems, Learning and Development, Pilot Study, Reliability, Manufacturing Industry

1. Introduction

Manufacturing organizations work in an environment where technological advancements, changes in production methods, shifts in job roles, and rising performance expectations constantly affect workforce needs. In this kind of environment, organizations require ways to identify, develop, evaluate, and align

employee skills with the changing needs of the organization. Therefore, training and development are significant parts of managing Human Resources in organizations.

Training is not just about delivering individual training programs. A systematic training process can include identifying competency needs, assessing current capabilities, finding skill gaps, determining training needs, choosing suitable training methods, carrying out training activities, and evaluating the results. Competency mapping can play a vital role in this process by pinpointing the competencies needed for specific roles and helping organizations recognize where employee skills need improvement.

Research has shown that competency mapping is relevant for assessing training needs. For instance, Sarkar, S. (2013) [1] looked at competency based training assessment in both public and private manufacturing organizations and showed how analysing competency gaps can help identify training needs. The effectiveness of training goes beyond just finishing a training program. A key issue in training literature is whether the learning is applied in the workplace afterward. Blume and colleagues (2010) [2] conducted an analysis of 89 studies and found that trainee characteristics, training interventions, and factors in the work environment are linked to the transfer of training. Evaluating training systems should take into account not just whether training takes place but also whether the training methods and activities are properly aligned with the needs of both the organization and the employees.

Training outcomes also matter for organizations. Garavan and others (2021) [3], through an analysis of 119 primary studies, found a positive link between training and organizational performance, noting that this relationship stronger over time. At the same time, Garavan and others (2021) [3] pointed out weaknesses in the methods used in studies on training and organizational performance and stressed the need for better measurement and methodological rigor.

Another factor to consider is the return on investment from organizational training. Training ROI is important because organizations invest financial, managerial, and employee time resources into training. However, measuring financial returns from training is complex. Subramanian, Sinha, and Gupta (2012) [4] looked at the feasibility of measuring training ROI in an Indian context and emphasized the need to systematically identify training costs and outcomes.

These points highlight the necessity for systematic measurement when examining organizational training systems. Before a new research tool is used on a larger sample, preliminary testing can help determine if its items show adequate internal consistency and if the tool is appropriate for further data-collection. Pilot testing is thus a critical methodological step in survey-based research. Recent methodological studies also stress that pilot studies can assess the reliability of questionnaires while distinguishing this preliminary assessment from full scale validation of the instrument.

The current study is part of a larger investigation into training systems in manufacturing industries. Questionnaires were created for various organizational stakeholders like Human Resource Heads and Learning and development Managers. The Human Resource head questionnaire includes 20 items divided into five construct that cover competency mapping and training activities, improved training techniques, training systems and competency mapping, training systems and return on investment, and organizational training systems and development procedures. The Learning and development Manager questionnaire has 30 items spread across similar broad areas, with more detailed item coverage.

The purpose of this paper is specifically focused on the pilot testing and initial reliability assessment of these instruments. The study does not explore the broader relationships of the main research and does not present the proposed framework or model. Instead, it looks at whether the developed instruments show satisfactory preliminary internal consistency before they are used in the main study.

2. Review of Literature

2.1 Training System Context

Training is essential processes within organizations for the developing employee capabilities and improve performance of the organization. In manufacturing organizations, the need for systematic training is especially relevant because employees work under changing technical, operational, and competency requirements. Evaluating training systems should take into account not just whether training takes place but also whether the training methods and activities are appropriately matched with the needs of both the organization and the employees. Aguinis and Kraiger (2009) [5] highlight the importance of training for individuals, teams, organizations, and society, while Salas and colleagues (2012) [6] emphasize that effective organizational training relies on appropriate needs assessment, instructional design, delivery, and evaluation. These perspectives support the idea of viewing training as a system of interconnected activities instead of an isolated learning event. This broader view provides the context for the dimensions included in the current research instruments.

2.2 Organizational Competency Mapping

Competency mapping provides a methodical approach to recognize the competencies that are essential for effective performance and to assess these against the current abilities of employees. This process can help in identifying competency gaps and determining appropriate training needs. Research in the Indian context supports this relationship. Vaishali and Kumar (2004) [7] developed a training needs assessment system based on competency mapping and showed how competency assessment can identify training needs. Similarly, Sarkar, S. (2013) [1] in 2013 looked at competency based assessment in Indian public and private manufacturing organizations and pointed out the use of competency gap analysis for identifying training needs. Priyadarshini and Dave (2013) [8] also showed how competency mapping can be applied for training needs assessment in an auto component company, stressing its role in integrating competencies with Human Resource processes. These studies establish competency mapping as a significant part of a systematic training process. Therefore, the current instruments include items related to competency mapping that address competency requirements, skill gaps, training needs, and associated organizational practices.

2.3 Training Activities

After identifying competency requirements and training needs, organizations require suitable processes for implementing training. Training activities may include assessment before training, structured delivery of training, and activities after training to check if learning has been retained and applied. Research on training transfer shows that training outcomes depend on more than just participation in a program. Burke and Hutchins (2007) [9] identify learner characteristics, training design and delivery, and factors in the work environment as significant influences on transfer. Blume and colleagues (2010) [2], through an analysis of 89 studies, found that training interventions, trainee characteristics, and the work environment all contribute to the transfer of learning. These findings show that training should be seen as a process that goes from preparation to delivery and then into later application. Therefore, the current tools have items that connect competency mapping to training activities and look at practices linked to different stages of the training process.

2.4 Training Techniques

The effectiveness of training also relies on the appropriateness of the methods used to facilitate learning. Organizational training may involve various instructional approaches, practical activities, technology-supported methods, and methods tailored to specific learning needs. Arthur et al. (2003) [10], in a meta-analysis of organizational training studies found that training can have meaningful effects across learning, behavioural, and organizational criteria. Salas and colleagues (2012) [6] also stress the significance of evidence-based approaches to training design and delivery. These studies show that training techniques need to be thought about in connection with training goals and the requirements of both the learners and the organization. As a result, the current tools have a part that focuses on better training techniques, which enables the study to gather information about organizational practices that are linked to how training is designed and delivered instead of only looking at how many individuals take part in training.

2.5 Training Systems and Return on Investment (ROI)

Training ROI is another factor to consider because it aims to link the investment in training with measurable benefits for the organization. Subramanian, Sinha, and Gupta (2012) [4] looked into how to measure training ROI in a government enterprise in India and pointed out the need to systematically identify the costs and outcomes of training. Training and organizational performance have also been examined on a larger scale; Garavan and others (2021) [3], conducted an analysis that found a positive connection between training and employee performance. Thus, the current tools include items related to training systems and ROI that address organizational methods for training evaluation, ROI assessment, considerations of cost benefits, and performance outcomes. The goal at the pilot stage is to determine the reliability of these measurement dimensions instead of testing their substantive relationships.

2.6 Need for Reliable Measurement

To Study multiple dimensions of a training system requires instruments that are appropriately structured. When instruments contain several items meant to represent specific dimensions, it is important to conduct a preliminary assessment of their internal reliability before collecting data on a larger scale. Cronbach's alpha is commonly used to assess the internal consistency of multi item scales. Cronbach (1951) [11] established the statistical basis for coefficient alpha, while Tavakol and Dennick (2011) [12] explain that alpha reflects the degree to which items within a scale show consistency and should be interpreted in relation to the characteristics of the instrument and the sample. For the current study, this distinction is significant because the instruments contain multiple dimensions and are planned for different groups of respondents. Therefore, reliability needs to be examined separately for each instrument and, where applicable, for its individual sections.

2.7 Pilot Testing of the Instruments

Pilot testing offers a chance to evaluate a research instrument with members of the intended population before moving on-to the main study. It can help identify unclear or problematic items and provide preliminary evidence regarding the functioning and reliability of the instrument. Boateng and colleagues (2018) [13] identify pretesting, survey administration, item assessment, and reliability evaluation as important stages in systematic scale development. Methodological guidance on developing questionnaires also recommends pilot testing before administering to a larger sample and identifies Cronbach's alpha as one of the measures that can be studied during this phase. In the current study instruments were created

for different organizational respondent groups Human resource heads and Learning and development Manager/Staff. Therefore, pilot testing was conducted to assess their preliminary internal consistency and to determine if modifications were necessary before their use in the main study. The results from the pilot are interpreted as preliminary reliability evidence rather than as definitive validation of the instruments.

2.8 Literature Synthesis

The literature shows a logical progression from systematic training requirements to competency mapping, training activities, training techniques, and evaluation of training outcomes. Competency mapping serves as a basis for identifying training needs; training activities turn these needs into learning interventions; training techniques affect how learning is delivered; and training evaluation and ROI provide ways to examine outcomes. Together, these dimensions create the conceptual context for the instruments developed for the current study. Since these dimensions are measured through structured multi item questionnaires, a preliminary assessment of the instruments is necessary before their use in the main study. The current pilot study thus focuses on the internal consistency and preliminary suitability of the two instruments, providing an empirical link between instrument development and the following largescale investigation.

3. Research Gap

Research that has been conducted up to this point has examined competency mapping and training needs along with training transfer and training techniques as well as organizational performance and training return on investment from different perspectives. However, the application of newly created tools to measure different aspects of training systems from various organizational stakeholders needs initial empirical evaluation before they can be used on a bigger scale. This current study focuses on this methodological need by detailing the pilot testing of distinct instruments that were created for Human Resources Heads and Learning and development Managers in manufacturing companies. Thus, this study is framed as an initial reliability assessment of the instruments instead of an examination of wider research connections.

4. Objectives of the Pilot Study

The pilot study was undertaken with the following objectives:

- To assess the preliminary internal consistency of the research instruments developed for studying training systems in manufacturing industries.
- To study the reliability of the individual dimensions incorporated in the Human Resource Head and Learning and Development Manager instruments.
- To measure the suitability of the developed instruments for data-collection from Human Resource Heads and Learning and Development Managers in manufacturing organizations.
- To determine whether revision of the instruments is required based on the pilot test results.

5. Research Methodology

5.1 Research Design

The study used a quantitative pilot study design. The pilot was a first step in a larger empirical investigation that looked into training systems within manufacturing industries. The main goal of the pilot was to assess

the initial internal consistency of the instruments that were developed prior to their application in the main study.

5.2 Pilot Sample

The pilot study comprised 20 respondents divided equally between the two intended respondent categories.

Table 1: Pilot Sample

Respondent Profile	Number
Human resource Head	10
Learning And Development Manager and Staff	10
Total	20

The output from the Human Resource Head reliability check shows that there are 10 valid cases and there are no excluded cases for the instrument that has 20 items.

5.3 Research Instruments

Two distinct structured questionnaires were created since Human Resource Heads and Learning and Development Managers have different roles within the organization and they might offer different viewpoints regarding training systems.

5.3.1 Human Resource Head Instrument

The Human Resource Head questionnaire included 20 items that were divided into five sections.

Table 2: Human Resource Head Instrument

Section	Description	Items
1	Competency Mapping and Training Activities	5
2	Improving Techniques for Training Impact	3
3	Training Systems and Competency Mapping	3
4	Training Systems and ROI	4
5	Organizational Training Systems and Development Procedures	5
Total		20

The reliability procedure in the supplied Statistical Package for the Social Sciences (SPSS) output used Q1–Q20 for the overall instrument.

5.3.2 Learning and Development Manager Instrument

The Learning and Development Manager questionnaire contained 30 items, distributed across five sections addressing:

Table 3: Learning And Development Manager and Staff Instrument

Section	Description	Items
1	Competency Mapping and Training Activities	10
2	Improving Techniques for Training Impact	5
3	Training Systems and Competency Mapping	5
4	Training Systems and Return on Investment (ROI)	5
5	Organizational Training Systems and Development Procedures	5
Total		30

The larger quantity of items in this instrument shows the wider item level coverage that was created for the Learning and Development respondent group.

5.4 Measurement Scale

Both questionnaires used a five point Likert type agreement scale which included the following options:

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

The consistent response structure allowed for quantitative analysis of the pilot responses.

5.5 Data Analysis

Cronbach's alpha served as the main indicator for preliminary internal consistency. The analysis was done separately for the two respondent groups since the instruments have different numbers of items and different content. Both the overall reliability of the instrument and the reliability at the section level were looked at.

Cronbach's alpha was seen as a sign of internal consistency instead of being seen as proof of complete construct validity. This distinction holds significance because reliability and validity are related but distinct measurement properties.

6. Results

6.1 Reliability of the Human Resource Head Instrument

The Human Resource Head instrument had a total of 20 items and was given to 10 respondents. All 10 cases were measured valid for the overall reliability analysis and no cases were left out.

The overall Cronbach's alpha was calculated to be 0.903 for the 20 item instrument.

Table 4: Reliability of the Human Resource Head Instrument

#	Dimension	Items	Cronbach's Alpha
1	Competency Mapping and Training Activities	5	0.966
2	Improving Techniques for Training Impact	3	0.932
3	Training Systems and Competency Mapping	3	0.936
4	Training Systems and ROI	4	0.817
5	Organizational Training Systems and Development Procedures	5	0.96
	Overall Instrument	20	0.903

The coefficients at the section level were between 0.817 and 0.966. The section with the lowest coefficient was the Training Systems and ROI section which had a coefficient of 0.817. The section with the highest coefficient was Competency Mapping and Training Activities which had a coefficient of 0.966. The reliability output showed a coefficient of 0.966 for the first section that had five items, a coefficient of 0.932 for questions six to eight, a coefficient of 0.936 for the four item section that included questions twelve to fifteen, a coefficient of 0.817 for questions sixteen to twenty, and a coefficient of 0.960 for the last section that had five items. The findings suggest that there is strong preliminary internal consistency across the Human Resource Head instrument.

6.2 Reliability of the Learning and Development Manager Instrument

The Learning and Development Manager instrument included thirty items and was given to ten respondents. The overall Cronbach's alpha from the pilot data was 0.933.

Table 5: Reliability of the Learning And Development Manager Instrument

#	Dimension	Items	Cronbach's Alpha
1	Competency Mapping and Training Activities	10	0.776
2	Improving Techniques for Training Impact	5	0.884
3	Training Systems and Competency Mapping	5	0.875
4	Training Systems and ROI	5	0.73
5	Organizational Training Systems and Development Procedures	5	0.888

	Overall Instrument	30	0.933
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The coefficients at the section level were between 0.730 and 0.884. The section titled Training Systems and ROI had the lowest coefficient which was 0.730, and the section called Improving Techniques for Training Impact had the highest coefficient which was 0.884.

The overall coefficient was 0.933 which shows that there is strong preliminary internal consistency for the entire instrument that consists of 30 items.

6.3 Comparative Reliability

Table 6: Overall Reliability of the Pilot Instruments

Instrument	Respondents	Items	Overall Cronbach's Alpha
Human Resource Head	10	20	0.903
Learning and Development Manager	10	30	0.933

Both instruments showed Cronbach's alpha coefficients that were above 0.90.

The results show some early proof that the items in each of the instruments have internal consistency in the pilot sample.

7. Instrument Retention Decision

The pilot study aimed to determine if the instruments that were developed showed enough preliminary consistency and if any modifications related to reliability were necessary before the main study. The Human Resource Head instrument had an overall alpha of 0.903, with section level coefficients that varied from 0.817 to 0.966. The Learning and Development Manager instrument had an overall alpha of 0.933, with section level coefficients ranging from 0.730 to 0.884. Based on these results, no items were deleted, added, or modified after the pilot reliability assessment. Both instruments were kept in their current form for the main study. The choice to keep the instruments was not made only based on the size of Cronbach's alpha. Internal consistency was evaluated along with the intended coverage of the instrument and the purpose of the pilot. This method aligns with guidance that warns against viewing alpha as a complete measure of instrument quality.

8. Discussion

The study was conducted to pilot test on research instruments that were created to examine training system dimensions in manufacturing organizations. The findings give preliminary evidence of satisfactory internal consistency for both instruments. The Human Resource Head questionnaire had an overall Cronbach's alpha of 0.903. Its five sections also showed relatively high coefficients, which ranged from 0.817 to 0.966. These results suggesting that the items within the sections produced consistent response patterns among the pilot respondents. The Learning and Development Manager questionnaire had an overall Cronbach's alpha of 0.933. Its section level coefficients ranged from 0.730 to 0.884. The lower coefficient for Training Systems and ROI was still acceptable as preliminary evidence of internal

consistency, while the other sections had stronger coefficients. The results are significant because the instruments were designed for different organizational respondent groups. Instead of assuming that one questionnaire would capture the views of all stakeholders, the study utilized separate instruments for Human Resource Heads and Learning and Development Managers. This allows the main study to gather data that is appropriate to the organizational responsibilities and perspectives of each respondent category. The findings also support the reasoning for conducting the pilot before largescale data-collection. Pilot testing enables researchers to evaluate whether an instrument performs adequately before investing resources in the main study. Recent methodological literature acknowledges questionnaire reliability assessment as one of the purposes of pilot studies. However, the findings should be interpreted with caution. Both instrument was tested with only 10 respondents. Therefore, the reliability coefficients should not be seen as definitive proof that the instruments have been fully validated. A larger sample is necessary for a more thorough psychometric assessment, especially regarding construct structure and generalizability. This inadequacy does not negate the immediate purpose of the pilot. The goal was to gather preliminary evidence about internal consistency and to assess if reliability related issues required immediate changes. The pilot findings did not show such a need, and thus the instruments were kept for the main study. The study also adds to methodological rigor in the broader research by documenting the instrument testing phase instead of moving directly from questionnaire development to largescale data-collection. This is particularly important in training research because Garavan and others (2021) [3] pointed out methodological weaknesses in a significant amount of research that looks at training and organizational performance. Therefore, the pilot should be viewed as a preparatory empirical step. Its findings support moving forward to the main study while acknowledging that later analyses with a larger sample will provide robust evidence regarding the measurement properties and applicability of the instruments.

9. Implications

9.1 Methodological Implication

The study shows the importance of conducting preliminary reliability assessments before administering newly developed instruments to a larger sample. The findings provide an empirical basis for keeping the instruments for future data-collection.

9.2 Research Implication

Having separate instruments for Human Resource Heads and Learning and Development Managers allows the broader research to capture training system practices from two relevant organizational viewpoints.

9.3 Practical Implication

The dimensions included in the instruments offer structured areas for examining organizational training practices, which include competency mapping, training activities, training techniques, training systems, training ROI, and development procedures.

10. Limitations

The primary limitation is the small pilot sample. Only 10 respondents participated in each respondent group. Therefore, the findings should be viewed as preliminary and cannot be generalized to the larger population of Human Resource Heads, Learning and Development Managers, or manufacturing

organizations. Second, while Cronbach's alpha measures internal consistency, it does not establish complete construct validity. Further investigation with the larger main study sample would be necessary where applicable. Third, the pilot study was not planned to test the broader relationships examined in the overall research. Thus, the findings should not be seen as evidence supporting or rejecting the substantive relationships that will be analysed in the main study. Finally, the study focuses on preliminary instrument reliability and does not challenge to establish population level psychometric properties. This limitation aligns with the purpose and scope of a pilot study.

11. Conclusion

The study reported on the pilot testing and preliminary reliability assessment of research instruments that were developed for studying training systems in manufacturing industries. The study involved 20 respondents, which included 10 Human Resource Heads and 10 Learning and Development Managers, with separate questionnaires given to the two respondent groups. The 20 item Human Resource Head instrument showed an overall Cronbach's alpha of 0.903, while the 30 item Learning and Development Manager instrument showed an overall Cronbach's alpha of 0.933. The section level coefficients also indicated satisfactory preliminary internal consistency with values ranging from 0.817 to 0.966 for the Human Resource Head instrument and from 0.730 to 0.884 for the Learning and Development Manager instrument. On the pilot results, no items were removed or modified, and both instruments were kept in their current form for the main study. The findings thus provide initial evidence that the developed instruments have acceptable internal consistency within the pilot sample. The study does not claim complete psychometric validation or generalizability. Instead, it establishes an initial empirical basis for proceeding with the larger investigation. The larger main study sample can later provide stronger evidence regarding the measurement properties and empirical applicability of the instruments. Overall, the pilot study shows that the developed questionnaires are sufficiently consistent at the preliminary stage to be carried forward to the main research while maintaining appropriate methodological caution regarding the small pilot sample.

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