Competency Framework Development for Effective Human Resource Management

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Abstract
Competence becomes competitive advantage for a business at all times. Making human resource more effective, competence-based hiring, development, and performance evaluation are popular phenomena discussed in the literature though not very common in practice. Despite their importance, the reason these are not commonly implemented may be the complexity of the subject and the absence of a generalized framework, which can be adopted with little or no modifications. There have been efforts made for competency framework development, but these are occupation-specific and usually limited in implementation. A need for an easily replicated general framework exists, which has followed a structured and scientific methodology utilizing professional expertise during development, which is simple to understand and is applicable to as many jobs as required. This article examines in detail the development approach of a generic competency framework using scientific tools and producing weighted ratings of competencies. The purpose is to establish confidence in potential users for a methodology that is applicable to the development of a similar framework for a diverse array of jobs.

Keywords
competency framework, effective human resource, panel of experts, scientific methodology

Introduction
To realize a product or deliver a service, an organization requires resources such as material, equipment, space, information, and human resource. The success of one organization over another is entirely dependent on the grade and quality of these resources. Typically, the first four can easily be replicated, leaving the human resource factor to finally determine the outcome and success of one organization over another. Capital and technology are increasingly becoming available to everyone everywhere. Organizations are finding that their true competitive advantage resides in the effectiveness of management of human resource (Ashkezari & Aeen, 2012).

The performance of human resource depends on many aspects, including knowledge, experience, technical and soft skills, motives, emotions, and behaviors. One word often used to define all these characteristics is competence.

Thus, the competency should be viewed as the combination of all these aspects in predicting potential efficacy in accomplishing a job (McClelland, 1973). Competencies refer to a description of requirements for work performance at the necessary level of proficiency.

Once the competencies are identified, these could be used throughout the professional lifespan. This may include, but not be limited to, job detailing, setting employment criteria, recruitment, performance evaluation, training needs identification, career, and succession planning. Therefore, it was needed to obtain comprehensive input from experts from various professions such as operations, industrial engineering, human resource, and industrial psychology to assist in framework development. Competency framework development utilizing such a degree of scientific and professional expertise can provide ease of use with confidence in its application for human resource managers. The virtue of such a framework would be its generic application to varied industries with either no or slight modifications. Some adjustments be required to meet specific industrial or organizational needs, and the underlying methodology provides guidance in the modification of the process. One may argue that competency frameworks must be specific to the organizations

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considering their culture, and present and future needs. However, it must also be considered that medium and small-sized organization may not put many resources to develop a competency framework of their own. The need of generic competency framework in such situation is compelling, and that is why generic frameworks are available. An organization may still require modifying to its need, but that would not necessitate a high magnitude of efforts. Therefore, the need is convincing and invaluable to the organizations in need of addressing the competency part of human resource. This study covers the project of developing a generic competency framework for the job of mechanical fitter.

The first step is to review the existing standards as if the job has been previously described and what is considered core functions and responsibilities of the job. To determine this, reference is made to ISCO-08 Part II for the purpose. To determine this, reference is made to ISCO-08 Part II for the purpose. The International Standard Classification of Occupations, is an International Labor Organization (ILO) classification data bank for organizing information on labor and jobs. For defining the core functions, one can refer to the “Guide to the World of Occupations” (GWO), a European Community-supported project. In addition, database O*Net Online managed by the “US Department of Labor” and “Employment and Training Administration” (ETA) is a good referral for the same. One could also find “Bureau of Statistics,” U.S Department of Labor and “Department of Training and Workforce Development,” Government of Western Australia, valuable sources of such information. Referring to these organizations, core functions and the detailed job responsibilities were documented.

Next, relevant competencies were identified by referring to the nine-tier competency model developed by the ETA 2008, U.S. Department of Labor. Each competency was to be evaluated at five levels as defined in Hubert Dreyfus’ Five-Stage Model of Adult Skills Acquisition. This preparatory work was submitted for review by a panel of experts. The panel of experts was formed to define the job purpose, key roles, responsibilities, related competencies, and their levels. The panel, through correspondence and meetings discussed, questioned, debated, and considered others’ opinion to modify their own opinion in bringing a consensus regarding competencies related to a particular job. Later, the same panel assigned weightages to the different competencies and determined the required level of competency to perform the job as per job description. The review by the panel followed a structured hybrid technique for convergence of opinion. The hybrid technique combines Delphi and Nominal Group Techniques (NGT). Both techniques have their own merits and limitations. To make use of the qualities in both techniques, one can utilize a hybrid technique that includes providing for the opinion of corresponding members to be considered in a panel meeting. Similarly, the remote participants are informed of the discussions and reformation of opinion that takes place in the meeting. Usually, two to three rounds of discussion took place before the final opinion could be considered as a consensus of the panel.

Literature Review

There is an extensive volume of literature available on competency and competency frameworks, be it books, articles, conference, or research papers. However, every contributor has experienced doing it for the specific requirements of an industry or an organization. Generic frameworks are either too broadly chalked down or are still too specific. The approaches taken in development of a framework are also varied catering to the specific need in focus. The concept of competence and having a framework for various applications during the employment lifespan has been discussed in the literature over the previous few decades. McClelland (1973) took a lead in establishing the importance of competence preferring it to the intelligence. The author dismissed testing for IQ both in schools and for recruitment and suggested that superior job performance had little to do with intelligence and was more related to cognitive elements such as writing or calculating skills and personality traits such as behaviors, motives, values, and interpersonal skills.

However, even before (McClelland, 1973), concepts related to competence were expressed in terms of knowledge, skills, and craftsmanship. Wilcox (2012) traced it back to 3,000 years when the Chinese civil service opted to administer skill/knowledge testing for hiring purposes instead of relying on supervisors’ references. Wallis (2008) studied the economics of apprenticeship in premodern medieval England and suggested that skill development through apprenticeship was one of the means to impart occupational training during that era in Europe. In other eras of world history from the Stone Age to the medieval and modern periods, one should conduct research to find out how competencies were assessed in terms of knowledge, skills, and artisanship (Prak, 2013). He noted that from the late medieval to modern times, European crafts underwent a series of changes that brought formalization of craft education in the form of apprenticeship and standardization by guilds that provided certification of skills (Applebaum, 1992). He made same observations in detail about the same middle age period. He highlighted the presence of guilds and apprenticeship systems for the learning of skills and crafts.

A great deal of knowledge about skill management is available for different phases of the industrial revolutions starting around 1760. According to Agolla (2018), from mechanical production powered by steam to electricity-driven systems and then to electronic and IT automation and finally artificial intelligence, it had been human capital and its competence that had brought solutions to human problems through innovations. The first phase of industrial revolution with primarily British dominance lasted to the 1840s. The revolution was a shift from manual production means to
machines and tools. This revolution eventually changed the
customary life and has been analyzed profoundly by many
economists and historians. The economic historian McCloskey (2017) disagreed with the claims of Adam Smith
and Karl Marx that the “great enrichment” since 1800 had
come from accumulated capital, arguing that it was “ideas”
and not capital or institutions which mainly brought the
industrial revolution in Europe. The author described
modern economies with terms such as “spirit–energy” and
“logical reasoning.”

Another distinguished historian (Mokyr, 2009) also
agreed to the same argument and saw economic growth
because of “ideas” instead of material conditions or political
and economic institutions, whereas Howes (Khanna et al.,
2018) supported slightly different findings. Howes (2016)
studied the relation of education and skills of 677 people
who had made various inventions during the first industrial
revolution in Britain between 1651 and 1851. Findings sug-
gested that skills and education surely influenced what peo-
ple would like to improve, although adherence to what is
already known did not always bring about a change. The
common skill that was noticed among all inventors was that
their contact with other inventors allowed the creation of
similar competencies unconsciously.

The second industrial revolution marked between 1870
and 1914, according to Mokyr (1992), is considered the con-
tinuation of the first in terms of knowledge, but it shifted the
base of the revolution from Britain to the entire Western
world. Another difference was reversing the sequence of
knowledge of nature and knowledge of techniques. Before,
it had been the observation of natural phenomena, which led
to pragmatic applications, but then it became the technology
that gave an impetus to seeking knowledge through research.

The third industrial revolution started somewhere around
the 1950s and is now heading into the fourth revolution of
robotics, artificial intelligence, nanotechnology, quantum
computing, biotechnology, three-dimensional printing, and
autonomous vehicles. According to Roberts (2015), both
these eras of present and future need investment in an infra-
structure of knowledge, new skills, and competencies, failing
which communities will fall into a loop of deficiency.

One can clearly find that the competency of the human
resource has been in play since the early ages through
industrialized times. The word “competency,” however,
may not have been used, but instead words which form part of competency. These may be human capital, skills,
artisanship, knowledge, education, ideas, reasoning,
energy, and spirit. To utilize the concept of competencies,
one may need some clear and pragmatic framework, which
must list down competencies with their rankings and level of
expertise for certain job(s). In the present days, a variety
of formats can be found representing a competency frame-
work that is usually specific to an industry. Fai and Von
Tunzelmann (2001) analyzed in detail whether industry or
firm-specific competencies were necessary to define or
whether such competencies could be seen as converging to
similar technical ones. Citing many examples, the study
concluded that the technological profiles of companies
became comparable over time and industry-specific com-
petencies were blurred.

Further review of the literature shows a variety of frame-
works developed by various teams of individuals or organi-
izations claiming to be generic. The interest is to examine
whether any or several of these can be utilized as a generic
framework to be adopted by any organization with or with-
out slight changes. It is also important to determine whether
these illustrate a methodology that can be adopted and rep-
clicated for the purpose of developing a competency frame-
work for a new job. This study evaluated whether these
frameworks have scientific basis, thereby having less sub-
jectivity. It was also investigated whether enough care was
given in defining levels of competencies in the framework.
Fourteen different frameworks were assessed on the above
given seven parameters. One of them, Portsmouth Hospital’s
Generic Competency Framework (Knight, 2004), was
specific to nursing profession where competencies were
identified by the management staff of the hospital. It was
observed that the study neither employed any scientific tool
nor a formal methodology was followed in development.
Competencies were listed against various staff groups, but
no levels were defined and all carried equal weight; thus,
no weighted rating was available.

Center for Tropical Medicine and Global Health presented
“globally applicable evidence-informed competency frame-
work” for clinical researchers by systematic analysis of 28
past frameworks as their methodology of development (Julé
et al., 2017). Fifty competencies were divided into five main
categories; however, there was no indication whether any
scientific tool was applied. There was no clue in narration
whether competencies had any skill levels and whether these
carry different weightages. Ahmadi et al. (2017) developed
a competency framework for nursing. The research was inter-
view-based where five nursing experts and 10 nursing staff
were selected for their input on required competencies in
nursing. Purposive sampling, qualitative content analysis,
and Delphi method at various stages of development were
applied. No levels or weightages were assigned.

Male et al. (2011) undertook a large project to identify
generic engineering competencies for graduating engineers
in Australia. For an understanding of competencies, the study
referred to the framework developed as a project “Definition
and Selection of Competencies” (DeSeCo) by the Organi-
sation for Economic Co-operation and Development. In the
framework, 64 competencies were identified through litera-
ture review and validated by surveys of professional engi-
neers. Multivariate analyses of variance (MANOVAs) were
used to find the relationship between competencies and their
relative importance of the engineering jobs. A focus group
comprising industry associates was held to fine-tune the
generic competencies thus identified.
Nguyen (2016) categorized necessary competencies for external quality professionals, leading to a review of competency frameworks available for these professionals. The results of that research served as elementary framework for the emerging profession and did not use any scientific tool nor it broke up the competencies into levels. No weightages or weighted rating was available. Shah et al. (2016) conducted a study to identify and understand which particular technical, managerial, and personal competencies were important in infrastructure management. The source of identification was initially the review of literature and web-based resources. Thereafter, questionnaire survey was carried out and hypothesis was tested to affirm that competencies could be determined for infrastructure management function. The competencies were presented under technical, managerial, and personal dimensions. There was, however, no division to levels or assignment of weightage or calculation of weighted rating.

The doctoral school of Hasselt University (2014), Belgium, developed competency overview and profile for PhD holders. Over 50 competencies under five clusters were identified, not expecting an individual to master all but to get inspired to identify one’s strengths and potential for growth. Further development was on the way to refine the profile of PhDs as per academia and business needs. The work done so far and plan of future did not include last five parameters of evaluation. Canadian Council of Human Resources Associations developed a Competency Framework for Human Resources Professionals (Human Resources Professionals Association, 2014). Under nine functional areas, group-wise competencies were identified with numbering system. Behavioral indicators were also mentioned against every competency, and these were divided into three levels: Certified Human Resource Professional, Certified Human Resource Leader, and Certified Human Resource Executive. No weight was assigned or weight calculated.

Society for Human Resource Management (SHRM, 2012) developed competency model in three phases. The model development was initialized through literature review. The model contained nine primary competencies with four levels. Contents of the model were validated through a survey with around 32,000 participants from 33 different nations. Criterion validity was done by collecting employee ratings from multiple sources. Competencies carried equal weightages, and thus no weighted rating was made.

Saville & Holdsworth Limited (SHL, 2012) developed generic competency model by 299 of its consultants working in 24 different countries. Framework was defined in a three-tier structure. The first tier consisted of 112 specific competencies. In the second tier, these competencies were mapped onto 20 broader competencies and linked to eight general competencies in the third tier. Research was also done to create the links between this framework construct and the job details in the O*NET database. Competencies were not defined in levels or assigned weightages. Campion et al. (2011) had presented best practices in generic competency modeling with review of work of two major companies, a major consulting firm, a major university in the United States, and the Society for Industrial and Organizational Psychology taskforce on competency modeling. The models took into account the five levels of competencies. However, no weightages or weighted rating was made.

The Greater London Authority (2010) had developed a competency framework specific to their employees indicating the behaviors that were necessary for the effective performance within the Authority. The framework detailed competencies into four levels. It is, however, not known whether any methodology was followed in developing the framework or any scientific tool was used. There is no mention of the weight given to competencies and a weighted rating calculation. Jolee and Chapman (2010) had reviewed generic competency frameworks in Australia, New Zealand, Canada, the United States, the United Kingdom, and other European countries. The work was based on the review of literature, and a set of 58 competencies was finally presented under six different clusters with frequency of appearance in the literature. Five of our parameters were not included in their study. Rao and Palo (2009) analyzed the research findings related to different competency studies and to the methodology used in identifying generic competencies. Based on these findings, a framework was also suggested, but that did not include levels or weightages of competencies.

Table 1 gives comparison of the “developed competency framework” with the aforementioned 14 frameworks on seven parameters. This comparative analysis indicates how the proposed framework encompasses the essential parameters more comprehensively. These parameters are identified in the literature as frameworks usually include some of these. It is apparent from these observed competency frameworks that there exists a gap in including all these parameters particular with respect to generality, sources these are derived from, methods adopted in development, dividing competencies into logical levels, giving weightages to competencies, and driving a number by multiplying level with weightages. None of the frameworks has an affirmative mark against all seven parameters, and this is not limited to the selected frameworks only; the literature generally gives the same picture. The frameworks mentioned here are representing a varied sample from prominent organizations around the world. That is where the proposed framework in this study stands out filling out the gap identified above.

Framework Development

The development of the competency framework undertook the steps of job identification, defining core functions, detailing tasks, listing required managerial and technological competencies at five levels, and giving weightages in the light of job details. All of the information gained was sorted and presented for review to the expert panel from psychology,
| Framework                                                                 | Generic/ specific | Competency derivation | Methodology explained | Scientific tool used | Levels of competencies considered | Weightages given to competencies | Weighted rating calculated |
|--------------------------------------------------------------------------|-------------------|-----------------------|-----------------------|----------------------|----------------------------------|---------------------------------|---------------------------|
| Developing Competency Framework for Effective Human Resource Management   | Generic           | ETA 9 Tier Model, Expert Panel | Yes                   | Yes                  | Yes                              | Yes                             | Yes                       |
| Generic Competency Framework for Nurses and Midwives (Knight, 2004)       | Specific          | Identified by Portsmouth Hospital Ireland | No                    | No                   | No                               | No                             | No                        |
| Developing a globally applicable evidence-informed competency framework . . . in Clinical Research (Julé et al., 2017) | Specific          | Study of 28 past frameworks | Yes, in brief         | No                   | No                               | No                             | No                        |
| Development of a Competency Framework: Thematic Content Analysis (Ahmadi et al., 2017) | Specific          | Purposive Sampling, and Qualitative Content Analysis | Yes                   | Yes                  | Yes                              | No                             | No                        |
| Understanding Generic Engineering Competencies (Male et al., 2011)        | Specific          | DeSeCo Framework, Literature Review, Survey, Panel Session and Focus Group | Yes, in brief         | Yes                  | No                               | Yes                            | No                        |
| An Exploration of the Competency Framework for External Quality Assurance Practitioners (Nguyen, 2016) | Specific          | Literature Review      | No                    | No                   | No                               | No                             | No                        |
| Identifying Generic Competencies for Infrastructure Managers A Study of Infrastructure Firms in India (Shah et al., 2016) | Specific          | Literature Review Survey | Yes, in brief         | Yes                  | No                               | No                             | No                        |
| Competency Framework for PhD Holders (Hasselt University, 2014)           | Specific          | Identified by Hasselt University | No                    | No                   | No                               | No                             | No                        |
| Human Resource Professional Competency Framework (Human Resources Professionals Association, 2014) | Specific          | HR Professional Association | No                    | No                   | Yes                              | No                             | No                        |
| SHRM Competency Model (SHRM, 2012)                                         | Specific          | Literature Review, Interview | Yes                   | Yes                  | No                               | No                             | No                        |
| SHL Universal Competency Framework (SHL, 2012)                             | Generic           | Identified by Saville & Holdsworth Ltd. | No                    | Yes                  | No                               | No                             | No                        |
| Doing Competencies Well; Best Practices in Competency Modeling (Campion et al, 2011) | Generic           | Review of Past Work | Yes, in brief         | Yes                  | No                               | No                             | No                        |
| The Greater London Authority Competency Framework (Greater London Authority, 2010) | Specific          | No                     | No                    | No                   | Yes                              | No                             | No                        |
| Generic Competency Frameworks: A Brief Historical Overview (Jolee and Chapman, 2010) | Generic           | Literature Review      | No                    | No                   | No                               | No                             | No                        |
| Identification of Managerial Competencies for Establishing a Conceptual Framework for HRD Practitioners (Rao and Palo, 2010) | Generic           | Literature Review      | Yes                   | No                   | No                               | No                             | No                        |

Note. HRD = human resource development; ETA = Employment and Training Administration.
human resource, industrial engineering, and manufacturing operations. The panel was selected based on their esteemed experience in their area and their interest in the work. Many participants physically attended review sessions, whereas others were connected through correspondence. The review followed a structured technique of opinion convergence.

In the first round, respondents just put forward their agreement or comment(s), if any, on the work. Those comments from corresponding participants were read out before participants convened. Reviewing all comments, the panel then opened discussion with the intent to elaborate on what was previously commented. Criticism to others’ opinion was never encouraged; however, questions were allowed for clarity. The corresponding participants received the same opportunity to participate in discussion through their channel of communication. The respondents could modify their earlier view by giving some weightage to others’ remarks (in a range of 0.0–1.00), which shows the likelihood of their opinion being merged with others’ comments. A certainty level for their own opinion was established as well (to what degree they stick to their opinion, or alternately, how flexible they are to change views in rounds to come; again from 1.00 to 0.00). For corresponding participants, there was a period set to receive their modified opinion before reconvening.

Hegselmann and Krause (2002) studied various models for the dynamics of continuous refinement of opinions by analytical methods, later further refined by Friedkin and Johnsen; one of such models was found suitable to adopt. For ease in working with the model, a module in MS Excel was created for input and readily viewing the results. The following assumptions were made: There are n number of respondents, and a particular respondent is i, so 1 ≤ i ≤ n. The respondent i opinion at time t is x_i(t). It is also assumed that the weight given by respondent i to the other respondent j is w_{ij}, such that w_{ij} ≥ 0, ∀i,j. Based on these assumptions, opinion formation of respondent i can be given for the proceeding rounds as

\[ x_i(t+1) = w_{i1}x_1(t) + w_{i2}x_2(t) + \cdots + w_{in}x_n(t). \]

It implies that respondent i adjusts their opinion in period t+1 by taking a weighted average with weight w_{ij} for the opinion of respondent j at time t. At instances, weights could be zero if a respondent i disregards all other opinions; this means w_{ij} = 1 and w_{ik} = 0 for j ≠ i, or if j follows the opinion of i, then w_{ij} = 1 and w_{ik} = 0 for k≠ j. This also means that w_{i1} + w_{i2} + \cdots + w_{in} = 1.

Taking it further, the modification suggested by Friedkin and Johnsen was also taken into account. They proposed that a respondent i sticks to their initial opinion up to some degree g_i and is influenced by other respondents to an extent of (1−g_i); by this argument, the model becomes

\[ x_i(t+1) = g_i x_i(t) + (1 - g_i) \left[ w_{i1}x_1(t) + \cdots + w_{in}x_n(t) \right]. \]

The target during the opinion convergence exercise is to have harmony unless there is some rationale for a different view. Following is one example of the outcome in Excel.

The first question given to the panel of experts was whether “Job description of Mechanical Fitter is complete in defining this profession so that competencies could be derived at later stage.” Four people participated, out of which one was remotely responding. Table 2 shows their opinion expressed in numerical form and Figure 1 is a pictorial representation of how the differences in their opinion are getting closer to zero. As the rounds proceed, the number changes, thus reducing the differences in initial opinion. Initially, the opinions x_1 to x_4 were 0.93, 0.80, 0.90, and 0.85, which means that Panel Member 1 replies in affirmation at a rating of 93% and likewise others do. Participants were also asked to determine a certainty level “g” for their own opinion particular to this round and inform with a number. As they already know the opinion of others by discussing or reading, they were to give weightage “w” to others’ opinion in a number summing up to 1. The values of “g” and “w” are to be asked before every round as these may change due to the discussion in the previous round.

Therefore, in Initial Round 0, the first respondent agreed 93% to the question, and 75% of the time they would stick to their opinion. Nevertheless, they may consider others’ opinion as well, and considering the initial response to the same question, they comparatively give weightage to Respondents 2, 3, and 4 of as 20%, 30%, and 50% respectively. The other panel members in similar fashion respond with their numbers. The opinion x_i in Round 1 is determined by applying the Friedkin and Johnsen model. For example, Respondent Number 1 was 93% in favor of the question initially, but the level fell to 91% based on the certainty level and the logic they find in the opinion of Respondent Numbers 4 and 3, and to some extent Number 2. Panel continues discussion for another round to bring the opinion closer to each other; the numbers are collected again. Discussion continues centered on why or why not each one keeps or changes their opinion. Clarifications are given and questions asked. The discussion is facilitated, and after sufficient discussion and upon seeing the panelists in sufficient consideration of others, the round is declared to end.

To observe how opinions are getting closer to each other with every round of discussion and whether the standard deviation is reducing and getting closer to zero, x_1 to x_4 must be looked at. Looking onto the situation in discussion, no further rounds are necessary when the standard deviation is very low or repeatedly the same for two rounds or even a little higher. This study was stopped at Round Number 3 when the standard deviation is just 0.01. The opinion convergence exercise was undertaken in further steps of development as well. All opinions were concluded in two or three rounds except in one case where the opinion remained polarized and the best judgment was eventually to be made.
| Round | Respondent 1 | Respondent 2 | Respondent 3 | Respondent 4 (Correspondent) |
|-------|-------------|-------------|-------------|-----------------------------|
| 0     | x1          | g1          | w1          | 0.93 0.75 0.50 0.50        |
|       | w11         | w12         | w13         | 0.30 0.50 0.00 0.00        |
|       | x2          | g2          | w21         | 0.50 0.30 0.00 0.00        |
|       | w22         | w23         | w24         | 0.00 0.00 0.00 0.00        |
|       | x3          | g3          | w31         | 0.30 0.00 0.00 0.00        |
|       | w32         | w33         | w34         | 0.00 0.00 0.00 0.00        |
|       | x4          | g4          | w41         | 0.30 0.30 0.00 0.00        |
|       | w42         | w43         | w44         | 0.10 0.10 0.10 0.10        |
|       | SD          |             |             |                             |
| 1     | 0.91        | 0.60        | 0.90        | 0.04 0.02 0.01 0.00        |
| 2     | 0.89        | 0.60        | 0.89        | 0.04 0.02 0.01 0.00        |
| 3     | 0.88        | 0.60        | 0.88        | 0.04 0.02 0.01 0.00        |
| 4     | 0.00        | 0.00        | 0.00        | 0.00 0.00 0.00 0.00        |
Identification of Likely Competencies

A multtier competency model developed by the ETA 2008, within the U.S. Department of Labor, was referred to choose from relevant competencies and define them appropriately per the stated job description. This worked well as a checklist. Based on the ETA work, the competency model can be described as a pyramid consisting of a hierarchical set of three blocks. The blocks begin at the bottom with Foundational competencies over which are Industry-Related competencies with Occupation-Related competencies on the top tier. Then in each block there are subtiers, which consist of a set of competencies representing the skills, abilities, and knowledge essential to be successful in an occupation in the industry the model represents.

The bottom of the pyramid covers competencies, which are generic in nature and common to several occupations and industries. This may comprise Personal Effectiveness competencies, Academic competencies, and Workplace competencies, for instance. Moving up the pyramid, the competencies become industry- and occupation-specific like Industry-Wide Technical Competencies, Industry-Sector Technical Competencies, and Management Competencies.

Selection of this model is for the reason that it is constructed in a bottom-up approach using a combination of research, data collection and analysis, focus groups, and case study interviews. The presented model offers a different, comprehensive, and generic solution that can be in any industry with only minor modifications such as adding a few occupation-related competencies. It is important to note that it was attempted to include competencies which are general in nature while leaving it to the user to modify the framework for any specific occupation-related competencies following the same methodology as used in its original development as described herein. Another point to note is that Figure 2 does not suggest that this is a sequential model in which one needs to have all the lower level competencies to possess/develop the higher level competencies.

The review of identified competencies was made as explained above and by the same panel of experts.

Definition of Five Levels of Each Competency to Drive a Weighted Proficiency Rating (WPR)

According to Dreyfus (2004), individuals must progress through each stage of expertise and must draw on their experiences of solving problems in context to reach higher levels of expertise. Each time individuals acquire a new skill, they start at the novice stage where they need to learn the facts and the rules for determining action. The hypothesis presented by Dreyfus (2004) has been famously applied to various models of skill acquisition. Same definitions as given by Dreyfus are used to prepare five levels of competencies. Table 3 defines various parameters of knowledge, standard of work, autonomy, and decision making as differentiators to determine the various levels. Some elaboration is given below as well.
Table 3. Levels of Competencies Against Knowledge, Standard of Work, Autonomy, and Decision-Making.

| Differentiating parameters | Novice | Advanced beginner | Competent | Proficient | Expert |
|----------------------------|--------|-------------------|-----------|------------|--------|
| Knowledge                  | Is familiar with the skill/theory/principle. Knows the basic concept behind the skill/theory/principle and applies it when given the situation and explicit instructions to apply it | Can determine which skill/theory/ principle to apply to different situations without guidance, but not aware of how to optimize its application or other factors that should be considered | Can identify factors to consider in application outside of the obvious. Can give a few examples of application | Knows how to optimize the solution for a given content. Can give examples of specific applications and the outcomes | Has an all-encompassing understanding of the skill/theory/principle and all issues involved with applying it to different situations. Can give examples of related personal experience and what was learned |
| Standard of work           | Can complete a simple application if given detailed instructions | Can complete straightforward application with minimal instruction | Can complete assignment, but not necessarily optimally | Can optimize solution, but takes some effort | Optimizes the solution without effort |
| Autonomy                   | Can apply skill/theory/ principle with guidance, needs feedback to learn | Can apply skill/ theory/principle to individual assignments but needs supervision to ensure solution fits into overall project | Can apply skill/theory/ principle successfully and knows there are outside issues that need to be considered but consults others for guidance on how to address them | Can optimize the solution and knows the outside factors to consider without asking others | Needs no supervision or support. Others come to them for advice |
| Decision                   | Uses an analytical process to solve the problem using predetermined resources and applies a predetermined skill/theory/principle to the problem | Uses an analytical process to solve the problem and decides which skill/theory/ principle to use to solve the problem | Uses an analytical process to solve the problem. Thinks about outside factors that might affect the outcome and decide how to address them | Uses an analytical process to solve the problem. Thinks about how to optimize the solution in the big picture | Relies on intuition to solve the problem. Does not have to think about which skill/theory/principle to use or the outside factors affecting the outcome |

Note. https://www.asee.org/file_server/papers/attachment/file/0003/3677/Dreyfus_Five-Stage_Model_of_Adult_Skills_Acquisition_Applied_to_Engineering_ Lifel.pdf.

At the Novice stage, the individual focuses on learning the facts and instructions. They are given rules for determining actions like a computer following a program or an automobile driver learning to watch the speed on the speedometer and relating gearshift with observed speed. In case of a medical practitioner, for example, the novice may be the first-year resident. They would have a knowledge of basic medicine and, to some extent, knowledge in their specialization. All they would focus on are the instructions as what information to collect regarding medical history of a patient. The resident would usually not reply to any question patients might have but rather wait for the specialist to come.

The Advance Beginner starts to see common situations in real life and can relate to the experiences when faced with similar situations. For example, the driver would now recognize by the sound of the engine when to shift to a higher gear. The resident here may ask more questions based on their previous experience of gathering history relevant to the patient’s symptoms and presentation.

The Competent based on his experience starts taking risks in various situations, makes decision on his own, and may still be supervised. Again, taking the example of an automobile driver, a competent driver leaving the highway on a curved off-ramp may, after taking into account speed, surface condition, criticality of time, and so on, decide it is too fast. They could then decide to ease up on the accelerator, remove their foot, or apply the brake. The resident at this level is probably in the last year of their 3 years of specialization and they may take the patient’s history, recommend tests, make a diagnosis, and advise medicine and procedures. They may still need to consult with superiors at some stages for reinforced confidence and learning.

Proficient uses their experiences and senses to analyze and determine the optimal solution which may overrule other factors such as instruments or indicators. For example, a proficient driver approaching a curve on a rainy day may sense that they are traveling too fast. Then they will decide whether to let up on the fuel, take their foot off, or to step on the
brake. The competent driver, on the contrary, was using many factors to decide that they are speeding. The medical practitioner has become a specialized doctor by now. Their experience dominated over the indicative tests and they will come up with a diagnosis by making a more detailed analysis, which not only takes into account the laboratory tests and imaging but also the history of patient and known facts about the illness. They will decide on their own about any procedural intervention, medication, or referring to some other specialist.

With enough experience with a variety of situations, the proficient performer gradually starts to make intuitive response to any situation becoming an Expert of the skill. When the driver becomes an expert, sense and acquaintance will determine their action like slowing down, knowing how and when to take an action without much manipulation, and consideration of options. Without it being a conscious move, the Expert will shift between gears as and when it is suitable. When coming off the ramp, they will simply lease off the accelerator. At the expert level, a doctor not only diagnoses and treats the illness but also intuitively looks for other problems that have not become apparent yet. They prefer to oversee procedures rather than perform them and are inclined not to necessarily go for patent medications but consult a pharmacist to formulate accordingly.

Keeping this analysis of skill levels from Dreyfus (2004), five levels are used for each competency, and the expert panel reviewed them through hybrid opinion convergence as explained earlier.

Assigning Weightages to Competencies

A popular mathematical technique for coming up to complex decisions based on principles of psychology is Analytical Hierarchy Process (AHP) (Saaty, 1987). It was developed by Thomas L. Saaty in 1970s, refined and studied since then. As it works based on ranking alternatives in comparison with each other, it is used here for assigning weightages to competencies. Online calculators are available for the purpose. The AHP priority calculator translates individual preferences into numbers. It calculates priorities or weights for a set of criteria based on pairwise comparison.

We conducted the exercise of assigning weightages in panel again. The opinions were called and there were relatively quick agreements with occasional discussion. When concluding a number, the panel members were advised to remember the preferences they had recorded so that they could consider the same while evaluating the importance for other sets. Inputs were given to the software as shown in Table 4. Every individual competency was pair-wise compared with all the others, with a total of 66 comparisons made. The software generated a matrix as in Table 5 and solved it to come up with the ranks depicted in Table 6.

### Results and Discussion

The review of published data regarding scientific and technological development since prehistorical time to present day fourth industrial revolution showed that these relate to human skill and spirit as a dominating factor. The study revealed that this describes what is termed as competence or set of competencies. Defining competencies in a structured manner should be an elementary requirement of unfolding the human resource. A large body of work has been published regarding the development of competency frameworks by both the private sector and government agencies around the world seeking to address the skill requirements of the human resource. However, developers had followed their own method and format. In addition, the work remained specific to certain professions such as medicine, nursing, education, or information technology. Little evidence could be found suggesting that the experience from one organization
Table 5. The Resulting Weights Are Given in a Decision Matrix.

| #  | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1  | 1.00|     |     |     |     |     |     |     |     |     |     |     |
| 2  |     | 1.00|     |     |     |     |     |     |     |     |     |     |
| 3  | 0.17| 0.11| 1.00|     |     |     |     |     |     |     |     |     |
| 4  | 0.17| 0.25|     | 1.00|     |     |     |     |     |     |     |     |
| 5  | 0.14| 0.20|     | 0.50| 1.00|     |     |     |     |     |     |     |
| 6  | 0.17| 0.14|     | 1.00| 0.20| 0.25| 1.00|     |     |     |     |     |
| 7  | 0.12| 0.12| 1.00| 0.17| 0.25| 1.00|     |     |     |     |     |     |
| 8  | 0.33| 0.25| 6.00| 2.00| 2.00| 6.00| 2.00|     |     |     |     |     |
| 9  | 0.33| 0.33| 7.00| 3.00| 5.00| 6.00| 5.00| 1.00| 1.00| 5.00| 4.00| 5.00|
| 10 | 0.25| 0.25| 1.00| 0.20| 0.25| 2.00| 2.00| 1.00| 0.20| 0.20| 1.00| 2.00|
| 11 | 0.20| 0.17| 4.00| 0.33| 1.00| 4.00| 4.00| 1.00| 0.25| 5.00| 1.00| 4.00|
| 12 | 0.14| 0.14| 1.00| 0.33| 0.25| 0.33| 1.00| 0.17| 0.20| 0.50| 0.25| 1.00|

Source. https://bpmsg.com/ahp/ahp-calc.php.

Table 6. The Resulting Weights for the Criteria Based on Pairwise Comparisons (Ranking H to L Green to Pink).

| Category                          | Priority (%) | Rank |
|----------------------------------|--------------|------|
| 1 Analytical                     | 23.0         | 1    |
| 2 Reliable technical support     | 22.6         | 2    |
| 3 Knowledge of other crafts      | 1.9          | 12   |
| 4 Compliant with SOPs            | 8.5          | 5    |
| 5 Fills out reports              | 5.9          | 7    |
| 6 Can read drawings              | 2.2          | 9    |
| 7 Guide, supervise, and motivate workers | 2.2     | 10   |
| 8 Cost-conscious                 | 9.5          | 4    |
| 9 Listens and expresses verbally | 13.5         | 3    |
| 10 Team worker                   | 2.7          | 8    |
| 11 Initiative                   | 6.2          | 6    |
| 12 Develop workers               | 1.9          | 11   |

Note. SOP = standard operating procedure.

had come to utilization by any other. Therefore, it indicated the necessity for a generic framework that is not too industry- or occupation-specific to exist, which can be broadly applied.

A generic competency framework for a specific job must be derived utilizing a replicable scientific method. The method should involve the participation of experts from relevant disciplines that cover a wide range of professional knowledge and experience. The competency framework should be presented in a format that can easily be adapted to any required job and be flexible enough to allow the incorporation of industry-specific competencies. All these considerations demonstrated a need to prepare a competency framework following the process charted in Figure 3.

Analyzing the results and looking onto Table 7, the final WPR came out to be 235 for the example job. The required score (235) was 61.84% of the maximum possible WPR, 380. Having this evaluation made for various jobs, one can predict the level of competence required in these jobs. All such evaluations can be determined by the consensus opinion of relevant experts tasked to determine them according to the methodology described. The weightages were determined by pairwise comparison for all 12 competencies of Mechanical Fitter; there were 66 comparisons to make. Every competency was to be ranked against the other in terms of importance or significance in job performance on a scale of 1 to 9 ranging from equal importance to extreme importance. Table 3 shows one example of the comparison made between “Is analytical in troubleshooting problems” with the rest of 11 competencies. Similarly, other comparisons were made and application software was run to make ranking calculations.

The system generated a $12 \times 12$ decision matrix as shown in Table 5. Diagonal 1 was put where the same competency crosses; comparing Competency 7 against 5, Competency 7 has been rated as 4 which meant to be between “moderate” and “strong importance.” If it should be seen otherwise, that is, 5 against 7, then it would be the reciprocal of 4.

The priority percentage and the ranks of competencies based on the panel feedback are presented in Table 6. The consistency ratio (CR) came out to be 6.9%; any CR less
than 10% should be acceptable. Equal “priority” percentages, if any, were ranked consecutively like in competencies 3-12 and 6-7. These ranks became weightages of the competencies; there were 12 competencies, so Rank 1 has a weightage of 12 and so on. Equal ranks got same weightage, but the next level has to have one number skipped; for example, if two competencies had weightage 3 each, then the next competency would have 5. The Dreyfus model (Dreyfus, 2004) of adult skill acquisition has proven to be a good reference point in determining the competency levels for framework development. Discrete identification of competency levels made it easy to pick one for the job in consideration. This model had found applications in a number of fields such as medicines, engineering, and software development.

The classification of competencies has been widely discussed in the literature. The arrangement presented in the ETA work stood comprehensive covering a broad range of competencies organized in a clear manner. It separately listed various personal, academic, and workplace competencies in tiers and provided users with information to identify industry-wide and industrial sector-specific competencies distinctly. Three additional tiers defined occupation-specific competencies related to knowledge, technical, and general requirements with top tier with a set of management-related competencies. This model could be considered a good checklist to follow, though not necessarily for every framework developed to be an exact map of this model.

The development of a competency framework came out to be reliant on the opinion of experts from relevant professions. The varied views should attempt to converge on a harmonized consensus. Table 1 shows the result from an opinion convergence exercise using a hybrid of Delphi and NGT. The standard deviation of opinion to each question was reduced to 0.01, which is close to zero. Four participants took part in a discussion over their initial opinion ranking their own certainty level and giving weightage to others’ opinions; all expressed as a number. Participant 1’s initial level of opinion of 93% during the affirmation discussion eventually fell to 88% along with a falling certainty level, which means that the participant took the influence of other participants in dropping his own arguments and accepting others’ opinion. The process was similar with Participant 3, whereas Participants 2 and 4 were influenced to adopt arguments of others as numbers associated with their opinion rose to 86% and 87% respectively. Table 2 gives a representative analysis
Table 7. Competency Framework, Mechanical Fitter.

| No. | Competency                                      | Weightage | Proficiency level 1–5 scale (novice to expert) | Weighted proficiency rating WPR |
|-----|------------------------------------------------|-----------|-------------------------------------------------|--------------------------------|
| 1   | Is analytical in troubleshooting problems      | 12        | 4                                               | 48                             |
| 2   | Can perform as reliable technical support      | 11        | 3                                               | 33                             |
| 3   | Listens and expresses verbally                 | 10        | 3                                               | 30                             |
| 4   | Is cost-conscious                              | 9         | 3                                               | 27                             |
| 5   | Is compliant to procedures including Occupational Health and Safety | 8         | 3                                               | 24                             |
| 6   | Can take initiatives                           | 7         | 3                                               | 21                             |
| 7   | Is able to fill out reports                    | 6         | 3                                               | 18                             |
| 8   | Is a team worker                               | 5         | 2                                               | 10                             |
| 9   | Is able to read drawings                       | 3         | 3                                               | 9                              |
| 10  | Can guide, supervise, and motivate workers     | 3         | 3                                               | 9                              |
| 11  | Has knowledge of relationship with other maintenance crafts | 1         | 4                                               | 4                              |
| 12  | Can develop workers                            | 1         | 2                                               | 2                              |

Total: 76 235

Note. Proficiency level: novice = 1, advance beginner = 2, competent = 3, proficient = 4 and expert = 5.

of the changes which occurred during the discussions and the pattern of convergence leading to a determination of standard deviation. The competency framework provides a qualification of the quality of human resource to be applied within the entire human resource life cycle especially, but not limited to recruitment, performance evaluation profiling jobs, and the design of educational and professional certification curricula.

Advantages and Limitations

The competency framework in subject has merits to other such frameworks in many respects. It has been developed through a rigorous exercise, which draws its essence from the rich experience of professionals who are in some sense connected to the competence of human resource. None of the opinion from these professionals is discarded; rather, a shared view or consensus is drawn. The development methodology at each step utilizes scientific tools that eliminate or minimize the biasness in any form. The framework remains dynamic as it includes progressing levels of competencies. The framework at the end provides a numeric rating which gives a sense of ranking to jobs in any organization.

The work, however, has its own limitations. The development has been done in Karachi, Pakistan. Although the expert professionals did not contribute to develop a framework in Pakistani perspective only, if the study could be broadly undertaken, it would provide more confidence to the users. This article shows the framework replicated to a job of mechanical fitter as an example; if the same is exercised to a variety of jobs and saved as a library, the benefit would be many folds.

Conclusions

Every step in the process of competency framework development was taken based on established work of either a reputable organization or widely accepted research. All the parameters in the framework were reviewed by a panel of experts and generally included only after their consensus.
Where subjectivity was a challenge, mathematical tools were used. The presented framework is generic in nature; it can be used in any industry or organization, with either no or slight modifications. The framework can be adapted for any other job with the same methodology. This work intended to answer the need for and record the development of a generally applicable competency framework that can be easily adopted by organizations of any size and industry. This proposed competency framework development calls for further experiences in applying it over a wide variety of jobs to gain validation in various functions for human resource evaluation, acquisition, and development.

The nature of work required a higher level of participation in framework development. Expanding the framework to more and more jobs is necessary so that interested organizations can implement it handily. For further development, it is suggested a survey within a specified geography be conducted that includes varied industries and businesses to evaluate the suitability and adaptability of the framework. The survey should involve human resource heads and practitioners. Additional research could also be conducted to validate the framework at various stages of human resource such as recruitment, performance evaluation, and training needs identification.

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References
Agolla, J. E. (2018). Human capital in the smart manufacturing and industry 4.0 revolution. In Digital transformation in smart manufacturing and industry 4.0 revolution. https://www.intechopen.com/books/digital-transformation-in-smart-manufacturing-human-capital-in-the-smart-manufacturing-and-industry-4-0-revolution
Ahmadi, S., Yazdani, S., & Mohammad-Pour, Y. (2017). Development of a nursing competency framework: Thematic content analysis. International Journal of Scientific Study, 5(4), 827–831.
Applebaum, H. A. (1992). The concept of work: Ancient, medieval, and modern. State University of New York Press.
Ashkezari, M. J. D., & Aeen, M. N. (2012). Using competency models to improve HRM. Ideal Type of Management, 1(1), 59–68.
Campion, M. A. F., Ruggeberg, A. A., Carr, B. J., Phillips, L., Odman, G. M., & Ronald, B. (2011). Doing competencies well: Best practices in competency modeling. Personnel Psychology, 64(1), 225–262.
Dreyfus, S. E. (2004). The five-stage model of adult skill acquisition. Bulletin of Science, Technology and Society, 24(3), 177–181.
Fai, F., & Von Tunzelmann, N. (2001). Industry-specific competencies and converging technological systems: Evidence from patents. Structural Change and Economic Dynamics, 12(2), 141–170.
Greater London Authority. (2010). Competency framework: Guidance for managers and staff.
Hasselt University. (2014). Competency framework for PhD holders. https://www.uhasselt.be/51114-competency-framework-for-PhD-holders.html
Hegselmann, R., & Krause, U. (2002). Opinion dynamics and bounded confidence models, analysis, and simulation. Journal of Artificial Societies and Social Simulation, 5(3), 1–33.
Howes, A. (2016). The relevance of skills to innovation during the British Industrial Revolution, 1651–1851. https://www.eh.net/eha/wp-content/uploads/2016/08/Howes.pdf
Human Resources Professionals Association. (2014). Human resources professional competency framework. https://hrpa.s3.amazonaws.com/uploads/2020/10/Professional-Competency-Framework.pdf
Jolee, Y., & Chapman, E. (2010). Generic competency frameworks: A brief historical overview. Education Research and Perspectives, 37(1), 1–24.
Julé, A., Furtado, T., Boggs, L., van Loggerenberg, F., Ewing, V., Vahedi, M., . . . Lang, T. (2017). Developing a globally applicable evidence-informed competency framework to support capacity strengthening in clinical research. British Medical Journal Global Health, 2(2), Article 229.
Khanna, A., Kishore, A., Sarkar, B., & Jaggi, C. K. (2018). Supply chain with customer-based two-level credit policies under an imperfect quality environment. Mathematics, 6(12), Article 299.
Knight, D. (2004). Generic competency framework. Portsmouth Hospitals, NHS Trust.
Male, S. A., Bush, M. B., & Chapman, E. S. (2011). Understanding generic engineering competencies. Australasian Journal of Engineering Education, 17(3), 147–156.
McClelland, D. C. (1973). Testing for competence rather than for “intelligence.” American Psychologist, 28(1), Article 1.
McCloskey, D. N. (2017). Bourgeois equality: How ideas, not capital or institutions, enriched the world. University of Chicago Press.
Mokyr, J. (1992). The lever of riches: Technological creativity and economic progress. Oxford University Press.
Mokyr, J. (2009). The enlightened economy: An economic history of Britain, 1700–1830. Yale University Press.
Nguyen, H. C. (2016, November). An exploration of the competency framework for external quality assurance practitioners [Conference session]. 11th European Quality Assurance Forum, Ljubljana, Slovenia.
Prak, M. (2013, October). An artisan “revolution” in late medieval and early modern Europe [Conference session]. International Conference on Knowledge Formation and the History of the Book, Belfast, North Ireland.
Rao, M. K., & Palo, S. (2009). Identification of managerial competencies for establishing a conceptual framework for HRD practitioners. Asia Pacific Business Review, 5(4), 56–69.
Roberts, B. H. (2015). *The third industrial revolution: Implications for planning cities and regions*. Urban Frontiers.

Saaty, R. W. (1987). The analytic hierarchy process: What it is and how it is used. *Mathematical Modelling*, 9(3–5), 161–176.

Shah, M. N., Chowdhuri, S., Mathew, S., & Murali, A. (2016, June). Identifying generic competencies for infrastructure managers: A study of infrastructure firms in India. European Academy of Management Conference, Paris, France.

Wallis, P. (2008). Apprenticeship and training in premodern England. *The Journal of Economic History*, 68(3), 832–861.

Wilcox, Y. (2012). An initial study to develop instruments and validate the Essential Competencies for Program Evaluators (ECPE). University of Minnesota.

Saville & Holdsworth Limited. (2012). *SHL universal competency framework*. https://www.shl.com/en/assessments/behavior/universal-competency-framework/

Society for Human Resource Management. (2012). *SHRM competency model*. 