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# Enterprise competency modelling in practice-an exploratory case study

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**Abstract**

Competency modelling is a standardized way to found an enterprise area of experts. Identifying and managing competences acquired by an enterprise and further representing them in a structured manner provide important knowledge for 'know-how' approach. The purpose of this paper is developing a competency based knowledgebase for an enterprise using case study approach. The developed competency knowledgebase for the case study provides information important to decision-making, and can act as an indicator for an enterprise's willingness to engage in robust collaboration.

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*Keywords:* capability, competency, enterprise engineeirng, modeling

## 1. Introduction

Now days, a number of enterprise engineering researchers have outlined the theoretical case for enterprise knowledge management. It is claimed that with product life-cycles shortening and technologies becoming increasingly imitable, enterprise knowledge emerges as a major source of competitive advantage by virtue of its inimitability and immobility. Enterprise engineering is an approach for easy-to-understand definitions of the enterprise's (a) business entities and relationships; (b) processes and planning; (c) organisational structure; (d) market details and products/services; (e) and high-level planning and preferences [1-2]

Enterprise competency refers to the skills and abilities of an organisation needed to carry out certain tasks based on knowledge and experience of its methods and resources [3]. In earlier definitions and models, competency primarily refers to capabilities. As a result, 'competency' and 'capability' are often considered synonymous. The author in his past research article proposed a different definition to supplement the conceptualisation proposed by others [4-6]. Enterprise competency is defined as across functional co-ordination and integration of capabilities [7]. This definition includes three broad sub-categories: coordination, integration, and capability. First, coordination, according to Mooney and Reelay 1998, 'is orderly arrangement of activities to provide unity of action in the pursuit of common goals within a sector'. Second, integration is defined as 'establishing mechanisms and links that facilitate the needed integration of the activities of different functions to ensure that these functions work together effectively to achieve the overall objectives of the enterprise' [8]. Finally, capability is defined as: a sector's capability is represented by a set of information that is embodied by all available resources and corresponding activities that can be performed by those resources, as well as the knowledge about how these resources and activities can be used effectively, efficiently, and economically [9].

Despite the plausibility of these arguments, however, relatively few studies have provided empirical insights into how companies identify, represent, and manage 'enterprise competency' through the interplay between organizational context and information technology. Indeed, much of the existing literature is concerned with an ontological debate about the conceptual nature of competency and therefore tends to promote particular approaches as universal panaceas. More


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specifically, with the development of the field of 'competency management' there has been a massive outpouring of articles dealing with these issues from a prescriptive standpoint. Their relatively weak empirical base notwithstanding, many of these contributions confidently define enterprise competency as a kind of economic asset or commodity, or as a purely cognitive phenomenon. These theoretical arguments are difficult to relate to the actual experience of business organizations. We also know comparatively little about the actual organizational processes through which enterprise competency is valorised in competitive outcomes. In an attempt to shed some light on the above-mentioned issues, this paper has objective to highlights the study uses a case-study of one enterprise to examine the dynamics of successful competency modelling practices, and to consider the extent to which such practices can be generalized and adapted by others. Therefore, the overall effect of this theoretical approach is to bridge a gap between the abstract concepts that we employ to understand enterprise competency and the practical, context-dependent realities facing business organizations.

## 2. Capability

Within the literature, several terms indicate the fundamental aspects of capability, including production skills, technologies, resources, capabilities, processes, and actors. Boucher et al. 2005 [10] consider professional situation, actor, and resource in their analyses. Mueller 2006 [11] considers humans, resources, and fulfilled tasks as fundamental components. The authors adapt the Molina, Ellis, et al. (1999) [12] research on manufacturing data modelling, and distinguishes resource, activity, and knowledge for each of the sectors within the enterprise as the fundamental aspects for sector capability modelling.

The formalisation of sector capability is as follows. Let's consider for subsequent modelling a set of sectors at an enterprise E= {S1, S2, S3, …}.

**Definition 1** (Sector capability)- Capability can be understood as sector's ability to perform activities, tasks, acts or processes possible through corresponding resources and knowledge, aimed at achieving a specified number of outcomes.

For modelling the remaining concept, let's consider the set of capabilities at sector α: $C_\alpha = \{ C_{\alpha1} , C_{\alpha2} , \dots , C_{\alpha n} \}$ in which each element $C_{\alpha i}$ stands for a capability. The following definition introduces the concept of capability, which is built upon three building aspects. It can be specified as a set

$C_{\alpha i} = \{X_{\alpha i}, R_{\alpha i}, K_{\alpha i}\}$ , i=1…n

Such that:

$X_{\alpha i} = \{x_{\alpha1}, x_{\alpha2}, x_{3\alpha}, .., x_{\alpha j}\}$
$= \{x_{\alpha j} | x_{\alpha j}$ is a activity, task, act or process for $i^{th}$capability at sector $\alpha\}$ ,
i=1,…,n , j=1,…,m

$R_{\alpha i} = \{r_{\alpha1}, r_{\alpha2}, r_{3\alpha}, .., r_{\alpha j}\} =$
$\{r_{\alpha j} | r_{\alpha j}$ is a resource for $i^{th}$capability at sector $\alpha\}$ ,
i=1…n, j=1,…, m

$K_{\alpha i} = \{k_{\alpha1}, k_{\alpha2}, k_{3\alpha}, .., k_{\alpha j}\} =$
$\{k_{\alpha j} | k_{\alpha j}$is a knowledge for $i^{th}$capability at sector $\alpha\}$ i =1…n, j=1,…, m

**Definition 2** (Sector's task-oriented capability) – is a sub-set of a sector capability set, this sub-set represents capabilities which are needed to run a specific outcome or specific goal.

For sector α it can be shown as $C^*_\alpha$ where:

$C^*_\alpha \subseteq C_i$

$C^*_\alpha = \{C_{\propto1}, C_{\propto2}, C_{\propto3}, \dots, C_{\propto n}\} =$
$\{C_{\propto k} | C_{\propto k}$ is a selected capability at sector α for a specific task $\}$ ;
k=1,…, n

## 3. Cross-functional co-ordination and integration processes

Cross-functional co-ordination of capabilities of a sector has been identified as a key operation for enterprise competency creation process [11]. The successful achievement of the enterprise's global goals depends not only on the appropriate co-ordination of sectors' capabilities, but the proper integration of the capabilities at enterprise level is also vital. The interdependencies (sequence/parallelism, synchronisation, data flow, precedence conditions) among capabilities, at the various sectors, must be properly integrated in order to achieve the enterprise global goals. 'Cross-functional co-ordination' and 'Cross-functional integration' of capabilities is defined as:

**Definition 3** (Cross Functional Co-ordination (CFC) of capabilities) – is a link among capabilities within a sector, this link seeks to fund relations between the activities of the capabilities using sector's 'product/service workflow diagram.' CFC is act as union for the other component of the capability (i.e. resource $\{R_{\alpha1} \cup R_{\alpha2} \cup R_{\alpha3} \cup \dots \cup R_{\alpha n}\}$ , knowledge$\{K_{\alpha1} \cup K_{\alpha2} \cup K_{\alpha3} \cup \dots \cup K_{\alpha m}\}$,).CFC is the set of ordered pairs$(x , \mathfrak{x})$; where x is the independent activity and the $\mathfrak{x}$ is dependent onx.

$$CFC(C) = \{(x , \mathfrak{x}) \mid x \in C \text{ and } CFC(x) = \mathfrak{x}\}$$

$$CFC(x)\begin{cases} = 0 \text{ ; if a is not sector to the other activities} \\ = x \text{ ; is reachable from } \dfrac{\text{product}}{\text{service}} \\ \text{workflow diagram} \end{cases}$$

Where:
C- is a capability set
x, $\mathfrak{x}$, $\mathcal{x}$- is a activity, task, act or process

**Definition 4** (Cross Functional Integration (CFI) of capabilities) - CFI is a link among capabilities of sectors within an enterprise. This link seeks to fund relations among the activities of the capabilities at the enterprise using enterprise's 'product or service structural model'. CFI acts as union for the other component of the capability between sectors (i.e. resource $\{R_{\alpha1} \cup R_{\alpha2} \cup R_{\alpha3} \cup \dots \cup R_{\alpha n}\}$ , knowledge$\{K_{\alpha1} \cup K_{\alpha2} \cup K_{\alpha3} \cup \dots \cup K_{\alpha m}\}$,).

$$CFI_{\alpha\beta}(C_\alpha, C_\beta) = \{(x_\alpha , \mathfrak{x}_\beta) \mid x \in C_\alpha \text{ and } CFI(x_\alpha) = \mathfrak{x}_\beta\}$$

$$CFI(x_\alpha)\begin{cases} = 0 \text{ ; if } x_\alpha \text{ is not sector on the other activities at sector } \beta \\ = \mathcal{x}_\beta \text{ ; is reachable based on } \dfrac{\text{product}}{\text{service}} \\ \text{structural model} \end{cases}$$

**Definition 5** (Enterprise's competency) –Is defined as

cross functional co-ordination and integration of task-oriented capabilities aimed at achieving a global outcome or goal.

Enterprise's competency definition can be formulated as:

$$\text{Competency}\,|_{G}^{1,2} = C_1^* \otimes C_2^* = CFI_{12}\left[CFC\left(\bigcup_{i=1}^{n}\{C_{1i}^*\}\right), CFC\left(\bigcup_{i=1}^{m}\{C_{2i}^*\}\right)\right]$$

$$\text{Competency}\,|_{G}^{1,2,3} = C_1^* \otimes C_2^* \otimes C_3^* = CFI_{12}\left[CFC\left(\bigcup_{i=1}^{n}\{C_{1i}^*\}\right), CFC\left(\bigcup_{i=1}^{m}\{C_{2i}^*\}\right)\right], CFC\left(\bigcup_{i=1}^{m}\{C_{3i}^*\}\right)]$$

$$\text{Competency}\,|_{G}^{1,2,..,n} = C_1^* \otimes C_2^* \otimes \ldots \otimes C_n^*$$

Where:

- G- Represents a specific outcome or goal.
- 1, 2, 3,…, n- Is an index for representing sectors.
- $C_m^*$- Task-oriented capability for Sector m as defined previously.
- $\bigcup_{i=1}^{n}\{C_{\alpha i}^*\} = \{C_{\alpha 1} \cup C_{\alpha 2} \cup C_{\alpha 3} \cup \ldots \cup C_{\alpha n}\}$.
- $\otimes$ cross functional integration and co-ordination
  - $CFI_{nm}$- Cross Function Integration between sector n and sector m.
  - CFC- Cross Function Co-ordination.

## 4. Case study

The competency modelling implementation is a part of knowledge management strategy for a corporation and with knowledge as an intangible asset, the usefulness of it usually cannot be seen in the short run. Therefore, this research uses the method of a case study and has directed our survey on Chika Food Industry (MFI). The reason that we have chosen this company is that it has already carried out knowledge management strategy so a part of knowledge for competency modelling proposes is accessible for the enterprise knowledge base system. This research anticipates through the case study of this company that we will be able to showing the inter-relationship between theory and business. We also hope the result of this study can provide a reference for academia and the business field.

Company summary: ChFI was established in 1984 with an investment capital of US$0.645 billion and currently owns three factories located in Tabriz (Iran), Tehran (Iran), and Erbil (Iraq), with more than 10,000 employees worldwide. ChFI is one of the regional leading providers of Halal foods. Its main products include various conserve base foods.

Reason for competency management: The focus of ChFI's operating strategy is customer satisfaction. ChFI's competency modeling started with the common suggestion by the authors and the VP of R&D, regarding the need to develop an "enterprise competency knowledge base" which potentially will be used in decision making processes such as: (1) decisions to meet the demands of the customers, (2) product pricing strategy related decisions, (3) partner selection process for doing collaboration with other related enterprises, and so on.

For this to happen, ChFI needed to:

- Identify and list required capabilities of the sectors
- Assign resources, activities and knowledge to the sequenced capabilities.
- Founds Interactions of capabilities within sectors and between the sectors
- Develop model for sector's capabilities.
- Realize the 'Cross-functional co-ordination' process of capabilities within a sector, also, realize 'Cross-functional integration' process of capabilities between sectors
- Represent the enterprise competency

To exemplify competency modelling at ChFI, let's deliberate on 'Production' and 'Laboratory' sections in this industry. These sectors cooperate to produce variety of conserve base foods. Competency modeling objectives at this example concern the identification, updating and exploitation of the intra-enterprise competency.

### *3.1 Identify and list required capabilities of sector*

The first step for competency modelling is identification and evaluation of the exits capabilities at the sectors. Work-station oriented (or goal-oriented) approach is used for identification and evaluation of necessary and acquired capabilities at the sectors. This process include four stages(1) analysis of goal; (2)deriving the structure of goal; (3) determination of the various capabilities needed to overcome goal; and (3) sequencing those acquired. There are methods for identification and evaluation of necessary capabilities at a sector. Among the existing methods, the observation, the description, the interview, the method of the critical incidents and the grid of Kelly can be mentioned [13]. The method used here to identify capabilities is based on the interview approach. In this example the goal of the sectors is producing a conserve base 'Macaroni &Sauce' food. After identification process, the listed capabilities are then sequenced so that they follow the order in which they will be performed. Successful completion of these attempts often requires a good knowledge of process planning, manufacturing features and manufacturing resources. 'production' and 'Laboratory' of ChFI have sets of capabilities:

$C_{Pro}$={*'Cooking', 'Mixing', 'Filling', 'Weighing', 'Freezing', 'Sealing', 'Palletizing'*}

$C_{Lab}$={'Microbiologic test'}

Since the goal is producing 'Macaroni & Sauce", 'Production' and 'Laboratory' sectors' task oriented capability set is as:

$C^*_{Pro(M\&S)}$={ *Cooking' ,'Mixing', 'Weighing', 'Sealing', 'Palletizing'*}

$C^*_{Lab(M\&S)}$={'Microbiologic testing'}

### *3.2 Assign resources, activities and knowledge to the sequenced capabilities*

The second step for competency modeling is assigning resource, activity and knowledge to the identified capabilities. For the resources, activity and knowledge assign processes of acquired capabilities, interviews of personal appreciation, samples, references is used. For instance, the 'Cooking' and 'Mixing' capabilities at 'Production' sector also 'Microbiological test' at 'Laboratory' sector has the following sub elements (raw ingredients Code are: 1,2,3,4,5):

'$Mixing_{@Pro.}$'=

$$\begin{Bmatrix} \{Draining, Mixing\} \\ \{Mixinging\ kettle, Draining\ kettle, Technician2\} \\ \{MixingKettleManuals, Recipe3, Bill\ of\ Material2\} \end{Bmatrix} =$$

$$\begin{Bmatrix} \{x_{M1,}, x_{M2}\} \\ \{r_{M1,}r_{M2,}r_{M3}\} \\ \{k_{M1,}k_{M2,}k_{M3}\} \end{Bmatrix}$$

$$\text{'Microbiological test}_{@Lab}\text{'} = \begin{Bmatrix} \{\text{Microbiologic testing}\} \\ \{\text{Sample Precreation Machine, Oven, Testing Machine}\} \\ \{Manual1, Manual2, Manual2, Worksheet\} \end{Bmatrix} = \begin{Bmatrix} \{x_{MT1}\} \\ \{r_{MT1,}r_{MT2,}r_{MT3}\} \\ \{k_{MT1}, k_{MT2}, k_{MT3}, k_{MT3}\} \end{Bmatrix}$$

### *2.3 Interactions of capabilities within sectors and between the sectors*

Clarification of the interactions between the capabilities within the sector and among sectors of an enterprise is vital since it will be used at next level of the framework. For simple cases, numbers (also called capability numbers) indicate the sequence in which the capabilities will take place. Sometime a capability can have a flexible sequence and sometimes, two or more capabilities can take place simultaneously. In a similar way, specific interactions between the capabilities have to be done for each of the sectors of the enterprise. For a case with numerous interactions between the capabilities sequence diagrams are applicable for this purpose.

### 2.4 *Capability modelling*

To store competency aspects in a structural manner, it is significant to model the capabilities within the sectors. Thus the study has been oriented to create capability models. The capability model which is introduced previously (definition3) was adapted to all the identified capabilities at the enterprise. This model is used to capture all the aspects (i.e. resource, activity, and knowledge) of the capabilities. A capability knowledgebase is developed to assure that the knowledge of capabilities at the sectors is capitalized. At present, the knowledgebase is developed under ACCESS and is operational. The relational model of the capability knowledgebase is represented by Fig.1. The use of a standard incoming application adds knowledge gathering process to the capability knowledgebase system.

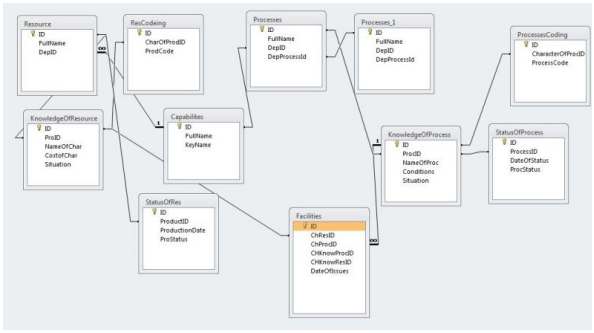


Fig.1 relational model of capability knowledgebase

### 2.4 *'Cross-functional co-ordination' and 'Cross-functional integration' of capabilities*

Three main sub-categories of enterprise competency exploitation are defined as (1) sector capability; (2) cross-functional co-ordination; and (3) cross-functional integration. The sector capability sub-category, concerns the store of enterprise competency aspects (i.e. resource, activity, and knowledge) which is resulted as a capability based knowledgebase. The 'cross-functional co-ordination' and 'cross-functional integration' sub-categories concerns the linking of enterprise competency aspects. The 'Cross-functional co-ordination' process (definition 3) was adapted to all the identified capabilities at the sectors. For do this, the sector's capabilities sequence diagram is used. As an example:

Cross Functional Co-ordination (CFC) Cooking→ Mixing: $\begin{Bmatrix} \{(x_{C1,}x_{M1,}), (x_{C1,}x_{M2}), (x_{C2,}x_{M2})\} \\ \{r_{C1,}r_{C2,}, r_{C3,}, r_{M1,}r_{M2,}r_{M3}\} \\ \{k_{C1,}k_{C2,}k_{C3,}k_{C4,}k_{C5,}, k_{M1,}k_{M2,}k_{M3}\} \end{Bmatrix}$

Using the capabilities sequence diagram among the sectors, the 'Cross-functional integration' process (definition4) was adapted to the identified capabilities at the enterprise. As an example:

(CFC) Cooking→ Microbiological test:

$$= \begin{Bmatrix} \{(x_{C1,}0), (x_{C1,}0), (x_{C2,}x_{MT1})\} \\ \{r_{C1,}r_{C2,}, r_{C3,}, r_{MT1,}r_{MT2,}r_{MT3}\} \\ \{k_{C1,}k_{C2,}k_{C3,}k_{C4,}k_{C5,}, k_{MT1}, k_{MT2}, k_{MT3}, k_{MT3}\} \end{Bmatrix}$$

The 'cross-functional co-ordination' and 'cross-functional integration' processes were separately adapted to each of the identified capabilities at the enterprise.

### *2.5 Enterprise competency representation*

At this stage all the competency aspects were stored, and all the competency associated sub-categories were linked as well; the next step is to represent enterprise competency. Using enterprise competency definition (definition 5) the example blow depicts competency creation process at the enterprise. For simplification in this example only three capabilities ('Cooking' and 'Mixing' from 'Production' sector and 'Microbiological test' from laboratory department) are taken in to consideration.

Competency (Cooking, Mixing) →(Microbiological test):

$$\begin{Bmatrix} \{(x_{C1}, x_{M1}, 0), (x_{C1,}x_{M2}, 0), (x_{C2,}x_{M2}, x_{MT1})\} \\ \{r_{C1}, r_{C2}, r_{C3}, r_{M1}, r_{M2}, r_{M3}, r_{MT1}, r_{MT2}, r_{MT3}\} \\ \{k_{C1}, k_{C2}, k_{C3}, k_{C4}, k_{C5}, k_{M1}, k_{M2}, k_{M3}, k_{MT1}, k_{MT2}, k_{MT3}, k_{MT3}\} \end{Bmatrix}$$

Fig.2 depicts the dialog boxes in which the competency are shown. The dialog boxes also show the features of the competency stored in the knowledgebase. The experimental software developed can show capability attributes by clicking on the particular sign beside each row. Furthermore, external related activity which results from cross-functional integration process and its desired capability is listed in another row. It is important to emphasize that by clicking on a capability at the boxes, the activity and resource information and the activity and resource knowledge will be displayed in separate dialog boxes. The developed prototype application and competency knowledgebase, captured, managed, and published the enterprise internal competency knowledge with a consisted set of concepts and aspects. The contents of competency knowledgebase is demonstrated in two formats human usage and machine readable (XML).This knowledgebase can be used to support various enterprise applications related to

competences of an enterprise and, presents a clear understanding of the enterprise detail area of expertise.

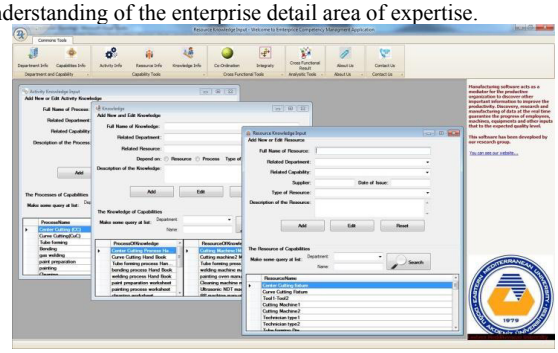

Fig.2 enterprise competency representation

## 5. Conclusions

Under the influence of the enterprise engineering paradigm with enterprise's productability, companies need to start to actively implement competency management with the goal of obtaining important information for their future decision making processes. This research first concluded that 'cross-functional co-ordination', 'cross-functional integration', and 'sector capability' are three of the sub-categories in enterprise competency modelling. Furthermore, based on past published papers, resource, activity, and strategy (knowledge related resource and activity) are three of the aspects for sector capability modelling. A generic sector capability model is proposed; also cross-functional co-ordination and cross-functional integration of the capabilities are defied as major advancements for intra-enterprise competency modelling. Through the case study of ChFI, we implement the academic 'enterprise associated' concepts with real practice in the industry. The developed experimental system for the case study of ChFI offers four benefits, in that they a) enhance the organizations willingness to collaborate, b) boost the organization's competitiveness, c) facilitate appropriate decision-making, and d) finally help to integrate the entire organization.

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