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Development of a knowledge taxonomy and a tool to support business development decisions in construction companies

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ABSTRACT

Business development (BD) is critical for construction firms to achieve competitive advantages in selected markets. This study aims to develop a knowledge-based tool that can be used to support BD tasks and decisions. The first step of the development of this tool is creating a new knowledge taxonomy. Firstly, the components of the taxonomy were collected by conducting a detailed literature review, and semi-structured interviews with 12 well-experienced construction experts from 11 construction companies. Five main components and fifty-two sub-components were identified at the end of this stage. Six experts participated in focus group discussions to finalize the knowledge taxonomy. Finally, a new taxonomy with three hierarchical levels was proposed. The developed knowledge taxonomy was validated using three validation methods: interactive workshops with three scholars, navigation tests with three domain experts, and a case study conducted through an oral history interview with one expert. Based on this taxonomy, a knowledge-based tool was developed to manage knowledge related to the BD of construction organizations. Researchers and professionals can benefit from the findings of this study when developing similar knowledge-based systems and improving BD decisions.

1. Introduction

The construction industry has become more complex and competitive due to globalization, increasing the probability of significant business failures and bankruptcy. Also, the scale of construction projects makes the construction business potentially more brutal. The construction companies should have unique skills, techniques, and capital to survive in the market. However, having adequate resources, market opportunities, business ideas, and talented staff can be not enough, and still, these companies can fail [1]. Therefore, companies should also have appropriate business models [2], and companies seeking to develop successful business models should leverage business development (BD) as a source of sustainable competitive advantage. [3].

The construction industry is a dynamic marketplace since companies can confront many quick changes in a short time. Therefore, to respond to such changes, construction companies should develop new businesses according to newly emerged market needs. Especially, the pandemic led to a turbulent business environment. Besides, COVID-19 led to de-growth and severe shrinkage in the workload. For instance, the UK construction industry shrank by 5.9 % in March and 40.1 % during the lockdown in April [4]. Although the effects of COVID-19 have decreased in recent months, businesses in all industries still suffer due to the new, unexpected, and serious problems resulting from the pandemic [5]. Besides, experts mention the possibility of new pandemics. Consequently, construction companies should be ready for these extreme conditions and should have dynamic BD strategies.

The knowledge-based view theory proposes that knowledge plays a critical role in the survival of companies in a competitive market, and organizations should adopt a knowledge-based approach in today's economy, which heavily relies on knowledge [6]. This is also valid for BD, and companies should understand knowledge of the market, the form of business, and technology to develop new businesses [7,8]. Bose and Sugumaran [9] also confirm that managing customer knowledge would help companies address their customer's needs and deliver consistent services rather than a mass generalization of customer characteristics. Similarly, Migdadi [10] revealed that KM affects customer relationship management, which is a critical management tool for BD. Moreover, he showed how KM enhances the innovation capabilities of companies through successful customer relationship management. Furthermore, knowledge sharing helps companies create new opportunities in different markets and become more competitive [11]. Lustono [12] also verified the importance of knowledge sharing in BD and

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proposed that companies can remain competitive in rapidly developing markets by capturing and storing knowledge. Similarly, Aljuwaiber [11] underscored the significance of knowledge sharing in the context of BD and conducted a study into how knowledge sharing among members of industrial committees can promote BD. Some researchers have even proposed that companies cannot perform BD without knowledge sharing [13]. Therefore, effectively managing BD knowledge may support organizations in selecting their markets, clients, partners, and other related decisions en route to creating new revenue channels for higher profits.

Many studies related to the construction industry emphasize the importance of knowledge and KM [14–16]. However, due to the characteristics of the construction industry, such as the instability of teams and labor forces [17], complicated, dynamic, and interactive construction projects [18], and the complex and dynamic nature of the construction industry [19], KM is a challenging task for the construction companies. Therefore, KM implementation in construction companies is low which leads to many construction problems [20]. Also, construction companies are struggling to collect data for BD, since generally, they use reports to capture and store BD knowledge [21] which is an inefficient and time-consuming method. Therefore, most companies cannot employ the captured and stored BD knowledge in their reports, and they reinvent the wheel for similar problems whose effective solutions can be available in these reports. Whereas, KM systems can facilitate the identification and recognition of market operations, operational management, and innovation which leads to effective BD [22]. Therefore, construction companies can also apply KM systems to manage knowledge in BD appropriately. Unfortunately, construction companies are struggling to implement KM systems throughout their organization due to the extensive and diverse range of knowledge associated with a particular task, as well as the organizational culture that can hinder the adoption of the established KM system [23]. Besides, not all companies implementing KM systems achieve performance improvements, despite the many benefits of KM [24], since there are still gaps in implementing effective KM strategies and tasks [20,25].

To successfully implement KM systems, a systematic development approach is critical. The researchers [19,26] proposed that knowledge should be classified before the development of the KM system since distinct types of knowledge within a specific domain should be structured in a convenient way for effective organization. Besides, knowledge classification accumulates, organizes, and represents a domain. Therefore, via classifications, what is known can be represented explicitly, and concepts can be connected in a valuable structure [27]. Also, a classification can be used as a rich representation once concepts have been materialized and linkages between them have been identified, facilitating communication while producing a new cycle of inquiry, comparison, and thinking [27]. Additionally, classifications provide the basis for creating a consistent semantic representation of knowledge, which can benefit from the advantages of the semantic web and KM systems [28]. Taxonomy is a simple and effective approach to representing classification since it is based on similarity, making the proposed classification more understandable. However, the existing taxonomies are inappropriate to implement KM since they are too abstract and difficult to use [29]. This is also valid for the construction industry, and there is a significant knowledge gap in KM taxonomies [16]. Therefore, recently, different taxonomies have been developed and proposed. However, no taxonomy has ever been developed for BD. Besides, in the literature, no tool for BD based on a taxonomy is proposed for BD specifically.

This study aims to develop a new knowledge-based tool for business development management (BDM) in construction organizations. Therefore, firstly, a knowledge taxonomy for BDM in construction companies was developed by conducting a literature survey and semi-structured interviews with experts from the construction industry to represent BDM. Then, the presented taxonomy was validated by conducting interactive workshops, navigation tests, and case studies. Finally, this taxonomy becomes the main input to the tool, which can be used for managing BD knowledge. Considering the limitations of the scholarly literature on BDM, this study will also contribute to the BD literature and practice by providing a clear grasp of the semantic nature of BDM and supporting the decision-making process in construction companies via the developed tool.

2. Literature review

2.1. Knowledge management systems

As one of the most critical issues in today's knowledge-based economy [30], knowledge and its usage play a critical role in the success of an organization. Regarding the resource-based view of the firm [31,32], companies can create competitive advantages when they have rare and inimitable resources. Therefore, since the available knowledge of a company can be considered an intellectual asset and an intangible resource, knowledge is one of its most critical resources.

KM is necessary and important in the construction industry, given its characteristics, such as the instability of teams and labor forces, its complex and dynamic nature, and the unstructured data collection systematic [33]. However, managing knowledge is a challenging task, since knowledge can be classified into two types, namely tacit and explicit. The tacit knowledge is in the employer's mind and is difficult to explain and share. Therefore, they should be captured and shared systematically [34]. Otherwise, employers cannot realize the tacit knowledge in their minds. In BD, especially the tacit knowledge such as negotiation know-how explanations, problem descriptions in customer relations, and market suggestions is critical. Knowledge management systems (KMS) can be useful for managing tacit and explicit knowledge [35]. Besides, KMSs can be used to overcome the cultural barriers that lead to poor KM in construction companies [36]. As a result, there has been an increased effort to develop KMSs to store, retrieve, and capture information to support organizational decisions. In other words, different KMSs are proposed for managing knowledge more efficiently. For instance, Motawa and Almarshad [37] developed a knowledge-based system for building maintenance. They used building information modeling and case-based reasoning to capture the knowledge, and the captured knowledge can be retrieved to facilitate the decision process and track a building element's entire history and all elements affected due to past repair procedures. Eken et al. [15] created another knowledge-based tool for learning lessons, and with the help of the tool, companies can reuse these lessons to manage the problems that emerge in similar projects. Similarly, Okudan et al. [14] developed a knowledge-based risk management tool. This tool can capture risk-related knowledge and retrieve this knowledge using case-based reasoning to facilitate risk identification, risk assessment, and risk treatment. Finally, Mirshekarlou et al. [38] proposed a knowledge-based tool that can be used to predict waste in a prefabricated construction project and assess the waste management performance of a project by retrieving waste quantities from similar projects.

Deng et al. [33] reviewed the studies about information and communications technology in KM of the construction industry and categorized these into three main categories, namely ontology, semantic network, and knowledge graph. Therefore, the development of ontology to implement KM in construction companies is a trending topic. In most of these studies, the first step is developing a knowledge taxonomy, since each purpose requires different knowledge, and this knowledge should be represented accurately. In other words, to develop a decision support system based on knowledge, a knowledge taxonomy should be initially developed. Although knowledge taxonomy is critical in developing KMSs, most of the proposed KMSs appeared less effective than expected due to the lack of appropriate knowledge taxonomy [29].

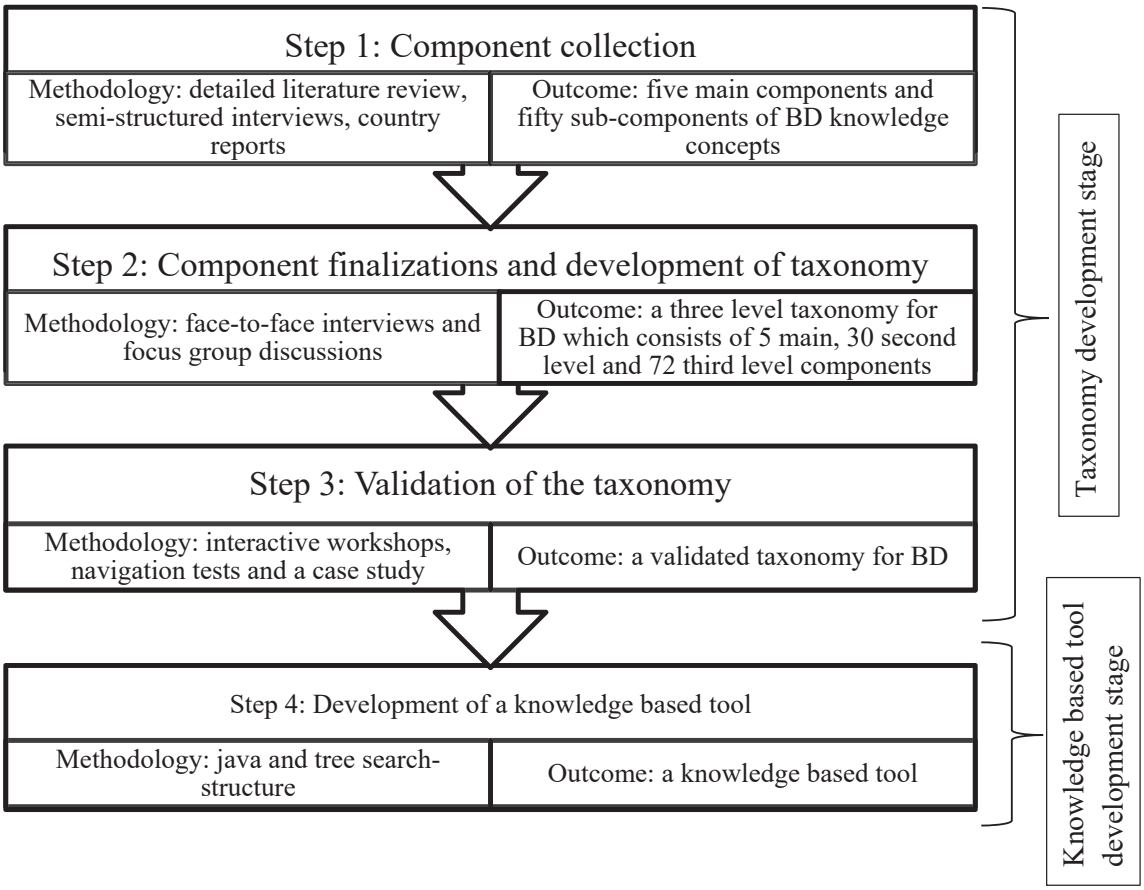

Fig. 1. Research methodology.

2.2. Knowledge taxonomy

Knowledge taxonomy is widely used to represent knowledge semantically. The term "taxonomy," which was formed from the Greek words "taxis" and "nomia," which mean "order" and "method," respectively, refers to a conceptual superclass-subclass hierarchy for categorization or classification of items in a domain. Taxonomy arranges the terms in a controlled vocabulary, establishing a hierarchical structure that does not incorporate any additional details. Essentially, taxonomy enables the ontology to be comprehensible to humans while also facilitating its seamless integration with other ontologies [39]. Since construction companies started using the semantic web and KM in the industry intensively, researchers have been interested in the development of taxonomies to represent available knowledge according to the needs of the industry. Goodman and Chinowsky [40] have presented a taxonomy of construction knowledge required for construction business executives. Their taxonomy serves as a map for knowledge focal areas regarding construction organizations and enterprise management. El-Diraby et al. [28] proposed a domain taxonomy for construction concepts to represent construction knowledge semantically. This taxonomy can be used to develop a system that allows knowledgeable users to share ideas, decisions, and best practices digitally. El-Gohary et al. [41] developed a taxonomy for the infrastructure and construction domains. This taxonomy was used to create an ontology, which was then used to create a knowledge model that supports knowledge-enabled process management and represents the multi-stakeholder project development process. Fidan et al. [26] used the taxonomy concept to develop an ontology that can be used to establish relationships between project risk and vulnerability to avoid cost overruns in international projects. The developed ontology integrates into a database system representing risk events that emerge in international construction projects. Niu and Issa [42] proposed a taxonomy development methodology for contractual management, and they used this methodology to develop the taxonomy of the AIA A201 document. Another taxonomy was developed by Ahmed and Kassem [43] to facilitate BIM adoption in the construction industry. This taxonomy unifies the drivers and factors of BIM adoption. Xing et al. [44] presented risky facts through a knowledge taxonomy that can be used to develop an ontology for safety risk management in metro construction projects. Many other taxonomies developed for different knowledge domains in construction companies can be observed. However, no study has yet presented a semantic classification for the knowledge in the BD domain of construction companies.

Table 1
Company specifications of the interviewees.

Company No.	Company Age	Average Annual Turnover (US$ million)		Number of Employees in the Company
		Domestic	Overseas	
1	46	350	650	500<
2	38	70	20	500<
3	49	186	530	500<
4	50	0	700	500<
5	13	0	11.5	<100
6	20	0	1000	500<
7	25	65	135	500<
8	53	143	1160	500<
9	85	0	3100	500<
10	30	160	20	500<
11	10	0	100	100–150

2.3. Business development in construction firms

In today's competitive business environment, economically successful companies are expected to have certain specifications such as being innovative, consistently delivering high-quality products, operating at a fast pace, maintaining low costs, and being flexible to adapt to changing market conditions for customer satisfaction [45,46]. Such companies should encompass technologically up-to-date products and services. The construction industry has also undergone considerable change in recent years due to the more demanding clients and fierce competition [47], and the current COVID-19 situation has presented new challenges. Therefore, construction companies should change their positions to deal with the current changes in the market.

To achieve this, BD plays a critical role in a construction company [48], since effective implementation of BD enables companies to modify and restructure their business processes for further efficiency [49]. Additionally, BD facilitates modifications or enhancements to existing products, the development of new products and services, entry into new markets, and the establishment of new partnerships and strategic alliances [50]. By conducting BD, the companies can overcome the classical barriers that exist between different departments of the companies, such as sales, marketing, customer relations, operations, and management [51]. Thus, the companies can develop their positions and grow in the market.

BD involves various activities such as market and client knowledge, strategy and tactics, cooperation, relationships, marketing, proposal preparation, and commercial expertise. It also entails risk assessment and analysis, contract terms and conditions, technical expertise, time management, project experience, and networking [52]. These activities require the skills, knowledge, and creativity of BD managers, which they acquire through their previous experiences. Alonso et al. [53] also showed the relationship between KM and BD based on a knowledge-based view and clusters of activities with dynamic capabilities. The authors proposed that micro firms must improve their knowledge to devise firm strategies and capitalize on market opportunities. In BD, especially the tacit knowledge such as negotiation know-how explanations, problem descriptions in customer relations, and market suggestions is critical. Due to the importance of the business developers, they have been mentioned as the champions of the companies that make the tacit explicit [51]. However, business development managers are generally undervalued in the construction industry [52]. Thus, companies should develop methods for capturing this tacit knowledge and storing it. Also, the companies should share the existing knowledge, which is an interactive process, to perform BD effectively [7,11]. In knowledge sharing, the owner of knowledge gathers knowledge in the form of information and sends that information to the recipient via multiple media [54]. However, knowledge sharing is challenging due to the tacit knowledge, since the recipients cannot fully understand the knowledge shared with them or elicit the required knowledge from the verbal reports. Besides, an adversarial culture that exists in construction companies has a negative impact on knowledge-sharing habits [55]. Consequently, managing knowledge is crucial in business development, especially in companies like construction firms, nevertheless, this task is quite challenging and requires intensive effort [55]. The KM taxonomy can also be a critical facilitator for managing knowledge. For instance, Whyte and Classen [56] proposed a KM taxonomy for organizational stories that can enable the sharing of tacit knowledge within organizations.

Based on a literature review, it is evident that existing efforts for KM in BD are insufficient. Therefore, the primary objective of this study is to develop a knowledge taxonomy for BDM in construction companies. The study outlines the essential steps for generating a knowledge taxonomy to aid the BD process and presents a comprehensive semantic representation of the BDM domain. Besides, the proposed taxonomy is used for the development of a knowledge management system for BD in construction companies.

3. Research methodology

The research methodology used in this study is illustrated in Fig. 1. This study can be divided into two main parts. In the first part, a taxonomy for BD in construction companies is developed by following Rajesh et al. [57]'s study. Then, the developed and verified taxonomy is used to develop a knowledge-based tool to support BD decisions.

3.1. Taxonomy development stage

Rajesh et al. [57] proposed a taxonomy development model, which consists of four stages. These are component collection, allocation of subcomponents to the main components based on propositions, components finalization, and validation of taxonomy. Although the same steps are followed in this study, the methods used in these stages are different than Rajesh et al. [57].

3.1.1. Component collection

In the first stage, terms related to the focused domain were identified

Table 2
BD knowledge stored in participating companies.

Com.	Topics of stored knowledge in the company
1	Country political and economic conditions, Legal agencies in a specific country, Partners, Competitors, Competitive advantages & disadvantages in a market.
2	Country political and economic conditions (in-house reports and consultant companies' reports), Past projects (documents), Technical knowledge (know-how) for specific construction methods, Contact information of clients, and governmental links.
3	Country political and economic conditions, Market competition and demand, Knowledge related to Partners and Subcontractors.
4	Knowledge about Client profile, Contact information of client, and governmental links.
5	Country political and economic risks, Country social conditions, Facilities and Infrastructure condition of a country, Information about client key personnel, Client demand, Client customer relations, Local partners, Own company business condition, vendors, Suppliers and Subcontractors, Own company business development performance.
6	Country economic and financial figures, Country natural resources, Country constructional resources (availability and costs), Geography condition of host country, Market needs, Political stability and political figures, Available budget for construction projects, Client requests, Competitors performance and price levels, Local contractors, Contact info of market links, Previous tenders (documents), Partners.
7	Market connections.
8	Country political and economic conditions, Country climate, Country official calendar, Market regulations, Client contractual conditions (payment policy, prequalification condition), Client projects, Financial agencies (host country and international), Partners, and Suppliers.
9	Country political and economic conditions, Market conditions (analyze reports), previous tenders (documents), Competitors' advantages and disadvantages, Competitors' prices, Client's attitude, and expectations (minutes of meetings and correspondence).
10	Contact information (business cards, reports), Country infrastructure conditions (trip reports), Previous project costs, Client business opportunities, terms of cooperation with the client in the future (know-how), Agreements with the clients (minutes of meetings and correspondence), Own company qualifications (documents), Suppliers, Previous projects (reports), Relevant standards, Market conditions (reports of global market analyzing agents).
11	Contact information of politicians, Available natural resources in the country, Opportunities for foreign investment, Available business fields, Potential private investors (Business interests and performance), Foreign policy of different countries, Policies towards foreign investors in different countries, Clients' needs and demands, Constructional and non-constructional resources, Financial institutions such as the IMF and world bank, Country and Client risks.

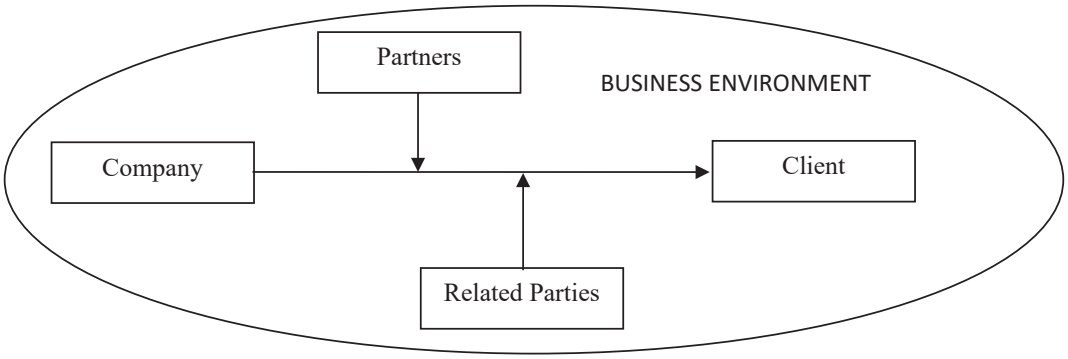

Fig. 2. Construction business diagram.

by conducting a literature- review, semi-structured interviews, and country reports. In other words, firstly, the main and sub-components of the BD knowledge taxonomy were collected.

To perform the literature review, the available studies conducted in the field of BD were identified via Google Scholar and Scopus. The authors reviewed these studies one by one to extract the knowledge concepts of BD. Based on the literature review, 50 BD knowledge items were extracted. Besides, the literature survey shows that the critical knowledge for BD circulates three main categories: own company [21,49,58–60], host country [26,47,58,61–65], and clients [26,47,60,61,65,66].

Following the preparation of the preliminary list, semi-structural interviews were conducted to gather knowledge of concepts that had not been mentioned in the literature. There were four reasons for utilizing the semi-structural interview method in this study. Firstly, interviewees were able to express their valuable opinions without reservation, thus enabling a comprehensive understanding of the domain. The second reason was that tacit knowledge, which cannot be obtained from available documents, could be captured more effectively through socialization and narratives facilitated by an interview-based approach. Thirdly, the taxonomy is supposed to model a framework that reflects how specialists in a field perceive and categorize knowledge; therefore, semi-structural interviews were employed to reveal these existing frameworks in the minds of experts. Finally, the use of semi-structured interviews ensured that respondents understood and interpreted the questions accurately.

Turkish contractors are highly active in the international construction market. According to ENR [67], there are 40 Turkish construction companies on the list of the top 250 international contractors in 2021. Therefore, in this study, the target population was determined to be Turkish contractors. The judgment sampling method, which is an effective method for determining the experts in a specific area, was utilized. This method improves the reliability of the study. Three criteria were used in selecting the experts to achieve high expert competency and eliminate the researcher's bias, which is one of the most crucial deficiencies of judgment sampling [68]. According to the first criterion, the experts' companies should have at least ten years of experience in the construction market. To fulfill this criterion, the study contacted eleven construction companies affiliated with the Turkish Contractors Association, Turkey's largest contractors' association. All these companies agreed to participate in this study. Secondly, these companies were evaluated based on their workload in the international construction market to ensure that they have the necessary international BD knowledge. According to Table 1, all the companies are active in the international market, even, nine of the companies are on ENR's Top 250 International Contractors list for 2021. Also, these companies are active in various construction project types such as building, transportation, infrastructure, industrial structures, energy, and other fields, indicating their diverse experience. Finally, to ensure that the experts chosen for this study have relevant experience in the BD processes of their respective organizations, participants holding managerial and administrative positions were selected from these companies. A total of twelve experts who met all criteria were invited to participate in this study. Each company is represented by one interviewee, but only one company is represented by two interviewees. All participants hold executive positions such as BD managers, country managers, project managers, and deputy general directors. Additionally, the experts have an average professional experience of 18 years, with extensive experience and knowledge in BD, both locally and internationally, enabling them to provide valuable insights into the research.

While all interviews were performed one-on-one, a focus group discussion method was used with two interviewees from the same company. However, their responses were treated as individual responses, just like those of the other participants, to ensure a consistent data collection process. The duration of each interview was approximately 1.5 h.

In the first part of the interview, the interviewees provided information about themselves and their companies. Secondly, they were asked to list the knowledge concepts that are captured and stored in their respective companies, to disclose valuable BD knowledge.

Besides, to reveal the additional knowledge concepts, country reports were also examined, since most construction companies use country reports to store valuable BD information and knowledge [21]. In these reports, country information (such as weather conditions, and accommodation possibilities), market information (such as regulations, standards, and potential opportunities), contact details, meeting reports, reports on accomplished missions, and information about other markets are available. By integrating the country reports provided by the interviewees and insights obtained from semi-structural interviews, a list of topics of stored knowledge concepts given in Table 2 was extracted.

3.1.2. Component finalization and development of a taxonomy

As stated above, the literature review identified three key components. To ensure their validity, these components were presented to the interviewees. However, nine participants objected to this framework and proposed that the primary components should pertain to the construction business. Therefore, the construction business models were examined, based on Berg et al. [69], The business model refers to the actions that involve a company's products or services, which are available to existing or potential clients in a business setting, and involve partners and related parties. Fig. 2 illustrates the construction industry based on this definition. Subsequently, by discussing this model with the participants, five new main components were identified. These essential components include the Business environment, Clients, Partners, Related parties, and Own company.

To confirm the knowledge concepts extracted from the literature survey, the interviewees also evaluated fifty knowledge concepts based on a 1–3 Likert scale. On this scale, 1, 2, and 3 stand for uncritical, medium, and critical, respectively. Based on the average of the knowledge concepts, only the "advertisement technologies" knowledge

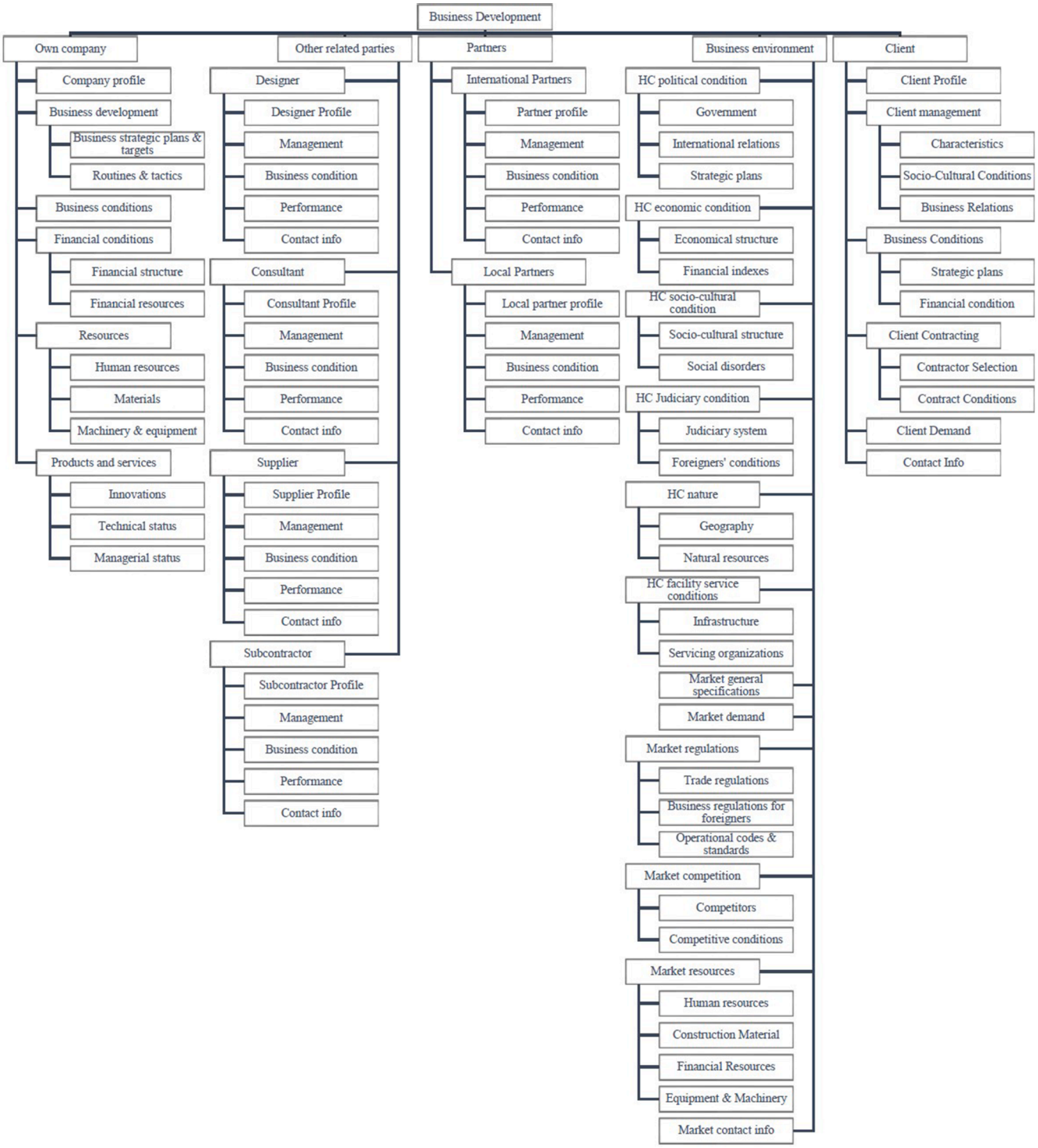

Fig. 3. Hierarchal structure of the taxonomy (Note: HC = Host Country).

Table 3
Results of the navigation test.

Respondent	Accuracy in navigation of concepts (%)	Final decision about the taxonomy
Participant 1	85 %	"Good"
Participant 2	74 %	"Acceptable"
Participant 3	76 %	"Good"
Average	78 %	–

concept has an average lower than 2 (average = 1.55). Therefore, it was eliminated from the final list. By integrating the knowledge concepts extracted from a detailed literature review and insights and suggestions obtained from conducted interviews, a new list of knowledge concepts was prepared. The number of knowledge concepts increased to fifty-two by renaming, splitting, and merging various categories to increase usability and understandability in this list. This new list consists of three newly suggested knowledge concepts, namely "host country strategic plan", "host country natural resources", and "contractor selection".

Fifty-two knowledge concepts were categorized under these five

main categories by conducting brainstorming sessions. This list was presented to the experts; however, eight experts found this list complex and difficult to use. Therefore, to increase the applicability of the taxonomy, another level was inserted into the taxonomy. In other words, a new taxonomy structure with three hierarchical levels was adopted in this study.

To identify second-level subcomponents, a focus group discussion method in which data is gathered through a dynamic and participatory group conversation, supervised by a moderator [70], was used. This method was selected over the other methods since the interaction among participants in the focus group discussions allows for the exchange of ideas, points of view, and experiences [71]. First, the number of experts who will take part in the focus group discussions should be determined. According to the literature, there is no agreement on the size of the focus group. However, more than ten participants can make the session complex and difficult to manage, while a focus group session with a few participants can lead to reliability concerns [72]. Therefore, the best size is recommended between six and eight. Consequently, the focus group discussion sessions were conducted with six experts who also participated in the previous stages of this study. The first six experts in Table 1 are these experts.

At the first stage of the focus group discussion, the fifty-two subcomponents were grouped based on their similarities to establish the second level of the taxonomy. In other words, the inductive approach was followed during this stage. Until all subcomponents were assigned to a group, focus group discussions were performed. Some third-level subcomponents were allocated to multiple groups, while others did not fit into any category and were subsequently promoted to the second level. Initially, the taxonomy did not include any second-level subcomponents under the "other related parties" and "partners" main components. However, to enhance its comprehensiveness and clarity, the participants recommended decomposing these main components into second-level subcomponents. As a result, four second-level components were identified for other related parties, namely, designer, consultant, supplier, and subcontractor. Similarly, partners were decomposed into two subcomponents, namely local and international partners. Ultimately, the taxonomy encompassed thirty second-level subcomponents and a total of seventy-two third-level subcomponents. At the end of the focus group discussions, a taxonomy whose hierarchical structure is represented in Fig. 3 was obtained.

3.1.3. Validation of the taxonomy

To confirm the practical aspects of the offered taxonomy, three separate methods have been used, which will be discussed below.

3.1.3.1. Interactive workshop. Initially, interactive workshops were conducted with three distinguished scholars who have significant experience in the fields of BD and KM. These scholars have also established a sound research record on these subjects. The final taxonomy was presented to the participants, who thoroughly examined the concepts and clustering patterns. The participants evaluated the taxonomy in terms of completeness and the user's comprehension of its concepts. After the workshop, the participants deemed the taxonomy to be comprehensible. Additionally, they acknowledged that it incorporates a practical classification system containing critical and pertinent concepts.

3.1.3.2. Navigation test. A navigation test was conducted with three domain experts to ensure the validity of the proposed taxonomy. These experts have over two decades of experience in construction and project management, and all of them have practical experience in this field. The test comprised fifty-three hypothetical knowledge subjects on different knowledge concepts. The participants navigated these knowledge subjects and assigned them to the appropriate concepts, then the completed lists were control for examining the taxonomy's layering condition and evaluating its feasibility of processing through its layers to locate the appropriate position for knowledge.

Upon completion of the test, the experts stated that they could navigate through the taxonomy and tag knowledge subjects to the correct positions in the taxonomy easily and practically. Furthermore, the experts were asked to comment on their understanding of the taxonomy's concepts. The respondents reported that the primary issue they faced while using the taxonomy was their inability to comprehend certain terminologies present in the test and taxonomy. However, after the test, the necessary explanations resolved most of the problems. A summary of the navigation test is provided in Table 3.

According to the results of the test, respondents can navigate through the taxonomy with 78 % average accuracy, and this can be considered a fit result. Finally, the respondents recommended the taxonomy to the construction industry and stated this taxonomy can be used by the construction industry to improve their BD processes.

3.1.3.3. Case study. Finally, the effectiveness of the taxonomy in organizing tacit knowledge in actual scenarios was evaluated through case studies. The case study was selected to examine the effectiveness of the proposed taxonomy since case studies are considered an effective

Table 4
Verbal analysis for identifying knowledge in a case study.

Actual Statement	Identified Knowledge	Appropriate Category in the Taxonomy
"In 1992, we participated in a housing project located in East Berlin. During the bidding stage, I received communication from the Turkish ambassador in Berlin, who informed me of an existing agreement between the Turkish and German governments that allowed for the transfer of a total of five thousand labor units from Turkey to Germany per year. Based on this information, we prepared our tender based on the price of Turkish labor costs and were successful in securing the project.	Under the agreement made between the Turkish and German governments in 1992, Turkish contractors have the right to bring a maximum of five thousand Turkish workers per year to Germany to work as laborers. However, this law applies only if the client is the German government and is not valid for any private or other types of clients.	HC judiciary condition-Foreigner's condictions
However, our application for a group work visa for our labor force was denied two months later. We immediately investigated to determine the cause of this issue and discovered an explanation that had not been previously disclosed. This explanation stated that the aforementioned agreement only applied to contractors who were collaborating with German government clients. Unfortunately, none of the Turkish contractors were aware of this explanation at the time of bidding.	Embassies located in two countries can be an excellent resource for obtaining information on governmental agreements. It is important to maintain positive relationships with ambassadors, diplomats, and other embassy personnel to properly appreciate their value. Keeping their contact information readily available will ensure seamless communication.	Market Contact Info
Due to our client being a non-governmental organization, we were unable to utilize labor from Turkey and were compelled to source it from Germany instead. This decision proved to be a costly one as German labor expenses were 2.5 times higher than those of Turkish workers. Consequently, the project's budget suffered a loss of nearly 70 % by its completion."	The bureaucratic period for applying for a group work visa to the German embassy in Ankara is approximately two months.	HC political condition-Government
	In 1992, German labor costs were 2.5 times more than that of Turkish workers.	Market resources-Human resources
	Turkish contractors have cost advantages in Germany's construction market due to their low labor costs.	Market competion-competitive conditions

Fig. 4. Use case diagram of a BD knowledge-based tool.

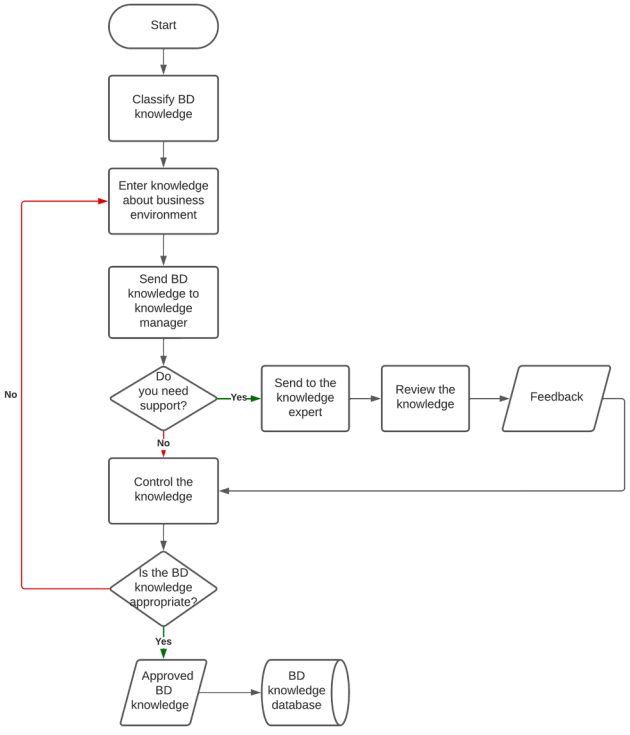

Fig. 5. Workflow of storing BD knowledge in the system.

method for performing an in-depth and comprehensive investigation [73]. Furthermore, it can demonstrate to construction companies how the taxonomy can aid in managing BD knowledge. To perform this validation test, the oral history interview method was used with an expert who has more than 30 years of BD experience in the international construction industry. In the oral history interview method, the participants talk about their own experiences [74], thereby knowledge that is only present in people's memories can be captured. In this study, the expert shared some of the insightful knowledge that he had acquired via his extensive experience working in several construction marketplaces, such as Germany and Oman, by recalling significant historical events from real-life cases. His comments were verbatim analyzed, and similar ideas were noted. With this method, the applicability of the taxonomy to organizing BD data was evaluated in a real-life case. Table 4 shows a verbal analysis example and the proper category for knowledge identified for Germany. This stage lasted three hours in total.

3.2. Development of a knowledge-based tool for business development

The final stage of this study involves the development of a KM tool that can be employed to capture, store, and apply BD knowledge. This tool will enable companies to utilize their knowledge more effectively to make better-informed BD decisions. The tool has been created using Java as a web-based application, as such applications allow for live knowledge capture, which is highly effective in capturing the user's tacit knowledge.[14]. Furthermore, web-based applications designed for live knowledge capture are considered to be practical solutions for successfully capturing knowledge, due to their ability to overcome time and geographic constraints [75].

In the first stage, a process model was designed to identify all the

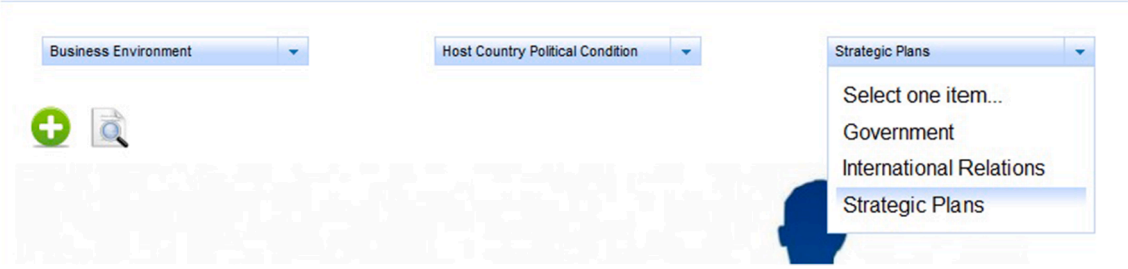

Fig. 6. Screen used for new knowledge submission and search the knowledge in the database.

Fig. 7. Knowledge input screen for business environment.

processes involved in utilizing the system. The model formed the basis for categorizing users into four groups that have varying levels of authority in the tool. Fig. 4 illustrates the roles and responsibilities of each group in the system.

The first group, called the data source, is responsible for entering BD data into the tool. The user must categorize the knowledge according to the taxonomy developed in this study. Specifically, the knowledge should be entered into the tool based on the third-level structure proposed in the study. The user must also provide a brief description, an explanation, the source, related country, date, and rate of the BD knowledge, and upload any relevant documents. This group is responsible for gathering newly developed knowledge linked to the BD.

The second group is the knowledge manager who plays a key role in the system and has complete access to all features and control over the actions of the other users. The knowledge manager is responsible for system maintenance, defining user roles, controlling data entry, and classifying approved data according to the proposed taxonomy. The primary responsibility of the knowledge manager is to monitor the data to ensure high-quality knowledge exists within the system. A successful KMS must produce high-quality knowledge (relevant, correct, and trustworthy) to persuade users to use the system efficiently [76]. Without this, users will have to conduct time-consuming and ineffective knowledge searches. To ensure high-quality data is maintained, all inputs provided by the data source must be analyzed, and adjustments requested where necessary. The knowledge manager also has the authority to edit user roles. Security is crucial to the KMS due to the value of the knowledge contained within it. Therefore, based on their roles, users have access to different system functions to achieve the required security.

The third group consists of knowledge specialists who are experts in their respective fields of KM. When knowledge is submitted to the KMS, the knowledge manager shares that information with the specialists to receive their feedback and authenticate the knowledge. The last group of users are the ones who use the system to make informed decisions based on the BD knowledge available. They can retrieve the knowledge from the system and review it, as well as add comments to it. These comments are first sent to the knowledge manager for approval, and if they are accepted, they become visible to other users.

The tool is used to capture, store, and retrieve the BD knowledge. The workflow shown in Fig. 5 shows the process details of capturing BD knowledge. According to the workflow, firstly, the user should classify the knowledge according to the taxonomy. For this purpose, the screen shown in Fig 6 is used. Once the data is classified, the user will enter the relevant country, code, a brief description, and an explanation of the data via the screen as shown in Fig 7 Additionally, the user can attach relevant files to the uploaded information to support the captured data. The user should also rate the data by selecting a rating between 1 and 10, where 1 indicates low criticality and 10 indicates high criticality. This rating helps the data user to compare the knowledge captured from different projects and identify the most critical knowledge. To elaborate on the captured knowledge, the user can also contact the provided data source.

After submitting the data, it is automatically sent to the knowledge manager for quality control before storing it in the system. The knowledge manager can also send the data to knowledge experts to evaluate the completeness and reliability of the data. The knowledge experts evaluate this data and provide feedback to the knowledge manager. The knowledge experts can also rate the criticality of the entered knowledge. The knowledge manager can either accept the knowledge or send it back to the data source for modification based on the feedback. If the data is

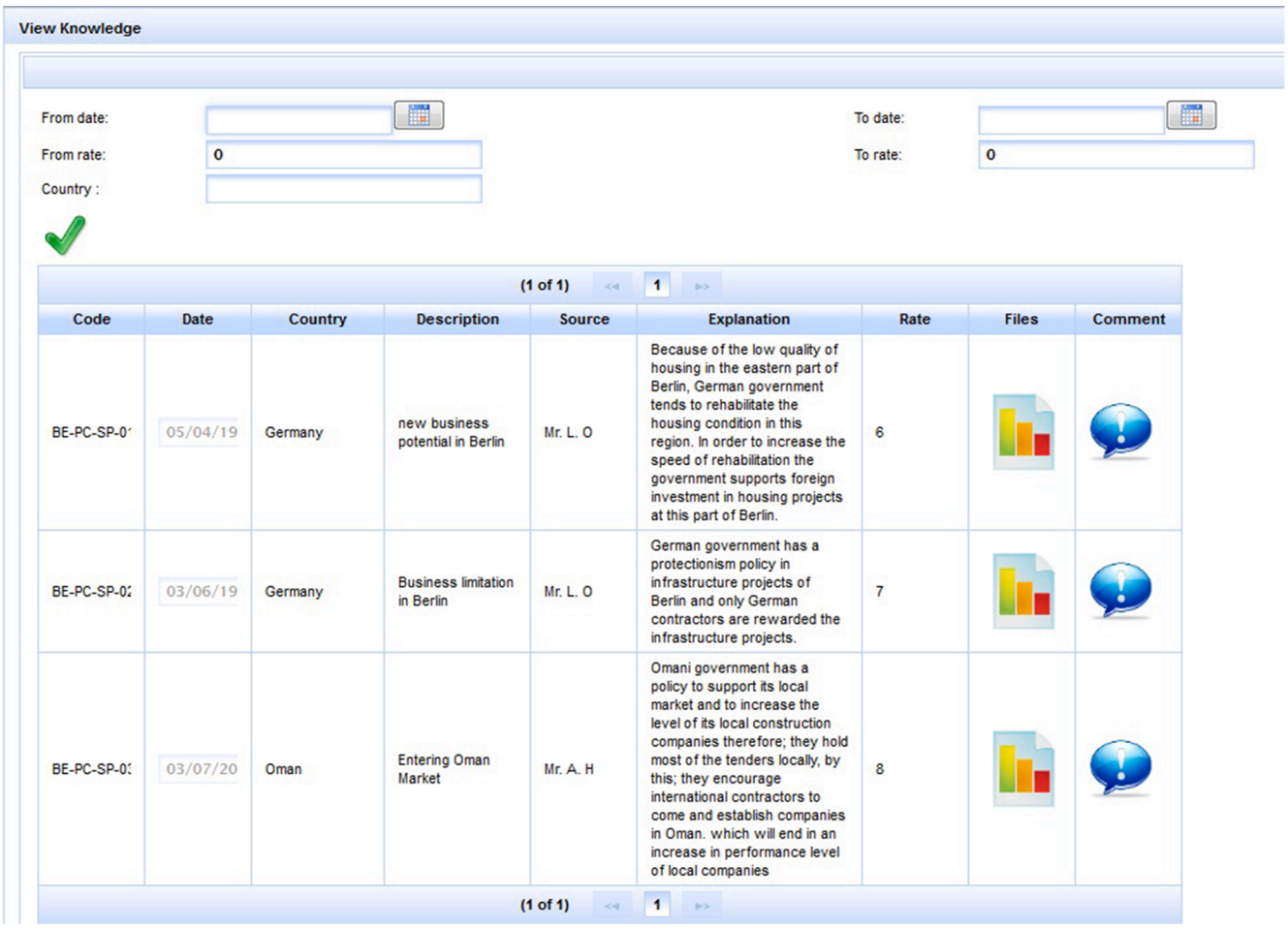

Fig. 8. Search result screen.

accepted, the final criticality rating is decided by the knowledge manager based on the ratings provided by the data source and the knowledge experts. The accepted data is then inserted into the system. This process shown in Fig. 5 continues until the data meets the quality criteria.

Users utilize the tool to support their business development decisions. They can submit new knowledge or search for existing knowledge in the system using the search screen shown in Fig. 6. The screen features a tree search structure that follows a hierarchical taxonomy leveling system. This browsing system is highly useful for knowledge diffusion within an organization, making it easier for users to find the information they need. By utilizing a well-structured taxonomy, users can more easily access relevant content, which helps overcome the current challenges they face in discovering the knowledge they need.

All the knowledge related to the selected component is retrieved and displayed as shown in Fig. 8. By using this screen, the user can also perform filter searches based on the "range of date", "range of rate", and "related country". Thus, the user can decrease the volume of knowledge listed if the scope of the search is clear. Also, the users can download the attached file of each knowledge and can make comments on the available knowledge.

4. Findings of the taxonomy

The developed taxonomy asserts that the main components should be the forces that shape the construction industry. The fundamental components in BD are identified as the main components of the business environment for construction companies. Therefore, construction companies that want to perform BD activities should understand their business environment and capture knowledge about the members of this business environment to explore, identify, and create business opportunities.

To understand the construction business environment, which is complex and dynamic [77], knowledge about the host country and market conditions should be captured and considered according to the proposed taxonomy. However, understanding the business environment is not enough to perform the BD effectively, but also the companies should also identify the changes in the business environment. To achieve this, the companies should observe the conditions of the host country and market continuously. Therefore, the companies can identify newly emerging threats and opportunities in the market. This can lead to taking the required strategic actions on time to eliminate the harmful effects of these threats or use these new opportunities.

Construction companies should also collect data about influencing groups to perform BD effectively. Especially, the client is critical for construction companies in BD since they can create business opportunities and competitive advantages via long-term relationships with their clients [78]. According to the taxonomy, the knowledge about the client that should be captured and stored encompasses the profile, management, business conditions, contract, demand, and contact information of the client.

In the business, the construction companies should collaborate with other parties to complete the projects. This study reveals that knowledge about these parties should also be required to perform BD effectively. According to the taxonomy, these parties are shown as partners, designers, consultants, suppliers, and subcontractors. Companies should know the strengths and weaknesses of these parties to overcome the threats and use the opportunities of the market, since while they are collaborating, the companies can use these strengths to gain a

competitive advantage, on the other hand, also, these weaknesses can lead to threats to the company. Based on the taxonomy, they should collect knowledge about these parties' profiles, management, business condition, performance, and contact information of these parties.

Construction companies should also know themselves to understand their capabilities. In this way, they can reveal whether they can use the available opportunities and overcome the threats in the market. Thus, they can compensate for their weaknesses and prepare themselves for new opportunities. In other words, BD should work with the company's organizational and marketing capabilities to move the opportunity through prequalification and bidding before delivery on the site [79]. According to the taxonomy, construction companies should know their business development processes, financial capabilities, resources, products, and services.

By applying the proposed taxonomy, the companies can capture knowledge about the market and them. This knowledge is critical for performing strength-weakness-opportunities-threats (SWOT) analysis, which is an effective tool for strategic BD [80]. In other words, the companies can perform SWOT analysis more effectively with the help of the taxonomy, and they can perform strategic BD, which is critical for surviving in the market in the long term.

Finally, when we check the subcomponents of the taxonomy, most of the knowledge can be seen as tacit. Capturing and sharing tacit knowledge is more challenging compared to explicit knowledge. Therefore, to capture this knowledge, the companies should follow specific KM strategies, techniques, and methods. Negara et al. [81] mentioned taxonomy and discovered that construction companies classified the tacit knowledge based on the taxonomy. Besides, KMS is recommended as an effective tool for capturing tacit knowledge [82], therefore, to perform BD effectively, the companies should develop KMS specific to the BD process.

5. Conclusion

Traditionally, construction companies use reports to store knowledge in their organizations. However, this is an ineffective method for managing knowledge. It should be captured, stored, and retrieved systematically, and knowledge-based tools can be used for achieving effective KM in organizations. Before developing a knowledge-based tool, the available knowledge must be represented comprehensively. For this purpose, the classification of the available knowledge is an effective method for representing the knowledge, and the companies can use the taxonomy approach to classify the knowledge.

BD has gained importance with the global crisis, such as wars, pandemics, and economic collapse, in recent years, and the companies must perform BD effectively to survive in the market. The available knowledge is an important input to effective BD. Therefore, a taxonomy developed to consider BD activities can be an effective tool for improving the performance of BD activities. Companies can organize their BD knowledge and refer to it in their upcoming decisions through taxonomy. Also, the taxonomy can serve as the initial step for collecting data for new business opportunities and updating the existing data. Consequently, Consequently, to help the construction companies in the management of BD activities, the foremost aim of this study is to construct a taxonomy for construction companies by referring to the experiences obtained from the Turkish contractors and to develop a knowledge-based tool to support BD decisions based on this taxonomy.

In the first stage of this study, knowledge concepts related to the BD domain were extracted after a comprehensive literature review. Later, these knowledge concepts were revised through semi-structured interviews and focus group discussions with industry professionals. Based on the captured insights, a taxonomy specific to BD knowledge was developed, and this taxonomy has been validated following three steps. First, researchers conducted an interactive workshop with three domain scholars. Later, a navigation test with three domain experts was conducted, and it appeared that, on average, 78 % of the knowledge concepts were navigated correctly. As the ultimate step, a case study regarding the usage of the taxonomy in real-life conditions was conducted.

According to the validation process results, the created taxonomy can be regarded as thorough, user-friendly, and exceptionally effective at organizing knowledge for BDM. Besides, the balance between depth and coverage can be achieved with the proposed taxonomy. Therefore, this taxonomy was considered appropriate for developing a knowledge-based tool, and a knowledge-based tool was developed. This tool can help decide the attractiveness of potential projects and markets based on the experience obtained from different projects.

The developed taxonomy supplies a semantic representation of the BDM domain for construction companies and this taxonomy can be further used to develop ontologies. Besides, this taxonomy can be used as a basis for further research concerning BDM in the construction industry. In the professional setting, business developers can use the focal areas of the taxonomy to evaluate their knowledge capabilities. The other researchers can use these steps while developing a taxonomy and developing a new knowledge-based tool. Finally, although the focus industry for this study is construction, new KMS for different industries can be developed by modifying the proposed taxonomy and developed tool.

It is crucial to mention that the study was conducted with the Turkish construction companies, therefore the findings of this study reflect the Turkish contractors' opinion on BD taxonomy. However, the data can be valuable for other contractors, since Turkish construction companies are active in the international construction market and work with companies from other countries. Besides, this taxonomy cannot be a "one-size-fits-all" solution. Therefore, the companies should tailor the proposed taxonomy according to their companies' priorities. However, this study still supplies comprehensive insights for developing the taxonomy particular for the company.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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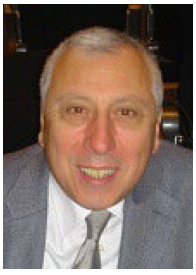

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