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Combination of Modeling Techniques for Business Process Modeling

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***Abstract*— Several modeling techniques have been proposed over time while selecting an appropriate modeling technique is a challenging task and requires to study on the evaluation and comparison of modeling languages. This paper concentrates on consolidating existing literature instead of modifying modeling techniques evaluation by utilizing the most commonly used evaluation methods (Curtis et al.'s framework). The focus of this study is based on seven modeling languages. Based on the selected modeling languages, a methodology is proposed for business process modeling, which is applied in a real case study. Finally, interviewing 15 experts by means of a questionnaire, which was prepared based on the Method Evaluation Model, validated the proposed methodology. The finding implies that the combination of three techniques -IDEF, UML, and BPMN- complement each other in modeling business process that would inspire rapid design and more flexibility in business process modelling.**

***Keywords*— modeling language; business process modelling; method evaluation model; verification and validation**

I. INTRODUCTION

With regard to Business Process Management (BPM), IT experts produce business process models as shared language among business managers and stakeholders, process analysts, and industrial engineers [1]. Therefore, business process should be structured in a flexible manner to allow full use of Enterprise Information Systems (EIS) [2]. Consequently, many reference models and modeling methodologies have been developed in the field of EIS to support the requirement for the modeling of business processes, the development, and implementation of information systems. However, they cannot support both the coordination and interaction of process models in more details, that is, the representation of detailed process models [3], [4]. To consider business process entails laying emphasis on process models as the core object for the attainment of the necessary agility and interoperability of information systems. Hence, on the problem of process modeling, tools and methodologies and the formal modeling languages are required to procure an interpretable, methodic, structural, and comprehensive explanation of information and varied characteristics of the processes [5]-[7]. Furthermore, no modeling construct fully covers different views and layers to represent the process models [8]. Therefore, to clearly represent a process model from different aspects and to make them more understandable both to the process analyst and Information systems developers, it is required to choose more than one kind of modeling languages [9]-[12]. Therefore, the problem is to select the appropriate modelling languages to accommodate for both practical and theoretical aspects appears to be a deficiency of process modelling. Hence, to address this issue, efforts are made to select appropriate modeling languages; and to propose a process modeling methodology by the combination of the modelling techniques.

An effective and integrated Business Processes requires Business Process Management (BPM) life cycle from modeling to implementing and monitoring of business processes [13]. In this regard, BPM is a specific field including concepts, methods, techniques, and tools to design and analysis, implementation, and enactment of business processes [14]. Industrial engineers apply BPM in organizations as an optimization technique. In order to execute and monitor the business process, IT specialists consider it to provide a shared language for communicating with business managers and process analysts, and industrial engineers [1]. Therefore, there are many stages in BPM for executing business processes and organizing business process cycle that is referred as BPM life cycle. Therefore, process modeling operates as a foundation for the consecutive stages of the BPM lifecycle [1], [15]. Moreover, process modeling can be used for different purposes such as to represent business logic more coherent as well as improvement BPM, to support communication between business users and IS developers, to help process analyst understand the domain, to procure documentation of the enterprise and requirement specification for IS development,

and as a means of process benchmarking and simulation [16]-[18].

A flexible execution of business processes requires process model in high quality of syntactical and semantic formats, particularly in the sequence of activities, events, information flow [19], [20]. Therefore, a proper modeling language must be selected to represent a conceptual model of business processes [21], [22]. Furthermore, it is worth mentioning that the properties of the real world and the interactions among its constructs and components have to be considered as the basis for modeling languages which are used in information system models [23]. Thus the significance of the process model should be based on underlying modeling techniques instead of focusing on the process representation [24].

The paper consists of four sections. It begins with an introduction followed by an overview of business process modeling with an emphasis on modeling techniques. Section II begins the evaluation of the business process modeling languages, and then a modeling methodology by the combination of the modeling languages is proposed. The proposed methodology applying in a case study is illustrated in Section III which includes the validation process. Finally, the last section terminates with concluding remarks on the scope of this study.

II. Material and Method

In this section, first the evaluation process for the modelling languages is discussed, and then the proposed method is illustrated.

A. Evaluation of Modeling Languages

Process modeling techniques can be evaluated by the extent to which they appropriately represent different perspectives in a real process environment. In a deeper sense, to describe software process models, the integrated information is concerned with who extracts information from a process model, what type of information is extracted, when and where it is performed, and how and why it is processed [36]. The aforementioned discussion sets the ground for a framework which represents software process models from various views; this framework, known as Curtis framework, includes the most common perspectives: Informational, Functional, Behavioral, and Organizational views. The informational view represents the information entities (data, artifacts, products, etc.) which are involved in processes; this view includes both the structure of information and the relationship between them[36]. The functional view represents what process elements (activity or atomic activity, and sub-process, etc.) are being performed, and what information entities are related to process elements. Behavioral (or dynamic) view represents when and how to process elements are performed. The organizational view represents when and by who process elements are being performed [36]. A critical comparison of the modeling techniques analysis based on Curtis framework is illustrated in Table 1. The applied framework compares BPMLs in terms of three scenarios: 'notation is available', 'construct is possible to present', and 'definitely'. This approach is based on studies by [26], [27]. 'Notation is available' is used for those perspectives, which are not fully supported by modeling techniques, though there are a few modeling techniques constructs, which represent the views. The situation which is termed "construct is possible to present" means that the perspectives cannot be fully supported by the modeling technique and there is no coherent construct to illustrate the view, but it is possible to represent it by similar or related notations. 'Definitely' stands for the proper construct of a modeling technique which illustrates the perspective, and there is no ambiguity about its suitability for representing.

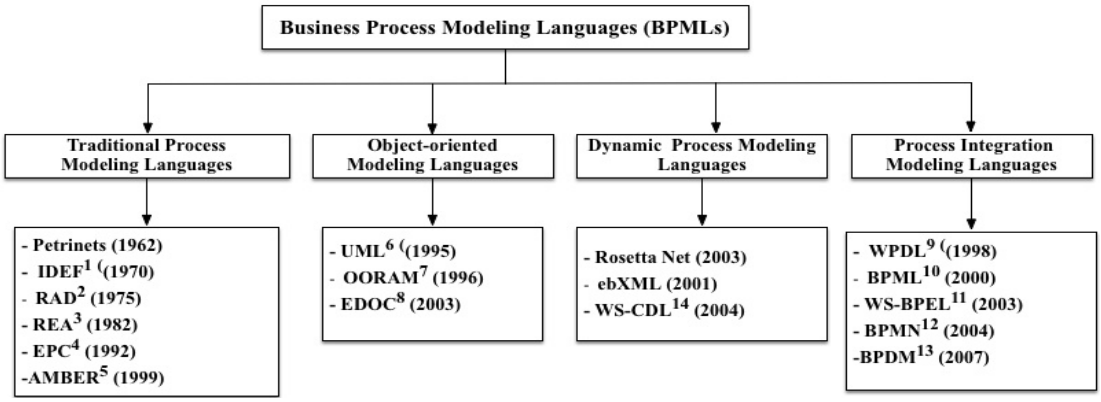

Fig. 1 Classification of business process modeling languages (BPMLs)[1]

Business Process modeling Language, 11 WS-BPEL: Web Service Business Process Execution Language, 12 BPMN: Business Process modeling Notation,13 BPDM: Business Process Definition Meta-model ,14 WS-CDL: Web Service Choreography Description Language. Business Process Execution Language, 12 BPMN: Business Process modeling Notation, 13 BPDM: Business Process Definition Meta-model, 14 WS-CDL: Web Service Choreography Description Language.

TABLE I
EVALUATION OF THE BPMLS BASED ON CURTIS'S FRAMEWORK

Language	Informational View	Functional View	Behavioral View	Organizational View
Petri Nets		Notation sub process and atomic activity possible to present	Definitely by notation Control flow	
IDEF	Definitely by IDEF1 and IDEF1x	Definitely by IDEF 0	Definitely by IDEF3	
UML2	Notation Event and Data repository are available, Data object and Data flow are possible to present	Notation (atomic) activity is available	Definitely	Notation Process participant is available, Units and Roles are possible to present
BPML	Data definition by using XSD		Definitely	It's possible to present
BPMN	Notation Event, Data object and Data flow are available	Notation sub process and atomic activity are available	Definitely	Notation Process participant is available, Units and Roles are possible to present
WS-BPEL	It's possible to addressed by executive language		Definitely	
ebXML	Definitely		Definitely	It's possible to identify the responding role

Table 1 shows that the behavioural (dynamic) view can be fully supported by all modeling techniques (100% completeness in this view), but the functional view and the organizational views are supported to a limited extent. The informational view is covered but not as well as the behavioural view. Also, all the modeling techniques can partly or fully support this view except Petri nets. Furthermore, none of the modeling techniques fully covers the organizational view. Therefore, from the organization's point of view, there is a need for explicitly supporting the business process context by modeling techniques [26]. Interestingly, modeling techniques such as UML, and BPMN are similar with regard to their coverage of not only organizational perspectives but also other perspectives, including informational, functional, and behavioural perspectives. It would appear that in order to describe which (atomic) activity is to be performed by which organizational entity requires connecting the underlining organizational structure of a company to the activities or the sub-process of its business process [37]. Table 1 demonstrates convincingly that the IDEF families, consisting of IDEF0 for function modeling, IDEF1 for information modeling, and IDEF3 for process modeling, have high performance for supporting different perspectives in terms of informational, functional, and behavioral views. Table 1 suggests convincingly that modeling techniques such as IDEF, UML, and BPMN are richer than others in terms of supporting different aspects based on Curtis framework. Therefore, this implies that the combination of these three techniques would inspire rapid design and more flexibility in business process modeling.

B. Proposed Modeling Methodology

The basic requirement of the modeling methodology in the Business Process Architecture consists of three layers including process landscape model, abstract models, and detailed process model [1], in which, these layers are supported by the combination of three modeling techniques, recognized as IDEF0, UML-Use case, and BPMN in the proposed modeling methodology. The methodology comprises of two phases, namely, Process Area Specification, Business Process specification. Each of these phases is shown in Fig. 2 and discussed in details.

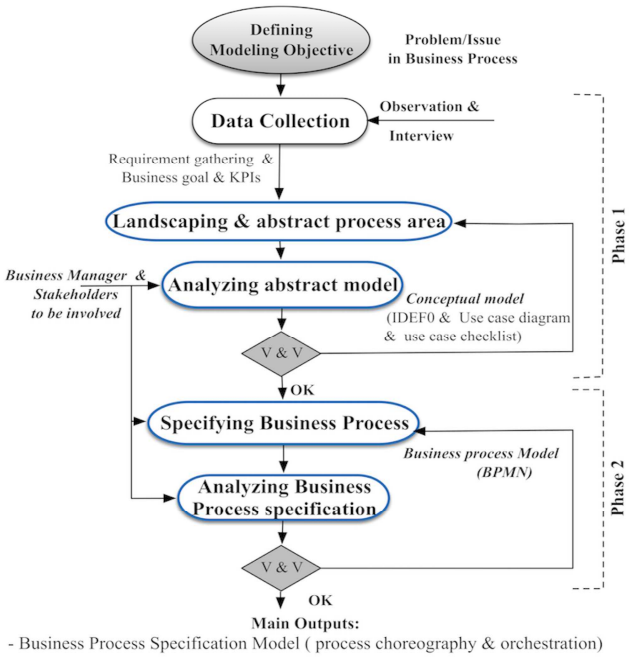

Fig. 2 The proposed modeling methodology

Regarding the modeling methodology in Fig. 2, a brief explanation of the major activities in the methodology is initially presented. "Method and Technique" is illustrated on the left side. Under this rubric, there are a number of sub-

rubrics, which demonstrate the methods, and techniques, which are applied, for each main activity. On the right, under the rubric "Output," the diverse outputs resulting from each main activity is listed.

In Phase 1, the data related to the business process are first collected. The applied techniques include observation and interview. In case there exist documents, these documents can also be used along with observations and interviews. At this stage, business goals are identified. Then, the data related to the business processes are transferred to the worksheets, which are employed to identify the scope and boundaries of the process. Next, the worksheets and the collected data are documented in the form of a conceptual model. This documentation is a task of activity named as 'Landscape & Abstract Model Documentation'. The modeling techniques applied here are IDEF0 and UML-UC. The last activity in Phase 1 is concerned with 'Analyzing Abstract Model', which applies verification and validation (V&V) Questionnaire, participating the domain experts. The feedbacks are collected, and necessary modifications are applied. In the first activity of Phase 2, data related to the abstract model are transferred to the business process worksheets. In this activity, all detailed activities within business processes and their flows are identified, and finally, they are documented by means of BPMN. The outputs of this activity are detailed process models, which must be analyzed. For the analysis of business process models, the modeling tool SIGNAVIA and 'Business Process Analysis Questionnaire' are utilized. In the following, each of two phases in the methodology will be elaborated in more details. After data collection, the second activity in Phase 1 is the documentation of potential requirement via worksheets and checklists and to transfer them in diagrammatic format by function modeling and use case. At this point of Phase 1 first draft landscape and abstract models are designed. The process landscape model poses a serious hindrance for process identification [1], for to hold communication with business specialists is commonly based upon plain text and rarely in the form of a diagram. To this end, worksheets and checklist are supplied as efficient means to sustain the extant domain knowledge [38]. During the same task, standard worksheets—adopted from [38], [39] with some modification—are provided for landscape models (Tables 2 and 3).

TABLE II
BUSINESS AREA WORKSHEETS

Worksheet: Describing Business Area		
Author(s):	**Date:**	**Status:** *Draft, Review, Final*
Business Area Name		
Description		
Scope		
Boundary of the Business Area		
Constrains		
Stakeholders		
Process Area		

Source: Adopted from [38], [39]

TABLE III
PROCESS AREA WORKSHEET

Worksheet: Describing Process Area		
Author(s):	**Date:**	**Status:** *Draft, Review, Final*
Process Area Name		
Objective		
Scope		
Boundary of the Process Area		
Constrains		
Stakeholders		
Business processes		

Source: Adopted from [38], [39]

After identifying the scope of the business area, the boundary of process area points out the function model which can be decomposed into a structural level by IDEF0. Next activity is the identification of organizational roles and actors, which can be represented by Use Case diagram. The interaction between use cases and actors can be transformed in Use Case diagram according to the decomposed level of function modeling. Moreover, description of the use case diagrams can be performed by checklist such that it more supports inspection and review of the abstract model [40]. In this regard, a checklist is adopted from [40], [41] with some modification which is shown in Table 4.

TABLE IV
USE CASE CHECK LIST

Use Case Number:	**Title:**	
Author(s):	**Date:**	**Status:** *Draft, Review, Final*
Brief description:		
Actors:		
Trigger:		
Pre-condition and Post-condition:		
Basic flows & Alternative flow(s):		
Extension point(s):		
Business rules:		
Special condition:		

Source: Adopted from [40], [41]

The function modeling-IDEF0 can be interpreted as a sequence of activities, but roles cannot be represented [42] while in Use Case diagram, there is no sequence between use cases, but the role of actors can be expressed. Moreover, a process abstract model is initially represented by the definition of context diagram using IDEF0 in which can be decomposed in several layers. The decomposed level of function model can be followed by Use Case diagram to represent more details and to show how actors involve in the system. Therefore, as stated by Kim et al. (2003) and Razali et al. (2010), the combination of IDEF0 and Use Case diagram complete each other, which leads to represent process abstract models more perspective. The last activity in Phase 1 is concerned with the analysis of the abstract model to determine whether the adopted requirements are complete, unambiguous, clear, and correct. In this phase, validation poses a challenge without any domain expertise and verification continues to be insufficiently developed.

Abstract model quality is usually assessed by domain experts and business managers or users in inspections [40]. To this effect, a number of inspections are implemented to make sure that there are no errors in the models and that the

models are developed according to standards [40] in which inspection techniques are required by means which an expert provides visual evidence to prove that a given fact or a proposed requirement is taken into account. To do this, a checklist is provided based on the important quality attributes including functional correctness, completeness and consistency, and redundancy and ambiguity as main important quality attributes for process abstract model [40], [43, [44]. In the abstract process model, IDEF0 diagram can be decomposed to several lower levels, but it does not contain specific constructs for detailed process model [9], [45]; and in Use Case diagram important processes are identified, but details can not be captured [46]. As a result, both IDEF0 and Use case diagram are not able to represent all aspect of the process. Thus, for modeling all activities involved in the processes, it is required to apply standard process modeling language such as BPMN. So doing, the first activities of phase 2 are the analysis of the abstract models and business process worksheets.

To control the quality of process model is essential for the appropriate representation of the business logic and better communication with domain experts [1]. Drawing on the conceptual model quality framework proposed by Moody et al. [47], syntactic quality is related to verification and semantic quality to validation of process models, with syntactic quality forming the basis of semantic quality which is related to the vocabulary of the modeling language. Semantic quality is the statement of the process model derived from the real world. In the stage related to the analysis of the process models an online modeling tool (http://www.signavio.com) is applied for the verification of a given model; and for validation a questionnaire is prepared based on the core components in BPMN including user roles and activates, sequence flows between activates, alternative path, and events (notification, messages, and triggers) as stated in [48].

III. Result and Discussion

In this section first, the proposed methodology is applied in the case study; and then the validation of the methodology is discussed.

A. Case Study

The case study is the procurement process of Sapura Brake Technology (SBT) that supply and sale of brake systems for the automotive industry in Malaysia. In the case study, in-depth semi-structured interviews were performed with three operation managers; and the data collected were used to identify the scope and boundary of the process in order to create a preliminary version for the landscape process model of SBT's Procurement process. Drawing on the interview and data collection process discussed by Fettke (2007) and Dumas et al. (2013), in the second and third stages for the collection of primary data, three main aspects were taken into consideration: Functions/Processes (i.e. Which activities are carried out in what order?), Organization **(**Who is responsible for these activities?), and Data **(**Which input data are needed? Which output data are produced?).

After the third stage, the initial landscape and abstract process model were provided in the form of the conceptual model. The quality of the business process models had to be checked by V&V technique in order to gain feedbacks and achieve improvement [49], [50]. Therefore, in the fourth stage, the landscape and abstract process models were analyzed to assess the quality of the process model. Finally, in the fifth stage, the third round of interview was performed for examining the quality of detailed process model. In these stages, feedbacks had to be collected and corrected. In the following, a detailed discussion of applying the methodology to the case study is presented, and each phase of the methodology is elaborated.

Regarding the modeling methodology, the chief activities in Phase 1 consist of Data Collection, Documentation of Landscape and Abstract process model, and Abstract model analysis. The procedure of administrating each of the activities in Phase 1 and the output application in the case study is here elaborated. The necessary relevant data for the business process were collected and transferred into the worksheets, which are shown in Tables 5 and 6. In this regard, worksheets assist the communication with business managers and stakeholders, which is often based on plain text. After the worksheets are filled out, the function modeling, IDEF0-context diagram is created according to the data elicited from the process illustrated in Fig. 2. In the identified scopes, the context diagram was decomposed into three sub-functions, namely, Order Management, sourcing, and Purchasing (Fig. 3). The responsibility of the SBT' procurement system is to administer customer orders through the entire order cycle, from the customer inquiry to the delivery of the order. SBT' procurement follows a rather complex process. It consists of order management, sourcing, and purchasing. The three major sub-functions here are order management, sourcing, and purchasing each of which is represented in separate use case diagrams. Each use case diagram demonstrates major activity of the abovementioned sub-functions and the actors involved. The mechanism in function modeling substitutes the actors in use case diagram (Fig. 4). The operation of each sub-function by means of use case diagram is depicted in more details. In each of the use cases, the key activities and their respective actors demonstrate the operation of each sub-function. It must be mentioned that due to the limitation of paper size, the details of other use case are not presented here.

TABLE V
WORKSHEET BUSINESS AREA OF SBT'S PROCUREMENT

Worksheet: Describing Business Area		
Author(s):	**Date:**	**Status:** *Draft, Review, Final*
Business Area Name	Assembly and Brake component Manufacturing	
Description	The data file of the customer' order and requisition is transferred to SBT's Bill of Material (BOM) system, and SBT procures raw materials by the supplier(s).	
Scope	Customer, Production plan (Proton car manufacture), SBT's BOM system, ERP, and supply and sale of brake system	
Boundary of the Business Area	Manufacturing of brake system, Sales, Purchasing raw material, Delivery, Inventory management, system (finished goods and raw material stock), and Logistic	
Constrains	Ordering via product plan by customer company, Supporting MRP system, Automatically check inventory level in customer company, and Web hosting	
Stakeholders	Customer's company, Operation management, order clerk, Stock staff, Assembling dep., Carrier and deliver staff, Supplier, Sub-contractor, Q.C staff, Purchasing department, Accounting department, Banking institution, Stock clerk, and Assembling department	
Process Area	Product development, Manufacturing flow management, Demand management, Order fulfilment, SRM and Procurement, and Return management	

TABLE VI
WORKSHEET PROCESS AREA OF SBT'S PROCUREMENT

Worksheet: Describing Process Area		
Author(s):	**Date:**	**Status:** *Draft, Review, Final*
Process Area Name	Procurement	
Objective	To procure raw materials based on customer, company requirement	
Scope	Monthly forecast and daily customer order, Analysing customer's orders and requirement, and Procure raw materials to fulfil orders	
Boundary of the Process Area	Order management system, Inventory management, Suppliers, and Purchasing and accounting dep.	
Constrains	Automated customer production plan for requesting and ordering, Fully automated inventory system, BOM system	
Stakeholders	Customer company, Supplier, Operation staff, order clerk, Purchasing department, Stock clerk, Accounting department, Sourcing clerk, and Q.C staff.	
Business	1-Order management 2- sourcing 3- Purchasing	

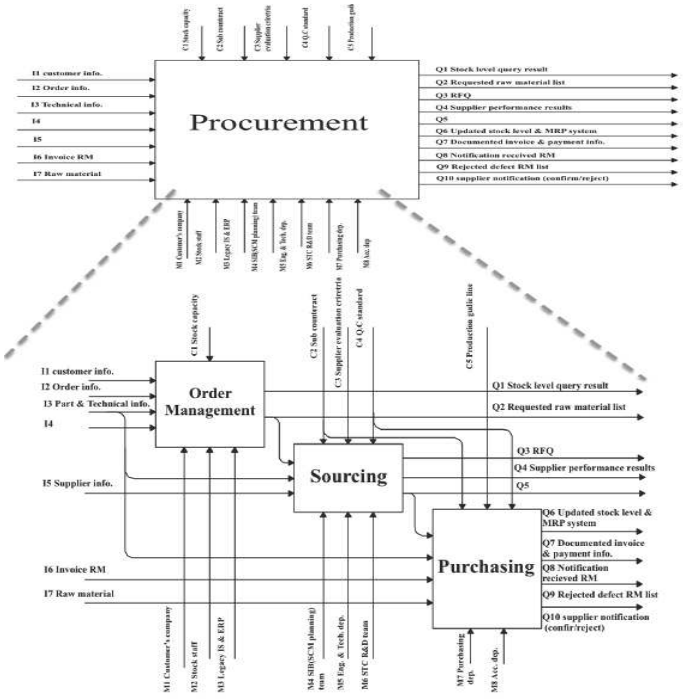

Fig. 3 Function modeling (IDEF0-context and decomposed diagrams)

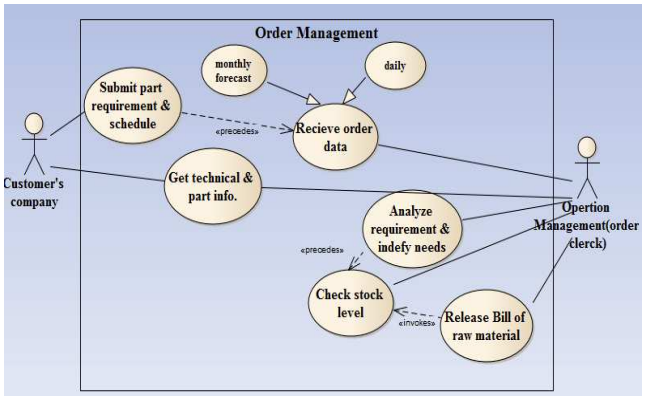

Fig. 4 Use case model of order management

1) Abstract Model Analysis: In this activity, the quality of process abstract models is checked by the use of inspection techniques in V&V such as functional correctness, completeness and consistency, and redundancy and ambiguity. To this end, the abstract model was reviewed and discussed by the domain experts. In this stage, the stakeholders are the individuals who were already selected as the interviewees. IDEF0-Context diagram in relation to SBT' procurement process was discussed. Then all the input and output data, as well as the related mechanism and

control for the main function, were reviewed. Next, the operation of each sub-function along with related use case diagram was scrutinized. After collecting the feedbacks from participating business specialists and stakeholders, the abstract process model was revised.

According to what have been presented in the phase of the abstract model, it could be observed that the combination of IDEF0 and Use Case diagrams including the worksheets and checklists complete each other to represent the abstract process model transparently. However, IDEF0 and Use Case diagrams cannot, in an abstract model, describe business requirements in details. To address this defect, the detailed process model can be represented in a separate diagram by BPMN. In doing so, the detailed process model (that is, BPMN diagram), supported by worksheets, can be linked to abstract process model systematically.

2) Specifying Business Process: The first activity in this phase is the analysis of the abstract model. To this end, the information derived from the abstract models is transferred into the business process worksheets so as to identify the events and activities in the process lifecycle. All necessary information from the abstract models is transferred into the business process worksheet (Tables 8). As it mentioned earlier, due to the limitation of paper size, the details of the customer service process are only presented here.

According to SBT' procurement process, Once the operation team (order clerk) receives monthly forecast or daily order files from customer companies, the orders will be analyzed in order to identify the needs and requirements. The fulfillment of an order can be promised based on existing filled-order in stock, or, for already planned items available as the scheduled capacity whereupon the raw material must be procured from the suppliers. In this situation, when the order clerk receives the bill of material, the sourcing clerk has received technical/part information. The next task is the selection of a supplier. If current supplier(s) cannot provide the requested raw material, potential supplier(s) will be identified, and RFQ is sent to the supplier(s), and then the feedback will be collected and evaluated. In this situation, after the raw material list is requested, sourcing department sends the raw material list, notifying the purchasing department. After receiving the raw material list, purchasing department prepares the purchase list and returns it to the supplier. Candidate supplier receives a requested list of raw material and sends the invoice to purchasing department. The next task is processing the payment by the accounting department and then notifying Q.C staff to check the quality of the raw materials. Finally, a notification (regarding the confirmation or rejection of the raw materials) will be sent to the supplier, notifying that stock clerk has to store the confirmed raw materials (Fig. 5).

Analyzing Business Process Model: For verification, the syntactic quality and the properties of the process model were checked by SIGNAVIO (BPMN online tool). Finally, the process model was corrected and modified by the respective business specialists and domain experts. Fig. 5 shows the BPMN diagram of the SBT' Procurement system.

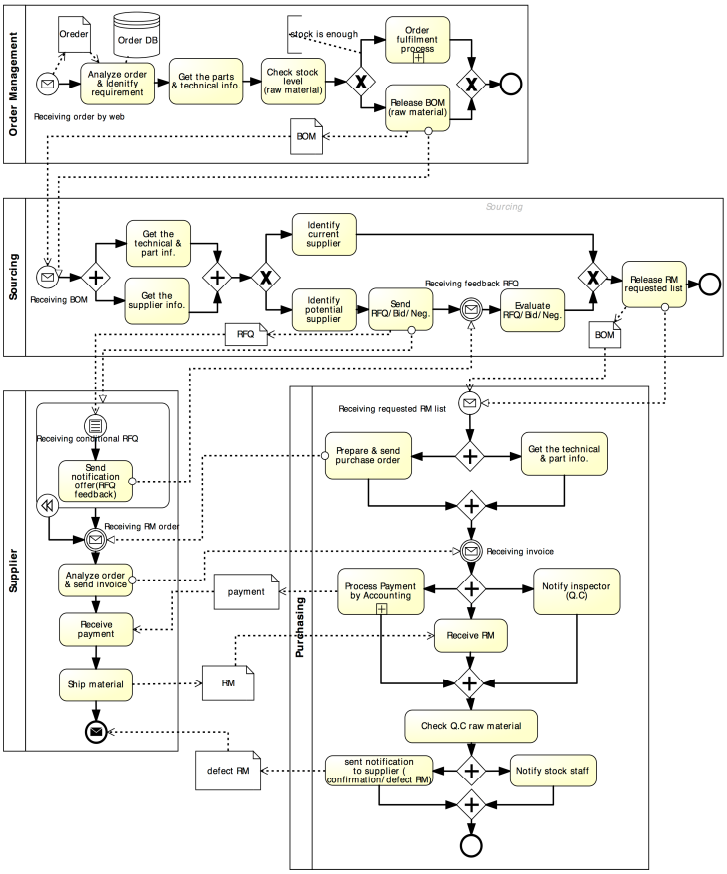

Fig. 5 BPMN diagram of procurement system

TABLE VII
USE CASE CHECK LIST OF ORDER MANAGEMENT

Use Case Number: 1	**Title: Order Management**
Brief description: The required parts are submitted from customer' company through the website. Next, order staff receives order data by operation management system, and after analysing requirements and orders, stock level will be checked	
Actors: Customer' company, Operation management (Order clerk)	
Trigger: order clerk receives the order information	
Pre-condition: Technical and part information have been created/updated.	**Post-condition:**1- Monthly forecast and daily order files are submitted 2- Order has been analysed and processed.
Basic flows:1- customer log in 2- customer selects a product and submits the order. 3- customer credibility is sent to authorize.4- Order notification is sent to relevant staff. 4.1- Invalid credit is notified. 4.2- accepted order is sent to analyse.	
Alternative flow(s): 1- Monthly forecast and daily order files are submitted 2- After receiving order file, order data are analysed . 3- Stock level is checked. 3-1 Order fulfilment process 3-2. Realizing Bill of raw material	
Special condition: the monthly forecast order must be checked by production plan in customer' company.	

TABLE VIII
WORKSHEET ORDER MANAGEMENT PROCESS

Worksheet: Describing Business Process		
Author(s):	**Date:**	**Status:** *Draft, Review, Final*
Business Process name: Order management **Participants/Stakeholders:** Customer' company, and Operation management (order clerk) **Included Sub-process (collapsed sub-process):** Sub-process Order fulfilment **Events (Trigger, notification, message flow):** 1- Message flow 'Order ' is generated by company' website 2-Message flow 'Release BOM' is sent to sourcing dep. **Process lifecycle:** Order clerk receives monthly forecast/daily order files. After analysing the order, identifying requirements and 'get part/technical information', next task is 'check the stock level' for raw material. If stock level is enough, 'order fulfilment' is processed; otherwise, the bill of raw material (BOM) will be released.		

B. MEM's Construct

This sub-section provides the evaluation of the proposed modeling methodology that is based expert panel using the Method Evaluation Model (MEM), widely applied in validating information system design methods. Based on expert panel's evaluation of the proposed methodology, the evaluation method in this study is carried out according to MEM constructs: Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and Intention to Use (ITU). The following sections provide further elaboration on MEM, the process of expert evaluation and the results from expert panel in validating the proposed methodology. To explain and measure how the users accept the information system, a broad range of models have been used the Method Evaluation Model (MEM) [51], [52]. The MEM is acclaimed as the most efficient and the most frequently utilized theoretical framework, for it has been extensively applied and examined in various researches to validate information system design methods. It consists of three main quantifiable constructs for evaluating a method in practice based on the Technology Acceptance Model [53], namely, Perceived Ease of Use (PEU), Perceived Usefulness (PU), and Intention to Use (ITU). In this study, the original and adopted definitions of MEM's constructs are shown in Table 9. These definitions are adopted from [54] with some modifications in the scope of this research.

TABLE IX
CONSTRUCTS DEFINITION

Construct	**Original definitions** (Davis 1989)	**Adopted definitions**
PEOU	*"The degree to which a person believes that using a particular system would enhance his or her job performance"*.	The degree to which an expert or practitioner believes that applying the proposed methodology would be effectual to attain the modeling objective.
PU	*"The degree to which a person believes that using a particular system would be free of effort"*	The degree to which an expert or practitioner believes that proposed methodology would be free of effort.
ITU	*"The extent to which a person intends to use a particular system"*	The degree to which an expert or practitioner intends to apply proposed methodology in the domain of BPM.

C. Expert Evaluation Process

In order to validate the modeling methodology from the expert panel, the structure of the evaluation process was adopted from [55]. The existing researches were examined the aforementioned constructs in the fields of business process modeling in order to procure appropriate quantifiable items for each constructs PEO, PU, and ITU. The item creation stage ensures that content validity of the measurement items is achieved. Content validity is defined as the extent to which the utilized scale or scope reflects the concept based on which a generalization is made [56]. Table 10 lists the definition of all measurement items along with the MEM's constructs, which are the basis for evaluating the proposed modeling methodology in our research. These items are adopted from recent studies, which are cited in the third column.

1) Selection of the Experts and Evaluation Procedure: For the evaluation of the proposed methodology, a number of disciplines were required. First, the experts' areas of study were examined to consider the relevance of their expertise to the field of information systems. Second, twelve experts (from practitioners and academicians) were finally shortlisted. An abstract along with the purpose of the study and the proposed methodology were submitted to the experts. Then, appointments were made via e-mail with the experts. The validation of the proposed methodology was done an in-depth face-to-face interview with 15 experts comprising of process analysts, IS developers, and business/industry managers. The validation of the proposed methodology was done an in-depth face-to-face interview with 15 experts as illustrated in the previous section. The items quantified each MEM's construct. To analyze and measure of the result from the expert panel for the proposed methodology, the Cronbach's alpha and the mean for answers choice (between 1 to 5) were calculated. For all data, a high-level reliability analysis was obtained with the Cronbach's alpha > 0.851. The results were classified according to three constructs (PEU, PU, and ITU) with related questions in which the total mean was calculated for all cases (See Table 11).

TABLE X
ADOPTED CONSTRUCT' ITEMS IN THIS RESEARCH

Construct	**Items**	**Items definition**	**Adopted research** (authors and year)
	PEOU 1	- I found the proposed methodology is clear and easy to understand.	[57]; [58]; [59]; [56]; [60]; [61]; [62]; [63]
	PEOU 2	- I found the proposed methodology is simple and easy to follow.	
PEOU	PEOU 3	- I found creating process models is easy through the selected process modeling languages by this method.	
	PEOU 4	- Overall, I believe this process modeling is easy to use in the domain of BPM	
	PU 1	- I believe the business process models obtained with this methodology are organized, concise, non-ambiguous, and clear	[57]; [58]; [59]; [64]; [54]; [61]; [62]; [63]
	PU 2	- I found the methodology would reduce the time required to design business process.	
PU	PU 3	- I believe the methodology provides an effective mean of representing and documenting business process models	
	PU 4	- I believe the methodology would improve the performance in reviewing process models between stakeholders.	
	PU 5	-Overall, I found the methodology to be useful in process modeling.	
ITU	ITU 1	- If I have to design a Business process model in the future (either as a user or an analyst), I intend to use this methodology	[57]; [61]; [65]; [63]
	ITU 2	- It would be easy for me to become skillful in using this process modeling method.	
	ITU 3	- I would recommend the use of this process modeling method for Process modeling	

TABLE XI
THE EVALUATION RESULTS

Constructs	**PEOU**				**PU**					**ITU**		
Items	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Mean	4.357	4.67	4.53	4.6	4.33	4.267	4.65	4.55	4.38	4.12	4.17	4.21

The average of the means in Table 11 was also calculated for each construct PEU, PU, and ITU, which are 4.5, 4.367, and 4.278 respectively. These Fig.s indicate that the best construct for the proposed methodology from the experts' feedback was PEO; however, there is no significant difference between these constructs. Therefore, the results show a feedback consistency of the methodology from the expert's panel, which demonstrates the significant applicability of the proposed methodology.

IV. Conclusion

The survey of previous research on modeling methodology for business processes reveals that there is a need for more attention to the details of a process model. Appropriate tools, proper methodologies, and formal modeling languages are the basic requirements for handling the problems of process modeling in order to procure a comprehensive and transparent business process model. It must be reminded that no modeling construct can thoroughly cover different aspects of a process model. Hence, to represent a process model transparently and accurately necessitates the selection of a proper set of modeling languages. Furthermore, in business process architecture, ranging from the top level to the lowest level, the process model provides detailed information on the role of the participants, data input/output, and control/decision flow. Therefore, a proper modeling language should be selected to cover more details of the business process. The combination of IDEF0 and UML-Use Case diagram was applied for defining the upper level of process models. BPMN and UML-Sequence diagram were utilized for designing the detailed process model with regard to the two phases of the proposed methodology; it was found that the combination of these modeling languages could complete each other in modeling business process. Table 12 shows that how the above-mentioned modeling languages completed each other to cover full perspectives of the business process model. This combination of modeling languages, as well as worksheets, guaranteed the consistency and accuracy within modeling business process (Table 12).

TABLE XII
PERSPECTIVES OF THE MODELING TECHNIQUES

Modeling perspective	**Modeling techniques**		
	IDEF0	**UML-UCD**	**BPMN**
Structural view of a system	√		
Sequential view of a system	√		√
Relationship between actor and system		√	√
User cantered view		√	
Detailed view and logical representation			√
Service transaction view			√

The proposed methodology has some limitations that have to be considered in future researches. Since this research did not consider business rules in the business process model; the business processes need to follow and then integrate with business rules. Therefore, in the field of business process modeling, future researchers should consider the integration of business logic with business rules, which improves the performance of the business process.

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