FBD_BMODEL
FASHION BIG DATA BUSINESS MODEL

D5.3

SCMPS Design Methodology

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FBD_BMODEL
FASHION BIG DATA BUSINESS MODEL

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CO	Confidential, only for the members of the consortium (incl. Commission Services)	

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V1.2	30.05.2020	Rudrajeet Pal (HB)	Deliverable completed
V1.3			

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1 Executive Summary

Within the scope of FBD_BModel, SCMPS is an inter-connected multi-service platform, with underlying embedded data services connected to Supply Chain and Production Management. The purpose of this deliverable is to generate an integrated design model for the proposed distributed SCMPS data-service system by providing:

(i) Proposing the functional model for the structural representation of the decisions, actions, and activities for describing each SCMPS data service, graphically,
(ii) Mapping of simple database schema of each SCMPS data service in order to provide a blueprint of how the database is constructed (divided into database tables), and
(iii) Constructing class diagrams for showing the conceptual model of the structure of each data service application.

In this work, we have excluded the static data services (SCMPS 2 and 6) and the ontological model (SCMPS 7) from constructing UML class diagrams, as these data services only flush out pre-computed outputs related to out pilot cases.

Finally, an example of a particular SCMPS data service is being used to provide description of:

(i) Information exchange and Communication protocols including API end points and documentation,
(ii) Data standardization (for data response), and
(iii) Data integrity and security controls

The API documentations are provided to show the connection between the front-end platform and the back-end computational servers delivering various databased solutions.

This intends to describe how queries are placed and maintained, in a secured manner, between FBD platform and the distributed computation data servers in different host environments. This interaction would differ partially from one SCMPS data service to another, however the generic procedure is intended to be made same/similar.

Overall, the adopted methodology used to construct the action-models and necessary connectors for the SCPMS side of the platform (with its embedded data services) is based on design science research.

KEYWORDS: Data service, Supply chain data, UML, API, Data security.

2 Overall design of SCMPS

Within the scope of FBD_BModel, SCMPS is an inter-connected multi-service platform, with underlying embedded data services connected to Supply Chain and Production Management. The scope of these data services are varied. For instance, while one data service aims at permitting classification and commissioning of small-series production orders of fashion products, another opts to offer an optimised distributed production planning in order to provide quick responses and fast delivery to consumers, while another aims to provide strategic production knowledge base in order to dynamically identify the parameters of the production chain.

At the project start, it was conceptualized that the key supply chain specifications connected to the overall aim of the project can be visualized into two key domains for developing the SCMPS data services. These are for: (i) operational and financial performance evaluation, and (ii) environmental performance evaluation. For realization, data services can be developed to provide testing and certification recommendation, environmental footprint evaluation, local supply chain/production network selection, production order commissioning and recommendation, as shown in Figure 1. These data services are also supported by a cloud-based database.

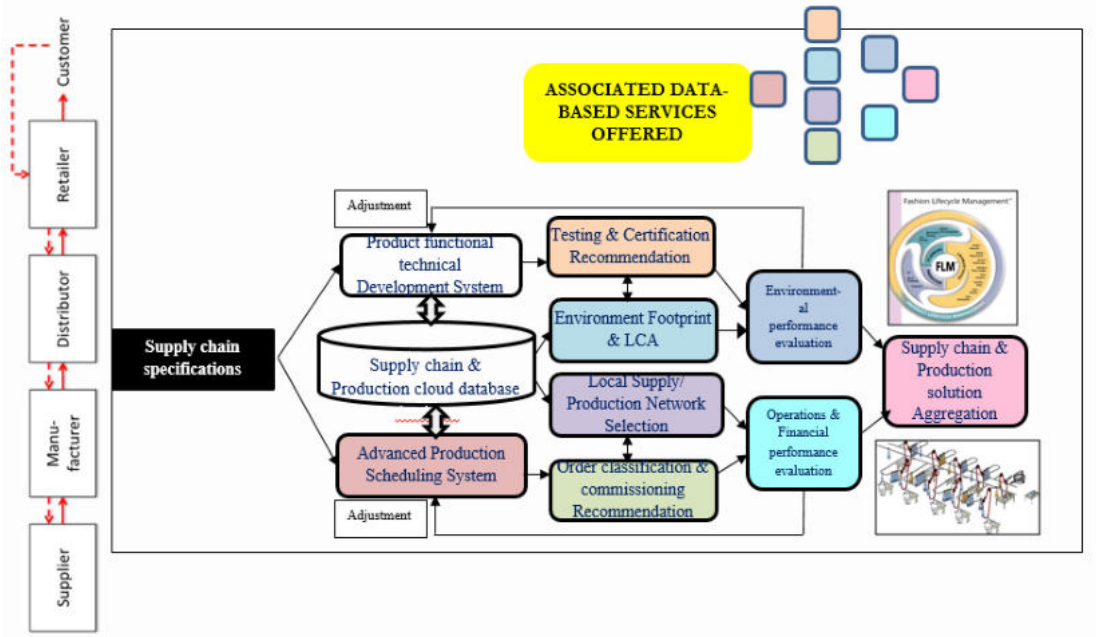

Figure 1. Original conceptual diagram of SCMPS – Inter-connected multiservice platform

For practicality reasons, and for realistic development of actionable SCMPS data services during the project, a conceptual adjustment was proposed. As an outcome of it, a revised data exchange model is proposed, which is shown in the form of a simplified conceptual model in Figure 2. The main reason for this adjustment was twofold.

1) proposal of using a distributed cloud-based database instead of a centralized one, as the SCMPS data services are developed by different partners in the project, and
2) small amendments in the scope and description of some of the data services, as shown in Table 1.

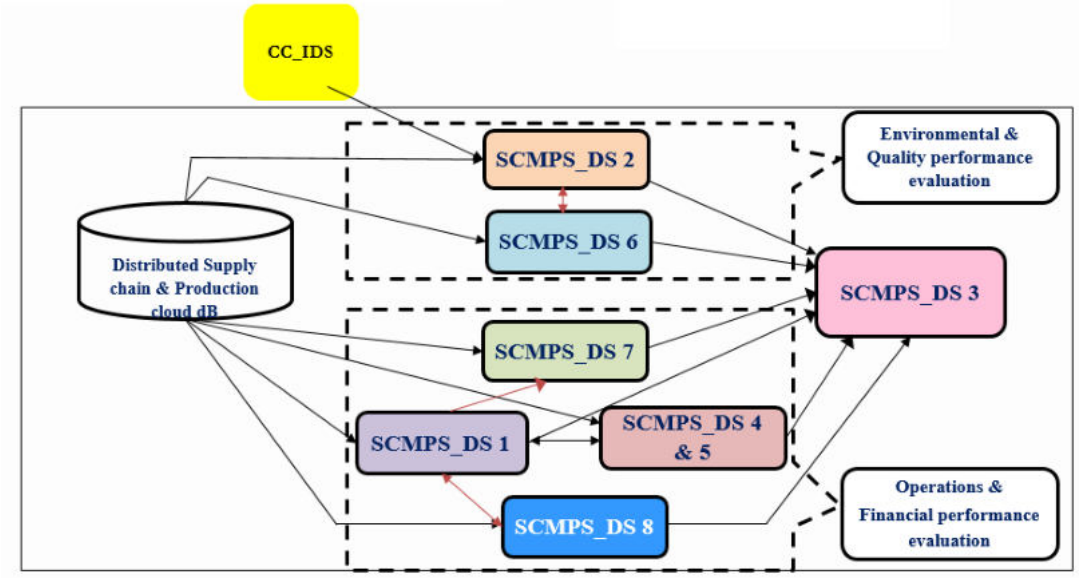

Figure 2. A simplified conceptual model for data exchange for SCMPS data services

Some of the main amendments in the scope of the proposed data services are related to:

1) Proposal of having SCMPS 3 not as a data service but as an interface for other data services,
2) Proposal of having SCMPS 2 and 6 as static outputs of pre-determined pilot cases in the project, while SCMPS 7 is an ontological model for data exchange.

Table 1. SCPMS data-services proposed in FBD

SCMPS NO.	LEADER/ WP	REVISED DESCRIPTION	IMPLEMENTATION SCOPE AS DATASERVICE
DS1	ENSAIT/WP 5	SCMPS1: **Selection of** relevant fabric **suppliers** and materials as well as garment makers in terms of technical parameters, cost, delay, stock, environmental footprint, ~~recycling capacity~~, and transport conditions.	As a **digitally integrated decision-support tool for supplier selection** on FBD_Bmodel platform
DS2	UoM/WP4	SCMPS2: **Testing and certifying** functional performance of textile materials from fibres, yarns, fabrics to garments for all the manufacturers in the fashion textile supply chain.	As a static service only related to the pilots cases of the industrial partners
DS3	Fitizzy/WP6	SCMPS3: **Cloud databases services** for the certified textile and apparel manufacturers, particularly SMEs.	Not a dataservice, but as the **interface for other dataservices** offered on FBD_Bmodel platform
DS4	ENSAIT/WP 5	SCMPS4: **Optimization** of production planning and scheduling by dynamically organizing tasks into different series (**reconfiguration**), i.e. **dynamical** classification and fusion of tasks at different stages.	As a **digitally integrated dynamic optimization and simulation tool*** for small-series production on FBD_Bmodel platform ** non real time and simulation-based*
DS5	ENSAIT/WP 5	SCMPS5: **Simulation of production** and adjustment of tasks planning according to simulated **performance**.	**Simulation tool** connected to the dynamic optimization model with feedback of performance evaluation
DS6	BEWG/WP7	SCMPS6: **Environmental footprint assessment** (Life Cycle Analysis) ~~and certification~~ of products and manufacturing processes.	As a static service only related to the pilot cases (products and actual supply chains) of the industrial partners
DS7	HB/WP5	SCMPS7: ~~On-line pricing,~~ Trading and **financial transaction** services.	As an **ontology for digital data exchange** for small-series production of personalized fashion products (based on eBiz 4.0) (only related to the pilot cases of the industrial partners)
DS8	HB/WP5	SCMPS8: Creation, management and updating of the **production knowledge base** (**rules** characterizing relations between design parameters, production parameters ~~and environmental impacts~~).	As a **digitally integrated tool for supply network design & configuration decision-support*** on the FBD_Bmodel platform ** Strategic level*

3 Adopted Methodology

Given, the need to design an action-model and necessary connectors for the SCPMS side of the platform (with its embedded data services), we have primarily adopted a design science research (DSR) strategy introduced by Simon (1996) [1]. DSR focuses on the development and performance of (designed) artefacts, here the SCMPS data services, with the intention of improving the functional performance of the artefact, i.e. the computational outcome or functional performance provided to the users in a simple and meaningful manner. Thus, the primary aim here was to develop design methodologies (including actionable models) and languages. Our generation process consisted of the following steps:

1) Proposing the functional model for the structural representation of the decisions, actions, and activities for describing each SCMPS data service, graphically. This is done by using basic IDEF0 (Icam DEFinition for Function Modelling) approach [2], where each data service block is represented by:
    a. Function nomenclature (SCMPS_DS n), where n is the data service number.
    b. Input and output variables.
    c. Mechanisms or computational methodology applied between input and outputs.

2) Mapping of simple database schema of each SCMPS data service in order to provide a blueprint of how the database is constructed (divided into database tables). For defining SCMPS design methodology we used the following aspects:

No.	Input/Output	Category of variable	Variables	Data type	Screen Options	Assumptions

3) Constructing class diagrams for showing the conceptual model of the structure of each data service application. Class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system [3], here each SCMPS data service, by showing the system's classes, their attributes, operations (or methods), and the relationships among objects. Class diagrams can also be used for data modelling. The classes in a class diagram represent both the main elements, interactions in the application, and the classes to be programmed.

In this work, we have excluded the static data services (SCMPS 2 and 6) and the ontological model (SCMPS 7) from constructing UML class diagrams, as these data services only flush out pre-computed outputs related to out pilot cases.

For constructing each step (1-3), data was provided by each project partner developing the SCMPS data services (i.e. HB, ENSAIT, UoM and BEWG), while the data schema templates were designed by HB and DSS, and verified by Fitizzy.

4 Action models for SCMPS data services

In this section, followed by a brief description of each SCMPS data service we have developed the pictorial representations of the IDEF0 and Data schemas of each SCMPS data service. This is followed by showing the class diagrams of data services for which it is relevant.

Link: https://hb.box.com/s/xrt35cge8g8queaf2a220qt82iax7xr3

4.1 SCMPS 1

The SCMPS 1 data service aims at “Selection of fabric suppliers and garment manufacturers”. This consists of two main steps:

1) Identification of supplier/manufacturer selection criteria, and

2) Evaluation of suppliers/manufacturers based on the selection criteria.

A fashion retailer selects various criteria according to its specific scenario and then evaluates them in order to identify the best criteria among them. Further, on the basis of identified best criteria, the candidate suppliers/manufacturers are evaluated and then ranked. In this decision making process, the MCDM (Multi-Criteria Decision Making) models, such as AHP and TOPSIS have been used. Figures 3a and 3b depict the IDEF0 A0 model and the Data schema of SCMPS 1.

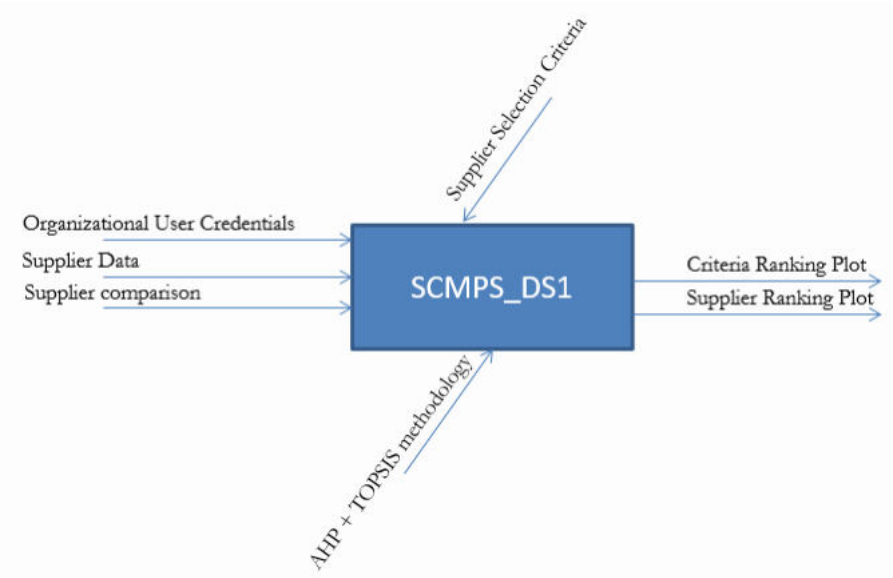

Figure 3a. IDEF0 model for SCMPS 1

No.	Input/Output	Category of variables	Variable	Data type	Screen Options	Assumptions
1	Input	Organisation ID	Username	*string*	Manual Input	Manual input to authenticate
			Password	*alpha-numeric string*		
2	Input	Supplier Selection Criteria	Qualitative Criteria	Supplier Selection Criteria	File Upload Option	Standard template in (.xls file)
			Quantitative Criteria			
3	Input	Suppliers' Names	Suppliers' Names/Codes	Suppliers Names: *text string*	File Upload Option	Standard template in (.xls file)
4	Input	Suppliers comparison	Pairwise Comparison of Supplier Selection Criteria	Linguistic Scale: *integers*		
			Pairwise Comparison of Suppliers viz a viz Customer Order Attributes	Numercial Data: *integers*	File Upload Option	Standard template in (.xls file)
1	Output	Supplier Ranking for Order allocation	Supplier ranking	Plot: *graph*	Display plot	Output of Supplier Selection Model

Figure 3b. Data Schema for SCMPS 1

Finally, class diagram in Figure 3c depicts how the supplier comparison is conducted in order to generate a ranking based on inputted criteria list and supplier list.

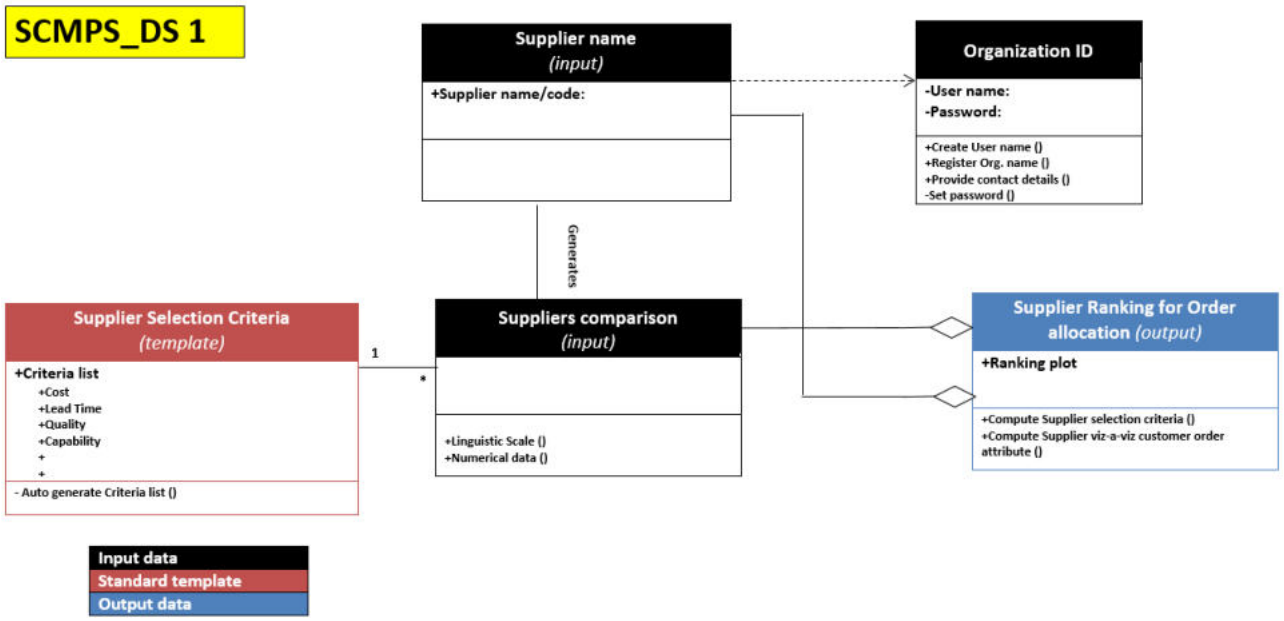

Figure 3c. UML class diagram for SCMPS 1

4.2 SCMPS 2

SCMPS 2 renders static testing service of all the pilot product cases chosen in the project. The results of the testing are related to fibre, yarn, fabric and garment properties and these data are flushed out on FBD platform. Figures 4a and 4b depict the IDEF0 A0 model and the Data schema of SCMPS 2.

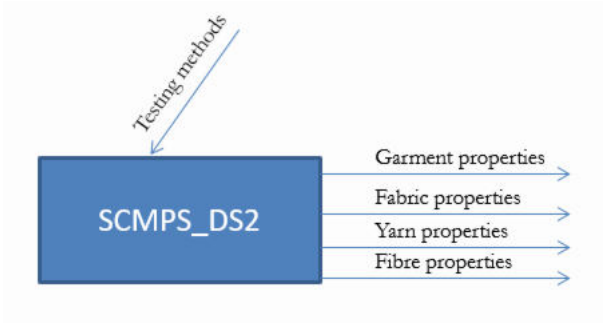

Figure 4a. IDEF0 model for SCMPS 2

No.	Input/Output	Category of variables	Variable	Data type	Screen Options	Assumptions
1	Output	Garment properties	Garment pattern	Option box	Static numerical data	No data modifications requested by the users
			Garment size chart	Vector of real numbers		
			3D garment ease parameters	Vector of real numbers		
2	Output	Fabric properties	Fabric thickness	Integer	Static numerical data	No data modifications requested by the users
			Fabric porosity	Integer		
			Fabric thermal conductivity	Integer		
			Fabric structure	option box		
			Moisture management properties	Integer		
			Membrane properties	Integer/option box		
			Air permeability	Integer		
			Fabric touch properties testing	Integer		
			Phase change materials and self-healing	Integer		
3	Output	Yarn properties	Yarn type	option box	Static numerical data	No data modifications requested by the users
			Fibre blend ratio	Integer		
			Yarn diameter	Integer		
			Yarn twist	option box		
			Yarn linear density	Integer		
4	Output	Fibre properties	Fibre type	option box	Static numerical data	No data modifications requested by the users
			Fibre diameter	Integer		
			Fibre density	Integer		
			water contact angle	Integer		
			Fibre thermal conducitivity	Integer		
			Fibre moisture regain	Integer		
			Fibre water diffusion coefficient	Integer		
			Fibre thermal radiation absortion	Integer		
			Fibre moisture sorption heat	Integer		

Figure 4b. Data Schema for SCMPS 2

*No UML class diagram is required for this static data service.

4.3 SCMPS 4

The SCMPS 4 data service aims at “Selection of best supplier for order fulfilment”. TOPSIS (Technique for Order Performance by Similarity to Ideal Solution) method is used to compute ranking score of the suppliers as alternatives based on the evaluation of the data of suppliers against the fashion retailer’s list of all the criteria that are integral to their business needs and goals. Figures 5a and 5b depict the IDEF0 A0 model and the Data schema of SCMPS 4.

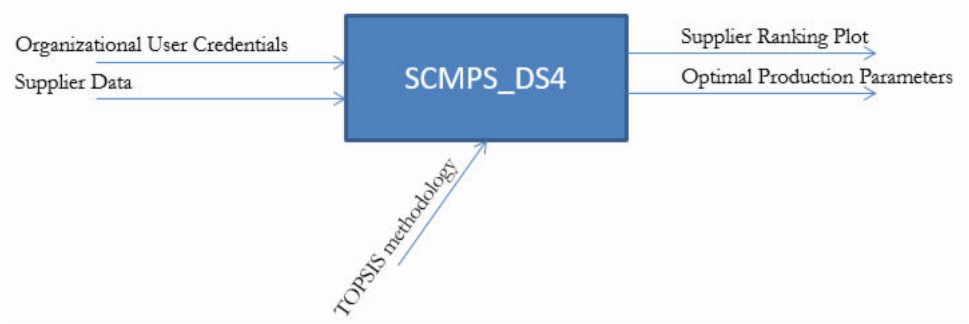

Figure 5a. IDEF0 model for SCMPS 4

No.	Input/Output	Category of variables	Variable	Data type	Screen Options	Assumptions
1	Input	Organisation ID	Username	*string*	Manual Input	Manual input to authenticate
			Password	*alpha-numeric string*		
2	Input	Suppliers' Data	Supplier side Production Attributes	Supplier Data File	File Upload Option/Database connection	
1	Output	Supplier Network Configuration	Targetted Suppliers	Nominal Data	chart (image format)	
2	Output	Optimal Production Parameters	Optimal production parameter	Numerical Data	chart (image format)	

Figure 5b. Data Schema for SCMPS 4

A preliminary class diagram in Figure 5c depicts how the supplier comparison is conducted in order to generate a ranking for order allocation, based on inputted supplier data and supplier list.

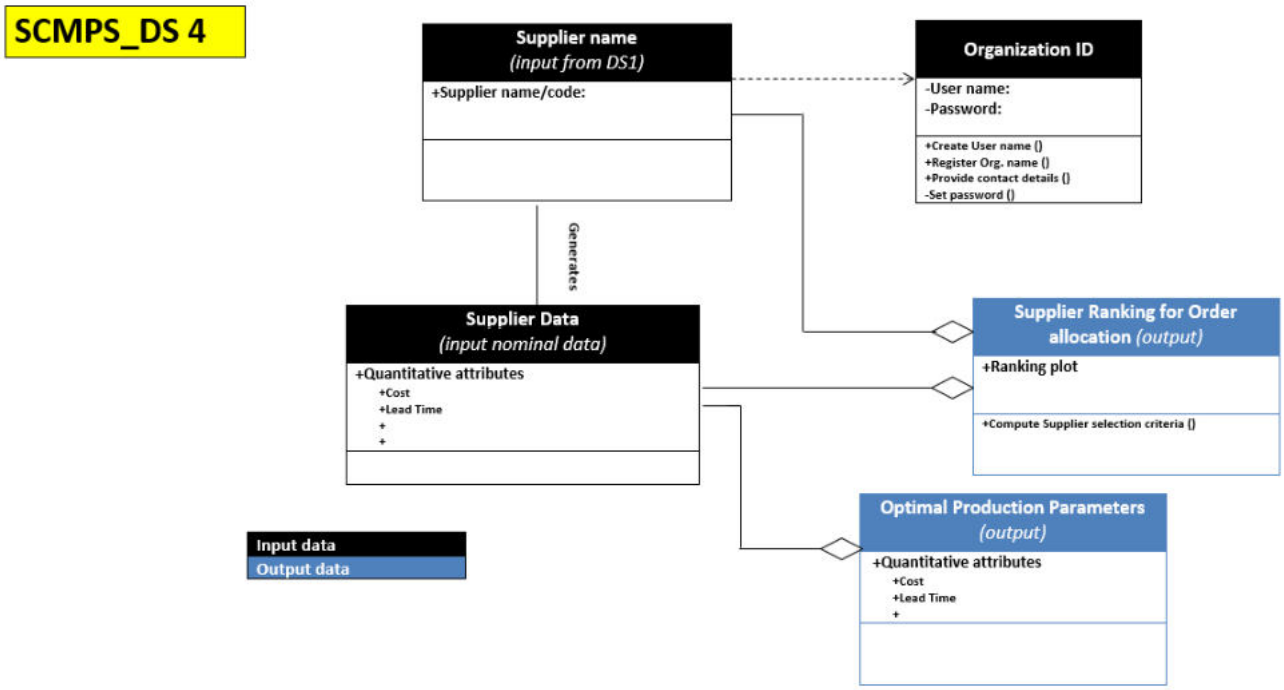

Figure 5c. UML class diagram for SCMPS 4 (preliminary/conceptual)

4.4 SCMPS 5

The SCMPS 5 data service aims at “Dynamic selection of suppliers for fabric and garments” that constitutes the major task in the “Optimized production planning” of small series fashion products.

As the step 1, this concerns the daily allocation of the orders to the best of the suppliers who are selected in the static supplier selection phase. The fashion retailer is responsible for making the decision as to which one of the suppliers from the static supplier selection list can be assigned newly arrived order for fulfilment.

As the step 2, the fashion retailer feeds the data related customer order and its suppliers’ production planning (selected in the static supplier selection phase) to the MCDM model, which simulates the various production planning scenarios based on the optimal solutions provided by the production planning optimization models. This illustrates the dynamic production planning to generate optimal production plans, optimal levels of production parameters, and evaluate the performance of each supplier. Figures 6a and 6b depict the IDEF0 A0 model and the Data schema of SCMPS 5.

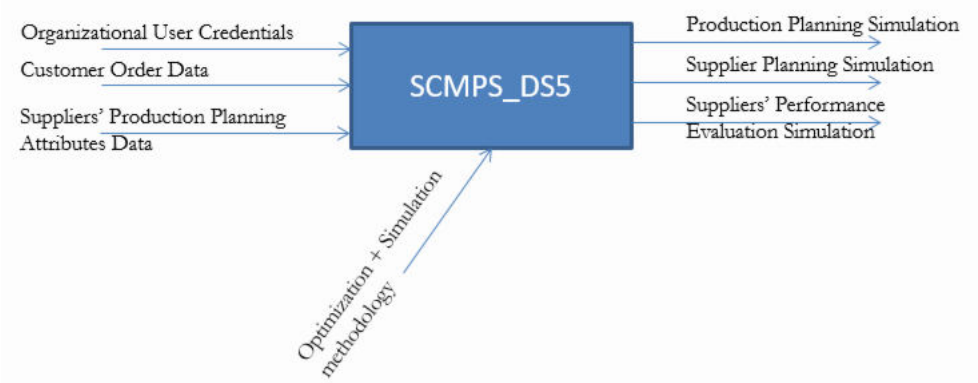

Figure 6a. IDEF0 model for SCMPS 5

No.	Input/Output	Category of variables	Variable	Data type	Screen Options	Assumptions
1	Input	Organisation ID	Username	*string*	Manual Input	Manual input to authenticate
			Password	*alpha-numeric string*		
2	Input	Customer Order Data	Order Attributes	Customer Order Data File	File Upload Option/Database connection	
3	Input	Suppliers selection and production planning	Supplier side Production Attributes	Supplier Data File, Planning Data File	File Upload Option/Database connection	
1	Output	Time planning	Delivery time per order	Vector of real numbers	SIMULATION Graphics	
2	Output	Suppliers planning	Selected supplier per order	Vector of integers	SIMULATION Graphics	
3	Output	Performance evaluation	Performance indicators	Vector of real numbers	SIMULATION Graphics	

Figure 6b. Data Schema for SCMPS 5

A preliminary class diagram in Figure 6c depicts how the advanced production planning is conducted in order to generate production environment scenarios (simulated and optimized) for each customer order.

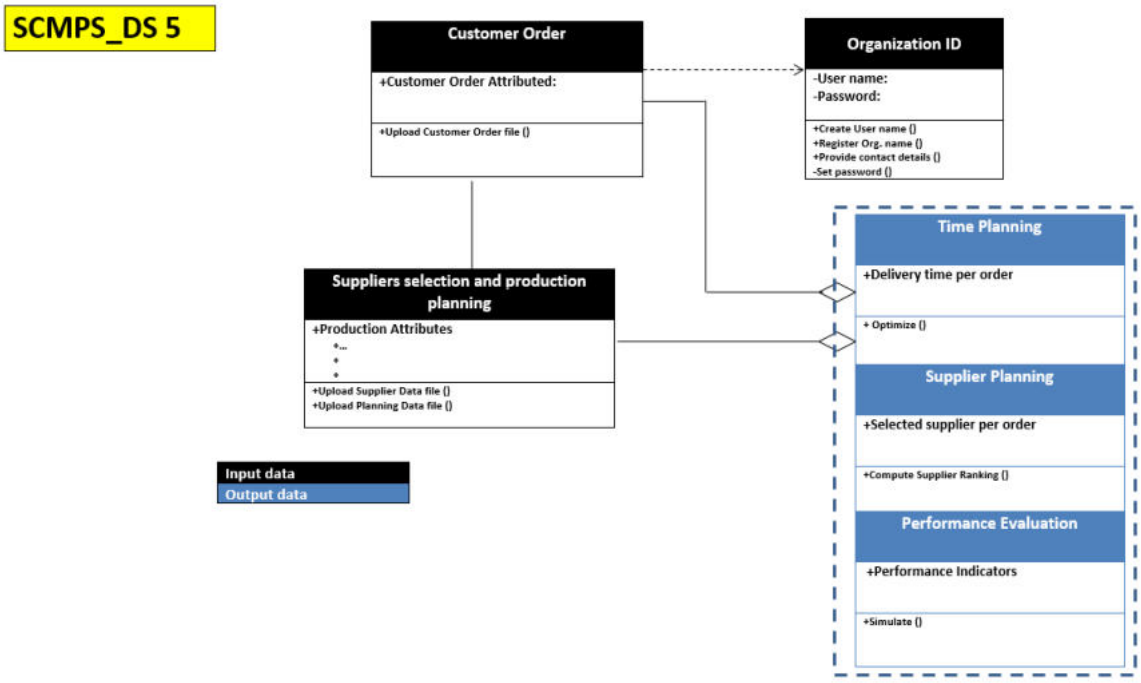

Figure 6c. UML class diagram for SCMPS 5 (preliminary/conceptual)

4.5 SCMPS 6

The SCMPS 6 data service aims at providing static assessment of environmental footprint for the pilot product cases in FBD_BModel. Being a static service, there is no input variable for this data service. Pre-determined output in the form of various environmental data are flushed out for each case. Figures 7a and 7b depict the IDEF0 A0 model and the Data schema of SCMPS 6.

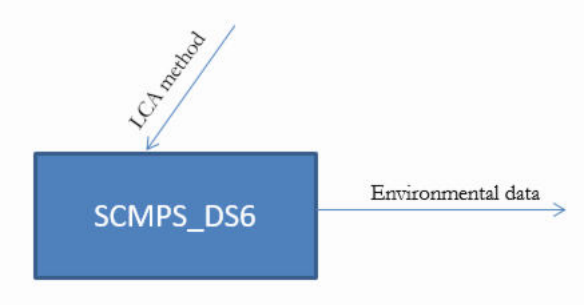

Figure 7a. IDEF0 model for SCMPS 6

No.	Input/Output	Category of variables	Variable	Data type	Screen Options	Assumptions
1	Input	Customer Order Data	Order Attributes	Customer Order Data File	File Upload Option/Database connection	
2	Input	Suppliers selection model	Supplier side Production Attributes	Supplier Data File	File Upload Option/Database connection	
3	Input	planning optimization model	Planning Attributes	Planning Data File	File Upload Option/Database connection	
1	Output	time planning	Delivery time per order	Vector of real numbers	SIMULATION Graphics	
2	Output	Suppliers planning	Selected supplier per order	Vector of integers	SIMULATION Graphics	
3	Output	Performance evaluation	Performance indicators	Vector of real numbers	SIMULATION Graphics	

Figure 7b. Data Schema for SCMPS 6

*No UML class diagram is required for this static data service.

4.6 SCMPS 7

SCMPS 7 aims at describing the underlying transaction for each of the pilot product cases in FBD_BModel. Hence it is developed as a static service, more in the form of an **ontology for digital data exchange** for small-series production of personalized fashion products. Input and output data types for this ontological model are already prescribed under Deliverable D5.1.

4.7 SCMPS 8

The SCMPS 8 is a digitally integrated tool for supply network design & configuration decision-support on the FBD_BModel platform. This data service aims at understanding supply chain configurational aspects for textile & fashion companies that are producing/planning to produce high value-added products in Europe. Seventeen supply network configurational (SNC) aspects form the input variables of SCMPS 8, while the output is in the form of dynamic cognitive visualizations of key strategic inter-relationships based on relational matrices. This production knowledge base is crucial to design European supply chains for small-series production. The data service is also associated with the data collected from several textile and apparel companies through a database, which allows making a comparative analysis of the configurational aspects. The access and communication with

the data service is secured with required security protocols. Figures 8a and 8b depict the IDEF0 A0 model and the Data schema of SCMPS 8.

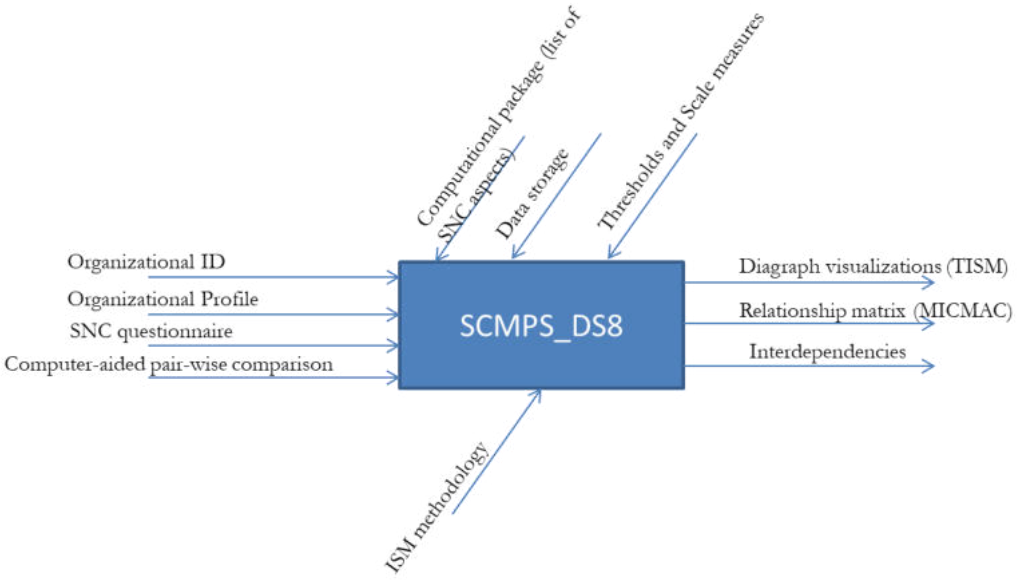

Figure 8a. IDEF0 model for SCMPS 8

No.	Input/Output	Category of variables	Variable	Data type	Screen Options	Assumptions
1	Input	Organisation Profile	Organization Name	*text string*	Manual Input	Manual input into Organisations Table/Collection
			Organisation Size	*enumeration*	MSME, Large	Manual input into Organisations Table/Collection (this is part of aggregation logic)
			Small Series focus		<90%, >90%	
			Product Focus		Fashion, Function, Hybrid	
2	Input	Organisation ID	Username	*string*	Manual Input	Manual Input to authenticate
			Password			
3	Input	Supply Network Configurations	Production/Sourcing Location	Abstract data: *list*	Master template	Standard template for SNC Table/Collection
			Communication and information sharing			
			Internal integration			
			Customer integration			
			Supplier integration			
			Quality			
			Product variety			
			Sustainability			
			Product structure (architecture)			
			Customisation			
			Delivery speed/reliability			
			Innovation			
			Operational flexibility and agility			
			Specialised knowledge and production technologies			
			Close/long-term relationships			
			Structural flexibility			
			Trust and mutual commitment			
4	Input	SNC Pairwise Comparison	Select comparison scale	Scale: *integer (0, 1,2,3,4)*	Slider option	Scale selection
1	Output	SNC Profile	MICMAC	*graph*	Display plot	Generated through HB's computational package
			Digraph	*graph*		
			Tables (Raw input, Reachability matrix)	*set*		
2	Output	Aggregated SNC Profile	MICMAC	*graph*	Display plot	Generated through HB's computational package incl. Aggregation method
			Digraph	*graph*		
			Tables (Raw input, Reachability matrix)	*set*		
3	Output	Aggregated Profile Comparison	MICMAC	*graph*	Display plot	Generated from Output 1 and Output 2
			Digraph	*graph*		
			Tables (Raw input, Reachability matrix)	*set*		

Figure 8b. Data Schema for SCMPS 8

Figure 8c depicts how the data is structured in SCMPS 8. For each organization ID there is a unique profile created that includes selection of organizational size (large or MSME), small series focus (>90% or otherwise), and product focus (fashion/function/hybrid). Based upon a master template of 17 SNC aspects a pairwise comparison is generated for manual input. Based upon each matrix of input a unique SNC profile is generated. Further a SNC knowledge stores this input in order to create an aggregated profile for comparative analysis.

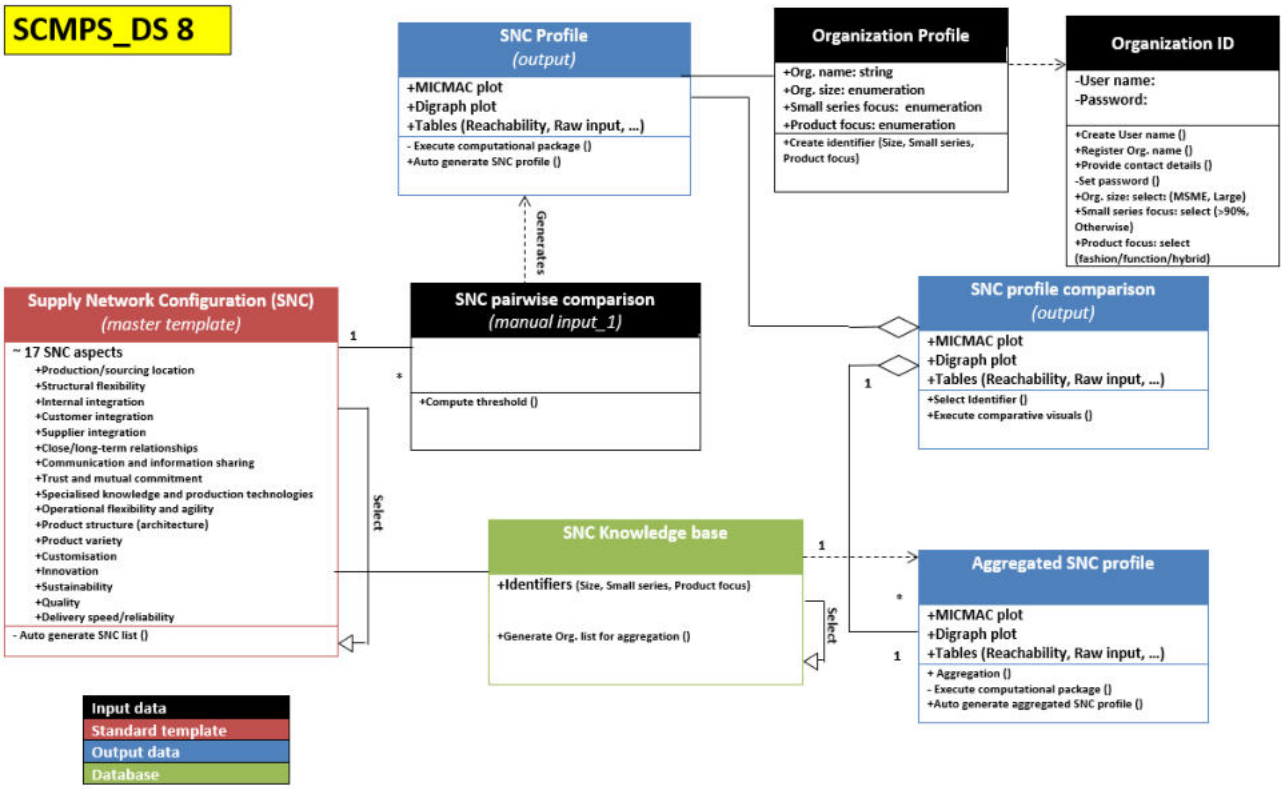

Figure 8c. UML class diagram for SCMPS 8

5 Description of formats and procedures

Through a demonstrative case of SCMPS 8, this chapter confirms the following:

1) Information exchange and Communication protocols including API end points and documentation,
2) Data standardization (for data response), and
3) Data integrity and security controls

The definition of the data layers, functional service-oriented architecture of SCMPS (e.g. input-output relationship, semantics and constraints) are already proposed in Deliverable 6.4 (pg. 17 “Zoom on the IN/OUT flow“). This chapter on the other hand intends to describe how queries are placed and maintained securedly between FBD platform and the distributed computation data servers in different host environments. This interaction would differ partially from one SCMPS data service to another, however the generic procedure is intended to be made same/similar.

5.1 Information exchange and Communication protocols

Server URL https://tvcm.ths.hb.se/fbd/

API base URL https://tvcm.ths.hb.se/fbd/scmps/8/api/v2.0

Please note that the partial **URL** mentioned in section 5.1.1 should be used with API base URL. For example /question_sets mentioned as URL in section 5.1.1 should be used with API base URL as https://tvcm.ths.hb.se/fbd/scmps/8/api/v2.0/question_sets

5.1.1 API end points and documentation

This collection contains the sample requests for API which allows accessing of the service SCMPS 8 developed for FBD_BModel project.

It contains the following requests:

- Get the questions-sets available on the server.
- Get the contents of the each question-set.
- Generate resutls for individual company based on the response inputs.
- Generate results for individual company alongwith the aggregated results generated from the knowledgebase.

Complete API documentation is available through:
https://documenter.getpostman.com/view/10316019/SztD47GU?version=latest (as per date: 29.05.2020)

GET Get Question-Set Names

https://tvcm.ths.hb.se/fbd/scmps/8/api/v2.0/question_sets

API endpoint to pull the name of question-sets available in the database.

URL

/question_sets

Method

`GET`

URL Parameter

None

Data Param

None

Success Response

A successful request will result *HTTP 200* ...status code.

Response example:

```
{
    "question set": [
        {
            "name": "Master_Q_Set"
        }
    ]
}
```

Error Response

Invalid or revoked *token* will generate *HTTP 400* status code.

GET Get Question-Set Contents

https://tvcm.ths.hb.se/fbd/scmps/8/api/v2.0/question_sets/{{question-set name}}

API endpoint to pull the contents of specified question-set available in the database.

URL

`/question_sets/Master_Q_set`

Method

`GET`

URL Parameter

REQUIRED

`questionSet_name:String`

`questionSet_name` variable can be pulled from Get Question-Set Names endpoint.

Data Param

None

Success Response

A successful request will result *HTTP 200* ...status code.

Response example:

```
[
    {
        "contents": [
            {
                "abbreviation": "PS",
                "question": "Product structure/architecture"
            },
            {
                "abbreviation": "PV",
                "question": "Product variety"
            },
[clipped]
            {
                "abbreviation": "DE",
                "question": "Delivery speed/reliability"
            }
        ]
    }
]
```

`abbreviation` refers to the short-identifiable tag assigned to the corresponding `question` for the requested dataset. The `abbreviation` term is referred later to make a pair-wise comparison and get response on `Results for Individual Company` and `Results for Individual Company with Comparison` endpoints.

Error Response

Invalid or revoked *token* will generate *HTTP 400* status code.

POST Results for Individual Company

https://tvcm.ths.hb.se/fbd/scmps/8/api/v2.0/get_results/

API endpoint to pull the contents for specified question-set available in the database.

URL

`/get_results/`

Method

`POST`

URL Parameter

Required

`None`

Data Parameters

Contents type: `JSON`

Contents example:

Example

Explanation:

The tag `abbreviations` can be obtained for a specific question-set using `GET Question-Set Contents`. `row` and `column` refer to the one-to-all combination of `abbreviations` and `value` refers to the value assigned to a row-column combination. For example, in the above case, there are a total `17` `abbreviations`, which results `17x17=289` `row-column-value` combinations. The parameter `value` can take minimum `0` and maximum `4`, and same parameter value in `row`-`column` combination would always be `4`.

Success Response

A successful request will result *HTTP 200* ...status code.

Input example

```
{
    "matrix": {
        "abbreviations": [
            "CI",
            "CM",
            "PS",
            "IN",
            "RE",
```

```
            "CU",
            "DE",
            "LO",
            "SI",
            "OF",
            "SF",
            "II",
            "TR",
            "QU",
            "PV",
            "SK",
            "SU"
        ],
        "elements": [
            {
                "row": "CI",
                "column": "CI",
                "value": 4
            },
            {
                "row": "CI",
                "column": "CM",
                "value": 4
            },
[CLIPPED]
            {
                "row": "SU",
                "column": "SU",
                "value": 4
            }
        ]
    }
}'
```

Response example


```
{
    "matrix": {
        "abbreviations": [
            "CI",
            "CM",
[CLIPPED]
            "SU"
        ],
        "elements": [
            {
                "row": "CI",
                "column": "CI",
                "value": 4
            },
            {
                "row": "CI",
                "column": "CM",
                "value": 4
            },
            {
                "row": "CI",
                "column": "PS",
                "value": 2
            },
            {
                "row": "CI",
                "column": "IN",
                "value": 0
            },
            {
                "row": "CI",
                "column": "RE",
                "value": 0
            },
[CLIPPED]
```

```
        {
            "row": "SU",
            "column": "PV",
            "value": 0
        },
        {
            "row": "SU",
            "column": "SK",
            "value": 0
        },
        {
            "row": "SU",
            "column": "SU",
            "value": 4
        }
    ]
  }
}'
```


Explanation:

The response is responded under five tags namely, `abbreviations`, `original_data`, `final_data`, `digraph`, and `micmac`. `abbreviation`. `abbreviation` and `original_data` refer to theinput `abbreviations` and `original_data` data.

`final_data` provides the data for table generation, where `row` refers to the table row, `column` refers to the table column, and `value` refers to the cell value referred by `row`-`column` combination. The additional tag `type`, which can take values as `transitive` or `direct`, which signifies the relationship among the `row`-`column` combination. The `type` parameter is used for table cell highlighting, as shown in example below where all cells with `type: transitive` are highlighted.

`digraph` provides the necessary data for creating relationship digraph among the components mentioned in `abbreviations`. The tag `levels` enlists the components in different levels of digraph, where `level` under `levels` indicate the level number and `elements` under `levels` enlists the components or elements on the given level. It should be noted that level `0` is placed on the top of the graph followed by subsequent levels added downwards.

Further, the tag `relations` under `digraph` enlist the relation among the various components/elements in the digraph. `source` and `destination` under `relations` indicate that the relation arrow should

start from `source` element to `destination` element. And the `type` indicates if the relation is `direct` or `transitive`, which are indicated with different arrows. In the example below, `direct` relations are represented by a solid arrow while `transitive` relations are indicated by dotted arrows.

The `micmac` provides the necessary data to create the MICMAC plot. MICMAC is a 2D scatter plot, for which minimum and maximum of the XY axes are provided by `min` and `max` tags. The MICMAC scatter plot is divided into four quadrants, where the horizontal and verticle dividing lines can be drawn using data provided by coordinates, i.e. `[x,y]`, provided by `division_x` and `division_y` tags respectively. `element` tags provide the `name` and `position` tags to show the name and geometrical position of the elements in the MICMAC.

Error Response

Invalid or revoked *token* will generate *HTTP 400* status code.

POST Results for Individual Company with Comparison

https://tvcm.ths.hb.se/fbd/scmps/8/api/v2.0/get_results_with_comparison/

API endpoint to pull results for specified question-set responses and make a comparison with data available on the database.

URL

`/get_results_with_comparison/`

Method

`POST`

URL Parameter

Required

`None`

Data Parameters

Contents type: `JSON`

Input Example

```
{
  "comparison": {
    "comparison_category": "organization_size",
    "comparison_attribute": "msme"
```

```
  },
  "matrix": {
    "abbreviations": [
      "CI",
      "CM",
      "PS",
      "IN",
      "RE",
      "CU",
      "DE",
      "LO",
      "SI",
      "OF",
      "SF",
      "II",
      "TR",
      "QU",
      "PV",
      "SK",
      "SU"
    ],
    "elements": [
      {
        "row": "CI",
        "column": "CI",
        "value": 4
      },
      {
        "row": "CI",
        "column": "CM",
        "value": 4
      },
[CLIPPED]
      {
        "row": "SU",
```

```
        "column": "SU",
        "value": 4
      }
    ]
  }
}
```

Output example:

See appendix 1.

Explanation:

This endpoint uses input `JSON` template as mentioned for `Results for Individual Company` endpoint with additional tag `comparison`, which had two sub-tags namely `comparison_category` and `comparison_attribute`, with possible combinations mentioned below.

comparison_category	**comparison_attribute**
`organization_size`	`msme`, `large`
`small_series_focus`	`yes`, `no`
`product_focus`	`hybrid`, `function`, `fashion`

Success Response

A successful request will result *HTTP 200* ...status code.

Contents:

Example

Explanation:

This endpoint provides output in `JSON` in the same format as used generated in `Results for Individual Company` endpoint, with a change that data is provided under tags `individual` and `agregated`. The data under `individual` tag shows the results for the individual company, where data under `agregated` shows the data generated from the database for specified `comparison_categoty` - `comparison_attribute` combination.

Error Response

Invalid or revoked *token* will generate *HTTP 400* status code.

5.2 Data standardization (for data response)

The server responds to the requests with JSON format. The response details are already provided in 5.1.

5.3 Data integrity and security controls

- **Service security:** The service is secured by the unique API Keys which can be generated each user. In case of suspicious behaviour (such as excessive number of requests in a short duration), which indicates any compromise with the confidentiality of the key, the user API key can be revoked by the admin. The initial API key revoking or generation rights can be controlled by the admin.
- **Communication security**: The communication with the server is secured with SSL certificate (generated using SHA-2 hashing algorithm with 2048-bit encrypted key). The used hashing is widely used method for internet communication and considered one of the best methods for secured communication.
- **User login credentials security**: The user login credentials are stored in a hashed form, which are not decodable without the encryption key. Therefore, in case of rare security breach, the login credentials cannot be used for login or accessing database.

6 Conclusion

This deliverable provides an overview of the SCMPS, an inter-connected multi-service platform with underlying embedded data services, proposed in FBD_BModel. The integrated design model proposed for distributed SCMPS data-service system includes (i) functional model for the structural representation of the decisions, actions, and activities, (ii) database schemas, and (iii) class diagrams, for each SCMPS data service.

The demonstration of this is provided through a fully operational SCMPS 8, where we show:

- how information exchange takes place,
- what communication protocols are followed,
- what APIs are used,
- how data standardization is done for appropriate response, and finally
- how is data integrity and security maintained.

This showcases the connection between the front-end platform and the back-end computational servers delivering various databased solutions, by describing how queries are placed and maintained, in a secured manner, between FBD platform and the distributed computation data servers in different host environments. This interaction would differ partially from one SCMPS data service to another, however the generic procedure is intended to be made same/similar.

7 References

[1] Simon, H. A. 1996. The Science of the Artificial. 3rd ed. Cambridge, MA: MIT Press.

[2] Veis Šerifi, Predrag Dašiü, Ratomir Jeþmenica, Dragana Laboviü (2009), Functional and Information Modeling of Production Using IDEF Methods, Strojniški vestnik - Journal of Mechanical Engineering 55(2), pp. 131-140.

[3] http://www.cs.sjsu.edu/~pearce/modules/lectures/uml2/class/index.htm (accessed 15.05.2020)

8 Appendix 1

Output example:


```
[
  {
    "individual": {
      "abbreviations": [
        "DE",
        "PV",
        "SK",
[CLIPPED]
        "CI",
        "OF"
      ],
      "original_data": [
        {
          "row": "DE",
          "column": "DE",
          "value": 4
        },
        {
          "row": "DE",
          "column": "PV",
          "value": 0
        },
[CLIPPED]
        {
          "row": "OF",
          "column": "OF",
          "value": 4
        }
      ],
      "final_data": [
        {
          "row": "DE",
          "column": "DE",
          "value": 1,
          "type": "direct"
        },
        {
          "row": "DE",
          "column": "PV",
          "value": 0,
          "type": "direct"
        },
        {
          "row": "DE",
          "column": "SK",
          "value": 0,
```

```
          "type": "direct"
        },
[CLIPPED]
        {
          "row": "OF",
          "column": "OF",
          "value": 1,
          "type": "direct"
        }
      ],
      "digraph": {
        "levels": [
          {
            "level": "0",
            "elements": [
              "DE",
              "PV",
              "SU",
              "QU",
              "CU",
              "IN"
            ]
          },
          {
            "level": "1",
            "elements": [
              "SI",
              "PS"
            ]
          },
[CLIPPED]
          {
            "level": "6",
            "elements": [
              "II",
              "TR"
            ]
          }
        ],
        "relations": [
          {
            "source": "SK",
            "destination": "SU",
            "type": "transitive"
          },
[CLIPPED]
          {
            "source": "OF",
            "destination": "CU",
            "type": "transitive"
          },
          {
```

```
            "source": "OF",
            "destination": "IN",
            "type": "transitive"
          }
        ]
      },
      "micmac": {
        "graph": {
          "min": 0,
          "max": 17,
          "micmac": [
            {
              "DE": [
                11.461450667342573,
                1.3371766504155098
              ]
            },
            {
              "PV": [
                10.714511080381914,
                0.8253493543915331
              ]
            },
[CLIPPED]
            {
              "OF": [
                9.389656867298148,
                9.127338996623596
              ]
            }
          ],
          "division_x": [
            {
              "min": [
                0,
                8.5
              ]
            },
            {
              "max": [
                17,
                8.5
              ]
            }
          ],
          "division_y": [
            {
              "min": [
                8.5,
                0
              ]
            },
```

```
            {
              "max": [
                8.5,
                17
              ]
            }
          ]
        },
        "table": [
          {
            "autonomous": []
          },
          {
            "independent": [
              "SK",
              "II",
              "RE",
              "SF",
              "TR",
              "CM",
              "LO",
              "CI"
            ]
          },
          {
            "dependent": [
              "DE",
              "PV",
              "SU",
              "SI",
              "QU",
              "PS",
              "CU",
              "IN"
            ]
          },
          {
            "linkage": [
              "OF"
            ]
          }
        ]
      }
    }
  },
  {
    "aggregated": {
[CLIPPED]
}
}
```