Systematically Establish an Information Processing Mechanism: A Valuable Solution

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Abstract

The process of solving information management’s problems is a hardheaded thinking in decision-making. Although many scholars proposed related theories and suggestions, these are so conceptual and one-sided that cannot be a systematic application. As the result, enterprises are always disorganized when solving problems. The reason is that enterprises can’t clearly utilize systematic processes in an idea of problem-solving. Therefore, this research (1) uses Information Processing Theory to control the concept of problem-solving; (2) builds “Systematic Information Problem-Solving Process” with Pyramid Principle; (3) verifies and modifies the systematic process through qualitative methods; (4) refers the process of building APP from a bio-technology company in Taiwan to confirm the substantive. It is believed that the research not only shows a new perspective in academia, but gives enterprises a systematic process to improve the ability of solving problems.

Keywords: Information processing theory, Pyramid principle, Problem-solving process, Systematic thinking, Application software

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I. Introduction

PROBLEM-SOLVING PROCESS was a critical part of hard-headed thinking in information management decision-making area 〔1〕. Many scholars had provided solutions and suggestions〔2〕, but these suggestions (1) Were insufficient for enterprise to deal with actual core problem; (2) Extremely conceptual, vague, and lacking of practical process, caused users can't apply it systemically; (3) Lacking of actual process and implementation case for users to following and referring; (4) Solutions and processes were concerned on specific case that hard to apply on all kinds of information problem; (5) Just dealing with shallow problem, that caused big gap between actual results and expected results.

To improving the benefit to solving information problem, this research aimed to proposed "Systematic Information Problem-Solving Process (SIPSP)" with following steps: (1) Establishing systemic problem solving process through information processing theory and related research results; (2) Constructing the draft and initial table of "Systematic Information Problem-Solving Process (SIPSP)" with qualitative method and pyramid principle proposed by McKinsey & Company; (3) Confirming the rationality of SIPSP through Delphi method; (4) Checking the benefits and values by APP development with case company; (5) Presenting management implication. These research results were helpful for enterprise to improve the ability to solving problem and making decision, construct systemic process, even dealing with information management problem by blending academic and practical point of view.

II. Literature

At this section, this research would introduce following research results and reference: (1) Information processing theory, (2) Problem-solving process; (3) Pyramid principle; (4) Qualitative method and its implementation steps.

1. Information Processing Theory

To aware risk things, human had to notice the changing of information environment, and determine decision 〔3〕. Human was deal with information in following process: (1) Brain providing information; (2) Information processing; (3) Information activation; (4) Connecting networks of association; (5) Illustrating the structure of thinking. Apparently, human was the information-seeing organism.

In contrast to, some scholars indicated during the information processing, human need to analyze and filter information by information features, so 〔2〕 raising the "Information processing theory". The theory regarded any problem was constructed with similar basic parts or structures, which so-called a method of "general problem solver". This theory defined the anatomy of a problem as a problem-space. The space including (1) Initial state (Explaining current situation and related factors of problem); (2) Goal state (Illustrating expected goal after solving problem); (3) Intermediate state (Presenting all path and movement sets to solving problem). In the intermediate state, they had to propose the rules and constraints to solving problem, then showed the application of a series of operators/transformation functions, even reached goal state 〔4〕.

〔5〕 taked "The Tower of Hanoi puzzle" to explain the information processing. The tower of Hanoi puzzle contained 3 rods and 3 disks of different sizes. Initial state was defined all disks was stacked on A rod; Goal state was defined to move all disk on B rod; Intermediate state was defined to set up constraints to solving the problem during moving disks (Shown in Fig 1).

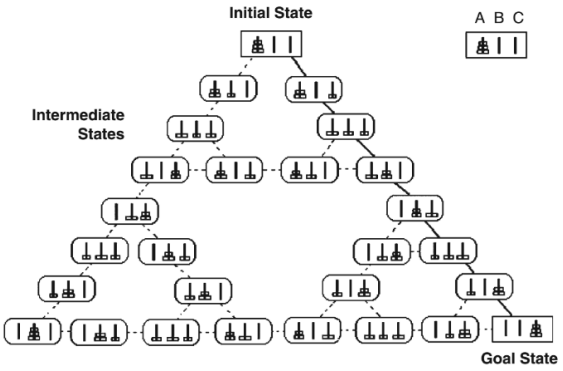

Fig. 1. The tower of Hanoi puzzle.

2. Problem-Solving Process

When the gap was existed between actual result and expected results, solver must establish the anatomy of a problem and find the appropriate solution to solving problem. Apparently, the problem-solving process was a complicated thinking path 〔6〕. To enhance the problem-solving process was valuable and comprehensive, many scholars had proposed kinds of problem-solving process 〔7〕.

〔8〕 based on scientific point of view to proposed 5 steps for solving problem: (1) Encountering problem (Recognizing problem); (2) Defining problem (Realizing the natures, requirement, and constraints of problem); (3) Developing hypothesis (Proposing solution project); (4) Verifying hypothesis (Finding out optimal project by examining the feasibility of each project); (5) Applying project (Practicing projection on real problem). 〔9〕 proposed (1) Realizing problem (Collecting data and defining problem); (2) Designing solution project (Planning all possible projects); (3) Selecting project (Selecting optimal solution); (4) Practicing project (Establishing solving process).

〔10〕 took experience on teaching to suggesting 4 steps: (1) Understanding problem (Illustrating the actual concepts of problem by signs or graph); (2) Designing solution (Dividing problem into sub-problems, and listing possible solution); (3) Practicing solution (Raising optimal project by evaluating the relationship between sub-problems, detailed tasks, and goals); (4) Reviewing overall process (Assessing the benefits and performance of the implementation process). 〔11〕 propose 5 steps: (1) Classifying problem (Defining problems and requirements); (2) Exploring clue (Checking solution of each problem); (3) Evaluating alternative project (Selecting all possible solution; (4) Combining alternative project (Integrating the possible and appropriate solution); (5) Examining solution project (Verifying the feasibility of solution project in real case).

〔12〕 based on innovation perspective to state solver should feature the ability to observe problem, and aware the appropriate solution, which contained 4 steps: (1) Preparation (Collecting data based on problem); (2) Brewing (Presenting the directions of solving classified problem); (3) Inspiration (Raising possible project); (4) Verification (Examining potential problem of each project).〔13〕had solving engineering problem through problem-solving method, who suggested 6 steps: (1) Overview (Viewing the contents of problem); (2) Listing feasible project (Proposing possible solution project); (3) Building model (Describing problem with graph and sign); (4) Modifying surface (Arranging solution and process); (5) Requesting (Raising doubt of solution); (6) Questioning (Examining output result). 〔14〕 proposed 5 steps to solve mathematics and scientific problem: (1) Defining problem (Collecting data for realizing problem); (2) Evaluating situation (Proposing hypothesis and investigating current situation); (3) Arranging solution and strategy (Constructing solution strategy of problems); (4) Practicing project (Implementing and modifying project); (5) Presenting results (Analyzing, assessing, and showing actual results).〔15〕recommended (1) Recognizing problem (Understanding and accepting that problem must be existed); (2) Defining problem

(Finding related data and selecting goal); (3) Generating the paths to solve problem (Establishing feasible project); (4) Making decision (Selecting optimal project); (5) Verifying result (Evaluating performance of implementation and modifying project).

〔16〕 indicated the required ability to solve problem was related with the types of problem and its complexity. Hence, who publishing the IDEAL problem-solving process: (1) Identifying problems; (2) Defining and representing them with precise; (3) Exploring possible strategies; (4) Acting these strategies; (5) looking at the effects.〔4〕 proposed 6 steps: (1) Defining problem; (2) Shaping the nature of problem; (3) Proposing problem-solving project; (4) Practicing project; (5) Evaluating and assessing the plan; (6) Evaluating project.

〔17〕 summarized different point of views to construct software development project solution – common model, its implementation steps were: (1) Describing problem (Stating and defining problem); (2) Planning solution project (Confirming and selecting solution problem, and dividing into sub-problem); (3) Designing solution project (Establishing the logics and connection between sub-problems); (4) Translating solution project (Coding project into program script); (5) Testing solution (Examining the correctness of program); (6) Presenting results (Documenting solution project and publishing results). And so on, 〔6〕 considered the problem-solving to deal with common problem was (1) Exploring problem (Finding unsolved problem); (2) Describing problem (Understanding the differences between initial status and goal status of problem); (3) Planning solution (Raising solution project); (4) Implementing solution and projects; (5) Assessing solution (Scoring the solution); (6) Rewarding (Recording these experiences into documents).

3. Pyramid Principle

McKinsey & Company had illustrated pyramid principle (so-called “Pyramid Structure”) in 2010 〔18〕. The method was based on hard-headed thinking to find the layers and relationship between disperse events and problems. Also, this method was applied on (1) Writing; (2) Thinking; (3) Problem-solving; (4) Presentations.

Pyramid structure was coming up with points and key lines. The point including 2 different relationships: Vertical and horizontal. The pyramid structure was connected by key line in top-down approach or bottom-up approach. The construction processes were: (1) Confirming topic (conclusion) point of view; (2) Establishing vertical relationships by SCQA method. In other wise, this process may illustrate the relationships by “Situation (S)”, “Complication (C)”, “Question (Q)”, and “Answer (A)”; (3) Categorizing by induction, Reasoning by deduction, working out cause-and-effect relationship by chronology, dividing a whole into its parts by structuring, drawing horizontal relationship and find importance difference by comparison; (4) In the horizontal relationships, every perspective must follow “Mutually Exclusive, Collectively Exhaustive (MECE)” to avoiding duplicated perspective. 〔19〕 combined above point of view to proposed “The storyline of pyramid structure” (Shown in Fig. 2).

The problem-solving logic process of pyramid structure was defining and analyzing problem by sequential analysis. In problem-definition stage: (1) Listing the starting point and laying out the elements of problem; (2) Catching opening scene of problems; (3) Describing situation, complication, and question with opening scene; (4) Exploring disturbing events; (5) Realizing the gap between undesired result and desired result; (6) Clarifying actual and physical problem. In problem-analysis stage: (1) Finding actual facts and devising diagnostic framework by

collecting data, showing physical structure, tracing cause and effect, and classifying possible cause; (2) Analyze the facts and subjective result by applying the framework and deduction; (3) Analyzing issues, raising possible answer, then establishing logic tree of implementation process and project through deduction.

〔20〕 considered that brain would categorize the common fate into same group once which happened at the same time. However, restricted by short-term memory, our brain was just able to contain "The magical number seven, plus or minus two" perspectives. In other word, when 4 or 5 different perspectives was appeared, our brain would classify these perspectives for easily memorizing it. According to the constraints, the pyramid structure asked for each time of classification, the perspectives should less than 7. Furthermore, pyramid principle must follow following principles: (1) Higher layers were the summarization of low layers; (2) Classification was happened when each perspective featured similar attributes; (3) To presenting the causal order, each logic group should order logically.

4. Qualitative Interviews

To integrating experts' opinions, this research was going to implement 3 kinds of qualitative method in following research. KJ method can integrate complex factors to establish the relationship of mutual dependency between factors 〔21〕. And the implementation steps contained: (1) Determine the theme; (2) Gather data; (3) Sort data into groups; (4) Create header cards; (5) Draw finished diagram 〔22〕.

Focus group interviews (FGIs) was able to assist interviewees to share experts' opinions, experiences, and motivation in specific topic, then confirm, suggest, modify its result with serious communication and demonstration. The implementation steps contained: (1) Identification of the problem; (2) Identification of population; (3) Identification of moderator; (4) Pretest of the interview; (5) Recruiting the sample; (6) Conducting the interviews; (7) Analysis of the data; (8) Writing the report; (9) Decision making/action 〔23〕.

Delphi method (DM) was major in confirm the consistency, correct and eliminate factors through collecting experts' opinions by frequent questionnaire survey.〔24〕regarded DM may assist researchers to acquire the consensus among experts through frequent questionnaire survey. The implementation steps contained: (1) Identification of the problem and definition of the subject; (2) Determining the expertise required; (3) Selection of the experts, a heterogeneous response group; (4) Preparation and distribution of the first questionnaire; (5) Analysis of the first questionnaire; (6) A second written round, if necessary; (7) Analysis of the second questionnaire; (8) Having a group meeting 〔25〕.

III. Research process

The following section presents a theoretical framework which is used to illustrate the "Systematic Information Problem-Solving Process (SIPSP)" and improve efficiency to solve problem: (A) Applying KJ method to classify steps of information processing and processes of problem solving; Holding focus group interviews for constructing "Problem-solving process" by confirming "Stages" and "Steps" of problem solving; (B) Taking the "Pyramid principle" to establish "Steps" and "Key tasks"; and building the draft and initial table of SIPSP with KJ method and focus group interviews; (C) Determining "Stages", "Steps", and "Key tasks" of problem solving through DM, then presenting the final table of SIPSP.

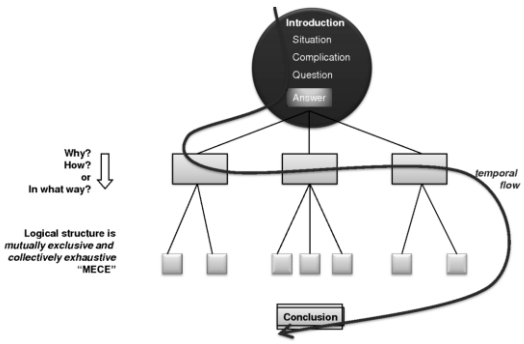

Fig. 2. The Storyline of Pyramid Structure.

1. Illustrating the structure of SIPSP

Many scholars had already discussed “Problem-solving processes / steps” and established quite similar results, but this research still collecting and summarizing the 65 steps (proposed by 12 researches) by twice KJ method with 1 scholar〔22〕.

The above analysis classifying 65 steps as (1) Perceiving problem areas and factors (Perceiving problems and defining clear requirement); (2) Recognizing background and status of problem (Exploring the root causes and factors of problem, and drawing expected target); (3) Dividing problems into staged target (Categorize target into different group and analyzing it individually); (4) Ensuring the limitation of each problem (Collecting data of the root causes for understanding the restricted conditions); (5) Planning the solution to solve problem (Designing implementation steps of the solution); (6) Selecting the appropriate solution (Evaluating the rationality and feasibility of each solution); (7) Tracking performance during implementing solution (Conducting solution carefully and modifying the details based on changed requirement); (8) Raising new issues and problems (Finding extended problems and correcting implementation steps); (9) Checking differences between target and practical result (Examining efficiency and completeness of practical result).

The above implementation steps of solution had to be further confirmed. Hence, this research held twice FGIs (based on 9 steps〔23〕) with 2 business management consultants and 2 project management professors. The overall results of twice FGIs indicated: (1) Much detailed and clear requirements and distinct requirement framework is essential in “Perceiving problem areas and factors”; (2) Blending “Dividing problems into staged target” and “Ensuring the limitation of each problem” into “Checking factors and conditions” due to some tasks of the 2 steps were overlapping; (3) Evaluating rationality and feasibility and proposing alternative solution should be done right after solutions were designed, so the “Planning the solution to solve problem” and “Selecting the appropriate solution” are combined into “Planning the solution to solve problem”; (4) Exchanging the order of “Raising new issues and problems” and “Checking differences between target and practical result” for fitting the general process to diagnosis problems; (5) Adding “Raising suggestions to solving problem” after “goal state” for displaying the benefits of implementing solution and presenting advanced suggestions.

At the stage, these steps were allocated into “Systematic Information Problem-Solving Process (SIPSP)” by information processing theory, which contained 3 different states and 8 steps.

Based on the results of twice FGIs with experts, each step was carefully and clearly defined. In initial state, (1) Step 1 “Perceiving problem areas and factors” was defined as “Recognizing and describing all essential knowledge and related area of problem”; (2) Step 2 “Recognizing background and status of problem” was defined as “Identifying the status of current problem and presenting expected result and situation”; (3) Step 3 “Checking factors and conditions” was defined as “Analyzing and classifying current problem, narrowing goal and

collecting basic data, even establishing the restriction and limitation of current problem.

In intermediate state, (4) Step 4 “Planning the solution to solve problem” was defined as “Proposing necessary implementation task to solving problem, then realizing shortcoming from causal relationship, even constructing feasible solution to overcome the limitation mentioned above”; (5) Step 5 “Tracking performance during implementing solution” was defined as “Raising sub-questions and detailed implementation steps of each problem, and checking targets were well achieved by recognizing relationship between implementation task and target”.

In goal state, (6) Step 6 “Checking differences between target and practical result” was defined as “Comparing and evaluating correctness and efficiency of reached goal, then listing insufficiencies and conflicts”; (7) Step 7 “Raising new issues and problems” was defined as “Figuring out core causes and probably extended problems by concerning on insufficiencies and conflicts ”; (8) Step 8 “Raising suggestions to solving problem” was defined as “Presenting implementation goal and suggestions”.

2.Illustrating draft and initial table of SIPSP

This research aimed to check implementation details of SIPSP by according pyramid principles, KJ method, and focus group interview, then presented the draft of SIPSP.

Firstly, this research aimed to implement the first stage – “initial state”, and according to “starting point” in pyramid principle to implementing Step 1 “Perceiving problem areas and factors”, and analyzing requests of activities. Furthermore, this research asked “What is the root cause of the events?” to find the clear scope and basic information of each problem.

In the Step 2 “Recognizing background and status of problem”, this research based on the step “Opening scene” to discover rough content of problems; And find out the evaluation characteristics and 7 following possible situations to divide problems (1) Understand current situation and expected results but don’t understand the paths to achieve the goal; (2) Understand paths to achieve the goal, but don’t sure the path is correct; (3) Sure the path is correct, but can’t illustrate solutions; (4) Can illustrate solutions, but unable to recognize related factoirs; (5) Difficulty to select the best appropriate solution; (6) Hard to construct implementation process of each solution; (7) Unable to monitor the results were fitting with expected result. Finally, this research according to “Situation, complication, question (SCQ)” for define implementation task of different context conflict and problems.

In the Step 3 “Checking factors and conditions”, this research assuming these events or results may happen: (1) Disturbing event (DE); (2) Undesired result (UR); (3) Desired result (DR), even identifying the actual SCQ content of each problem.

In the Step 4 “Planning the solution to solve problem” of intermediate state, this research considered (1) Essential processes and expected results to achieve current UR; (2) Essential activities to reach current UR; (3) Essential processes and expected results to achieve current DR, then accorded these 3 principles to think out the answer of problem. At the same time, this research had constructed “Devising diagnostic frameworks” of each problem, aimed to present (1) Collected data of related area; (2) Established diagnostic framework which can deal data insight and unlisted fact. Furthermore, this research had focused on current assessment benchmarks to (1) Conducting deductively reasoning; (2) Constructing deductive logic tree by logic-reasoning; (3) Describing the processes and activities of each solution conclusion; (4) Presenting different points and issues of solution conclusion

inductively; (5) Showing inductive logic tree; (6) Re-ordering each issues chronologically; (7) According to pyramid principle to reasoning vertical relationship by sentences like “Why so?” and “So what?”; reasoning horizontal relationship by “Mutually Exclusive, Collectively Exhaustive (MECE)”.

In the Step 5 “Tracking performance during implementing solution” of goal state, this research according 5W1H method to (1) Verifying goal (Why?); (2) Ensuring problems (What?); (3) Determining steps and process (How?); (4) Checking time-schedule (When?); (5) Confirming implementation occasion and location (Where?); (6) Assigning responsibility departments or units (Who?). Hence, this research presented the requirements and goals of each problem, and viewing overall details when implement activity.

In the Step 6 “Checking differences between target and practical result”, this research taking pyramid principle (1) Measuring the consistency between goal and actual result of each problem; (2) Presenting extensive problems and related limitation of each implementation activity as the foundation of proposal and processes in future. In the Step 7 “Raising new issues and problems”, this research concerned on different context and conflicts, hoped to discover potential issues, and even modify targets and solution. In the Step 8 “Raising suggestions to solving problem”, this research (1) Summarizing actual implementation results when problem were solving; (2) Raising opinions and suggestions in view of the activity.

For ensuring the rationality of SIPSP draft, this research implemented twice FGIs with 1 business consultant, 1 project manager, 1 McKinsey logical thinking course lecturer, 1 case company manager in 9 steps 〔23〕.

Response to these opinions of experts, this research (1) Renaming “Initial state”, “Intermediate state”, “Goal state” into “Problem stage”, “Diagnosis stage”, “Solution stage” for making consistent between steps and functions of task; (2) Renaming “Checking factors and conditions” into “Illustrating conflict solving goal” for making consistent between steps and functions of task; (3) According pyramid principle, application frameworks, and experts’ opinions, this research divided the step “Planning the solution to solve problem” into “Designing problem diagnosis framework” and “Applying problem diagnosis framework”; (4) Following practical process, we renaming “Tracking performance during implementing solution” into “Establishing problem solving process” and move to solution stage; Furthermore, experts suggested us to construct work flow for tracking implementation progress; (5) Combining “Checking differences between target and practical result” and “Raising new issues and problems” into “Checking differences between target and practical result” due to their implication and task were less and similar. So, this research had constructed the initial table of SIPSP, which contained 3 stages, 8 steps, and 19 tasks.

3. Establish the final table of SIPSP

Previous interviews and experts’ suggestions were identified for assessing the rationality, but this research aimed to carefully confirm the consistency of table. Hence, this research based on 〔26〕 (more than 10 experts’) implemented twice Delphi questionnaire survey with previous 4 experts, 3 business consultants, 3 project management professor, and 2 case-company managers in 8 suggested steps 〔25〕.

In total, 12 questionnaires were adopted, and this research applied Quartile method (Q method) 〔27〕 to assess the items and overall questionnaires consistency of stages, steps, and tasks. The 2nd survey result revealed, (1) In stage part, 2 items are

highly consistent (Q≤0.6); 1 items are fairly consistent (0.6≤Q≤1); 0 items are poor consistent (Q>1); the rate of highly and fairly consistent is 100.0% (=〔2+1〕/3); (2) In step part, 5 items are highly consistent (Q≤0.6); 2 items are fairly consistent (0.6≤Q≤1); 1 items are poor consistent (Q>1); the rate of highly and fairly consistent is 87.5% (=〔5+2〕/8); (3) In key task part, 10 items are highly consistent (Q≤0.6); 5 items are fairly consistent (0.6≤Q≤1); 4 items are poor consistent (Q>1); the rate of highly and fairly consistent is 79.0% (=〔10+1〕/19).

Despite according to general principle, this research may stop Delphi questionnaire while survey results were reliable (consistence ≥70%), However, based on the spirit of Delphi survey, this research conducted the 2nd questionnaire survey after 1 week. The result shown: (1) in stage part, consistency is 100.0%; (2) in step part, consistency is 75.0%; (3) in key task part, consistency is 84.2%. The "final table of SIPSP" (Shown in Table. 1) was confirmed by Delphi questionnaire survey and Q method, apparently, which is reliable and acceptable for both experts and business managers.

IV. Case study

Hong-Jing Biotech Inc. (HJBI) was founded in 2013, who major involved in developing highly sensitive and accurate molecular diagnostic reagent product. These products can diagnose 8 cancers and 16 gene mutation, and get ISO13485/9001and Taiwan Good Manufacturing Practice (GMP) certification.

HJBI aimed to shifting "In Vitro Diagnostic Devices (IVD)" to "Internet of Things (IoT)" intelligent diagnose by APP cloud-service. Therefore, common people may get screening report with cloud-service by sampling their own blood and completing screening process.

TABLE I
STYLES SYSTEMATIC INFORMATION PROBLEM-SOLVING PROCESS

Stage	Step	Key task
Problem stage	Perceiving problem areas and factors	Exploring the beginning and requirement contents of events
		Recognizing clear scope and factor of events
	Recognizing background and status of problem	Finding contents, causal context of problem based on events
		Assessing the status of each problem with its causal context
		Defining context conflict and problem by problem status
	Illustrating conflict solving goal	Clarifying the root cause of each problem
		Recognizing current status and potential bad result
		Comparing problem and expected goal for finding better result
Diagnosis stage	Designing problem diagnosis framework	Proposing feasible solution to solve practical problem
		Constructing current view of event and collecting foundational data
	Applying problem diagnosis framework	Establishing deductively logic tree based on reasoning benchmark
		Generating feasible solution by previous result
		Establishing inductively logic tree by analyzing projects and issues

Solution stage	Establishing problem solving process	Making sure the solutions were fitting requirements
		Arranging the steps, responsibility, schedule, and implementation location of solutions
	Checking differences between target result	Checking the consistency between staged result and expected goal
		Investigating extensive problem and related limitation
	Raising suggestions to solving problem	Describing the core part of implementation process and final result
		Confirming the final conclusions and suggestions were correct

During the project to cooperate with HJBI, this research according to "Systematic Information Problem-Solving Process" to develop APP. The development process of APP may clearly catch requirements, analyze goal and target effectively, designing and developing APP fluently, set database well, even can systemized examine APP system. These results revealed each key task is helpful for enterprise or scholar to solving problem rationally and reliably.

1. Introduction of Genonfire APP

In response to the statistics report generated by Taiwan Health Promotion Administration, Ministry of Health and Welfare in 2015, cancer was the highest death rate disease after 1980. However, applying gene screening of oncogene for analyzing deoxyribonucleic acid (DNA), users was able to implementation prevention activity in advances. Hence, HJBI according to our research results to develop cloud-based gene screening APP – GenonFire, so this research (1) Combining GenonFire and anonymous social media like Facebook or Google+; (2) Providing simple mobile-pay service and GPS function for user to pay and locate hospital or clinical, users may complete registration and blooding process; (3) Sending screening report and solution of patients' condition to users through cloud-service.

2. Establish the problems stage of APP

In the project beginning, this research had held "systematic information problem-solving process training and education session" for HJBI employee realize comprehensive operation process of the mechanism. Also, this research had requested HJBI project members should hold coordination meeting twice a week for cultivating team consensus and finding problems or solutions as well.

According to the Step 1 "Perceiving problem areas and factors" in problem stage, this research conducted 6 times of requirement interviews for exploring starting point of the events, and recording it down 5 page report. For instance, "HJBI could generate screening reagent which may screen 16 oncogenes of 8 organs: blood, breast, stomach, digestive organs, liver, lungs, and ovary, prostate". These screening reagent was highly accurate and relatively parity for people to use it. However, most of all people paid rare attention on screening oncogene and cancer, caused HJBI couldn't catch people requirement well. Thus, HJBI was hard to developing GenonFire APP by connecting following 6 units: (1) Screening reagent development company; (2) Clinical or inspection (blooding unit); (3) Laboratory of sequencing; (4) Gene analysis unit of raw data; (5) Gene consulting service providers; (6) Users and patients, even providing a series of complete service model and establishing body map of each user. Moreover, HJBI aimed to construct a gene

map involved in public health, which may illustrate and present the risk indexes of special cancer in different area, then catch the distribution of gene and cancer between Taiwan and others countries.

In requirement interview stage, this research induce HJBI innovation service model as 6 units: (1) Manager unit (HJBI system manager); (2) User unit (Common users and end users); (3) Blooding units (Hospital, Clinical, or Inspection unit who featured blooding technical and tool); (4) Laboratory unit (Unit who can aliquot blood / specimen, and use Next Generation Sequencing (NGS) to generate raw data); (5) DNArails (Report generator who can analyze big data of DNA, and generate gene sequencing report).

In Step 2 "Recognizing background and status of problem", this research defined the Situation (S), Complication (C), Question (Q) of each context by investigating opening scene (OS) and its status with sequential analysis. For instance, (1) OS1: HJBI service model involved various units and tasks, so the functions and forms of APP were complicated. That may cause once the processes were modified, lots of functions and data would be added, deleted, or corrected. Therefore, this research firstly established user face and forms of data which used in APP, managers may add or modify system much easier, even boost the flexibility of APP; (2) OS2: To establishing the service model, this research constructing the front-end user face of APP and Web-based management system; (3) OS3: For catching the and ensuring the information flow of internal auditing and controlling likes (a) Blooding units had carefully verified identification of user; (b) Laboratory units had confirmed the correctness of blood / specimen; (c) Laboratory units had matched different blood collections of same user during aliquot process. This series of processes were complex, so this research applying barcode technique (Code 128 of 1D Barcode) to simplifying the verification process.

Concerning on above 3 situations, this research aimed to look for the question (LQ) and define SCQ. Such like OS1: (1) LQ was "Understand paths to achieve the goal, but don't sure the path is correct"; (2) S was PE, UR, and DR; (3) C was solution; (4) Q was "Difficulty to select the most appropriate solution"; OS2: (1) LQ was "Sure the path is correct, but can't illustrate solutions"; (2) S was PE; (3) C was UR and DR; (4) Q was "What to do from UR to DR?"; OS3: (1) LQ was "Can illustrate solutions, but unable to recognize related factors"; (2) S was PE, UR, DR, and solution; (3) C was "Solutions wasn't work"; (4) Q was "What to do when solution wasn't work?" This research had constructed 72 OSs and defined LQ and SCQ in Step 2.

In Step 3 "Illustrating conflict solving goal", this research illustrate actual SCQ of the 72 OSs. Such like the S in OS1: (1) PE: HJBI modified basic parameter of database and functions for dealing with probable modification of APP and management system; (2) UR: system developer correct data structure and functions of database; (3) DR: HJBI managers had to modify basic data and functions by themselves. The C in OS1: (4) Solution: managers could modify basic data and parameter by management platform which contained independent forms and data that main process used. The Q in OS1: HJBI should ask managers to confirm the modified parameters were correct and work.

The S in OS2: (1) PE: developers must reach consensus of constructing system for fluently developing APP and WEB-based management system. The C in OS2: (2) UR: The APP and WEB-based management system may failed once process fit tiny part of actual process; (3) DR: Analyzing actual using situation and establishing adoptable system process. The Q in OS2: (4) what processes should exist in system process?

The S in OS3: (1) PE: The way to verify information must be simple and well designed for internal auditing and controlling; (2) UR: The failed information verification would cause system failed in match data between users, blooding activities, blood collection, and report; (3) DR: System could provide simple verification functions for blooding units recognize users by its information, or match blood collection and users in system; (4) solution: System applying barcode to recognize users information, then stick the barcode in blood collection. Blooding units could send the information back to APP system by scanning barcode by mobile phone. The C in OS3: (5) Once solution doesn't work: Barcode was hard to use due to its low-speed and inefficiency on scanning barcode. The Q in OS3: (6) Are any others way to verify this information when barcode was failed to use? Above SCQ definition process of 3 situations was presented in Fig. 2. According to the process, this research assisting HJBI to clearly illustrate actual SCQ contents of 72 OSs.

In the Step 4 "Designing problem diagnosis framework", this research proposed the answer of each OS by SCQA method: (1) The answer of OS1: In long term, this research isolated basic data and setting of main process into independent forms for flexibly modifying APP, and reaching the goal of internal auditing and controlling; (2) The answer of OS2: This research establishing independent logistics, cash flow, specimen, information flow for each characteristic and task, such like : (a) Users may install APP and sign up members; (b) Users could reserve screening service in advanced; (c) User should accept blooding service from blooding unit; (d) Laboratory should aliquot blood / specimen and translate DNA sequence into raw data; (e) DNArails should sequence DNA and generate DNA analysis report; (f) Users must can accept DNA analysis report and explanation. (3) In the answer of OS3: User had to scan quick response code (QR Code) for identifying users and specimen, even boosting the value of culture and creative to apply QR Code.

3. Establish the diagnosis stage of APP

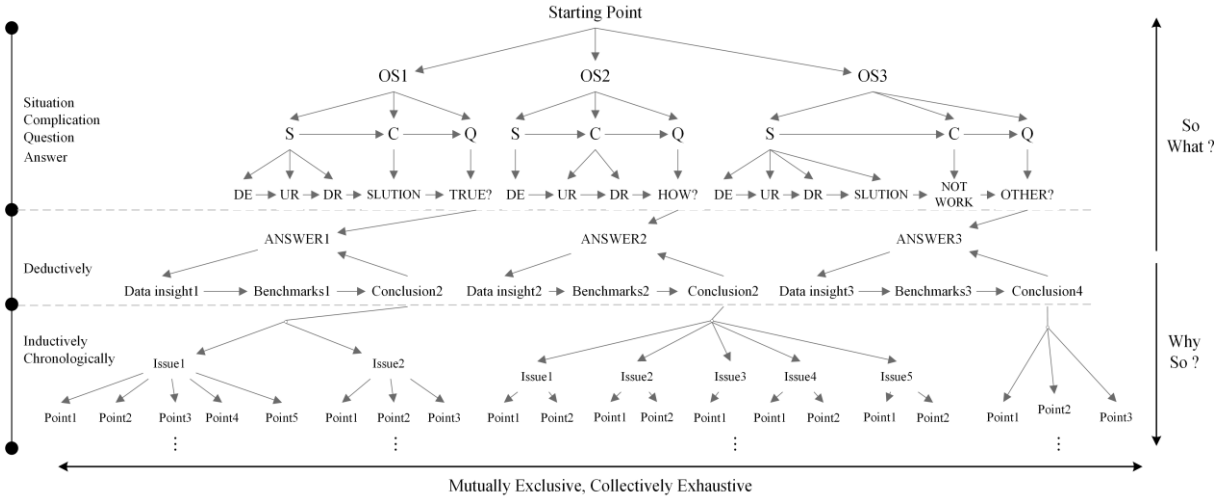

Fig. 3.　The Pyramid Structure Storyline of APP.

To present actual data insight which contain non-considered facts of each problem, and construct the framework of diagnosis stage. (1) The fact of OS1: For flexibly modifying forms, many information systems such like enterprise resource planning (ERP) would add select option and checkbox in task forms.

Thus, forms could modify much flexible once related fields of form were adjusted. Hence, this research firstly conducts 1st – 5th normalization for database, then divide data into dimension table, fact table, and even star schema. (2) The fact of OS2: For clearly realizing the tasks of each unit, this research was struggling to exploring information and event of each task, then defining the input and output. And so on, all input and output was connected for easily viewing by information flow, logistic, specimen flow. (3) The fact of OS3: We decided to apply QR code due to its large capacity (4,296 characteristics), high speed (10 times barcode), high recognition rate, small area.

In the Step 5 "Applying problem diagnosis framework" of diagnosis stage, this research established deductive logic tree by deduction, and (1) Describing data insight then set benchmarks; (2) Inferring possible conclusion of events.

For instance, (1) The benchmarks of OS1: In long term, APP and WEB-based management system had to integrate vertically, sharing and managing their data and task; The analysis result of OS1: HJBI should develop following 3 forms: major task, basic data and parameter for conveniently maintain system.

(2) The benchmarks of OS2: HJBI must confirm the system completeness and avoid repeatedly development or requirement modification, so held many times of coordination meeting with all involved units; The analysis result of OS2: APP and WEB-based system operation process should assist: (a) manager authorize system right for each units, including different gene screening package and items amount, viewing and explaining report, setting screening basic data, using coupon, adding or deleting blooding unit (hospital, clinical, inspection unit), laboratory, and blood collection barcode; (b) User is able to easily install APP, sign in member, participate screening activity, paying fees, and reserving blood collecting service; (c) Blooding units may apply APP to scan blood collection and add new specimen data; (d) Laboratory can scan specimen QR code by APP and update data to WEB-based management of generated raw data of surplus blood after aliquot specimen; (e) DNArail may download raw data, analyze data, generate report, and update analysis report to WEB-based system; (f) WEB-based system is able to send analysis report and related explanation to user promptly; (g) User is easily to review gene report and health explanation through APP.

(3) The benchmarks of OS3: HJBI must verify 3 kinds of information: (a) Coupons which users apply for screening service; (b) User registration information; (c) Blood collection which used for warehousing. The verification information based on secure sockets layer (SSL) for generating encrypted website. These websites characteristics were short, so HJBI don't consider the barcode size, but should stick identification mark in blood collection (Shown in Fig.3); The analysis result of OS3: To speeding scanning efficiency, HJBI determined to verify all information with QR code.

Fig. 4. Barcode and QR code in blood collection.

Above deduction process (Shown in Fig. 3) revealed this research had diagnosed the 72 problems and found solution by asking "Why so?" and "So what?" At the same time, this research also digging the points and issues of each solution by deducting and construct deduction logic tree. Furthermore, during deduction process, we still applied MECE principle to scanning the insufficient and duplication

part of issues.

According above process, this research conduct deep analysis (1 layer to 5 layer) of each problem. But restricted by pages limitation, this research just had stating the 1 – 2 layers of each problem. (1) The point of OS1including: (a) 1st layer: contained basic data (Issue 1), major task forms (Issue 2); (b) 2nd layer: Issue 1 contained Management of “member”, “APP”, “Characteristics”, “Area”, “Gene”, “Nucleic acid”, “Gene screening area”, “Specimen”, “Spare specimen”, and “Gene consulting service”; Issue 2 contained management of “Service”, “Activity”, “Blooding”, “Laboratory”, “Scheduling”, “Trading”, “Preferential application review”, “specimen status”, “Raw data”, “DNArials”.

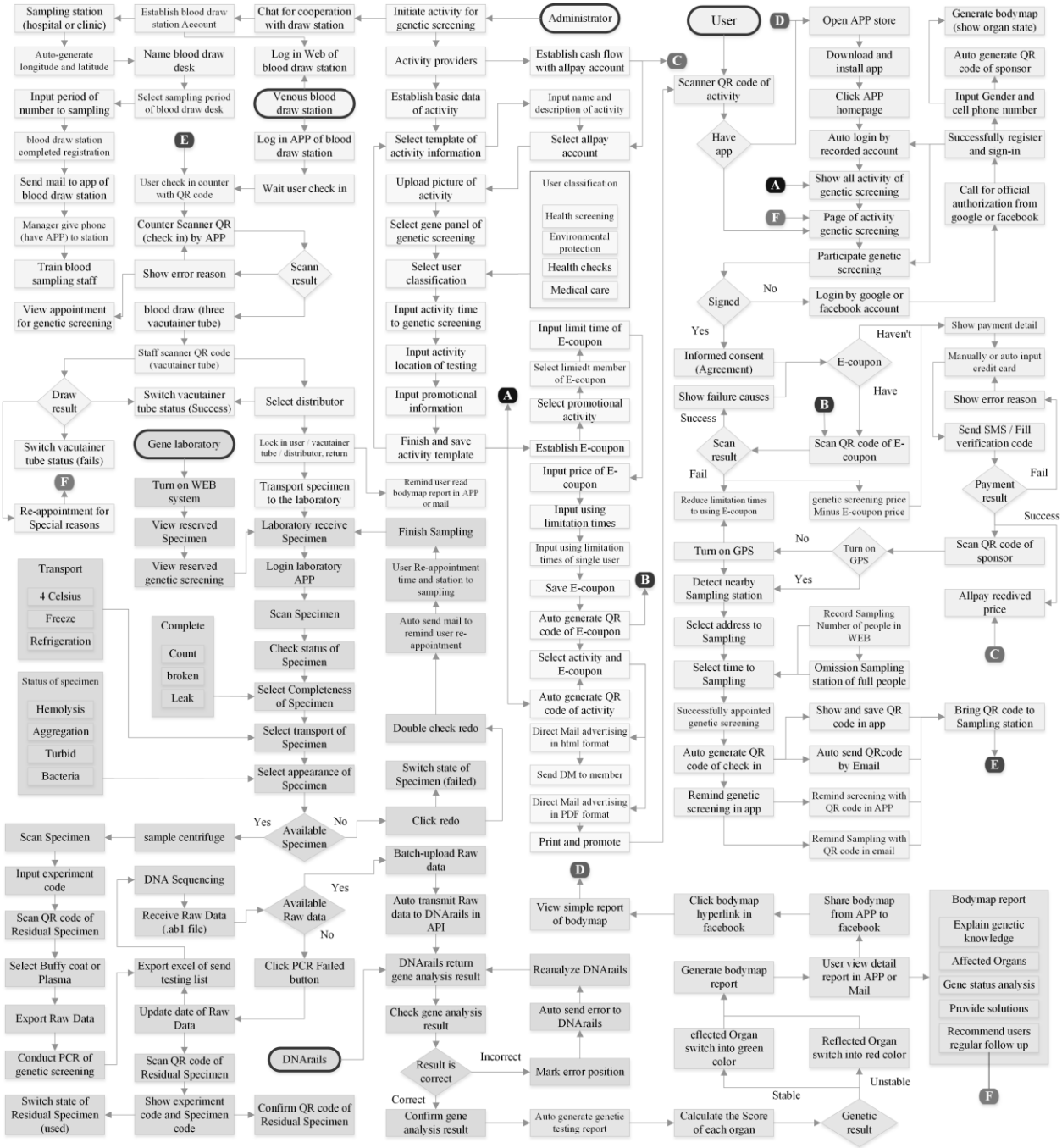

Fig. 5.　Process of GenonFire App and Web system.

(2) The point of OS2 including: (a) 1st layer: contained manager (Issue 1), user (Issue 2), blooding unit (Issue 3), laboratory (Issue 4), and DNArails (Issue 5); (b) 2nd layer: Issue 1 contained "APP disclaimer", "Gene items data", "Gene consultant data", "Screening activities data", "E-coupon", "Blooding collection data", "Laboratory data", "Blood collection QRcode"; Issue 2 contained "Installing APP and sign in member", "Doing screening and paying fee", "Reserving time and location of blooding", "generating QRcode of registration", "Viewing gene screening report"; Issue 3 contained "Scanning QRcode of registration", "Scanning QRcode on blood collection after blooding "; Issue 4 contained "Scanning specimen QRcode", "Checking specimen status", "Aliquot specimen and scanning QRcode of left blood", "Generating and updating raw data"; Issue 5 contained "Automatically downloading API ", "Analyzing raw data", "API updating gene analysis report to cloud automatically".

(3) The 1st layer in point of OS3 contained: System would produce users' reservation information, and generate QRcode for identification and registration (Issue 1); produce the setting and parameter of E-coupon, and generate E-coupon QRcode for consuming (Issue 2); System would generate blood collection QRcode, which was available for printing by printer (Issue 3).

Take the logic process shown in Fig. 3, this research established the diagnosis stage of APP "Systematic Information Problem-Solving Process" and take it as foundation of solution stage.

4. Establish the solution stage of APP

In the Step 6 "Establishing problem solving process" of solution stage, we applied 5W1H method to clarify: (1) Proposal (Why?); (2) Problem (What?); (3) Implementation steps (How?); (4) Time (When?); (5) Location (Where?); (6) Responsible person (Who?), and ordered these steps chronologically. Such like (1) Proposal: APP and WEB-based management system should be available for every characteristic to finish their own job and task; (2) Problem: Confirming the implication, undependability, and clearness of the 72 issues. Take above 3 issues as example: (a) What functions was essential for designing easily-maintained and flexible system; (b) What process was necessary for building practical system process; (c) What verification mechanism could ensure the consistency between internal auditing, internal controlling, work flow, cash flow, and specimen flow.

With above results, this research re-ordered the 72 solution of problem by implementation steps, time, location, and unit. We showed our flow chart in Fig. 4, which considered 6 characteristics, 3 systems, 12 categories of tasks, and 231 steps.

In the Step 7 "Checking differences between target and practical result" of solution stage, to confirming the actual development result was fitting with expected goal, HJBI had held development coordination meeting twice a week. At the same time, HJBI had found extensive problems and related limitation in check and acceptance process.

In the Step 8 "Raising suggestions to solving problem", the GenonFire APP developed by HJBI was: (1) Recorded by "BioMeder" in 2015; (2) Invited to participate "ITRI-NRC Medical Device Forum and Industrial Partnership Opportunities Event" held on by "Industrial Technology Research Institute (ITRI)", and published GenonFire in the scope "Business Model from In Vitro Diagnostic Devices (IVD) to Internet of Things(IoT)"; (3) Stated the perspective of GenonFire on "Research result presentation" held on "Rapid Prototyping service Center (RPC), Industrial Technology Research Institute (ITRI)"; (4) Applied Food and Drug Administration (FDA) for including in health care

insurance, hoped to raising self-sufficiency rate; (5) Signed contract with many hospital, clinical, inspection unit, laboratory, companies in same industry; (6) Distributed twice questionnaire survey in Likert 7 scale, each user had to score the steps satisfaction of each key task. The overall average satisfaction was reached grade 5.0. In contrast to, over 70% users were satisfied the APP.

V. Conclusion

Many decision makers had illustrated the solution of problems with vague and subjective process, which caused the problems can't effectively have solved, even influence business operation and innovation performance. Therefore, this research established "Systematic Information Problem-Solving Process (SIPSP)" by a series qualitative interviews, which brought 3 values: (1) Detailed presented the steps and key tasks during implementing solution, made the implementation steps and processes was complete and comprehensive with the systemic process; (2) Effectively defined / diagnosed problem, catch root cause, and reasoning core; (3) Clearly showed the paths, units, tasks, time, locations, and goals to decision maker, then they could easily and carefully arrange the plan to deal with problems.

Furthermore, these research results including 3 perspectives of management implication: (1) In management mechanism, SIPSP was the foundation for enterprise to establish standard operation procedure (SOP), which not only can diagnose the performance during solving problem, but enhance the ability to solving problem; (2) In management application perspective: SIPSP may assist enterprise to effectively apply deduction, induction, chronology, 5W1H method, maximize the efficiency to solving problem, and improve the competitiveness; (3) In management decision perspective, SIPSP was helpful for decision maker to arrange resource and find root cause of problem. Moreover, these results may provide the basement for decision maker to figure out optimized project and implementation steps.

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系統化資訊處理架構：價值解決方案

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摘　要

資訊管理問題之解決過程，經常是決策上的重要理性思維。雖有學者提出相關理論與建議，但過於概念與缺乏程序，而無法系統化應用。致使，企業在解決問題時，總是散漫無章。究其原因，在於問題解決思維的系統化流程，未能明確可用。對此，本研究(1)以「資訊處理理論」為基礎，掌握解決問題總體概念；(2)以「金字塔原理」為思維架構，建立「系統化資訊問題解決程序」；(3)透過質性方法，確認與優化此系統化程序；(4)以台灣某生物科技公司，建置 APP 系統之設計流程為例，來佐證本研究成果之實務性。相信，本研究成果不僅呈現學術新觀點，更令企業在解決資訊管理問題時，有一具體系統畫可遵循的程序，進而提升問題解決能力。

關鍵字：資訊處理理論、金字塔原理、問題解決程序、系統化思維、APP

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