FRAMING AN NUCLEAR EMERGENCY PLAN USING QUALITATIVE REGRESSION ANALYSIS

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ABSTRACT

Since the arising on safety and maintenance issues due to post-Fukushima disaster, as well as, lack of literatures on disaster scenario investigation and theory development. This study is dealing with the initiation difficulty on the research purpose which is related to context and problem setting of the phenomenon. Therefore, the research design of this study refers to inductive approach which is interpreted and codified qualitatively according to primary findings and written reports. These data need to be classified inductively into thematic analysis as to develop conceptual framework related to several theoretical lenses. Moreover, the framing of the expected framework of the respective emergency plan as the improvised business process models are abundant of unstructured data abstraction and simplification. The structured methods of Qualitative Regression Analysis (QRA) and Work System snapshot applied to form the data into the proposed model conceptualization using rigorous analyses. These methods were helpful in organising and summarizing the snapshot into an 'as-is' work system that being recommended as 'to-be' work system towards business process modelling. We conclude that these methods are useful to develop comprehensive and structured research framework for future enhancement in business process simulation.

ABSTRAK

Sejak timbul isu-isu keselamatan dan penyelenggaraan kerana selepas bencana Fukushima, dan juga, kekurangan kesusasteraan siasatan senario bencana dan pembangunan teori. Kajian ini adalah berurusan dengan kesukaran permulaan pada tujuan penyelidikan yang berkaitan dengan konteks dan suasana masalah fenomena. Oleh itu, reka bentuk penyelidikan kajian ini merujuk kepada pendekatan induktif yang ditafsirkan dan dikanunkan secara kualitatif menurut penemuan utama dan laporan bertulis. Data-data ini perlu dikelaskan induktif dalam analisis tematik untuk membangunkan rangka kerja konsep yang berkaitan dengan beberapa kanta teori. Selain itu, rangka rangka kerja yang diharapkan daripada pelan kecemasan masing-masing sebagai model proses perniagaan spontan banyak terdapat abstraksi data tidak berstruktur dan memudahkan. Kaedah-kaedah berstruktur Kualitatif Analisis regresi (QRA) dan Sistem Kerja gambar digunakan untuk membentuk data ke dalam model konsep yang dicadangkan menggunakan analisis ketat. Kaedah-kaedah ini telah membantu dalam menganjurkan dan merumuskan gambar yang menjadi 'seperti adanya' sistem kerja yang sedang digalakkan kerana sistem kerja 'to-be terhadap pemodelan proses perniagaan. Kami menyimpulkan bahawa kaedah ini adalah berguna untuk membangunkan rangka kerja penyelidikan yang komprehensif dan tersusun untuk peningkatan masa depan dalam simulasi proses perniagaan.

Keywords: Qualitative Regression Analysis (QRA); Work System snapshot; interpretational analysis; emergency plan.

INTRODUCTION

In this expected emergency plan, the implementation of empirical interpretive approach is divided into three analytical inductive processing methods known as interpretational, structural and reflective analysis. These analyses based on thematic coding. Significantly, this approach begins with contributing solutions for the construction of a tacit design. The tacit design centred on interpretational analysis (such as fishbone diagram and work system snapshot which are initially acclaimed as the conceptual framework of this study), then translated into the design space mapping of structural analysis. As the result, these actions implicated the design of the upcoming business process simulation of RANEP (radiation and nuclear emergency preparedness and response plan) as the outcome of the reflective analysis (Gregor & Jones, 2007; Hawryszkiewycz, 2010; Kuechler & Vaishnavi, 2012). This paper is focusing on the identifications of the research problem setting centred on interpretational analysis. This study used Qualitative Regression Analysis (QRA) as a tool to interpret the research participant's view on the phenomenon of the development of the expected emergency plan. To perform data reduction using inductive data processing, the research participant's views were transformed and organised into data categories, themes and codes. The translation of these analysed codes reconstructed into an initial conceptual framework by framing the business case of this study using Work System Snapshot. Most likely, these investigations are compromising as suggested in the prior literatures. The snapshot was validated according to expert's agreement during member checking sessions are to keep the assurance of the future development of the business process simulation. Verification of the proposed conceptual framework is to be converted into business process model based on the systems modelling of the simulation itself.

There are some other methods to conduct a case study research. This paper deliberately matters on the problem formulation of the selected case study. This initiative involved conceptualising and translating the research framework into a business process simulation from separate but conjoined information systems theoretical perspectives. This paper is proposing interpretational analysis to determine the contextual setting within the problem existed in the phenomenon. However, the researcher is facing with ample of unstructured data which is hard to describe through abstraction and simplification alone.

In summary, there are five sections in this paper; of which the current position pertains to the research introduction. Prior works relating to empirical interpretive approach by which implementing interpretational analysis explained in Section 2. Section 3 describes the considered research methods applied to conduct the interpretational analysis. Section 4 discusses research analyses and findings that were going to be concluded in the final section. The key feature in producing this paper is to define structured approach in organizing abstraction and simplification of unstructured data. This study initiated the problem formulation till model translation of the business process simulation. This paper partly discusses the steps within the research design focusing on the framing of the associated business process according to multiple theoretical perspectives which embedded within the expected phenomenon.

LITERATURE REVIEW

Information Systems Design Theory

This study consists of several perspectives of theories as scaffolding approach in order to eliminate contaminating elements such as vagueness and bias. This approach implied to understand a shared phenomenon from different views (Dobson, 1999). These perspectives taken during the member checking sessions interpreted as the main emphasis in developing the information system of this study as business process modelling. The main concept of this study is applying development method of business process model which adopts information system design theory (ISDT). The ISDT adoption comprises analytical data processing (such as interpretational analysis) to frame the process involved in the expected emergency plan. The framing process indicates a set of related processes especially targeted process to be improved by developing an initial process landscape known as the overall process map. The overall process map indicates the established process, context, scope and goals highlighted in the investigated phenomenon (Sharp & McDermott, 2001, 2009). This process is applied to understand the process workflow and sequence of activities which are interdependent between them (Gregor & Jones, 2007; Hawryszkiewycz, 2010; Kuechler & Vaishnavi, 2012). In addition, this approach also known as empirical interpretive in this IS research study which correlates with Gregor's type V theory. Empirical interpretive study subjected to acknowledged unexpected but significant findings through research participant's tacit knowledge and assumptions. This validation of this study conducted through familiarity and empirical confirmation (Stahl, 2013). Following that, empirical IS research in this study performed well-grounded knowledge development for constructing tangible theory (such as WST as part of ISDT) within the domain of the respective emergency plan (Ågerfalk, 2004).

Interpretational Analysis

This research adopts the approach of an empirical interpretational analysis in a pragmatic way by which relating to the process of the sequential techniques involving meaning description, decoding and translation of a phenomenon. This approach is implemented despite the measurement or frequency of a statistical analysis. This research implied interpretive and pragmatism paradigm. This situation indicates the research participant's deep insights which is due to their complex experiences they have undergone (Andrade, 2009; Rowlands, 2005) whereby pragmatism knowledge claims arise out of actions, situations and consequences of inquiry (Creswell, 2003, 2007). For instance, QRA and the framing of the work system snapshot as a social construct can be used as a vehicle to converts reality into characterized interaction between the researcher and the research participants (Andrade, 2009). Andrade (2009) also added that these interactions involved the subjectivity of the research critical issues and challenges represented as quality argumentations rather than statistical exactness (for instance, fishbone diagrams). This research demonstrated pragmatism as a form of recognition toward knowledge through action reasoning followed by knowledgeable action (member checking sessions and simulation modelling) to signify action research (Goldkuhl, 2004). The action research conducted in this research proclaimed as explanatory which involves multiple units of respondents within a single-case study or focus group (Baskerville & Myers, 2004). This research approach is also related to the qualitative research process which involves inductive data processing. This process involves the data organisation of categories as patterns (relationships) identifications. These patterns of analysed data are to obtain data reduction known as interpretational analysis. These data interpreted as processed codes, and themes, in order to determine the research context and goal setting (Creswell, 2003; Gall, Gall, & Borg, 2007; Wiersma & Jurs, 2009) as well as constructing the research case study (Yin, 2009).

Work Systems Theory

Alter introduced the Work Systems Theory (WST) taken as a theory for analysis (as described in Gregor, 2006), moreover, to view abstract concepts and describing organisational systems (Alter, 2013). In other words, WST is a design-relevant explanatory and predictive theory (DREPT), which combines both the analytic and attributes of explanatory and predictive (EP) theory of type IV (Kuechler & Vaishnavi, 2012). Besides that, WST provides claims to form artefact construction of type V theories. The uniqueness of WST as a combined type IV and V theory can be used to support the development of emergency management systems and in interacting with information technology professionals. Kuechler and Vaishnavi (2012) further discussed that both DREPT and ISDT are mid-range theories. Mid-range theories are inductively and deductively derived in linking conceptual levels from broad based theory of a phenomenon; which then made specifically provides empirical data covered by the general theory of a tacit design.

Thus, nuclear safety in this particular emergency plan considered as work in organisational settings. These settings are due to holistic environment in which human beings generate products and services that engage the information, physical and other resources. This emergency plan is also considered as a work system. This emergency plan is by default an implicating socio-technical system which is due to information processing embedded processes and activities. This paper focuses on WST framework as shown in Figure 1 as means towards better understanding of the requirements of radiation and nuclear (RN) emergency plan as defined by the stakeholders in the Nuclear Power Plant Development Programme (NPP).

This framework is a practical tool for analysing the expected advantages and disadvantages of a system, discuss potential changes, and develop relevant outcomes as those changes reproduced into other parts of the system. There are two useful methods applied to form this framework, work system method (WSM) and snapshot. WSM is a system analysis and design method. This method analyses an 'as-is' work system and designing an improved version of it known as 'to-be' work system snapshot.

Socio-Technical System Perspective in Developing an Emergency Plan

Post-Fukushima disaster inquiries about the safety and maintenance issues of the respective emergency plan are arising. Then this study reveals contextual problem setting related to lack of literature in disaster scenario investigation and theory development (Altay & Green, 2006; Canton, 2007). The respective emergency plan required to have legal, regulatory and safety framework in order to pursue high-economic growth and is also to prevent unforeseen situation in reducing public fears. Therefore, a framework of an effective radiation and nuclear emergency plan is required. Subsequently, this case designated planning and handling of expected radiation and nuclear emergencies and disasters. An effective accomplishment of such risk management tremendously needed to develop a good emergency plan framework (for example process models). Provided framework can be emphasize as a disaster recovery plan as an early indicator to perform the required model conceptualization. Therefore, prerequisite understanding of the highlighted emergency framework from selected stakeholders, required. In addition, the framework clearly identifies as a socio-technical system from the perspective of system approaches (Miller, Jyuji Misumi, & Wilpert, 1998; Moray & Huey, 1988). Furthermore, Moray and Huey (1988), as well as Miller et al. (1998) expressed this phenomenon as composed components of that both affects and is affected by one and the other dynamically in a timely manner (see Figure 2). Yet, the best quality and combination of technical equipment and components of the social system will optimise system outputs such as productivity, reliability and, safety. These components, known as subsystems described in Table 1.

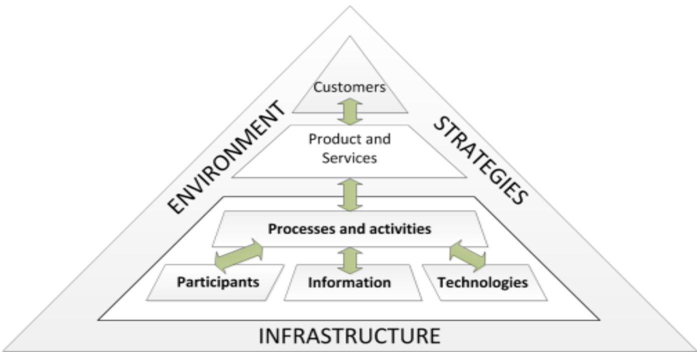

Figure 1 Work system framework

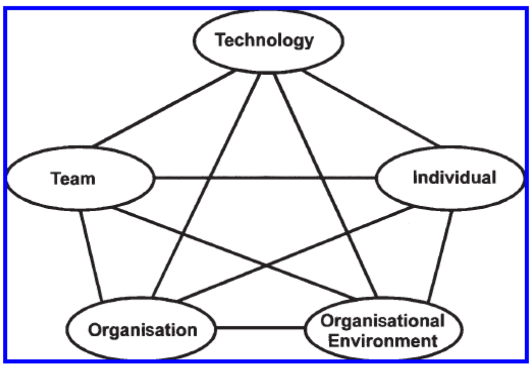

Figure 2 Subsystems of a nuclear power plant as a socio-technical system (Miller et al., 1998)

Table 1 Socio-technical System Components Descriptions

Subsystem/Component	*Description*
Technology	The physical system such as the workplace infrastructure and equipment used
Individual	Acting person (operator) and those functions relating to his or her workplace
Team or Work Group	Several persons with a common work task and group specific characteristics, for example, competencies, norms and social relations
Organizational	Comprising managerial and organisational structures, rules and regulations
Extra-Organizational Environment	All groups or organisations lying outside the focal organisation but contributing to the goal of safety

RESEARCH METHODS

Case Study

First, the study interviewed a focus group of stakeholders for the RN emergency preparedness plan to understand the 'how' and 'why' questions surrounding emergency preparedness and response plan. The stakeholders consisted of purposively selected 58 officers, which made up about 84.2% of those involved in the emergency plan. Male participants were 54.4%, and the rest were female. Stakeholder's permission were sought and obtained for the study. These stakeholders were asked to define their Needs (also known as Requirements), Expectations Want and Satisfactions (NEWS) analysis for the existing emergency plan. The outcome of the interviews produced qualitative data that were documented, coded and interpreted in order to produce the details of their requirements in the form of expected business processes.

Data collection were allowed during office working hours alongside participants validation to occur both within the questionnaire delivery sessions, a single interview and also across the interviews as participants were asked to compose their expectations they had initially identified. Participant's validation strategies were involved during data collection, where research findings and interpretations were fed back to the stakeholders and evaluation was in response to questions fabricated in the open-ended questionnaires.

Next, the member checking sessions involved selective research participants providing related expert's perceptions, which were verified in a systematic manner, and the project's data chain of evidence was established. In this case, the executions of member checking sessions were to improvise research accuracy and representativeness in order to reflect the information rigorousness and relevancy of the proposed WST snapshot. There are 20 experts interviewed during these sessions that took nearly 4-month period. There were 75% male officers interviewed, and the rest were females. The organisational representations among these experts are namely; national governance bodies and institutions such as main rescue agency and other supportive agencies like healthcare institutions including related international organization. This expertise made up 70% of those who are involved with the respective emergency plan. The member checking sessions were conducted accordingly alongside formalised permissions and ethical considerations.

Qualitative Regression Analysis

This paper enhances the framing of the expected emergency plan and business process modelling by using QRA which is validated through theoretical lenses (such as socio-technical system and WST). The overall view on this research operational framework adapting from empirical interpretive approach (Creswell, 2003; Oates, 2006) and sequencing simulation modelling steps (Banks, Carson II, Nelson, & Nicol, 2001, 2010). Main discussion in this paper is four major steps (see Figure 3) namely as; the research problem formulation, setting up of the research objectives, towards the development of the conceptual model according to preliminary data collection, which will be translated into a business process simulation later. These major steps are emphasizing the inductive approach of main analytical processing methods depicted as arrow lines in Figure 3. These imposing steps created due to the relinquishment of the conceptual framework development (Bloomberg & Volpe, 2008) resulting from the lack of literatures on disaster scenario investigation and theory development (Altay & Green, 2006; Canton, 2007). Provided snapshot, then re-evaluated accordingly as depicted dotted lines. The dotted lines enforcing reformulation of the research problem and objectives. This is also a part of action research which is integral in identifying the research purpose related to emerging primary findings and prior literatures. The conduct of model conceptualization and preliminary data collection is useful in justifying the research framework and supported with main analytical processing analyses (such as interpretational analysis). The research design of the interpretational analysis is indicated as darken boxes in Figure 3.

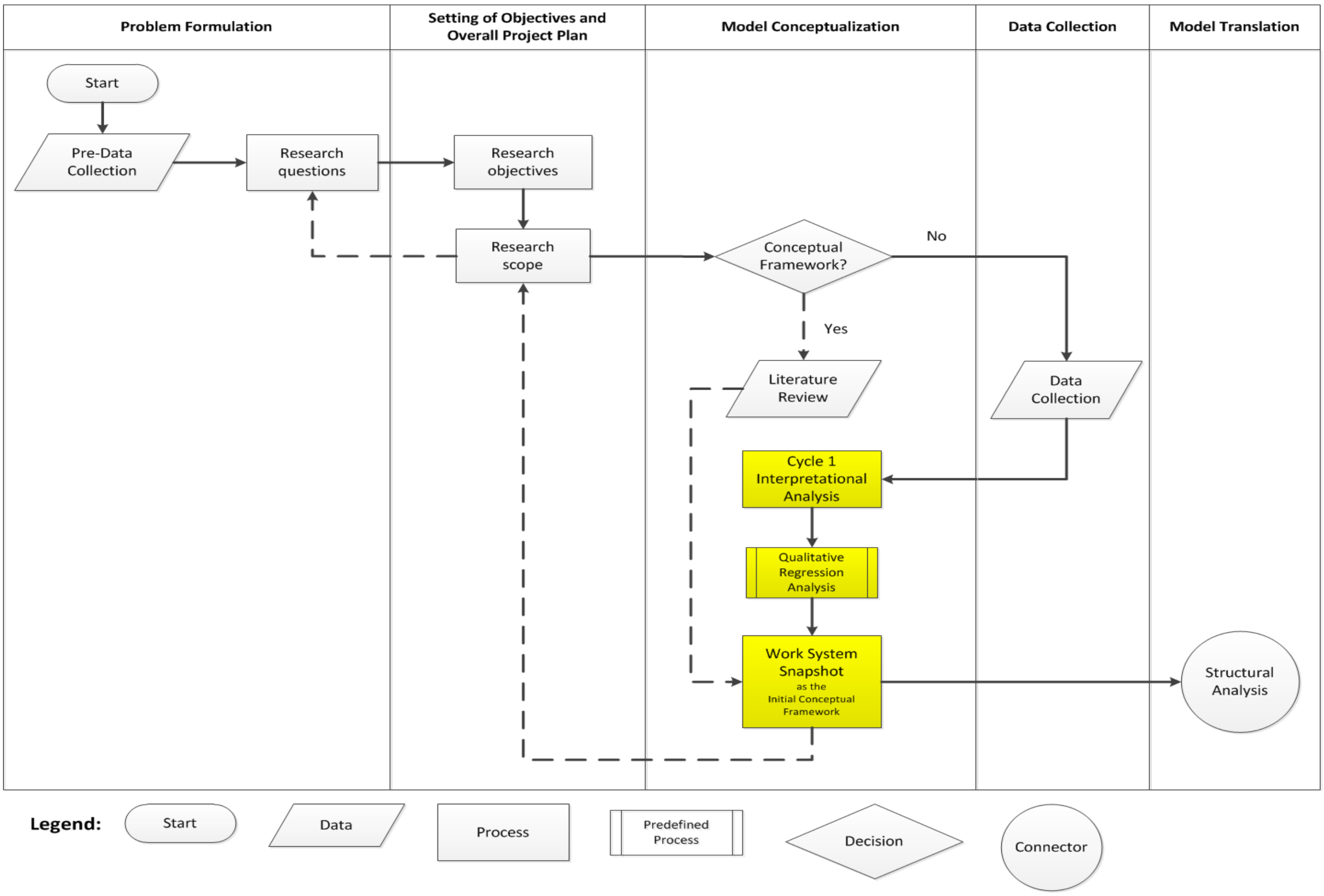

Figure 3 Research Process for business process simulation using Interpretational Analysis

QRA (see Figure 4) focuses on the research participants as subjects to give their opinion freely in expressing their tacit as well as formal, codified or explicit knowledge anonymously. This preserved knowledge interpreted as their complex experience and involvement in the respective occurrence or case study. Socio-technical system (STS) commonly used to materialize the theoretical lens as mentioned earlier (Miller et al., 1998; Moray & Huey, 1988) in the expected phenomenon. By doing so, this action would be visualized (namely; using NEWS analysis, affinity analysis and contingency table, Pareto analysis and Ishikawa (fishbone) diagram), by which transformed into the initial conceptual framework of the research. This QRA techniques used for removing bias in the control limits of the generalised variance chart adapted from Djauhari (2005) noted in (Djauhari & Mohamad, 2010). This QRA analysis would be finalized whenever the initial conceptual framework, revised.

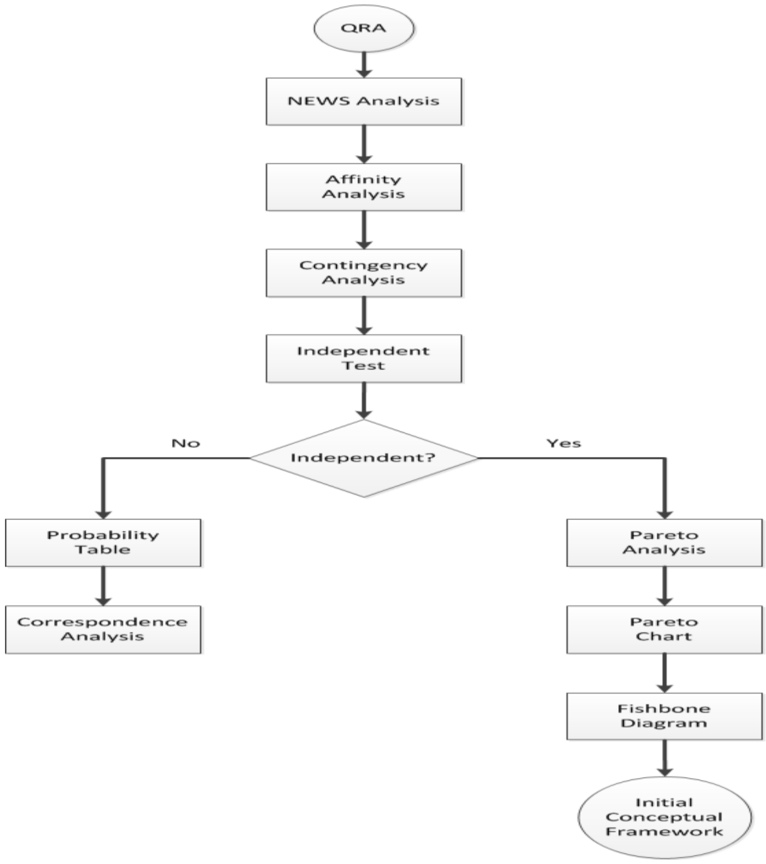

Figure 4 Steps for Qualitative Regression Analysis

Framing the Expected Emergency Plan Business Case into Work System Snapshot

The notes from the open-ended survey and interview with the stakeholders help to define the complex relationships among the stakeholders ('participants' in the WST snapshot) RN emergency preparedness plan and its work system elements (see Figure 5). These work system elements are described in Table 2. Figure 5 developed using a CADQAS (computer aided qualitative data analysis software) tool known as ATLAS.ti. The transcription of the research participant's answers and perception referring to a coding scheme based on the Table 2 using ATLAS.ti. An inductive analytical data processing produced a network diagram of the expected emergency plan (see Figure 5). Figure 5 is deliberately illustrating the relationships between the elements in the snapshot (Amy Hamijah Ab. Hamid, Mohd Zaidi Abd Rozan, Safaai Deris, & Roliana Ibrahim, 2013). The preliminary snapshot is a setup of the business case of the respective emergency plan in order to construct structural analysis of the proposed conceptual framework. The business case is a basic tool of WSM which depicted as a formatted one-page summary of the defined work system elements in Figure 5. This business case snapshot used to summarize the 'as-is' work system and the recommended 'to-be' work system (Alter, 2013; Sharp & McDermott, 2001). The acknowledged major processes and activities are the main contribution in this study. These processes and activities are the required business processes to be aligned accordingly. The prescribed business processes associated to the stakeholders (technical and healthcare support teams) because they are part of the participants and customers of the emergency plan. Effective implementation of the expected emergency plan initially associated with the highlighted regulators (also as the required stakeholder and disaster coordinator).

Table 2 Definitions of Work system snapshot (Alter, 2002, 2013)

Element	*Definition*
Customers	People who receive direct benefit from product and services produced in the work system.
Product and services	Combination of physical things, information and services that the work system produces into tangible and intangible items.
Participants	People who perform the business process as work system participants whether they are using little or no technology.
Information	The participant's work performance as codified and non-codified information of those used and created.
Technologies	Technologies divided into tools and techniques, which will help the work system participants.
Major processes and activities	The business processes of the work system.

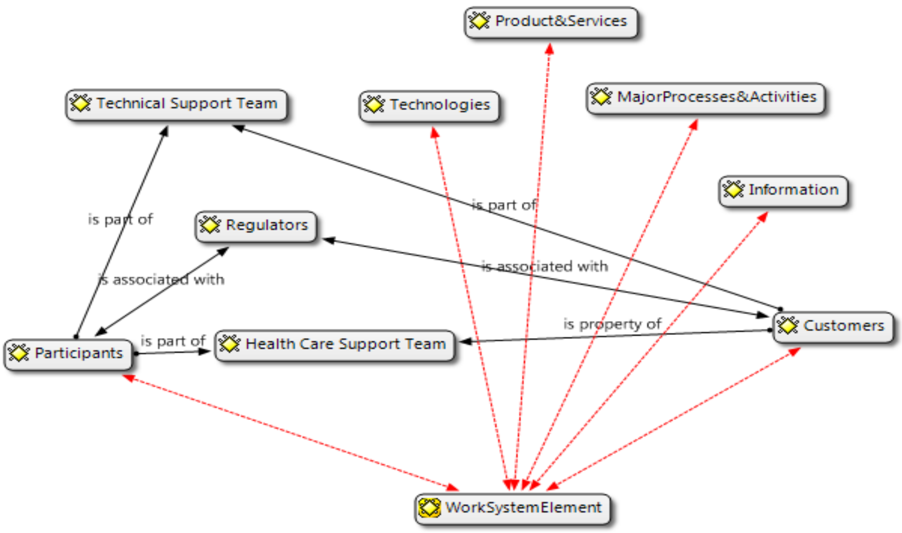

Figure 5 Network diagram of the expected emergency plan using WST snapshot

RESULTS AND DISCUSSION

Interpretational analysis of the case study centred on the theoretical emphasis of the respective emergency plan as a business case. This study analysed using QRA in order to determine the research context and goal setting. Alongside QRA, critical analysis of literatures supported the earlier findings in order to frame the Work System snapshot. The descriptions of the steps carried out as follows:

Qualitative Regression Analysis

NEWS Analysis

The first step of QRA is to identify current perspectives among research participants related to the investigative question asked. The question circulating on the issues of radiological and nuclear emergency preparedness and response plan (EPR) which belong to their Needs, Expectations, Wants and Satisfactions (NEWS) which has introduced by Djauhari (see Figure 4). The categorisation of this participant's perception applied in MS Excel file accordingly. The result of this study could not be displayed due to confidentiality matters. Highlighted issues in EPR are divided into phases of disaster operation management (DOM) such as mitigation, preparedness, responses and recovery action plan. The answers given are divided and interpreted into NEWS categorisation as an interpretational analysis.

Affinity Analysis and Contingency Table

Secondly, the affinity analysis and contingency table is calculated in order to discover co-occurrence of relationships relating to the activities performed by (or recorded about) individuals or groups, while simultaneously meeting the demand for broad, critical thinking. Subsequently, the idea generation and sorting generating affinity table decided on the STS components as depicted in Table 3.

Table 3 Affinity Analysis and Contingency Table

No	*Classification*	*Unit A*	*Unit B*	*Unit C*	*Total No of Answers Relative Frequency*	*Total Percentage (%)*
1	**TC-Technology**	38	29	7	74	16
2	**I-Individual**	64	38	3	105	22
3	**TM-Work Group or Team**	61	41	4	106	22
4	**OR - The Organisation**	52	54	16	122	26
5	**OE-Extra-Organisational Environment**	41	15	9	65	14
Total No of Answers		**256**	**177**	**39**	**472**	**100**

Contingency analysis seeks to determine the relationship dependency between the classifications of STS components and the research participants' opinion using Cut-Off Test (also known as Independence Test) as described in Table 4. The contingency table execution can be referred to Appendix 1. This analysis applies cross tabulation or cross tab to record and examine the relationship between two or more categorical variables. As a result, the T value of the Contingency Table is less (0) than the Cut-Off Value (15.5), concluding that the respondent's opinion are impartial toward the STS components. In other word, the respondent's opinion is not dependently related to the STS components (see Table 5). Therefore, these findings should be studied according to interpretive and qualitative approaches to gain deep insights and understandings to describe the holistic situation of the respective phenomenon. Furthermore, this result strongly indicated the implementation of empirical interpretive approach as the research design of the expected case study.

Pareto Analysis

Thirdly, Pareto analysis represents the most common sources of issues and challenges in the framework of the respective phenomenon. The Pareto chart showed the rise of the 80-20 rule, whereby 80 per cent of the problems usually related to 20 per cent of the causes (Tague, 2004). According to the cumulative frequency presented by these figures, the most pertinent issues and challenges from an overview perspective are those of organisational, team or work group issues and also from an individual point of view, respectively. Besides that, Unit A and B respondents subsequently highlighted the same issues. However, Unit C respondents expressed their concern on two issues only in both an organisational and extra-organisational environment.

Table 4 The Cut-off Test

Step 1: Create frequency table for the contingency analysis according to the NEWS categorisation.

Step 2: ni. n.j/n

Step 3: nij-(ni. n.j/n)

Step 4: [nij-(ni. n.j/n)]^2

Step 5: [nij-(ni. n.j/n)]^2 /(ni. n.j/n)

Table 5 Independence Test

Results of the Contingency Table			**Sum**
-2.13559322	1.25	0.88559322	0
7.050847458	-1.375	-5.675847458	0
3.508474576	1.25	-4.758474576	0
-14.16949153	8.25	5.919491525	0
5.745762712	-9.375	3.629237288	0
		Sum (T)	**0**
		Cut-Off=	**15.50731306**

The Pareto analysis depicted in Table 6 and Figure 6 highlights the most critical issues and challenges among a (typically large) set of factors. The left vertical axis depicts the frequency of answers given by the respondents accordingly. The right vertical axis refers to the cumulative percentage of the total number of answers given. As a result, reasons in the decreasing order in which the cumulative function is a concave function. It represents the most common sources of issues in respective circumstance as described previously (Tague, 2004). This figure depicted reducing issues and challenges in the event by 80%. As a result, it is sufficient to explain the first three issues (organisational, work group or team and also individual) which are similar to the cumulative frequency results given in the presentation beforehand. The organisational subsystem could be seen to be the most highlighted.

Table 6: Overall Frequency

No	***Classification***	***Value***	***Relative Frequency***	***Cumulative Frequency***
1	**OR**	122	25.85	25.85

2	**TM**	106	22.46	48.31
3	**I**	105	22.25	70.55
4	**TC**	74	15.68	86.23
5	**OE**	65	13.77	100
Total No of Answers		**472**		

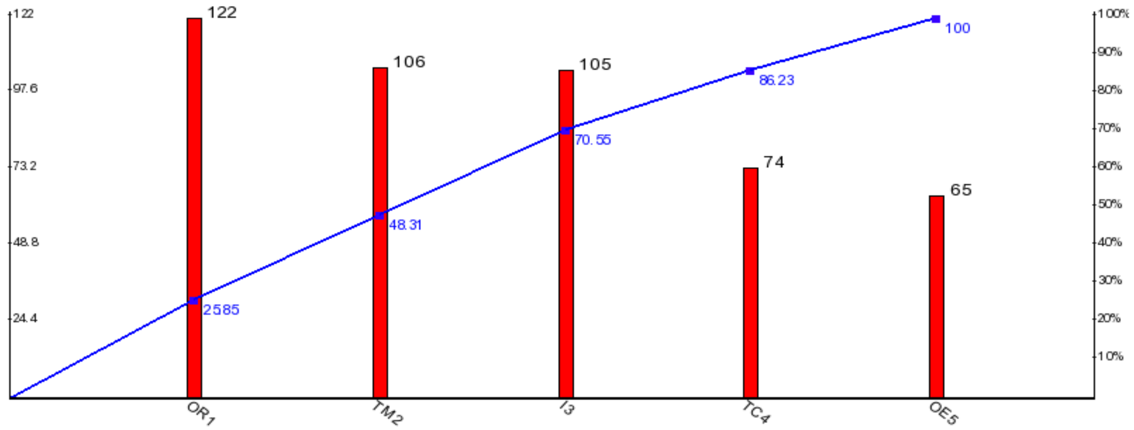

Figure 6 Overall Pareto Chart

Fishbone Diagram

According to earlier results, this study suggested fishbone diagram in order to highlight potential factors causing an overall effect in this case, together with issues and challenges in the respective phenomenon within the components of the STS (Miller et al., 1998; Moray & Huey, 1988). Previous studies have acknowledged that these subsystems will optimise a system output, such as safety if well implemented (Miller et al., 1998; Moray & Huey, 1988). Every cause or reason identified a defectiveness source of a variation. These causes or reasons identified and categorized in key categories according to the Job Hazard Analysis (JHA) in order to understand the sources of variation known as, namely: Task/Step, Personnel/People, Policies and Procedures, Tools/Equipment/Materials/Machines and Environment (Chan, 1998; Cructhfield & Roughton, 2008; Kaoru Ishikawa, 1990) as described in Table 7.

Table 7 Job Hazard Analysis Categories Descriptions

Category	*Description*
Task/Step	Analysis of the job and the step definition to do with the job in sequence.
Personnel/People	Anyone involved with the process or in some manner may affect the task/job.
Policies and Procedures/Methods	This category explains to what extent the process is performing requirements (such as policies, procedures, rules, regulations and laws). This category is developing guidelines for tasks or steps that may affect other tasks or steps involved.

Tools/Equipment/Materials/Machines	Any equipment, computers, tools and other items required to perform the job or task, including raw materials, arts, pens, papers used to produce the final product.
Environment	The conditions or elements, such as location, time, temperature, and culture in which the process operates or needed for the tasks/job to be undertaken.

Finalised causes and reasons analytically generalised within the organisational, team or work group and individual subsystems issues within the respective phenomenon are illustrated according to Figure 7.

Figure 7 Causes affecting the respective phenomenon

Most likely, this research centred on the policies and procedures or methods involving the RN emergency plan (EPR) need to be announced publicly. This may result in enhancement of awareness among Malaysian citizen upon the managing of expected risk involved. This suggestion is also open for the corresponding candidates among managerial and technical personnel. These people can be invited to witness and assess procedures during an RN emergency plan drill or demonstration.

Further, a good RN emergency plan must be both structured and thorough. It refers to standard laws and regulations emphasizing a clear definition of roles and commands which indeed are indications of a good management procedure. Therefore, it will ideally possess a strong policy which is regularly inspected, revised (one to three years term) and appropriately implemented suitable for the Malaysian environment. In that case, an established and reliable Standard-of-Procedures (SOP) is recognised and satisfied if it is appropriately synchronised within the stakeholders' flowchart. Thus, the RN emergency plan mechanism enhancement can be feasible during its operation handling. These mechanisms, as mentioned in the diagram previously circulate through various areas in order to both improve and enhance the quality of the stakeholders' work or tasks. Therefore, they are knowledgeable and well-prepared to be able to save the community, environment and other constituents during RN emergencies and disasters.

Critical Analysis of Literatures

According to highlighted issues in Figure 7, these prior studies (Hirsch, 2004; Royston, Dost, Townshend, & Turner, 1999) indicated five key sectors as the key elements of RN recovery stage framework indicated as systemic aspects of emergency health and social care (see Figure 8). These aspects are developed according to the key stakeholders whom are professionals in health and social care. These sectors are accepted because it is representing the large, complex and socio-technical system with the people as its key players. Healthcare system key elements are presented in the model which are focused in this study are hospitals, physicians' offices and long term care facilities. These key elements will be related its interdependencies with other infrastructures. Alongside with it is the population among the people requiring regular basis and particular care, for instance, referring to disaster or bio-terror attack. In this case the paper is referring to the radiation and nuclear disaster and emergencies.

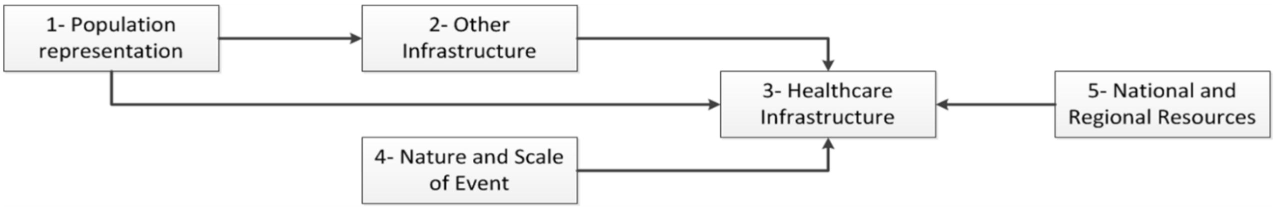

Figure 8 Conceptual framework of the expected phenomenon

Consequently, Royston et al. (1999) and Hirsch (2004) further explained that during any occurrences of expected emergencies and disasters initiated, the population is divided into a healthy, functional population among the workable group and a non-functional population who need medical attainment. These people are given distinctive healthcare treatment according to appropriate triage screening system by initiating the initial area treatment and reception area treatment. More critically severed casualties are transported to the hospital to be given further medical care and treatment. However, during this moment, healthcare and emergency services workers might be disabled due to disorganized rescue mission. Other complications might be happening that emergency medical team is not adequately equipped and trained to use personal protective equipment. In constant, this scenario might immobilize services and workers from other infrastructures such as transportation, electric power, telecommunications, and water and sewage treatment. In addition, these conditions might take a back for certain population which are exposed and disabled by the expected disaster and emergencies.

Population who are exposed and disabled to the nature and scale of radiation and nuclear emergencies and disaster are mainly classified accordingly, (as described in Amy Hamijah binti Ab Hamid, Lau Kee Wah, Hairudin Abdul Majid, Azurah A. Samah, & Wan Saffiey Wan Abdullah, 2012; Demin & Yatsalo, 2000) as external exposure, external contamination and internal contamination. External exposure accidents involve localized, partial and/or total body exposures to radiological sources. Apart from that external and internal contamination can become widespread from skin contamination, wounds, burns and/or trauma arising from the inhalation and ingestion of radionuclide, ending with radiation absorption and also major irradiation with associated wounds and burns. Treatment for these exposures varies, according to the severity of the casualty, from initial clinical observation and treatment to detailed treatments in specialized centres to prevent life-threatening illnesses.

Framing The Work System Snapshot

The notes from the open-ended survey and interview with the stakeholders help to define the complex relationships among the stakeholders ('participants' in the WST snapshot) RN emergency preparedness plan and its work system elements (see Figure 5). These work system elements are described in Table 8. The notes are coded thematically using ATLAS.ti considering the emphasis highlighted by the finalised fishbone diagram and earlier conceptual framework. The participants of this study are also the customers of the respective emergency plan except for clinical patients and public community (which are the main customers of this study). For example, the technical support team is also a customer who benefits from the work system but at the same time is a participant in the work system. They are the selected stakeholders as research participants involved as regulated by the policy and guidelines (listed under 'product and services'), primarily responding on the radiation emergency plan. There is no such thing as nuclear emergency plan so far due to the non-existence of any nuclear power plant in Malaysia. Frequently, several attempts initiated to further fulfil this policy and regulatory requirements for encapsulating future demands. The policy and regulatory outlines the process and procedure to execute product and services of this study, which is the RN emergency plan itself. These product and services emphasize multi-level regulatory governance policies implementations. The use of high quality standards as major references of the emergency plan which is strengthened by the execution of best practices, tools or technologies and information proposed within the lower level regulatory standards. By doing so, the stakeholders are well-versed in identifying the required information and technology in order to obtain successful performance of the respective emergency plan.

Regardless of that, there are several disjoints in determining and justifying the major activities or processes apparently. Major business processes required focusing on preparedness and response strategies that take into consideration RN risk management planning and disaster coordinator roles and responsibilities. RN risk management planning also requires diagnosis (such as radionuclide migration), protections (such as shielding), inspections, assessments, (such as environmental impact assessment and also, air contamination and survey assessment) and also, monitoring on a 24/7 stand-by basis. This circumstance reflected and supported this study assumptions, namely; vague expectations of disasters, complex identifications and characteristics of RN disasters and emergencies, difficulty in identifying the failure of risk management in such emergency, and finally, difficulty in the experimentation of the respective emergency eruptions using the conventional approach which are based on prior studies (Abd Aziz bin Mhd Ramli, Idris bin Besar, Mohd Ashhar Hj Khalid, & Shafaai bin Hassan, 2008; Abd Khalik Hj. Wood & Azali bin Muhamad, 2006; Altay & Green, 2006; Canton, 2007; Crick, McKenna, Buglova, Winkler, & Martincic, 2004; International Atomic Energy Agency (IAEA), 2002; Kelly et al., 2004; Miller et al., 1998; Murao, 2006; Niculae, French, & Carter, 2004; Phillips, 2009; Tanabe, 2006; Watanabe, 2006). The determination and justifications of those activities involved using several tools introduced by WST which would be explained in the future.

Table 8 Preliminary Work System Snapshot for Malaysia RN Emergency Plan Requirements

Customers
• Regulators and Technical Support Team Members • Internal and External Radiation and Radiation Related Workers • Healthcare Support Team Members • Patients in Hospitals and Clinics • Public Community
• ***Product & Services***
• International Atomic Energy Agency (IAEA) recommendations such as Nuclear Safety Framework and also, Safety fundamentals and requirements • National policy and mechanism on Disaster and Relief Management Policy (Directive 20) • Atomic Energy Licensing Act 1984 (Act 304) • National Radiological Emergency Preparedness and Response Plan (RADPLAN) • RN Emergency Standard-of-Procedure (SOP) guidelines
Major Activities or Processes
• Regulators consider International Atomic Energy Agency (IAEA) guidelines in policy making processes for regulating the proposed RN emergency plan and safety procedures • Brief summary on RN risk management planning during emergency drills and eventual situations delivered • Disaster coordinator take charge and responsible for any RN preparedness and response emergency plan handling and implementations in any radiological working area and assembly drills • Resources and equipment identifications conducted according to stakeholders' roles and responsibilities • Stakeholders coordinate and retrain their subordinates about the emergency plan systematically using state-of-art technologies for national and institutional levels

• Stakeholders are continuously conducting RN risk management consisting the radiation and nuclear diagnosis, protections inspections, assessments and monitoring within 24/7 stand-by regulations • Stakeholders revisit their RN emergency plan requirements on a regular basis

Table 8 Preliminary Work System Snapshot for Malaysia RN Emergency Plan Requirements (cont.)

Participants	*Information*	*Technologies*
• **Regulators** who is also the Disaster Coordinator • **Technical Support Team Members** • Internal and External Radiation and Radiation Related Workers • **Healthcare Support Team Members** • Accident and Emergency Department Staff • Hospital Radiology Unit Staff	• RN Emergency Plan Technical Training and Assembly Drills Request • RN Emergency Administrative and Operational Procedure Request • Technical Skill, Techniques, Competencies and Capabilities Specifications • RN Monitoring and Laboratory Data Collection, Diagnosis and Testing • RN Monitoring and Laboratory Reports	**Tools** • Mobile Vehicles • Helicopters • Laboratories • Safety Equipment and Instruments • Specified Hospitals and Clinics For RN Casualties **Techniques** • Mobile Devices (Using GPS, RFID) • On-Line Alarm System • Radiation Monitoring System • Radiation Diagnosis and Shielding System • EPR System • Environmental Impact System **Others** such as newspaper and bulletin

Alter (2013) added that work system framework and snapshot are critical in analysing work practices and help identify business processes, which might be tightly or relatively unstructured. Within these business processes, various activities including saturated information processing, communications, sense making, decision-making, and physical activities are taking place. Different participants might be performing the same business processes but in different forms based on their worldview of the emergency plan and their level of skills, training and incentives. In fact, Alter (see Alter, 2008, 2012; Truex, Alter, & Long, 2010) envisions that these idealized business processes might deviate from their original design. Following Alter (2013), a preliminary 'snapshot' of the RN emergency preparedness system shown in Table 8 provides 'to-be' picture of the work system (as described in Amy Hamijah Ab. Hamid et al., 2013).

CONCLUSION

In conclusion, according to the recognized research process steps, the findings of this paper establish the context and goal setting of the interpreted emergency plan in the respective phenomenon in form of a work system snapshot. These recommendations contribute the enhancement of the existing emergency plan, which is a 'good emergency plan' according to the research participant's perspectives. Provided enhancements improvise the expected emergency plan by giving reasons and explanations behind the embedded 'why' queries. Then, the 'how' queries are taken into account and will be investigated in the near future.

Several future studies, which support the snapshot need to be undertaken. The validation of the snapshot is applied using structural analysis. The structural analysis is based on the codified expert's perception retrieved in the suggested snapshot as follows.

First, the development of process models divided into process model, logic flow model and activity cycle diagram. These recognised models will be extended as revised conceptual framework of the emergency plan. Nevertheless, the business process analysis applied, involves multiple sources of information (e.g. observations, interviews and written reports). The business process is going to be justified according to multiple theories; in this case, Socio-Technical System (STS) and Work System Theory (WST), or else, any external priory in a broad context (such as the RN emergency plans of Japan and Korea) as the benchmark of this research.

Second, the subjected conceptual framework will be developed into well-defined conceptual data models to address standardised business process involved. This action might improve the coordination of the future construct of the simulation system. Consequently, these suggestions might further verify the revised conceptual framework into better dimensions of simulation modelling. The simulation model is verified and to be tested further in order to decide upon the best development and design (for instance, system dynamics, discrete event and agent-based modelling simulation) in addressing and implementing them in a considerate manner. Consequently, following recommendations will highlight upcoming methods.

Finally, as equally indicated, a future case study analysis also needs a sufficiently strong theory in order to maintain the whole idea of this study ahead of time. It also needs to be subjected to a review and discussion in relation to the adopted theoretical lenses. In short, future structural analysis will be constructing into business process simulation to a greater degree to proceed into a decision making on the disaster capacity planning, rather than for just manual or regular table top emergency drills in action. This future accomplishment is to comply with the assurance of the required business processes in the respective emergency plan.

Appendix 1

STEP 1 - Table of frequency displayed in form of each data generated from the NEWS categorisation.

TABLE 0

Category	Need	Want	Expectation	Satisfaction	Total
case 1	n11	n12	n13	n14	n1
case 2	n21	n22	n23	n24	n2
case 3	n31	n32	n33	n34	n3
Total	n.1	n.2	n.3	n.4	n

The yellow box reflected the frequency produced from the line-to-line coding based on prior thematic analysis.

STEP 2 - Calculate formulation ni.ni.j/n for each data accordingly. For example a11= n1x n.1/n.

TABLE 1

a11= n1xn.1/n	a12= n1xn.2/n	a13= n1xn.3/n	a14= n1xn.4/n
a21= n2xn.1/n	a22= n2xn.2/n	a23= n2xn.3/n	a24= n2xn.4/n
a31= n3xn.1/n	a32= n3xn.2/n	a33= n3xn.3/n	a34= n3xn.4/n

STEP 3 - Calculate formulation Nij-(ni.ni.j/n) for each data accordingly. For example b11= n11-a11.

TABLE 2

b11= n11-a11	b12= n12-a12	b13= n13-a13	b14= n14-c14
b21= n21-a21	b22= n22-a22	b23= n23-a23	b24= n24/c24
b31= n31-a31	b32= n32-a32	b33= n33-a33	b34= n34/c34

STEP 4 - Calculate formulation (Nij -(ni.n.j/n))^2 for each data accordingly. For example c11= b11^2.

TABLE 3

c11= b11^2	c12= b12^2	c13= b13^2	c14= b14^2
c21= b21^2	c22= b22^2	c23= b23^2	c24= b24^2
c31= b31^2	c32= b32^2	c33= b33^2	c34= b34^2

TABLE 4

				Total
d11= c11/a11	d12= c12/a12	d13= c13/a13	d14= c14/a14	d15= d11+d12+d13+d14
d21= c21/a21	d22= c22/a22	d23= c23/a23	d24= c24/a24	d25= d21+d22+d23+d24
d31= c31/a31	d32= c32/a32	d33= c33/a33	d34= c34/a34	d35= d31+d32+d33+d34
			sum (T)	d45= d15+d25+d35
			cut-off value	d55 =CHIINV (ls;LR)

How to finalised the results given in TABLE 4:

Step i - For example, the formula to calculate cut off value is = CHIINV (ls;LR).
ls means level of significance=0.05 and LR is degree of freedom=[(r-1).(c-1)].

Step ii - Next is to calculate the number of rows and columns for TABLE 4.
That means [(r-1).(c-1)] =[(3-1).(5-1)]=[(2*4)]=8 (r= row, c=column).
In addition, the cut-off value formulation for this example is CHIINV (0.05; 8).

Step iii - The final result of the cut-off value is validated as such.
*if T<cut-off value that means the value of X&y are independent and unbiased.
Sample a: sum (T) d45= 5 and cut-off value d55= 15.5073
**if T>=cut-off value that means the value of X&y are dependent and then need to further determined by constructing probability table.
Sample b: sum (T) d45= 100 and cut-off value d55= 15.5073

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