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Research Methodology: Use of Qualitative Comparative Analysis on Multiple Case Studies to Analyze Conditions and Outcomes of Information Technology Project Selection in University

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Abstract

A vast majority of research on the Information Technology (IT) decision making in the university uses the case study research methodology. However, many of these case studies are done in a stand-alone manner. This article demonstrates a research methodology on using more than one case study on the IT decision making at university. In addition, this article demonstrates how Qualitative Comparative Analysis (QCA) could be used to complement the multi-case study analysis of IT decision making at university. The article uses a hypothetical example to demonstrate the research methodology to conduct multi-case research on the IT project selection in university. Next, it demonstrates how QCA could be used to complement the case study research, by analyzing how the IT project selection conditions in university lead to an outcome.

Keywords: Research Methodology, Case Study, Multiple Case Studies, Qualitative Comparative Analysis, QCA, Information Technology, IT, IT governance, IT governance in university, IT project selection, IT project selection in university, condition, outcome, centralized IT decision, decentralized IT decision, IT awareness in university, IT governance committee structure in university, IT project performance in university

Background of Case Study Research

A case is a phenomenon occurring in a bounded context, a unit of analysis, which explores a process, or behaviors, which are little understood (Miles & Huberman, 1994, p. 24). A case study is the exploration of the case within its context, using a variety of data sources that allows the revelation and understanding of the multiple facets of the case (Baxter & Jack, 2008). "*A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefit from the prior development of theoretical propositions to guide data collection and analysis*"(Yin, 2009, p. 19).A case study is anup-close, in-depth understanding of a single, or a small number of "cases," set in their real-world contexts (Bromley, 1986).The case study involves a detailed investigation of one or more organizations, or groups within organizations to analyze the context and processes involved in the phenomenon under study (Meyer, 2001).

Schramm (1971, p. 7) suggested that a case study asks the following questions.

- Why a decision, or a set of decisions are made?
- How to carry out the decisions?
- What results were obtained because of those decisions?

Yin (2009, p.27) suggests that for *"case studies, five components of a research design are especially important, a study's questions, its propositions, if any, its unit(s) of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings. The case study method is most likely to be appropriate for how and why questions,"* questions on the topics, over which the researcher has limited control. A single case study may include a single case or more than one case. If more than one case is chosen, additional cases are used to test the validity and reliability of the theory, replicate the theory, and to find additional interesting evidence.*"Analytic generalization can be used whether your case study involves one or several cases"* (Yin, 2009, p. 39).

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Baxter and Jack (2008) defined six different types of the case study, which are as follows.

1. Explanatory. Seeking answers to a question that is too complex for the survey, or experimental strategies.
2. Exploratory. Explores the situations where the evaluated intervention has no clear, single set of the outcome.
3. Descriptive. Describes a phenomenon and its real-life context, under which it has taken place.
4. Multi-Case. Explore the differences within and between the cases, and replicate the findings across the cases. The cases are chosen carefully so that similar results can be predicted across the cases, or contrasting can be found based on the theory.
5. Intrinsic. The researcher has a particular interest in a case and wants to better understand the case. The goal is not to understand a generic phenomenon, but the case specific behavior.
6. Instrumental. Provides insight to an issue, or refine a theory, and provides a supportive role in understanding a theory.

Case study research is based on a constructivist paradigm, builds on the social construction of reality, acknowledges that the truth is relative, and is dependent on the perspective of an individual, which could be subjective (Searle, 1999). The case study allows close collaboration between the researcher, and the participant, and allows the participants tell their stories from the reality; which allows researcher better understand the action of the participants (Robottom, 2005). The experimental or quasi-experimental studies with data collection and analysis methods are known to hide some details (Stake,1995). *"Case studies, on the other hand, are designed to bring out the details from the viewpoint of the participants by using multiple sources of data. Case studies are multi-perspective analysis. This means that the researcher considers not just the voice and perspective of the actors, but also of the relevant groups of actors and the interaction between them.This one as pect is a salient point in the characteristic that case studies possess."* (Tellis, 1997).

Case Study as Research Methodology for IT Project Selection in University

The nature of the research questions dictates what research method should be chosen. The case study methodology is relevant when the researcher asks a descriptive question as how, and why something happened. The "how" and "why" questions could be researched on the contemporary set of events (Leonard-Barton, 1990). A case study is applicable in a naturalistic approach, which seeks to understand the phenomena in a context-specific real world setting, where the researcher does not try to manipulate the phenomenon of interest (Patton,2002, p.39).Case study research methodology is a good fit for the complex and contemporary, real world topics which are exploratory in nature (Ribbers, Peterson & Parker, 2002).

The IT project selection in university fit the explanatory, exploratory, descriptive, intrinsic and instrumental nature of the case study research. Also, because of the paucity of cumulative research, a case study is a good fit to research the IT project selection in university. The "why" and "how" questions asked in a case study fit well with the IT project selection in the university. It is important to understand how and why a specific IT project was selected.

Table 1. Case study protocol to be followed for IT project selection

Case Study Protocol	Cases Study Protocol to be Followed
A case study asks how, why question (Schramm, 1971, Yin, 2009, p. 2).	Study how IT projects are selected in the university, why these decisions were made.
A case study explores the complex phenomenon (Baxter & Jack, 2008).	IT project selection in the university is complex because the project priorities and stakeholder interests often conflict.
A case study is explanatory, exploratory, descriptive, intrinsic and in instrumental nature (Baxter & Jack, 2008).	The IT project selection in university is explanatory in nature because it is too complex for the survey only. It is exploratory in nature because it does not have a single set of outcome. It is descriptive in nature. It can be described in a real-life context in the project selection, which is already taking place. It is intrinsic in nature because the case specific information can be researched. It is instrumental in nature because it provides insight into the issue of project selection. Multi-case study research methodology is described in this article.
A case study conducts an in-depth investigation (Bromley, 1986).	Conduct an in-depth study of the IT project selection in the universities.
A case study is conducted within its real-world context (Baxter & Jack, 2008, Patton, 2002, Yin, 2009, p. 83).	Conduct interviews in-person and on the telephone, observer and collect data, obtain data from various records and archives.

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Multiple Case Study Research Approach

Multi-case study research approach methodology is explained in this article. The selection process of a single IT project in the university will serve as one case. It is neither necessary nor preferred to have a random selection of cases. This is because, it is more important to choose the cases based on theoretical sampling, where the additional cases may either replicate or augment a theory (Eisenhardt,1989a). Harris and Sutton (1986) used a case study to research the organizational behavior. They chose eight organizations, which were going through bankruptcy. This sampling was not random, rather, it was based on theoretical sampling; and the samples were chosen to replicate a case, or to enhance the theory.

The multi-case study is used for theory replication, which is used to predict similar results between cases or to predict contrasting results, but for predictable reasons (Yin,2009, p.39). The advantage of using multiple case studies is that the evidence created is stronger, and more reliable (Baxter & Jack, 2008). When choices and resources are available, the multi-case design may be preferred over single case designs, as the "evidence from multiple cases is often considered more compelling, and more robust" (Yin, 2009, p. 53). A new theory could be generated from a case study, or an existing theory could be tested (Eisenhardt,1989a). By conducting the multi-case study, the theory can be expanded and generalized (Johnston, Leach & Liu, 1999).

The case study could reach its closure when the theory saturation is reached, which means, additional learning is negligible; or similar behavior is observed, as was noticed before (Eisenhardt,1989a). At that point, the case study could be concluded. Eisenhardt (1989a) noted that there is no magic number on how many cases are researched, but a number between four and ten could be sufficient; any less than four may not be sufficient to validate a theory, and more than ten could make it complex. The later cases studied by the researcher may replicate the prior findings and extended the theory, by finding additional details.

Table 2. Multi-case protocolto be followed for IT project selection

Multi-Case Study Protocol	Multi-Case Study Protocol to be Followed
Multi-case study predictssimilar, or contrasting results (Yin, 2009, p. 87, Baxter & Jack, 2008)	Similar and contrasting results from multiple cases to be analyzed.
Four to ten cases could be sufficient when additional learning is negligible, or similar (Eisenhardt, 1989a).	Theory saturation is reached, as additional cases could not find significant additional learning.
Study cases from different organizations, or study multiple cases within the same organization (Yin, 2009, p. 82-83).	Study multiple cases from the same university, and/or study multiple cases from different universities.

Data Collection Approach in Case Study

The data are collected in a case study in a natural setting so that the phenomenon is studied within its real-world context as an original field work, as opposed to relying on the derived data, and survey response (Bromley, 1986). The findings in a case study can be presented in a tabular format instead of applying statistical significance tests (Eisenhardt,1989a). A collection of data from multiple data sources enhances data credibility (Patton, 2002).

- *"Case study evidence also can include both qualitative and quantitative data. Qualitative data may be considered non-numeric data, e.g., categorical information that can be systematically collected and presented; quantitative data can be considered numeric data e.g., information based on the use of ordinal if not interval or ratio measures. Both types of data can be highly complex, demanding analytic techniques going well beyond simple tallies" (Yin,2004, p.12). The potential data sources may include documentation, archived records, interviews, physical artifacts, direct observations, and participant observation (Baxter & Jack, 2008).*
- *"Good case studies benefit from having multiple sources of evidence. In collecting case study data, the main idea is to triangulate or establish converging lines of evidence to make your findings as robust as possible. The most desired convergence occurs when two or more independent sources all point to*

VOL: 4, ISSUE: 8
August 2018
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the same set of events or facts" (Yin,2004, p.9). Each data source would contribute to the understanding of the researcher, support the findings, and allow a better understanding of the case. The data from each source is converged in the analysis process, instead of treating the data individually.

The seminal research by Eisenhardt (1989b) on decision making in the microcomputer industry used the case study research methodology. She studied eight microcomputer firms and collected the data by interviewing employees with different roles in the firm. For each firm, she interviewed the Chief Executive Officer (CEO), manager, and non-management employee. She gathered the quantitative data from the questionnaires, which asked the questions on conflict and power. Industry reports and internal documents were used as a secondary source of data.From the interview responses obtained; she conducted a pattern matching and content analysis. Finally, she formulated the research propositions and supported them based on the data collected.

The data gathered from various sources applies rigor, but the researcher has to limit the amount of data so that it does not become overwhelming. The researcher could study the case after it has taken place, and the case research could span a range of time (Schramm,1971, p.8). The data on IT project selection process can be collected from the university archives, documents, interviews with the IT project selection decision makers.

Table 3. Data collection protocol for IT project selection

Data Collection Protocol	Data Collection Protocol to be Followed
Collect data in real-world context (Pettigrew, 1985, Bromley, 1986).	The data could be collected by the researcher from the universities, where the cases took place.
Collect data from multiple sources, archival records, documents, interviews, physical artifacts (Patton, 2002, Baxter & Jack, 2008, Yin, 2004, p. 9).	The data could be collected by the researcher from the publicly available sources, university website, and the interviews.
Interview CEO, manager, non-management employee (Eisenhardt 1989a), IT decision makers, managers, IT staff and users (Albrecht &Pirani, 2004, Bhattacharya et al., 2007, Fraser et al., 2003)	The researcher could conducta structured interview of the IT project selection committee members.

Triangulation Approach in Multiple Case Studies

A case study is known as a triangulated research strategy, as triangulation provides an important way of ensuring the validity of case study research (Tellis,1997). The data collected from different sources, different case participants, and the existing literature could be used to triangulate a finding in support of the research proposition (Eisenhardt, 1989a). The desired convergence occurs when the independent sources point to the same set of interpretations in support of the case study proposition (Yin, 2009, p. 28). Denzin (1978, pp. 294-307) classified triangulation in case study research into four categories, which are as follows.

1. Data triangulation. The researcher studies whether the data remains the same in different contexts.
2. Investigator triangulation. More than one researcher examines the same phenomenon.
3. Theory triangulation. The researchers with different views study the same phenomenon.
4. Methodological triangulation. One method is followed by another to increase the confidence level of the finding.

Generalization of the findings in a case study research is done through induction, which is inductive theory-generation, or conceptualization based on the data found from the cases (Johansson,2003). Generalization depends on the principle of abduction, where curious circumstances and variations are found, which could be explained by the researcher based on the unique context of the case (Johansson,2003).According to Grounded Theory, this is the way in which generalizations are made through triangulation of findings (Glaser & Strauss,1967). The objective of the case study is not to represent the universe, but theoretically could be generalized by studying multiple case studies. Triangulation in the research was achieved by collecting the data from multiple sources.

International Journal of Business and Applied Social Science (IJBASS)

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August 2018
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Table 4. Triangulation protocol to be followed for IT project selection

Triangulation Protocol	Triangulation Protocol to be Followed
Triangulate evidence from multiple sources of data, using multiple data collection methods, within the case and cross-case analysis, and by using existing literature. (Eisenhardt, 1989a, Yin, 2004, p. 9).	The existing sources could be used by the researcher to form the research proposition and the research questions. The data could be collected by the researcher from multiple participants, university archive, documents. The data collected from the multiple cases could be compared and contrasted. Multiple researchers could be used for investigator triangulation.

Testing Validity of Case Study Research

Validity test should be conducted to test the quality of the research design. Yin (2009, p. 41) proposes the following validity tests.

- Construct validity. "Use multiple sources of evidence, establish a chain of evidence, have key informants review draft case study report".
- Internal validity. "Do Pattern matching, do explanation building, address rival explanations, use logic models".
- External validity. "Use theory in single-case studies, use replication logic in multiple-case studies".

Internal validity is also known as logical validity, and it refers to the causal relationships between the conditions and outcome and can be done by matching the observed patterns (Yin,20009, p.41). Under a causal relationship, certain conditions are believed to lead to certain outcomes (Kidder & Judd, 1986, pp. 26-29).

Construct validity is the operational measures, for which the case study phenomenon is researched (Kidder & Judd, 1986, pp. 26-29). It is the phenomenon that the case study claims to investigate. Construct validity needs to be considered during the data collection process. It is important not to develop subjective judgments at this phase and to ensure that the participants do not feel any threat. (Yin, 2009, p. 41).

External validity is the domain to which the findings of the study can be generalized (Kidder & Judd, 1986, pp.26-29). External validity is a generalization of the theory with the belief that the phenomenon occurs not only under the setting under which it is studied but also in other settings (McGrath & Brinberg,1983). Neither a single case nor multiple cases allow for statistical generalization to infer conclusions about a population; however that does not mean that the case studies lack generalization."Analogy to samples and universes is incorrect when dealing with case studies. Survey research relies on statistical generalization, whereas case studies (as with experiments) rely on analytic generalization.In analytical generalization, the investigator is striving to generalize a particular set of results to some broader theory" (Yin, 2009, p. 43).

Analytical generalization is done using empirical observations in a case study, rather than using a population. In the widely cited article of Eisenhardt (1989a), it is suggested that a cross-case analysis of four to ten case studies may provide a good basis for analytical generalization and theory generation. The researchers can analyze case studies of different organizations or multiple cases studies with an organization, and "multiple levels are likely to fall within a nested arrangement: a broader level (e.g., a field setting) that contains or embeds a narrower level (e.g., a participant in the setting)," which is known as nested approach (Yin, 2011, pp. 82-83).

Table 5. Validity protocol to be followed for IT project selection

Validity Protocol	Validity Protocol to be Followed
Internal validity is tested by cause and effect (Kidder et al. 1986, Yin, 2009, p. 41).	The researcher could study the cause and effect of selecting IT project selection in the universities, and its outcome.
Construct validity is tested by using correct operational measures, (Kidder & Judd, 1986). Participants should not feel a threat (Yin, 2009)	Participation in the case study could be voluntary. The participants could review the interview questions before the interview. The participants have an opportunity to accept, or decline the interview, not answer a question, or terminate an interview without any effect on their personal and professional matter. The participants should not feel any threat.
External validity tested by generalization (Eisenhardt, 1989a, Yin 2009, p. 41)	The cross-case analysis could be conducted by the researcher to generalize the findings on the IT project election process in the universities.

VOL: 4, ISSUE: 8
August 2018
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Testing Reliability of Case Study Research

Reliability in a case study is achieved by setting the "*case study protocol"* (Yin,2009, p.41) so that the researcher can follow the same protocol and follow the same procedure to collect the data (Kidder & Judd, 1986, pp 26-29). A reliable case study can help us *"understand a situation that would otherwise be enigmatic or confusing"* (Eisner,1991,p.58).Systematic errors are known as predictable errors, and they systematically affect all the samples in the case study. Random errors are due to chance and unpredictability, such as the mood of the case study participant, and are the concerns of reliability. To guard against the random errors, triangulate the evidence; use multiple data sources, multiple observers, and external observers (Tellis,1997).

The research must make a case study protocol transparent "*that you must describe and document your qualitative research procedures so that other people can review and try to understand them"* (Yin, 2011, p. 19). The transparency can be increased by documentation and clarification of the case study protocol. *"One prerequisite for allowing this other investigator to repeat an earlier case study is the need to document the procedures followed in the earlier case. Without such documentation, you could not even repeat your own work (which is another way of dealing with reliability"* (Yin, 2009, p. 45).

Table 6. Reliability protocol

Reliability Protocol	Reliability Protocol to be Followed
Reliability is achieved by repeating the research protocol, and the data collection procedure, and by making the research protocol transparent (Kidder & Judd, 1986, Tellis, 1997, Yin, 2009, p. 41).	The researcher would follow the same research protocol and data collection approach in all the cases. The interview participants should be asked the same set of questions, and all the case study participants will be asked to furnish the same set of records. The research protocol should be transparent and should be reviewed by the case study participants ahead of time.

Choice of QCA as Research Methodology

This chapter explains the theoretical background of QCA, rationale behind choosing QCA to complement the case study research, and how QCA was used to analyze the causal conditions and outcomes.

Background on QCA Research Methodology

QCA was introduced by Charles Ragin in the 1980s. QCA is widely used for the applications in the social science research (Gross,2010). COMPArative methods for Systematic cross-caSe analysis (COMPASS) are a knowledge body, which is dedicated to the QCA research. QCA is designed for analyzing cross-case patterns, complex causal relationships between conditions and outcomes, and is useful in researching five to fifty cases (Rihoux & Ragin, 2009, p. 4). QCA *"strives to achieve some sort of explanation of a certain phenomenon of interest while still providing appropriate allowances for causal complexity"* (Rihoux & Ragin, 2009, p. 10). *"In general, QCA has been characterized as a new, "third" way to conduct social science research that combines the strengths of traditional quantitative and qualitative methods"* (Devers et. al., 2013).

QCA allows modest generalization to support a proposition, or to add new knowledge. *"QCA results may be used in support of limited historical generalizations. Most specifically, from a systematic comparison of comparable cases, it is possible to formulate propositions that we can then apply, with appropriate caution, to other similar cases. This view of generalization is much more modest than statistical inference, which allows very broad generalizations"* (Rihoux & Ragin, 2009, p. 12). Cress and Snow (2000) noted that the primary concern of QCA "*is not with generalizing to the universe, ...but with using our case findings to refine and extend understanding of the determinants of ... outcomes. Given the similarities and differences among our cases in terms of the causal factors and the range of outcomes obtained, they are well suited for assessing the influence of factors thought to affect outcome attainment."*(Rihoux and Ragin, 2009, p. 11) noted that *"without the ambition to generalize, in the*

International Journal of Business and Applied Social Science (IJBASS)
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search for an explanation, research would produce only tautologies and descriptions."

QCA allows replicability, as the other researchers using the same set of data, and choosing the same options would arrive at the same results, and this ability to replicate test *"provides the scientific character of the approach, in the sense that it eliminates vagueness and interpretation in the application of techniques"* (Rihoux & Ragin, 2009, p. 14). QCA allows transparency in research and requires the researcher to be transparent about the choices, selection, and thresholds (Rihoux& Ragin, 2009, p. 14).

A comparison between the cases is fundamental in case study research to understand the similarities and dissimilarities between the cases. QCA allows a systematic cross-casecomparison while understanding the complexity within a single case. QCA can be successfully conducted with small to a medium number of cases by gaining a sufficient intimacy of the conditions and outcomes of each case, selecting the cases which share sufficient similarities, and produce both positive and negative outcomes (Rihoux & Ragin, 2009, pp. 24-25).

QCA analyzes the conditions on the cases, which lead to an outcome. The conditions are the variables found in the cases. Each condition has a raw data, found in each case. The raw data on the condition on each case is translated into a coded value, based on a threshold. The outcomes are the results observed in the cases and have raw data. The raw data on each outcome is translated into a coded value based on a threshold. The threshold values are determined for each condition and the outcome. This determination is made in a transparent manner. The threshold values need to be justified based on the substantive theoretical ground; and if that is not possible, data distribution of the cases, or a cutoff point based on mean, or median of the data could be used (Rihoux & Ragin, 2009, p. 42).

The conditions selected are the ones which vary across the cases, and the number of conditions should be limited between six and seven for the number of cases ranging between ten and forty (Rihoux & Ragin, 2009, p. 28). QCA allows a systematic analysis of Most Similar Cases with Different Outcome (MSDO), and Most Different Cases with Similar Outcome (MDSO) by systematic matching, and the pairing of cases based on the conditions and outcomes (Rihoux & Ragin, 2009, p. 29). As such, the case selection in QCA should include the "most similar," and "most different" cases, and have an adequate number of cases with both 'positive,' and 'negative' conditions, leading to 'positive,' and 'negative' outcomes. The conditions with different threshold are paired to identify different configurations. Next, a minimization process is followed using Boolean algebra to identify the simplest set of conditions, which will result in an outcome.

There are three categories of QCA, which are as follows.

- Crisp-set QCA
- Multi-value QCA
- Fuzzy-set QCA

Crisp-Set QCA codes the raw data on the conditions and outcomes into a dichotomous threshold value of 1 (indicates presence), or 0 (indicates absence). It uses a truth table to represent the data. It uses Boolean logic to produce a combined expression and minimize the conditions leading to an outcome (Rihoux & Ragin, 2009, pp. 33-34). If the raw data for a condition and outcome is not found in a case, QCA allows substitution for the absent values using theoretical and substantive knowledge, which is considered a key strength of QCA (Rohwer, 2008).

Instead of limiting to only dichotomous threshold values of 0, and 1 as in crisp-set QCA, multi-value QCA extends crisp-set QCA by allowing the threshold values in the various intervals. The threshold values can be obtained from *"multi-categorical nominal, ordinal scale, or by the use of multiple thresholds of interval data"* (Rihoux& Ragin, 2009, p. 73), and *"in most cases, only three or four values per condition should be used"* (Rihoux& Ragin, 2009, p. 78). The purpose of multi-value QCA is the same as that of crisp-set QCA, and the main objective is to find a minimal solution, which would produce a specified outcome. Multi-value QCA still allows the dichotomous threshold of 0 and 1, along with the multiple values of 0, 1, 2 on the conditions (Cronqvist, 2003). The fuzzyQCA set allows the support for a richer data set by allowing the threshold values of the conditions and outcomes as a decimal value between 0 and 1 (Rihoux& Ragin, 2009, p. 119). This approach allows more granular information than what could be supported by crisp-set QCA and multi-value QCA.

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Apply QCA in Multiple Case Study Research on IT Project Selection in University

QCA is a good fit to systematically analyze the complex causal conditions for the IT project selection in university and its outcomes. A single IT project selection process in a university could be chosen as one case, and thus multiple cases are identified and researched.

Multi-value QCA *"can be viewed as a kind of middle-way between the greater parsimony of crisp-set QCA and the greater empirical richness of fuzzy-set QCA. It is ´not quite crisp´ because it allows the use of intermediate values to denote degrees of set-membership, but it is also ´not yet fuzzy´ because the outcome is always dichotomous. Its major advantage, according to its proponents, is that it deals better with the classic QCA problem of contradictory configurations where cases with the same explanatory characteristics display different outcomes and in principle cannot be taken into account for logical minimization"* (Vink&Vliet, 2007).

The research may not always have sufficient richness to justify fuzzy-set QCA but may have sufficient data to conduct multi-value QCA. The researcher could study eight to ten cases to fit in the size of intermediate cases, which is ideal for multi-value QCA (Herrman & Cronqvist,2006). *"The explanatory power of a QCA, fs/QCA, and MVQCA analysis is a function of two parameters; the size of a case set on the one hand, and the necessity to preserve the richness of rawdata information on the other. A researcher should use QCA for analyzing rather small, middle-sized case sets whose values can be converted into dichotomous scores without a loss of important cluster information. Fuzzy-set QCA, instead, is most useful whenever a researcher wishes to analyze a comparatively large middle-sized case set which requires preserving rich raw data information. MVQCA, in turn, strikes a balance between crisp-set QCA, and fuzzy-set QCA as it constitutes the most suitable method for analyzing genuinely middle sized case sets which necessitate the conservation of some rawdata information"* (Herrmann &Cronqvist, 2006).

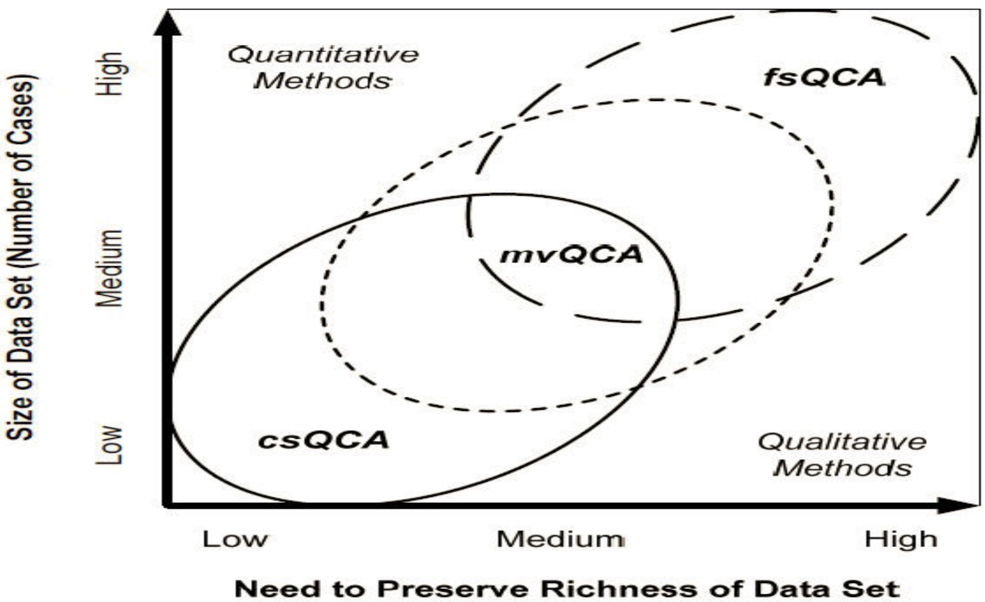

Figure1. Selection of QCA methods (Source: Herrman&Cronqvist, 2006)

In multi-value QCA, the preferred coded values of conditions could have dichotomous values of 0, and 1, or preferably not more than three, or maximum four values; but the outcome should be dichotomous (Wagemann& Schneider, 2010). As such, the threshold value set on a condition is either 0, or 1; or 0, or 1, or 2. The threshold value set on an outcome is 0, or 1.

Steps in QCA

The steps in QCA involve the following.

VOL: 4, ISSUE: 8
August 2018
http://ijbassnet.com/
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- Identify the cases.
- Identify the conditions in the cases that lead to an outcome.
- Find the raw data for each condition, and outcome in each case.
- Determine the threshold values for each condition and outcome, based on substantive knowledge. Based on the threshold value, assign a coded value to each condition and outcome of the case.
- Conduct QCA to analyze how the conditions affect the outcome, analyze the variances.

A hypothetical example is used to demonstrate the steps of QCA. In this example, three cases are chosen, such as Case1, Case2, and Case3. Each case has three conditions, such as ConditionA, ConditionB, and ConditionC, which lead to an outcome OutcomeX. For each case the raw data of the conditions and the outcome are identified. For each condition and outcome, the threshold ranges and a corresponding coded value for each threshold range are determined. Finally, the coded threshold values are analyzed to understand the causal relation between the conditions and the outcome.

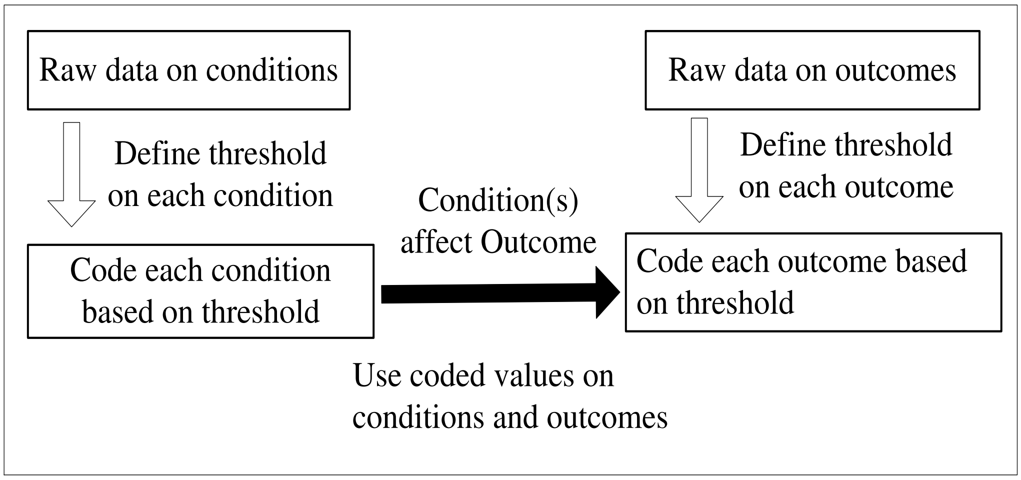

Figure 2. Raw data converted to code based on threshold

Table 7. Raw data on conditions and outcome

Case Number	ConditionA	ConditionB	ConditionC	OutcomeX
Case1	100	30	110	70
Case2	60	75	115	75
Case3	65	35	60	40

Next, determine a threshold value for each condition and outcome based on substantive knowledge, and replace the raw data of each condition and outcome by the coded value. In this hypothetical example, the dichotomous coded value of 0, or 1 are set in each condition and outcome. As such, raw value of ConditionA, ConditionB and ConditionC, and OutcomeX are coded to either 0, or 1. The tables below show assignment of the coded value based on the threshold range of each condition and outcome.

VOL: 4, ISSUE: 8
August 2018
http://ijbassnet.com/
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Table 8. ConditionA – Determining threshold and the coded value

Threshold Range	Coded Value
Greater of equal to 100	1
Less than 100	0

Table 9. ConditionB – Determining threshold and the coded value

Threshold Range	Coded Value
Greater of equal to 70	1
Less than 70	0

Table 10. ConditionC – Determining threshold and the coded value

Threshold Range	Coded Value
Greater of equal to 100	1
Less than 100	0

Table 11. OutcomeX – Determining threshold and the coded value

Threshold Range	Coded Value
Greater of equal to 70	1
Less than 70	0

The table below shows the raw data of each condition and outcome of the three cases being replaced by the coded value, based on the threshold assigned to each condition and the outcome.

Table 12. Coded data on condition and outcome based on threshold

Case Number	ConditionA	ConditionB	ConditionC	OutcomeX
Case1	1	0	1	1
Case2	0	1	1	1
Case3	0	0	0	0

VOL: 4, ISSUE: 8
August 2018
http://ijbassnet.com/
E-ISSN: 2469-6501

Based on the coded values, all the logical configurations between conditions A, B, and C are identified, which would result in the outcome of 0, or 1 for X. Shown below is an example of this analysis based on the coded values.

- A{1} represents the [1] value, the higher value for ConditionA
- A{0} represents the [0] value, the lower value for ConditionA
- B{1} represents the [1] value, the higher value for ConditionB
- B{0} represents the [0] value, the lower value for ConditionB
- C{1} represents the [1] value, the higher value for ConditionC
- C{0} represents the [0] value, the lower value for ConditionC
- X{1} represents the [1] value, the higher value for OutcomeX
- X{0} represents the [0] value, the lower value for OutcomeX
- Logical "AND" is represented by [*]

Following are the two available configurations for the outcome of X{1}.

A{1} * B{0} * C{1} =>X{1}

A{0} * B{1} * C{1} =>X{1}

The above two equations are minimized as C{1} =>X{1}.This minimization indicates that the condition C{1} is found in both the configurations for X{1}.

QCA Research Protocol

QCA research protocol needs to be followed in selecting the case, and selecting the conditions and outcomes. The validity and reliability also needs to be tested in the QCA protocol.

Case Selection

QCA allows a systematic analysis of similar and different cases. The number of cases has to be sufficient to exhibit both positive and negative behaviors of the conditions and the outcomes. The number of cases chosen should adequately show the combinations of positive and negative values for the conditions and the outcomes.

Selection of Conditions and Outcomes

The conditions are the variables that distinguish the cases. The number of conditions selected should be limited to six to seven for as many as ten cases (Rihoux& Ragin, 2009, p. 28).With a large number of conditions, the number of cases needed would increase; while a small number of conditions would result in contradicting outcomes. The outcomes identified are the observed behaviors.

Assign Coded Value Based on Threshold

QCA requires the researcher to be transparent about the threshold range, based on which a coded value can be assigned to the raw data of the condition and the outcome (Rihoux & Ragin, 2009, p. 14). There are multiple choices available to select the coded value to suit the research need. The coded value based on the threshold range on the conditions could be 0 and 1, or 0, 1, 2; and the thresholds set on an outcome are 0 and 1 (Rihoux & Ragin, 2009, p. 73). The values 0 and 1 represent the presence or absence; while values 0, 1 and 2 represent low, medium, and high.

This researcher is expect to gather the raw data on each condition and outcome, determine the threshold range for each condition and outcome and assign a coded value for each range. The threshold range and the corresponding coded value for each condition and outcome is have to be supported by the subject matter experts, existing literature and the case knowledge (Rihoux & Ragin, 2009, p. 42).

Condition Minimization

Using QCA, a minimal combination of conditions can be identified, which would lead to an outcome. QCA uses Boolean logic to find the minimal condition(s) leading to an outcome. The minimal condition(s) are the condition(s), which were common in all the cases, resulting in an outcome.

Validity Test

Validity is tested in QCA by ensuring that the following criteria are met (Rihoux& Ragin, 2009, p. 29).

- The study includes a sufficient number of cases with both 'positive and 'negative' conditions, leading to the 'positive,' and 'negative' outcomes.
- The conditions vary between the cases.
- The cases are diverse so that the conditions can be paired.

A visual test can be conducted on the cases studied to see if it passes the validity test. The cases researched have to have sufficient diversity. The conditions and outcomes have to have both positive and negative values among the cases studied. It was possible to pair the conditions, which lead to an outcome.

Reliability Test

The reliability is ensured in QCA if other researchers using the same set of data, and choosing the same option would arrive at the same results (Rihoux& Ragin, 2009, p. 14). The reliability in QCA is tested by ensuring the replicability. The threshold range assigned to the conditions and outcomes can be replicated by interviewing multiple case study participants and by verifying these values by multiple interviewees and multiple sources of data. A consensus can be reached between the case study participants in each case on the threshold, which can ensure reliability. The same case study protocol needs to be was repeated for all the cases. All the interviewees need to be asked the same set of questions and a similar set of data needs to be gathered for all the cases.

Hypothetical Example - Application of QCA on IT Project Selection in University

A hypothetical example is used to illustrate how to use QCA to analyze the effects of various conditions affecting the outcome in the IT project selection in university.

Research Steps

The research steps involved are:

- Based on the literature review, identify the conditions and the outcomes of the IT project selection in the university.
- Conduct the case study to find the raw data to on the conditions and the outcomes.
- Apply QCA to identify the threshold range on the conditions and the outcomes, and assign coded values to the conditions and outcomes.
- Apply QCA to analyze the conditions leading to an outcome, and minimize the conditions, and analyze any variance.

Identify Conditions of IT Project Selection Leading to an Outcome

Existing literature is reviewed to identify the following conditions and the outcomes of the IT project selection in the university.

1. Condition alignment. The degree to which an IT project aligns with the university's strategic objectives is considered as a condition in selecting an IT project. The IT project selected in the university is expected to align with the university's strategic objectives.

Table 13. Alignment with strategic objectives

Findings from Literature	Source
Select IT project which is aligned with the strategic objectives of the organization.	Weill & Ross 2004, ITGI, 2003, Grembergen& De Haes, 2005
IT projects in the university is expected to align with the strategic objectives of the university, which are teaching, research and administration.	ECAR, 2008, Albrecht &Pirani, 2004
A survey of over 100 Chief Information Officer (CIO)s of the universities in the USA noted that aligning IT with university's strategic objectives is a key consideration.	Creasey, 2008
IT functions in the university are expected to align with university strategy to meet the defined university goals and objectives	Washington University in St. Louis, 2018
The IT initiatives in the university aligns with the university's strategic plan and the business priorities	Northwestern University, 2018

2. Condition value. The value adds of an IT project is considered as a condition in selecting the project. The IT project selected is expected to deliver the expected value.

Table 14. Value add

Findings from Literature	Source
Select IT project which realizes the expected value.	Weill & Ross 2004b, ITGI, 2003, Grembergen& De Haes, 2005
IT projects are expected to provide the business value-add.	Spremic, Žmirak&Kraljevic, 2008
Value delivery for the IT projects means ensuring the economic and benefits values are realized	Washington University in St. Louis, 2018
IT projects are expected to maximize the the value provided to the stakeholders.	The University of Queensland, Australia, 2018

3. Condition urgency. The level of urgency of a project is considered as a condition in selecting the IT project in a university. The IT project selected in the university is based on its level of urgency. The urgency for executing a project in the university may arise because of the lack of compliance, potential leakage of proprietary information and private data, and IT threat related to vulnerability and unauthorized access.

Table15. Urgency level

Findings from Literature	Source
Select the project to manage the risk, the project is expected to realize the IT opportunities and mitigate the risks.	Weill & Ross 2004b, ITGI, 2003, Grembergen& De Haes, 2005
IT project investments should include risk management.	Denna, 2014
IT risks are examined and IT projects are selected to ensure the security objectives across the IT enterprise and to implement the protective measures	Washington University in St. Louis, 2015
Compliance and IT risk are identified and IT projects are initiated to mitigate them.	The University of Queensland, Australia, 2018

4. Condition budget. The budget of a project is considered as a condition in selecting an IT project in the university. The universities have a limited IT budget. The cost of the IT project and how to fund the project need to be addressed for selecting the project. The cost is incurred in building the IT system in-house, procuring a product, and the overall life-cycle cost, including the maintenance and upgrade.

Table 16. IT fund constraint

Findings from Literature	Source
The university's IT budget was not sufficient to meet the IT requests. The demand for the IT products and services in the university is increasing, while the IT funding is not.	Hilton, 2009, Gosenheimer, 2012
An IT budget cut of USD 24 million kept the student email and HR function IT projects on hold in the University of Illinois.	Hettinger, 2015
Funding the IT continues to be one of the top ten issues in the university.	Dewey &DeBlois, 2006

International Journal of Business and Applied Social Science (IJBASS)

VOL: 4, ISSUE: 8
August 2018
http://ijbassnet.com/
E-ISSN: 2469-6501

5. Outcome conflict. The level of conflict faced selecting an IT project is considered as an outcome. Because the IT fund is limited, conflicts arise in deciding which IT project to prioritize, select, and fund. The IT decision in the university may be influenced by the autonomous departments, and the centralized unit, whose interests and priorities may vary (McCredie, 2006). A high performance computing project may benefit the college of engineering, while a genomic research may benefit the college of science. While both these projects are aligned with the university's strategic objective of strengthening research, they benefit different groups of stakeholders. It is difficult to select the IT projects in the university, as the project objectives and the benefits differ (Clark, 2005, Gosenheimer, 2012). The conflict between the decision makers may improve the quality of the decision making (Schwenk 1990, Tjosvold 2008). But at the same time, the conflict may have a complex effect in the decision making, and may be harmful and aversive in the organizational decision making (Schwenk 1990).

Raw Data Collection

For the cases studied, collect the data on the conditions and the outcomes. If ordinal scale is used as a measure, then the data value is assigned based on substantive knowledge of the case study researcher, and the subject matter expert.

Condition alignment. A value can be assigned to the degree alignment based on an ordinal scale of lower, and higher. It is possible to assign the degree of alignment to low, medium and high; but for the sake of simplicity, the values of lower and higher are chosen.

Condition value. The value adds of the IT project is equated in monetary amount.

Condition risk. A value can be assigned to the level of risk addressed by the IT project, based on an ordinal scale of lower and higher. It is possible to assign the level of risk to low, medium and high; but for the sake of simplicity, the values of lower and higher are chosen.

Condition budget. The monetary amount needed to execute the IT project.

Outcome conflict. A value can be assigned to the level of conflict faced in selecting the IT project based on an ordinal scale of lower, and higher. It is possible to assign the level of conflict to low, medium and high; but for the sake of simplicity the values of lower and higher are chosen.

In this hypothetical example, a total of eight cases (Case1, Case2, Case3, Case4, Case5, Case6, Case7 and Case8) are shown. Each case has four conditions and one outcome. The hypothetical raw data is shown below.

Table 17. Raw data on conditions and outcome

	Conditions					**Outcome**
Case Study Number	Alignment	Value	Urgency	Budget		Conflict
Case1	Lower	$100,000	Lower	$225,000		
Case2	Higher	$90,000	Lower	$180,000		
Case3	Lower	$200,000	Lower	$275,000		
Case4	Lower	$150,000	Higher	$250,000		
Case5	Lower	$125,000	Lower	$350,000		Higher
Case6	Higher	$250,000	Higher	$410,000		Higher
Case7	Lower	$275,000	Higher	$425,000		Higher
Case8	Lower	$135,000	Higher	$380,000		Higher

QCA Coding

In this hypothetical example with eight cases, the QCA coded values are assigned to each condition and outcome of the case, based on the threshold ranges of each condition and the outcome.

Condition alignment. The coded value chosen are 0 for lower alignment and 1 for higher alignment. It was possible to choose the value of 0 for low alignment, 1 for medium alignment, and 2 for high alignment; but for the sake of simplicity of this example, the coded values are restricted to 0 and 1 only.

Condition value. For the threshold range of $150,000 or lower, the coded value chosen is 0. For the threshold range of higher than $150,000, the coded value chosen is 1. It was possible to choose the value of 0 for

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low threshold range, 1 for medium value, and 2 for high value; but for the sake of simplicity of this example, the coded values are restricted to 0 and 1 only.

Condition urgency. The coded value chosen are 0 for lower urgency and 1 for higher urgency. It was possible to choose the value of 0 for low urgency, 1 for medium urgency, and 2 for high urgency; but for the sake of simplicity of this example, the coded values are restricted to 0 and 1 only.

Condition budget. For the threshold range of $275,000 or lower, the coded value chosen is 0. For the threshold range of higher than $275,000, the coded value chosen is 1. It was possible to choose the value of 0 for low budget, 1 for medium budget, and 2 for high value; but for the sake of simplicity of this example, the coded values are restricted to 0 and 1 only.

Outcome conflict. The coded value chosen are 0 for lower conflict and 1 for higher conflict. It was possible to choose the value of 0 for low conflict, 1 for medium conflict, and 2 for high conflict; but for the sake of simplicity of this example, the coded values are restricted to 0 and 1 only.

Table 18. Coded value on conditions and outcome

	Conditions					**Outcome**
Case Study Number	Alignment (A)	Value (V)	Urgency (U)	Budget (B)		Conflict (C)
Case1	0	0	0	0		0
Case2	1	0	0	0		0
Case3	0	1	0	0		0
Case4	0	0	1	0		0
Case5	0	0	0	1		1
Case6	1	1	1	1		1
Case7	0	1	1	1		1
Case8	0	0	1	1		1

A visual inspection of the coded values of the cases studied suffices the validity test. The eight cases sufficiently show that the conditions varied between the cases and the cases are diverse. Reliability is ensured by choosing the same threshold range for a given condition.

Analyzing Outcome of Conflict

In the example above, the conditions leading to high conflict are studied.

A{0}* V {0} * U{0} * B{1} => C{1} [Case5]
A{1}* V {1} * U{1} * B{1} => C{1} [Case6]
A{0}* V {1} * U{1} * B{1} => C{1} [Case7]
A{0}* V {0} * U{1} * B{1} => C{1} [Case8]

The above conditions can be minimized as B{1} => C{1} meaning higher budget leads to a higher level of conflict in the decision making. This might be appropriate, as the universities have a limited IT fund it is a challenge to decide which project to fund. Especially if the funding requirement of an IT project is higher, other IT projects may have to wait.

It is also observed that the projects with a higher level of urgency have still faced a higher level of conflict, as found in the Case6, Case7, and Case8. The value add of the projects were higher in the Case6 and Case7 and they still faced a higher level of conflict. The level of alignment was higher in Case6 and it still faced a higher level of conflict. The possible reason is still the higher fund requirement, which resulted in a higher level of conflict in decision making.

Limitations

The number of cases studied may not may not exhibit all the possible unique combinations, leading to an outcome. A new case could be included but the new case may not exhibit the missing combination(s). Because of various constraints, the number of cases to be studied is limited. In the absence of all the possible combinations, QCA is conducted based on the known combinations.

The QCA is dependent on the threshold determined by the researcher. If the researcher chose a different threshold range for the value of the condition and the outcome, the result obtained might have differed. To safeguard against it, the threshold ranges are chosen based on the substantive knowledge of the researcher, subject matter expert and the findings from the existing literature.

In this hypothetical example, the values of 0 and 1 are chosen as the QCA coded value. A more granular QCA coded value set such as {0, 1, 2}, or {0, 1, 2, 3}, or {0, 1, 2, 3, 4} were not assigned because the number of cases was low. The data obtained from the cases to be studied may not always support the higher granularity of the coded values.

For the same combination of the conditions, it is possible to have different outcomes. That would infer that an additional condition, which was not initially included in the QCA, might have influenced the outcome. In that case, the research could be expanded to study the missing condition.

Future Research

Using the methodology demonstrated, research can be conducted to study the conditions and the outcomes various areas of IT decision making and IT project in the university.

1. Centralized and Decentralized IT Decision Making in University

Future research can be conducted on the conditions and outcomes of the centralized and decentralized IT decision making in the university. IT projects in the university could be selected in a centralized manner, or in a decentralized manner. In a centralized decision making, IT decision is made by the centralized unit in the university. In a decentralized decision making, an individual unit or a college makes the decision in a silo, without involving the other units. The shared IT services are provided by the centralized IT, and the unique IT projects are executed by the different colleges in a decentralized manner (Salle, 2004, McCredie, 2006, Jaafar & Jordan, 2011). The centralized IT gives the decision rights to a central organization while the decentralized IT gives the decision rights to the individual business units (Olson &Chervany, 1980, Sambamurthy &Zmud, 1999, Xue et al., 2008). Often the centralized IT and decentralized IT worked within a silo in the university (Albrecht &Pirani, 2004).

2. University-Wide IT Awareness

Future research can be conducted on the conditions and outcomes of the IT project selection decision, based on the level of awareness of university-wide IT need. Many senior leaders in the university are not aware of the IT opportunities and risks, and the university-wide IT needs. At The University of Minnesota, it was difficult to build a consensus on campus-wide IT priority, as university leaders had a varied understanding of university-wide IT need (Kvavik, 2004). At Indiana University, the enterprise goals of the university were unclear, and leadership lacked interest in IT (Golden, Holland &Yanosky, 2007).

3. IT Decision under IT Governance Committee Structure

Future research can be conducted on the conditions and the outcomes of the IT decision making in the university under the IT governance committee structure. The universities form IT governance committees to make decisions to support the teaching, research, administrative, and core IT needs (University of Texas, Austin ITG, 2014, University of Maryland, 2014). The universities depend on the IT committees to make the strategic IT decisions (Bowen, Cheung & Rohde, 2007). The input and decision rights, such as who makes the decision, who provides the input to the decision, who settles the disputes need to be clearly defined under the IT governance committee structure(ITGI, 2003, Weill & Ross, 2004, p.10). The IT decision rights, roles, and responsibilities of the IT committee members need to be clearly defined (Grembergen& De Haes, 2004).

4. IT Project Performance in University

Future research can be conducted on the conditions of IT project performance in university and its outcome. A survey of over one hundred CIOs of the universities in the USA indicated that it is important to set the project performance criteria (Creasey, 2008). Project performance is measured by the cost and time savings, improved security, modernization, efficiency, and customer satisfaction (Price Water House Cooper, 2006). Clark (2005) suggested that the IT project performance measures for the universities are how well the IT services and projects meeting the quality standards, and the end user expectations. The presence of Project Management Office (PMO), project management maturity may influence the project success in the university. The project success may vary depending on whether it was executed in a centralized or decentralized manner. These could be the areas of research which can be conducted using QCA as the research methodology to study the conditions and the outcomes.

Conclusion

This article demonstrates a research methodology on the IT project selection in university using multi-case study and QCA. The theoretical background of case study

VOL: 4, ISSUE: 8
August 2018
http://ijbassnet.com/
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research and QCA is discussed. A hypothetical example is used to demonstrate the research methodology and research protocol. It shows how QCA could be used to compliment the multi-case studies to analyze how certain conditions influence an outcome in the IT project selection in the university. The areas of potential future research using this methodology are also discussed.

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VOL: 4, ISSUE: 8
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VOL: 4, ISSUE: 8
August 2018
http://ijbassnet.com/
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