Assessing the Impact of Digital Procurement via Mobile Phone on the Agribusiness of Rural Bangladesh: A Decision-analytic Approach

Md. Mahbubul Alam · Christian Wagner

Abstract The research assesses the impact of a digital procurement (e-purjee) system for sugarcane growers in Bangladesh. The system itself is simple, transmitting purchase orders to local farmers via SMS text notification. It replaces a traditional paper-based system fraught with low reliability and delivery delays. Applying expected value theory, and using decision tree representations to depict growers' decision-making complexity in an information-asymmetric environment, we compute outcomes for the strategies and sub-strategies of ICT vs. traditional paper-based order management from the sugarcane growers' perspective. The study results show that the digital procurement system outperforms the paper-based system by tangibly reducing growers' economic losses. The digital system also appears to benefit growers non-monetarily, because of reduced uncertainty and a higher level of perceived fairness. Sugarcane growers appear to value the non-monetary benefits even higher than the economic advantages of the e-purjee system.

Keywords Information and communication technology (ICT), decision analysis, decision tree, digital procurement system, mobile phone

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1 Introduction

Information and Communication Technologies (ICTs) are now widely used as a tool for national and regional development (Cook, 2005; Dada, 2006). The availability of low cost computing, in the form of mobile phones and similar devices providing web access, creates opportunities even for less developed regions. However, the success rate of ICT-led development projects has been less than satisfactory (Heeks, 2003) in both developing and developed countries. Frequently the provision of technology without well identified project objectives, and without change management leads to slow adoption, reduced benefits, and ultimately project failure. The fact that most ICT-based projects are donor-funded and jointly operated with the concerned department of local government may not help, if projects are development-focused rather than business-oriented. As a result, many projects run on a pilot basis but may not be fully functionalized and sustained due to subsequent unavailability of funds (beyond project duration), lack of commitment, or waning political support (Avgerou, 2008, p.137). The success of such projects may be further compromised when a donor-aid based project adapts too little to the contextual factors of the recipient region's environment, such as local technological capabilities (Odedra-Straub, 1993), human resources capacity (Avgerou, 2008), or local practices (Bada, 2002; Avgerou, 2002). Frequently also, there is a challenge in measuring the success or evaluate the contribution of ICTs to the development process, especially if project objectives are not well defined and the details of existing and new processes are not fully mapped out.

Consequently, the purpose of this article is to explain and apply a method by which to determine the economic value of an ICT-led development project for its users (the sugarcane growers), using expected value theory combined with decision tree analysis. The underlying assumption is that sustained success can only be achieved, if the new system creates significant (typically monetary) benefits, which

convince users to change past habits and adopt the processes associated with the new system. To do so, we depict the strategies of decision makers under the old, paper-based and the new ICT-based system, identify best strategies, and determine the economic value of system adoption for individual decision makers. The project we analyzed is a mobile-based e-Government initiative in Bangladesh's agribusiness, namely the Digital Procurement System for Sugarcane popularly known as the 'e-purjee' (purjee = purchase order ticket) system. In performing the analysis, we sought to illustrate the measurability of project success, while also shedding light on the need to understand the impact on user processes, which effect user decision making strategies, and ultimately project outcomes.

1.1 Agribusiness and ICT in Bangladesh

Governments in developing countries have been keen to implement an IT-based service delivery model, with the expectation of significant economic and societal benefits (Dada, 2006). In the process of building a 'Digital Bangladesh' by 2021, the Office of the Prime Minister of Bangladesh Government together with the United Nations Development Programme (UNDP) initiated an 'Access to Information (A2I)' program. Both institutions have been working together to implement ICT-based services in different sectors prioritizing agribusiness, local government, and education. Initially most of the projects were web-based. However, the lack of success of web-based services such as the Agricultural Market Information Systems (AIMS) together with low IT literacy and IT infrastructure, brought a shift in focus. In consideration of the high mobile phone subscription rate, the Government launched mobile-based services to introduce ICT-based services to potential users in rural Bangladesh. Among the services, a digital procurement system for sugarcane became one of the prime initiatives, jointly operated by Bangladesh Food and Sugar Industries Corporation (BSFIC) and the 'Access to Information (A2I)' program. The digital procurement system (e-purjee system) sends SMS-based purchase orders from sugar mills to sugarcane growers during crushing season. It replaces a paper-based system, where the same purchase orders are delivered by a courier to rural communities and distributed there manually to local growers. The new system was intended to reduce uncertainty in the flow of raw materials to sugar mills, allow faster, less costly, and more reliable purchase order delivery, and ensure transparency. It was thus expected to minimize economic losses and physical hazards in the selling and crushing of sugarcane. The system was first launched in 2009 in two sugar mills on a pilot basis. After successful accomplishment of the pilot phase the project was extended to all of Bangladesh's sugar mills in 2010.

1.2 Digital versus Paper-based Procurement of Sugarcane by Bangladesh Sugar Mills

In the digital procurement system, purchase orders are sent to sugarcane growers via SMS. These purchase orders represent permits to supply a specific amount of raw sugarcane to a mill at a predefined date. To ensure stable raw materials flows, the sugar mill authority maintains a roster of growers. The sugar mill authority collects and uploads the contact and farming information of growers in its system, and issues digital purjees to growers in a system that maintains a stable flow of quality raw materials while also taking into account the delivery capacity of individual growers (smaller growers receive fewer purjees). The SMS (e-purjee) retains detailed purchase information such as quantity (weight in Kilograms) of raw sugarcane, name of the sale center, delivery date and time. Generally, one purjee is issued for each 1200 kg cane to be supplied. Growers either need to have a cell phone or may register a relative's or neighbor's phone. E-purjees are sent with relatively little lead time, about three to four days prior to delivery, typically just 1-2 days longer than the time required to harvest the canes, load them, and deliver them to the mill.

In the traditional system, a paper purjee was sent to growers, by "hand-to-hand" delivery or via traveling couriers, called Cane Development Assistants (CDAs). Growers often had to visit the nearest sales center to collecting their purjees due to a shortage of CDAs. Moreover, the system had several levels of uncertainty. Purjees took longer time to reach to the growers and frequently arrived only a day or two before delivery was due. Sometimes the permit was lost, while at other times a permit would reach a non-eligible grower instead, since purjees did not contain growers' names. These uncertainties affected growers economically, requiring them to rush the harvesting and delivery to the mills, or to harvest prior to receiving a ticket and face possible loss or shrinkage of their crop. The uncertainties also affected mills due to quality deterioration of harvested sugarcane, or operation below scheduled capacity.

1.3 Research Questions

According to stakeholder testimony, the digital procurement system (e-purjee) has brought benefits both for the supply-side (growers) and the demand-side (sugar mills). The sugar mill authorities also obtained benefits by ensuring a steady flow of quality raw materials during the crushing period, improving inventory management and enabling direct communication with the growers. Most importantly, the e-purjee system enabled sugar mills to crush the sugarcane frequently within 24 hours of harvesting. This, according to news reports resulted in a 7.5 percent increased in sugar recovery rate for the mills (The NewsToday, 2011). To

explain the adoption of the e-purjee system, however, we must look at the supply side, namely the economic and possibly non-economic benefits (e.g., transparency) that would convince local growers to switch from the traditional system to e-purjees. After all, if benefits only accrued to sugar mills, but not to cane growers, why should they switch to the new system? To understand these benefits, the study formulates two research questions concerning the impact of digital procurement on Bangladesh sugarcane growers.

1. Does the e-purjee system provide economic benefits to growers, and at what level?
2. Does the e-purjee system provide other, non-economic benefits to growers, which also would support the decision to adopt?

In the next section, the paper presents prior research on ICT-based agricultural market information systems. In Section 3, our method of investigating the research questions is described in detail, while the key findings are reported and discussed in Section 4, followed by a summary and conclusions in Section 5.

2 PRIOR RESEARCH

The exploration of prior research is divided into two subsections. The first sub-section discusses the roles of ICT in agribusiness development. The second sub-section addresses methodological approaches used in prior research to assess the economic impact of ICT-based initiatives in developing economies.

2.1 ICT and Agricultural Market Information

With the improvement of telecommunication technology and particularly the increase in mobile phone subscriptions of developing countries, new potentialities emerged in the sector of rural development. ICT-based services, including those delivered via mobile phone, can aid greatly in economic growth and good governance and thus, in development process by improving efficiency, effectiveness, equity and reach (Hudson, 2006, p.12). Ubiquity and convergence are the key attributes of mobile technology that not only lead to better communication but also create opportunities in exchanging farming information among different stakeholders in a timely manner. With the existence of a digital divide, farmers without connectivity are more likely deprived of access to pricing information across markets, or deprived from the receipt of time sensitive farming information (e.g. weather conditions, or pest or farm management advisories), resulting in reduced crop yields, lower selling prices and reduced income (Lwoga, 2010, p. 3). A summary of research concerning agriculture market information via ICT and its impact in developing countries is presented in Table 1.

The impact of users' access to information on economic growth and development, and thus on poverty reduction has already been well documented in past studies (Salia et al., 2011). ICT-based solutions, and particularly mobile phone applications can bring about positive social changes. Adoption of mobile phones by the fishermen in Kerala, India and the exchange of pricing information with traders increased market efficiency by reducing wastage 6%, reducing cross-market price dispersion, and increased fishermen's profits by 8%, while decreasing customer prices by 4% (Jensen, 2007). A study conducted in Niger found cell phones to reduce grain price dispersion across markets by a minimum of 6.4% and to decrease intra-annual price variation by 12% (Aker, 2008). Elsewhere, Muto & Yamano (2009) documented that expansion of mobile phone coverage increased small-scale farmers' participation in local markets. While many of these solutions only show single-digit efficiency gains for any stakeholder group, such an economic benefit, combined with intangibles, such as the removal of market inequalities, appears to provide sufficient incentive for the adoption of ICT and its sustained use.

Efficient communication on pricing in alternative market outlets and on market demand enables farmers to respond to market opportunities (Muto & Yamano, 2009; Labonne & Chase, 2009) and to choose marketing channels from various alternatives, thereby positively influencing selling intensity (Chowdhury, 2002). Small-scale farmers traditionally depend more on intermediaries than on direct sales to buyers. In intermediary-based supply chains, farmers share the transaction surplus with intermediaries and are often deprived of fair pricing. While intermediaries in the supply chain of developed economics serve to overcome transaction costs (i.e. negotiation cost), they tend to be economically counter-productive to small-scale farmers of developing countries (Chowdhury, 2002, p.2). ICT-led pricing information can replace the intermediaries and build a better linkage between sellers and buyers. In addition to reducing negotiation costs and ensuring fair price distribution across markets, ICT can assist in significantly lowering information search costs, which typically account for a major portion of transaction costs. Research shows that information search costs represent 11 percent of farmers' total costs and up to 70 percent of their transaction costs (Silva & Ratnadiwakara, 2008). Information asymmetry can also lead to higher transaction cost, namely by increasing farmers' information search costs and by forcing farmers sell more to intermediaries (Chowdhury, 2002). Hence, the reduction of information asymmetry provides considerable opportunity to improve fairness and economic benefit in developing economies (Muto & Yamano, 2009). Consequently, many ICT-based projects have been launched to reduce information costs, overcome information asymmetry, and to ensure

more transparency in the supply chain. Examples include Xam Marse ("Know Your Market") of Senegal, CAMIS of Cambodia, Farmprice of Zambia, KACE-MILS of Kenya, TradeNet of Ghana, FoodNet of Uganda, RESIMAO/ WAMISNet of Wet Africa and AMIS in Bangladesh (Islam & Alawadhi, 2008). Still, many of these projects face sustainability problems because they have neither generated broader economic and societal changes (Pade, et.al., 2006) nor sufficiently lowered the access barriers of their intended users (Kaaya, 2006; Chipchase, 2007; Islam & Alawadhi, 2008). One such project is the web-based Agricultural Market Information Service (AMIS) in Bangladesh, which neither satisfied farmers' informational needs nor sufficiently lowered users' access barriers (Islam & Grönlund, 2007). Aside from lack of economic benefits and missed participation targets, non-persistence or delayed funding (Islam & Grönlund, 2010b), as well as waning political support and funding discontinuation (Avgerou, 2008) are the root causes of IS-projects failure in developing countries. Even after the successful initial launch, many projects face scalability problems, either while waiting for a new funding source or while continuing as part of regular function of the concerned ministry (e.g., AMIS of Bangladesh, Myanmar, Mozambique) (Islam & Grönlund, 2010b). Since achievement of project goals is a major driver for funding, and funding is a major factor for project continuation, assessment or project success is essential to achieving long-term viability.

Table 1 ICTs impact on agricultural market information dissemination in developing countries

Authors	Context	Method	Findings
Islam and Grönlund, 2007	Web based Agricultural Market Information Service (AMIS), Bangladesh	Stakeholder analysis, design-reality gap analysis	A gap in technology use and access, plus failure to address stakeholder needs and preferences resulted in a lack of project success and sustainability.
Islam and Grönlund, 2010a	Mobile based Agricultural Market Information Service (AMIS), Bangladesh	Users-Technology-Process-Facility	Effectiveness of an e-service depends on the design and delivery of the service in accordance with individual information needs.
Jensen, 2007	Mobile phone impact on market performance of fishermen, India	Econometric analysis	Adoption of mobile phones by the fishermen reduces price dispersion.
Aker, 2008	Cell phone impact on grain market, Niger	Econometric analysis	Cell phone minimizes the price dispersion between different markets by reducing the search cost, thus improving fishermen, consumer, and trader welfare.
Muto and Yamano, 2009	Mobile phone coverage and market participation, Uganda	Econometric analysis	Expansion of mobile phone coverage increases market participation.
Silva and Ratnadiwakara, 2008	ICTs and transaction cost of vegetables growers, Sri Lanka	Measuring information cost	ICTs reduce transaction cost through reducing the information search cost.

2.2 Methodological Approach of ICT-based Projects Evaluation

The major concern of ICT-led projects in developing countries long term viability, or correspondingly, high failure rate. Prior research has paid considerable attention to success and failure evaluation, however the ICT-for-development (ICT4D) literature still lacks holistic evaluation frameworks for project development and management (Alshaawi & Alalwany, 2009). ICT4D and mainstream IS research are similar in some points, yet the issues and questions in ICT4D research are often quite different (Avgerou, 2008). ICT4D projects are more development focused (non-business). Their success evaluation thus requires consideration of multiple dimensions, including social, culture, economic and technical issues (Symons & Walsham, 1988), plus multiple stakeholder views (Davison et al., 2000). Hence, prior studies which often discussed success or failure from an IS design and implementation perspective—focusing on professional knowledge and practice—often overlooked the actual conditions of organizational practice in developing countries (Heeks, 2002, Avgerou, 2008). Table 2 summaries some of the prior studies on evaluation approaches of ICT4D projects in developing countries.

Among the proposed frameworks, Heeks' (2002, 2003) 'Design-Reality' framework is achieving wider acceptance among the ICT4D research community. It states that the reason of ICT4D failures in developing countries is the mismatch (gap) between the current reality and the system design and that the chance of failure increases as the gap grows (Dada, 2006, p.4). However, Heeks as well as other authors (Table 2) adopt a subjective ontological approach and lack the users-centralism needed to explore the impact of ICT4D projects on users' lives. By ignoring the user perspective, analysis frameworks are in danger to overlook a key driver of project success, namely adoption by users. User adoption however will be largely driven by economic and non-economic benefits, weighed against the effort required to make a change to the new system. Therefore, for our assessment of the e-purjee system versus the traditional paper-based purjee system, we adopted an alternative approach that would consider the sugarcane growers' decision situation, strategies, and economic as well as non-economic benefits. We analyzed e-purjee adoption using expected value theory together with a decision tree formulation, thereby examining whether the growers' decision to adopt the new system would bring positive changes in their individual situation.

Table 2 Summary of evaluation approaches in ICT4D research (adapted from Islam & Grönlund, 2010a)

Authors	Key aspects	Measuring dimensions
Heeks, 2003	Design-reality gap	Information-Technology-Process-Objectives & values-Staffing & Skills-Management-Resource (ITPOSMO model)
Alshawi& Alalwany, 2009	System and technology	Technical-Economic-Social
Horan et al.,2006	Usage	Utility-Reliability-Efficiency-Customization-Flexibility
Papadomichelaki, et.al., 2006	Usage and management	Service-contents-system-organization
Young, et.al, 1997	System and technology	Development-Management
Madon, 2004	Users' capabilities (interpretive approach)	ICT application-functionality-opportunity-accessibility

3 DECISION MAKING UNDER UNCERTAINTY AND DECISION TREES

When making decisions under uncertainty an individual is required to choose an action from multiple alternatives, not knowing what events might occur and what the corresponding outcome will be. Decision analysis is a quantitative approach to decision making. It enables people to make better choices under uncertainty, by helping them determine the probabilistic outcomes of different alternatives to enable choices leading to the best possible outcome. Outcomes can be measured for instance according to their expected value (Fishbein, 1968), assuming a highly rational stance, or according to their expected utility, which considers risk propensities and diminishing marginal benefits. Expectancy Value Theory calculates outcome values by weighing the outcome value under certainty, with the probability of the outcome's occurrence.

Decision trees are an analytical tool that can support and leverage expected value calculations by logically and systematically presenting a decision problem with multiple sequential decisions and multiple events affecting decision outcomes. A decision problem is depicted via decision nodes (rectangular boxes), event nodes (circles), and branches (lines) within the tree (Fig. 1). In Fig. 1 for instance, Decision 1 has two options, leading to either Event A or B. Event A has two possible outcomes, Outcome 1, or Event C, which then results in either Outcome 2 or 3. Decisions are exclusive so that only one option can be selected at each decision node. Nonetheless, sometimes branches emanating from decision nodes can lead to other decision nodes. An event node should represent all possible outcomes at that junction. Each of the possible outcomes of the event is represented as a line emanating from the event node. Each outcome is assigned a probability and a value, or a present value if the calculation takes into account discounting of value over time (as is the case in harvesting, where product quality and thus value can quickly deteriorate).

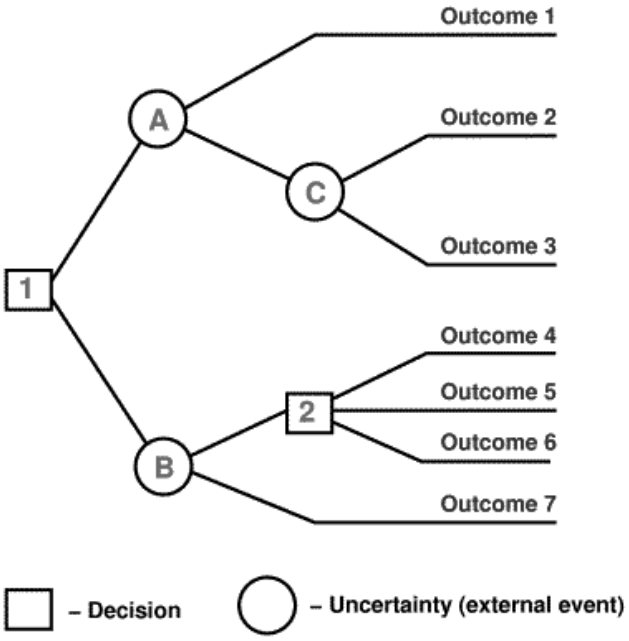

Fig. 1 A simple decision tree showing nodes and branches

To calculate the Expected Monetary Value (EMV) of each decision, a numeric value is assigned to each outcome branch of the decision tree. Finally, the EMV of an event is weighted average of all possible numeric outcomes, with the probabilities of each of the possible outcomes used as the weights. The formula for EMV (Schuyler, 1996) is:

$$EMV(x) = \sum [PV(x) \times P(x)]$$

Where,

- x – possible outcome
- PV(x) – present value of outcome x
- p(x) – likelihood of outcome x

To evaluate a decision tree (manually), the tree is 'folded back'. All branches emanating from the same node are combined and their values aggregated (via the EMV formula), working backwards from nodes closest to the outcomes. The process continues until it reaches the original decision node. In case of a decision node, the expected value is computed for each branch and the highest (EMV) value is chosen for further consideration.

4 APPLICATION TO THE E-PURJEE PROBLEM AND DISCUSSION

To capture the e-purjee decision problem in a decision tree model, we first need to identify the uncertainties and possible outcomes in both paper purjee and e-purjee systems, and examine the expected value of each alternative.

During the sugarcane crushing period (November-January), growers are invited to deliver raw sugarcane stalks to the sales center twice a week with an interval of 2 to 3 days. The number of purjees in each delivery depends on the estimated production of a farm. Growers can supply 1200 kg of sugarcane with each purjee. A purjee is issued about 3 days in advance of the delivery date, allowing growers to prepare for harvest, transportation, and delivery. In the past, growers had to go to the sales center to collect their purjee, or had to wait for a Cane Development Assistant (CDA) to bring it, or hope to receive it via hand-to-hand delivery. Hand-to-hand delivery of purjees and shortage of CDAs resulted in delays and losses, with losses (or wrong allocation) occurring also due to the lack of name identification on purjees. In the purjee distribution system, three outcomes are thus identified: on-time receipt, delay (2 to 3 days), or loss of purjee ("loss"). To determine the likelihood of probabilities of each outcome we interviewed a member of management of a sugar mill in Bangladesh, responsible for purjee distribution. The manager had several years work experience in that position. Based on his experience, he provided best estimates for the probabilities of each outcome (see Table 3). A cross-check against available records suggest his estimates to be valid and reliable.

Table 3 Purjee receipt events and their likelihoods

Event	E-purjee	Paper purjee
On-time receipt	85%	45%
Delay (2 to 3 days)	10%	40%
Loss of purjee ("Loss")	5%	15%

4.1 E-purjee versus Paper-purjee: Loss in Cane Weight

Growers are paid by the weight of delivered sugarcane. The estimated price of 1200 kg (1 purjee) of sugarcane is about 3000 Bangladeshi Taka (BDT)[1] . Given the delays in the system, growers sometimes harvest their sugarcane prior to purjee receipt, anticipating receipt of purjees on a certain date. When a purjees is delayed, the delay extends the time between harvesting and crushing, causing the sugarcane to lose weight by drying out. The rate of weight loss varies depending on the temperature, humidity, sugarcane variety and other agronomical factors. Solomon (2002, p.7) estimates weight reduction rates per day as shown in Table 4. Solomon's estimates refer to India, whose climatic conditions are quite similar to those in Bangladesh. Thus we consider the estimates reliable for this study. Table 4 indicates that for a delay of 2-3 days (60 hours) in delivery, and ap-

[1] USD 1 ≈ BDT 78

proximate weight loss and thus monetary loss of 6% should be expected.

Table 4 Sugarcane weight loss due to time lag between harvesting and milling (Solomon, 2002)

Duration (hrs.)	Weight loss (%)
24	2.72
48	4.54
72	7.27
96	12.72

In the decision tree, we added additional events and decisions that occur when purjees are delayed or lost (see Fig. 2). These additions were made based on interviews with four experienced sugarcane growers from two sugar mill zones, located 200km apart from each other. According to the interviewees, the practice to harvest in anticipation of receipt of a purjee was not uncommon under the volatile paper system. In case of a delayed purjee, this behavior could lead to partial (e.g., 6%) economic loss for the harvested canes, or to complete loss when the purjee was never received. To mitigate such losses, growers had the option to request a replacement purjee from the responsible Cane Development Assistant (CDA) or they could sell the harvested cane into the local market albeit at an approximate 50% discount. Table 5 summarizes payoff values.

The interviews with growers also revealed that under the e-purjee system, the reliability of purjee receipt had risen so much that growers stopped the practice of harvesting prior to receiving a purjee. At 85% on-time receipt of purjees, and only 5% lost purjees growers considered waiting for e-purjee to be the better strategy than early harvesting. A replacement rate of 90% for lost purjees further motivated this decision. The replacement rate grew from 60% for the paper based system to 90% for the e-purjee system, because the sugar mill authority tracked the success or failure of purjee distribution and thus could easily re-issue lost purjees. This change in events and resulting decision making behaviors is depicted in the decision tree in Fig. 2.

Folding back the decision tree, we observe that the highest expected value for growers is BDT 2,991 per purjee resulting from use of the e-purjee system, compared to BDT 2,886 under the paper based system.

4.2 E-purjee versus Paper-purjee: Information Seeking and Opportunity Cost

Research shows that information seeking costs represent a significant portion of total cost (Silva & Ratnadiwakara, 2008). One of the additional benefits of the e-purjee system to growers was the time saved by not having to physically visit the sales center to receive a paper purjee. Previously growers needed to visit the center at least once per week, which took time away from farming and incurred travel costs. In general, the distance between growers' farms and sales centers is approximately 5-7 kilometers. According to the interviews with growers, travel costs amount to BDT 20, while the time spent for each visit is approximately one hour. One hour of labor cost was quantified as an opportunity cost of BDT 30, resulting in total information seeking and opportunity costs of BDT 50. A loss or delay of purjees would potentially multiply these information seeking and opportunity costs, which are depicted in a second decision tree in Fig. 3.

Fig. 3 indicates that the e-purjee system significantly reduces growers information seeking and opportunity costs, with a difference of BDT 15 in favor of e-purjees. The combined benefits of reduced harvesting losses and reduced information seeking and opportunity costs suggest an aggregate economic benefit of BDT 120 per purjee for the e-purjee system, or approximately 4%. While this amount does not instantly change growers' economic conditions, it is in line with single-digit reported benefits elsewhere (e.g., Jensen, 2007) which led to adoption of ICT.

Interestingly, when interviewed, growers also expressed high appreciation in terms of the transparency in purjee distribution, the reduced graft and lessened uncertainty in farming operations (harvest and transportation), de-emphasizing the monetary benefits received from e-purjee adoption. In other words, the improved procedural fairness

Table 5 Payoff value of purjee receipt events

Outcomes	Payoff value (BDT)
On-time	3,000
Delay (2 to 3 days), resulting in 6% weight loss	3,000 × (1 – 0.06) = 2,820
Loss of purjee, harvest sold into local market ("Loss with local sale"), leading to a 50% loss in revenue	3,000 x (1 – 0.50) = 1,500
Loss of purjee ("Loss"), leading to a complete loss of the harvested canes	0

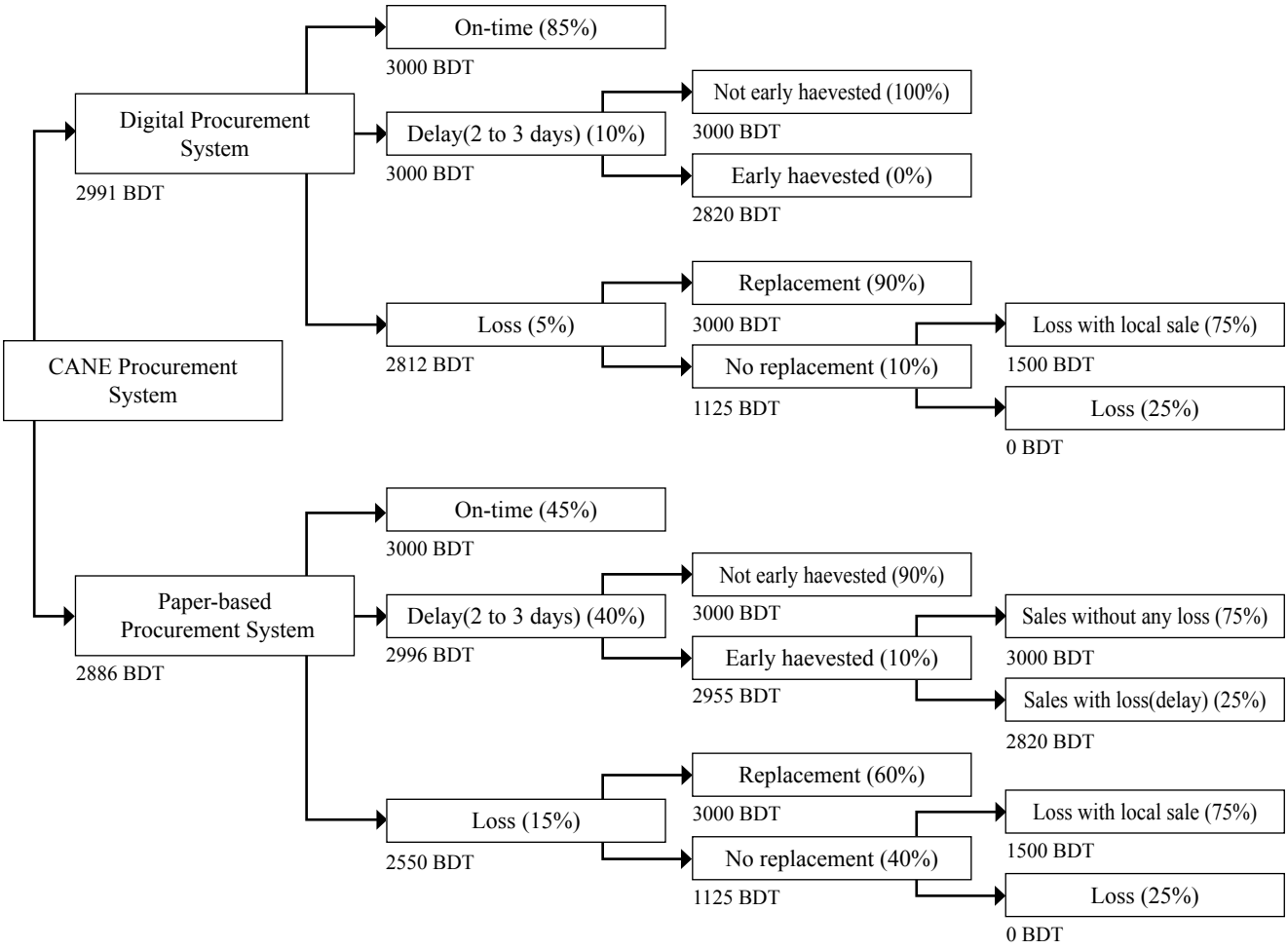

Fig. 2 Estimated economic value (based on sold cane weight) for e-purjee and paper-purjee

and reduction of uncertainty were perceived as potentially more significant than the approximate 4% monetary benefit. These results are consistent with prior research which has demonstrated the importance of procedural fairness (Erdogan, 2002) and the interest of people to reduce economic (and other) uncertainties (Lind & Tyler, 1988) for instance through the purchase of insurance. In fact, the e-purjee system may be viewed by growers as an insurance against unfair practices and against the uncertainties of the purjee ordering system.

5 SUMMARY AND CONCLUSION

Our research sought to assess the impact of a mobile phone based procurement system for sugarcane growers in rural Bangladesh. Modeling growers' decision situations under uncertainty, via an expected value and decision tree approach, we explored possible choices and calculated the expected monetary value of paper delivery versus e-delivery. The e-purjee system was found to outperform the traditional paper-based system by reducing financial losses of the growers, and by reducing information search and opportunity costs. Interviews also revealed important non-monetary benefits with respect to uncertainty reduction and increased procedural fairness.

The identified benefits of the decision situation also highlight the methodological value of a decision theoretic analysis. By exploring the entire scope of the decision problem, including for instance the need to request a replacement purjee in case of loss, and understanding the frequency of such events, planners can better assess the overall benefits derived from ICT systems for development and thus much better judge potential adoption. As we saw in the e-purjee system, whereas economic benefits were meaningful individually, additional benefits became a strong motivator for rural sugarcane growers. It should be noted that none of the benefits were highly technology dependent. The technology, at least on the user side was very simple (SMS), yet allowed to significantly change practices such as harvesting in anticipation of a not yet received purjee. This reinforces our earlier observation, that the success of development

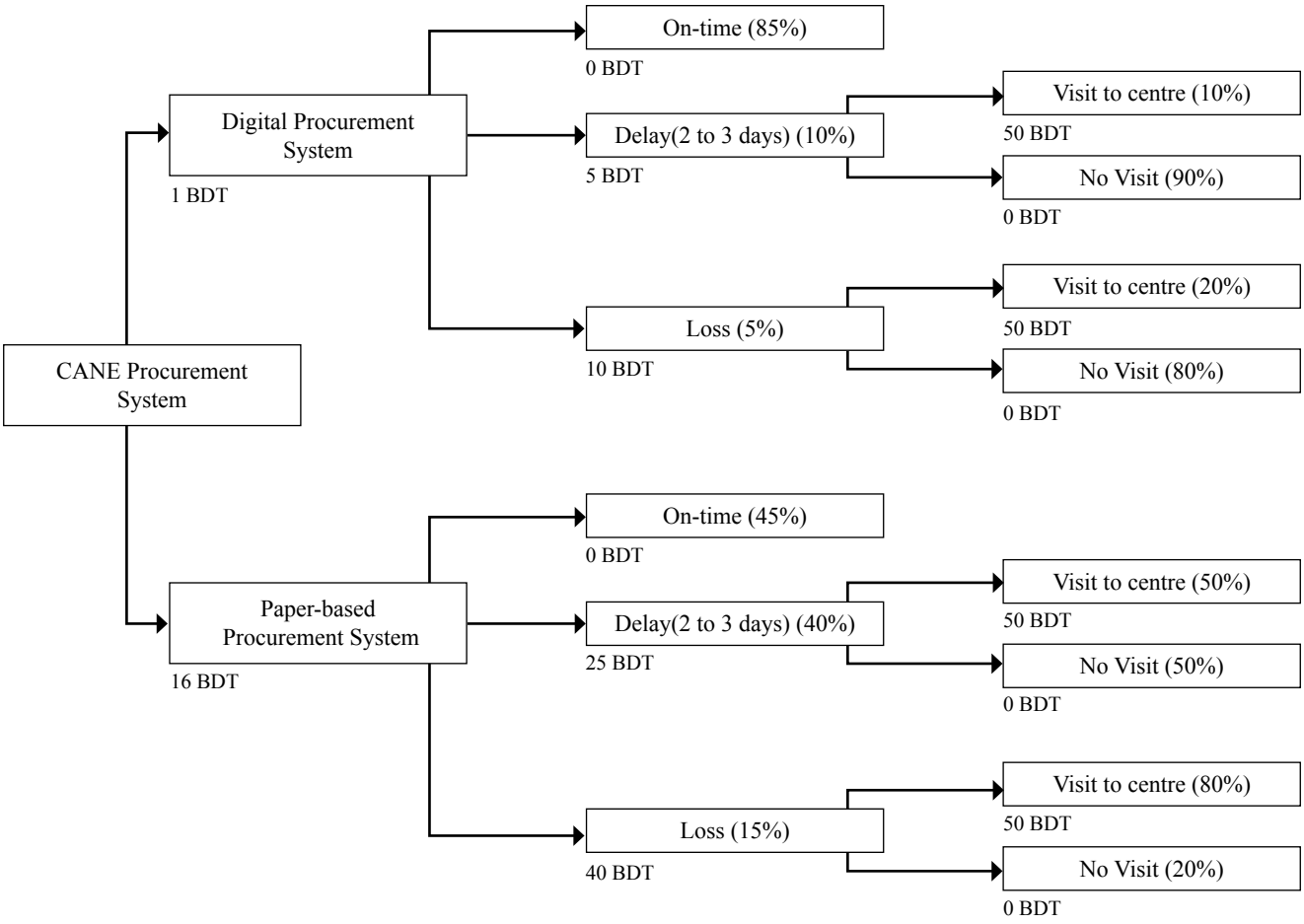

Fig. 3 Estimated economic value of information seeking and opportunity costs for e-purjee and paper purjee

oriented ICT systems may hinge on criteria quite different from those of regular IS.

Overall, we believe the findings will be useful in their policy implication for respective demand-side stakeholders such as the Bangladesh Food and Sugar Industries Corporation (BSFIC) and 'Access to Information (A2I)' programme, as well as the donor agency, UNDP, especially in light of the lack of success of an earlier web-based Agricultural Market Information System in Bangladesh. Therefore, the findings of this study may interest donor agencies and the government to promote more mobile-based initiatives in rural community development, but also to carefully analyze the impact on user decision making behaviors as demonstrated here.

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